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NBS MONOGRAPH 32 --- Part I

# Tables of Spectral-Line Intensities

Arranged by Elements



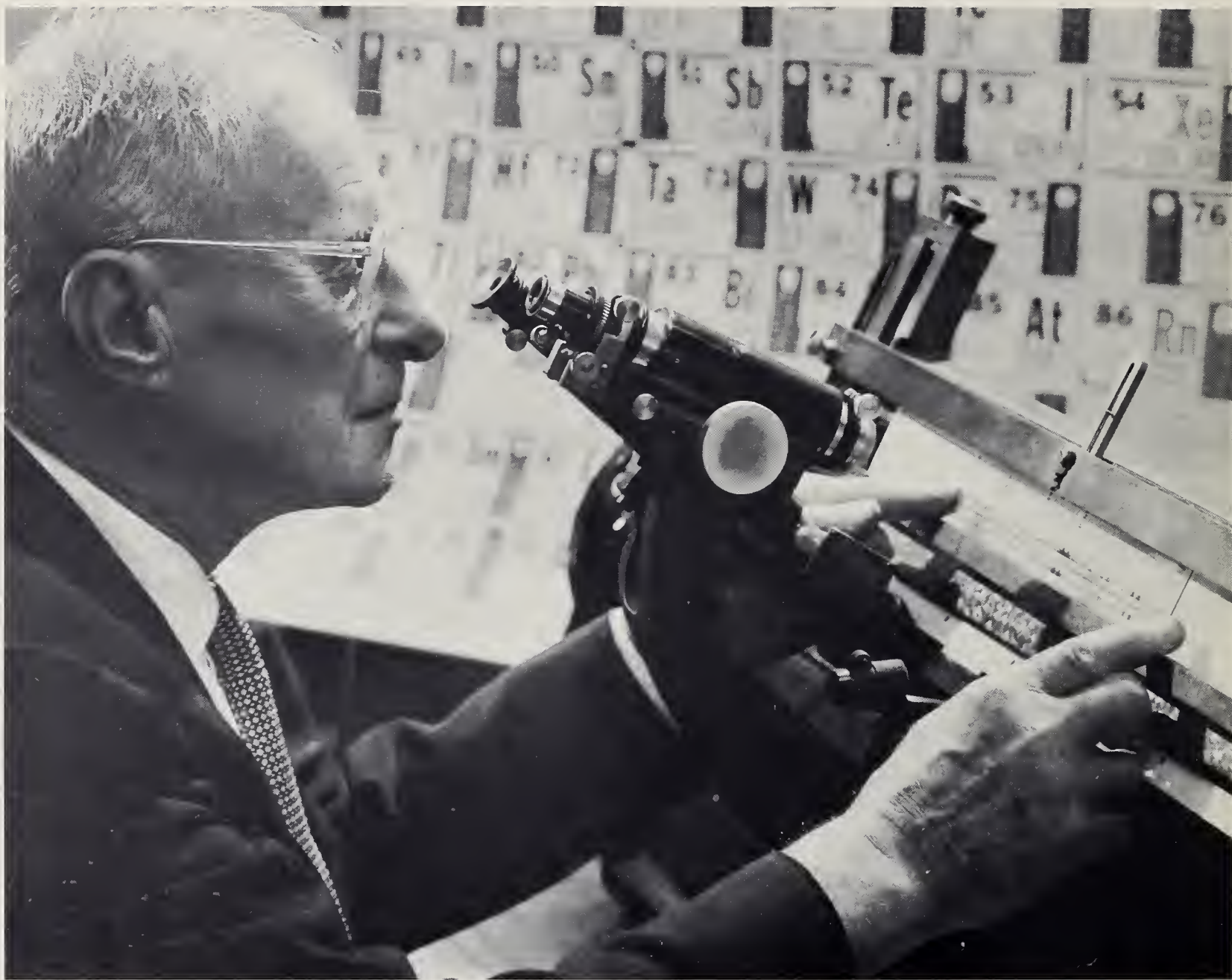
U.S. DEPARTMENT OF COMMERCE  
NATIONAL BUREAU OF STANDARDS











*W. F. Meggers prepares to measure one of the spectrograms on which these tables of spectral-line intensities are based.*

# Tables of Spectral-Line Intensities

## Part I

### Arranged by Elements

The intensity, character, wavelength, and spectrum of 39,000 lines between 2000 Å and 9000 Å observed in copper arcs containing 0.1 atomic percent of each of 70 elements.

William F. Meggers, Charles H. Corliss, and Bourdon F. Scribner.



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Chemical element	Sym- bol	Atomic number	Melting point*	Boiling point*	Page	Chemical element	Sym- bol	Atomic number	Melting point*	Boiling point*	Page
			°C	°C					°C	°C	
Aluminum	Al	13	660. 1	2450	3	Neodymium	Nd	60	1019	3180	191
Antimony	Sb	51	630. 5	1380	4	Nickel	Ni	28	1453	2730	207
Arsenic	As	33	817(28 atm)	613	5	Niobium	Nb	41	2468	4927	211
Barium	Ba	56	714	1640	6	Osmium	Os	76	2700	5500	227
Beryllium	Be	4	1277	2770	8	Palladium	Pd	46	1552	3980	239
Bismuth	Bi	83	271. 3	1560	9	Phosphorus	P	15	44. 25	280	241
Boron	B	5	2030	2550	10	Platinum	Pt	78	1769	4530	242
Cadmium	Cd	48	320. 9	765	11	Potassium	K	19	63. 7	760	245
Calcium	Ca	20	838	1440	12	Praseodymium	Pr	59	919	3020	246
Carbon	C	6	3727	4830	14	Rhenium	Re	75	3180	5900	262
Cerium	Ce	58	804	3470	14	Rhodium	Rh	45	1966	4500	273
Cesium	Cs	55	28. 7	690	42	Rubidium	Rb	37	38. 9	688	280
Chromium	Cr	24	1875	2665	43	Ruthenium	Ru	44	2500	4900	281
Cobalt	Co	27	1495	2900	53	Samarium	Sm	62	1072	1630	293
Copper	Cu	29	1083. 0	2595	61	Scandium	Sc	21	1539	2730	310
Dysprosium	Dy	66	1407	2330	62	Selenium	Se	34	217	685	315
Erbium	Er	68	1497	2630	77	Silicon	Si	14	1410	2680	316
Europium	Eu	63	826	1490	90	Silver	Ag	47	960. 80	2210	317
Gadolinium	Gd	64	1312	2730	97	Sodium	Na	11	97. 82	892	318
Gallium	Ga	31	29. 78	2237	113	Strontium	Sr	38	768	1380	319
Germanium	Ge	32	937	2830	114	Tantalum	Ta	73	2996	5425	321
Gold	Au	79	1063. 0	2970	115	Tellurium	Te	52	449. 5	990	336
Hafnium	Hf	72	2222	5400	116	Terbium	Tb	65	1356	2530	337
Holmium	Ho	67	1461	2330	125	Thallium	Tl	81	303	1457	355
Indium	In	49	156. 2	2000	136	Thorium	Th	90	1750	3850	356
Iridium	Ir	77	2454	5300	137	Thulium	Tm	69	1545	1720	380
Iron	Fe	26	1536. 5	3000	144	Tin	Sn	50	231. 91	2270	390
Lanthanum	La	57	920	3470	153	Titanium	Ti	22	1668	3260	391
Lead	Pb	82	327. 4	1725	161	Tungsten	W	74	3410	5930	402
Lithium	Li	3	180. 54	1330	162	Uranium	U	92	1132. 3	3818	416
Lutetium	Lu	71	1652	1930	163	Vanadium	V	23	1900	3400	437
Magnesium	Mg	12	650	1107	167	Ytterbium	Yb	70	824	1530	449
Manganese	Mn	25	1245	2150	168	Yttrium	Y	39	1509	3030	455
Mercury	Hg	80	-38. 36	357	173	Zinc	Zn	30	419. 50	906	461
Molybdenum	Mo	42	2610	5560	174	Zirconium	Zr	40	1852	3580	462

\*Melting points and boiling points are quoted from *Metals Handbook*, 8th Edition, Vol. 1, pp. 46-47, Cleveland, Ohio, 1961.



# Tables of Spectral-Line Intensities

William F. Meggers, Charles H. Corliss, and Bourdon F. Scribner

The relative intensities, or radiant powers, of 39,000 spectral lines with wavelengths between 2000 and 9000 Angstroms have been determined on a uniform energy scale for seventy chemical elements. This was done by mixing 0.1 atomic percent of each element in powdered copper, pressing the powder-mixture to form solid electrodes which were burned in a 10 ampere, 220 volt direct-current arc, and photographing the spectra with a stigmatic concave grating while a step sector was rotating in front of the slit. The sectored spectrograms facilitated the estimation of intensities of all element lines relative to copper lines which were then calibrated on an energy scale provided by standardized lamps, and all estimated line intensities were finally adjusted to fit this calibration. Comparisons with other intensity measurements in individual spectra indicate that the National Bureau of Standards spectral-line intensities may have average errors of 20 percent, but first of all they provide uniform quantitative values for the seventy chemical elements commonly determined by spectrochemists. These data are presented by element in part I, and all 39,000 observed lines are given in order of wavelength in part II.

## 1. Introduction

Spectrochemistry was born a century ago when Kirchhoff and Bunsen [1]<sup>1</sup> definitely demonstrated that chemical elements were uniquely identified by spectral radiations, or lines as seen in a spectroscope provided with a slit. This led immediately to the identification of many chemical elements in the sun and to the discovery of several new elements, but no quantitative chemical analyses were made until much later.

In 1874, Lockyer [2] stated that "while the qualitative spectrum analysis depends upon the *positions* of the lines, the quantitative analysis depends not upon their position but upon their *length, brightness, thickness, and number* as compared with the number visible in the spectrum of a pure vapor". Thus, position (or wavelength) and brightness (or intensity) are recognized as being the two most important properties of spectral lines; wavelengths identify chemical elements and intensities indicate the concentrations of identified elements in mixtures or chemical compounds.

During the past century there has been spectacular improvement in the accuracy of spectral wavelength determinations; the early ones were limited to 3 or 4 figures, the later use of diffraction gratings and wavelength standards permitted the specification of 5 or 6 figures. Since 1900 the application of interferometers and better gratings has refined many wavelengths to 7 figures, and recently some 8-figure values of wavelength standards have been provided. Unfortunately during this past century very little progress has been made in assigning uniform quantitative intensity values to spectral radiations. The great bulk of spectral observations have been made photographically because photographic emulsions provide detailed, permanent records

of spectra not only in the visible but also in the invisible ultraviolet and infrared regions. But even if the light source is reproducible and standardized it is not easy to evaluate the spectral efficiencies of spectrographs and photographic emulsions so the usual procedure has been to make subjective visual estimates of relative intensities of spectral lines on an arbitrary scale based on the relative blackness and/or width of spectral-line images appearing on a developed photographic plate. Consequently, in thousands of individual papers and in numerous comprehensive compilations of spectral data we find only qualitative data on intensities which may have some meaning for adjacent lines in a given spectrum but none at all when comparing widely spaced lines, or lines of different spectra of the same element or of different chemical elements.

In the beginning, most intensity data were reported on an arbitrary scale of 10 steps, weak lines being assigned an intensity of 1, and the strongest line intensity 10. Even as late as 1945 extensive new spectral tables prepared by Gatterer and Junkes [3] displayed estimated intensities on this limited 1 to 10 scale. Since 1910 some spectroscopists have arbitrarily expanded this arbitrarily compressed scale. For example, in the very extensive spectral tables published by Exner and Haschek [4] the estimated intensities range from 1 to 1000. In wavelength tables compiled by Twyman and Smith [5] the maximum intensity is 20, in the compilation of Kayser and Ritschl [6] estimated intensities rise to 4000, and in the well-known M.I.T. Wavelength Tables [7] they soar to 9000. The most recent compilation of Tables of Spectrum Lines by Zaïdel, Prokof'ev, and Raiskiï [8] quotes data from the M.I.T. Tables and more modern sources but adds nothing new on spectral line intensities.

<sup>1</sup> Figures in brackets indicate the literature references on page XII.

In or about the year 1925, microdensitometers were developed for the purpose of quantitative measurement of relative intensities among related lines in multiplets to test the sum rules derived from the quantum theory of spectral structure, but no general applications were made. Since then thousands of spectrochemists have applied microdensitometers to quantitative chemical analyses by calibrating intensity ratios of analysis- and internal-standard lines, but such measurements have contributed nothing to the basic data on spectral line intensities. Likewise, with few exceptions, the modern substitution of electronic photodetectors for photographic emulsions has added nothing to our knowledge of true line intensities over long ranges of different spectra of many chemical elements.

How may one hope to obtain, with a reasonable amount of labor, quantitative intensity data on the same scale for thousands of spectral lines representing practically all of the metallic elements? A hint was given in 1874 by Lockyer [2] who observed that "the lines of any constituent of a mechanical mixture disappeared from the spectrum as its percentage was reduced." Acting on this suggestion, Hartley [9], in 1884, began to study the spark spectra of metals in solutions with concentrations of 1 percent, 0.1 percent, 0.01 percent, and 0.001 percent, and proposed a method of quantitative spectrochemical analysis based on the lines that could be detected at each dilution. Similar studies were later made by Pollok and Leonard [10], by de Gramont [11], and by Löwe [12], all showing that with progressive dilution of an element its spectral lines weakened and vanished until only the most sensitive line remained to reveal its presence. In all these works the principle of quantitative spectrochemistry appeared to rest on the *number of lines* detectable rather than on their individual *intensities*. Casual observation must have shown lines of equal strength in spectra of solutions differing 1000 fold in concentration but no one mentioned it. It is difficult to understand why these early studies of residual spectra in quantitatively prepared mixtures or solutions did not suggest a method for obtaining physical intensities, but it is a fact that before our work had begun no one had attempted to express spectral line intensities as directly proportional to the number of radiating atoms or concentration of the element. The present monograph reports such an attempt [13].

Our method of deriving line intensities from arc spectra of elements diluted in copper was recently adopted by Allen [14, 15] to obtain oscillator strengths of some radiations from 3200 to 5400 Å representing nine elements.

At various times since 1932 we have photographed the arc spectra of 70 chemical elements diluted in silver or in copper, and determined the line intensities of the diluted elements relative to selected lines of the matrix. An energy calibration of the latter finally led

to physical intensities of 39,000 spectral lines representing 70 elements, all on the same energy scale. These experiments and results are based on the following propositions, regarded as fundamental for the quantitative description of residual spectra of diluted elements excited in ordinary d-c arcs.

1. *The limiting detectability of any line is defined as the atomic concentration that ensures positive detection of the line.* This limit is determined mainly by unavoidable background on a fully exposed spectrogram. The spectrum of an arc burning in air consists of discrete lines due to atoms, and of more or less extensive band systems from transient compounds (usually monoxides), all superposed on a continuous background arising from thermal radiation of incandescent oxides, from transitions in the continuum, and possibly from scattered light. This background sets a limit to the exposure for faint lines that may be given by any actual spectrograph. If this were not true, the exposure could be increased indefinitely to compensate for unlimited reduction in concentration, and detectability would always be infinite. Faint lines are not recorded by underexposure, and they cannot be recognized on a very dense background produced by overexposure. In order to guarantee positive recognition and unambiguous chemical identification a spectral line should be sufficiently well defined to permit accurate wavelength measurement. Experience shows that the minimum photographic density that meets this requirement is of the order of 0.05 above that of the background.

2. *The limiting detectability of any element in an arc depends on the matrix in which the element finds itself.* There is no doubt that in the conventional arc relative volatilities of the chemical elements as well as relative ionization potentials affect the relative strengths of their mixed spectra. In general, the elements with high-vapor pressure and/or low-ionization potential will be favored in spectral excitation, but elements with either high or low volatility may be underestimated if not uniformly present during the exposure, and easily ionized elements may appear less sensitive because of more complete ionization. In this connection it must be noted that large differences in apparent detectability are possible if concentrations are expressed in relative weights instead of numbers of atoms. Thus, 0.01 atomic percent of boron in uranium is equal to  $< 0.0005$  weight percent since the uranium atom is 22 times heavier than the boron atom.

3. *The primary substance (matrix) has no important effect on the relative intensities of lines due to a secondary substance.* It is conceded that the relative intensities of analogous spectra of different elements, and of successive spectra of the same element, may vary with the composition of the samples and/or with the type, or portion, of light source from which radia-

tion is taken, but there is no evidence that the relative intensities of lines in any particular spectrum of a given element are thereby greatly changed. It may be expected, therefore, that the relative intensities of lines observed in one metal arc will remain valid in any other metal arc, provided the arcs are at approximately the same temperature. The absolute intensities and the relative strengths of successive spectra may be altered by excitation conditions. For example, silicon may be more sensitive in carbon than in calcium, and it is well known that when easily ionized alkalis are present in sufficient quantity to influence discharge conditions they reduce the intensity of other spectra, especially those characteristic of ionized atoms.

4. *The order of lines arranged according to decreasing detectability in progressive dilution is the same as the order of decreasing intensity in the spectrum of the pure element.* In other words, emission line intensities in residual arc spectra (barring self-absorption) are proportional to the number of radiating atoms; and relative intensities may therefore be derived from concentrations at which different lines show the same intensity or limiting detectability.

Arc spectra usually exhibit a variety of lines, sharp or narrow ones, diffuse or wide ones (including band heads), strong ones accompanied by photographic spreading of developed images, others wide on account of hyperfine structure, and some partially reversed. All of these types, except the last, appear in residual arc spectra at low concentrations, and it may be questioned if it is possible to place them on a uniform intensity scale. It may be assumed that if total blackening integrated over the width of the line when recorded at a moderate level of density be considered in estimating relative intensities these will be on a uniform scale within the limits of precision in making such estimates on lines of different types.

5. *The order of spectral lines arranged according to decreasing intensity is the same when the intensities*

*are decreased by rotating stepped sectors as when the intensity reduction is produced by successive dilution of the element in a matrix.* This was recognized by Löwe [12] who published an atlas of spark spectra of 44 elements diluted from 1 percent to 0.001 percent and later obtained practically the same results by observing spectra with stepped exposure times [16]. In our experiments the labor of preparing samples of 70 elements in four or more dilutions was greatly reduced by adopting only one dilution (0.1 atomic percent) and then producing further reductions of spectral-line intensities by means of rotating step sectors.

6. *Limiting detectability (as defined in 1.) may be adopted as a physical scale of intensities.* Such intensities may be fixed as follows: In a fully exposed spectrogram of copper containing 0.1 atomic percent of another element any faint but unmistakable line at a given wavelength is assigned unit intensity. Any similar line appearing with unit intensity in a spectrogram when the energy, or concentration, is reduced to  $\frac{1}{5}$  is said to be 5 times as strong. Thus, all lines can be assigned relative intensities proportional to their limiting detectabilities by determining either the energy reduction or the concentration reduction at which the stronger lines finally show unit intensity. The atomic percent concentration at which any line will show unit intensity then results from dividing 0.1 by its required energy or concentration reduction. For example, a line of intensity 10 should show plainly at 0.01 atomic percent, while one of intensity 1000 should be easily seen at 0.0001 atomic percent (one in a million). Assuming the ratio concentration/intensity to be constant, the maximum intensity at 100 percent is easily obtained. Thus, a line of intensity 1000 at 0.1 atomic percent will have an intensity value of  $1000 \times 100/0.1 = 1,000,000$  at 100 percent. This indicates a much larger range of spectral intensities than mentioned heretofore, but it is not unrealistic.

## 2. Experiments

Whereas all earlier experiments on residual spectra of diluted elements involved spark excitation of solutions or fused salts, we decided to employ d-c arc excitation for the following reasons. It has been shown [17] that the first ionization potentials of some seventy metallic elements range from 4 to 11 v and the strongest spectral lines of most of these elements have wavelengths between 2000 and 9000 Å, which is the spectral region covered by the present investigations. Furthermore, it is known [18] that the second ionization potential of these elements ranges from 10 to 75 v and that the strongest lines of singly ionized atoms generally have shorter wavelengths than those of neutral atoms, nearly half of them being shorter than 2000 Å so that they can be detected only in vacuum spectrographs. Because low-voltage arcs have less ionizing

action than high-voltage sparks more atoms will remain in the neutral state and, in general, therefore, arc spectra will exhibit stronger lines and higher sensitivity than spark spectra.

The use of arc spectra in these experiments threatened to introduce errors on account of self-absorption of radiated energy in the arc aura or envelope which consists largely of unexcited neutral vapor atoms. In all spectra of arcs between metal electrodes this is the cause of conspicuous self-reversal of all lines involving the atom's ground state. However, this is a function of vapor density surrounding the arc and if this is reduced to 0.001, self-reversal is usually negligible (see fig. 2). This is our reason for making these experiments with individual elements diluted in copper in the ratio 1 to 1000. When ground-state lines of extra-

ordinary intensity were suspected of some self-absorption, intensity ratios were checked or corrected by examining our earlier spectrograms made with this element diluted to 0.0002 atomic percent in silver.

### 2.1. Dilution in Silver

Our preliminary experiments, begun in 1932, can be described briefly as follows: solutions of known strength of the elements under investigation were prepared and proper amounts added to pure silver oxide, which was then reduced to metal by heating to make samples containing 8 definite atomic ratios extending from 0.05 to 0.0002 atomic percent of the element added to silver, with a factor of about 2 between 7 successive dilutions. In order to save time and labor, each series of silver samples incorporated 3 to 6 chemical elements, in addition to zinc which supplied internal standards. These samples were burned on pure copper electrodes of a 220 volt d-c arc with 10 amperes. An image of the arc was projected onto the slit of a stigmatic concave grating spectrograph by means of a fused-quartz lens. Each series of excited samples was exposed on successive segments of the slit, and was photographed in four spectral regions ranging from 2000 to 9000 Å (see fig. 1). A comparator was employed to measure wavelengths (relative to silver and copper lines) for the identification of the added elements, and relative intensities of all lines belonging to residual spectra of diluted substances were estimated and related to concentration. These results were not satisfactory for the following reasons: The use of silver as a matrix and of copper for arc electrodes precluded the possibility of getting any data for these two elements or for any lines masked by silver and copper lines. Also the inclusion of 3 or more elements in each series of samples resulted in the blending of many lines, especially in complex spectra, so that it was not possible to assign proper intensities in these cases. Furthermore, the method of sample preparation and observing appeared to be unsuited to very volatile elements, or compounds, because no residual spectra could be recorded for them even at concentrations of 0.1 atomic percent.

### 2.2. Dilution in Copper

In 1941 these preliminary experiments were abandoned in favor of a modified procedure which led to satisfactory results. The chief changes in procedure

came with the availability and use of pure metal powders, and a hydraulic press to form solid electrodes of mixed powders. Instead of reducing spectral line intensities to the limit of detectability by successive dilutions of the element in different samples only one dilution (0.1 atomic percent) was prepared and line intensities were reduced by observing through rotating step sectors. The successful procedure may be outlined as follows: An element under investigation was mixed with pure copper powder in the atomic ratio of 1 to 1000. These mixtures were pressed into solid electrodes, and burned in a 220-volt, 10-ampere d-c arc which was imaged entirely on the collimator of a stigmatic grating spectrograph by a lens at the slit. A rotating step sector in front of the slit reduced the spectral intensities to one-fifth in each of four steps (see fig. 2). Spectral intensities of the element added to copper were estimated relative to those of selected copper lines, and this was done separately for each of 70 elements throughout the range of spectrum from 2000 to 9000 Å. The true intensities of the selected copper lines above 3300 Å that served as internal standards were then measured, by photographic photometry, relative to the known energy distribution in the spectrum of an incandescent tungsten-strip filament at a certain temperature (see fig. 3). Between 2000 and 3300 Å a calibrated hydrogen lamp was used to determine the relative intensities of copper lines. Finally the apparent intensities of 39,000 spectral lines of 70 elements, relative to copper, were adjusted to fit the copper calibrations. These experiments thus provide empirically determined lists of the principal lines of all elements actually detectable under average conditions in arc spectra when their concentrations are 0.1 atomic percent, and the individual lines bear intensity numbers approximately proportional to their detectability or their relative energy. That these intensity numbers really represent physical intensities was proved by comparing them with earlier, accurately measured relative intensities of lines in multiplets and with published relative  $f$ -values or oscillator strengths of lines in different multiplets extending over a wide range of spectrum.

In order to provide intensity data for spectral lines that are partially or wholly obscured by copper lines a sectorized spectrogram of the pure element excited with self-electrodes, or of a metallic compound or salt ex-

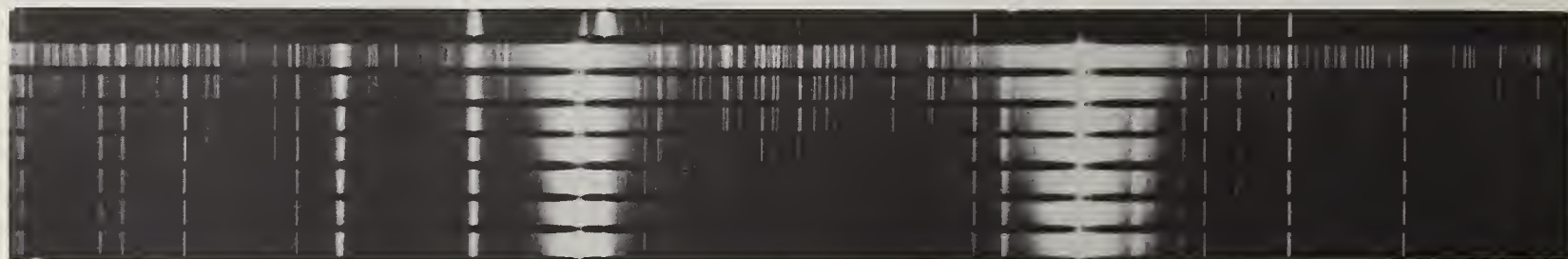


FIGURE 1. Arc spectra of elements (*V*, *Nb*, *Ta*) diluted progressively in silver, and burned on copper electrodes. Spectral range 3880 to 4320 Å.

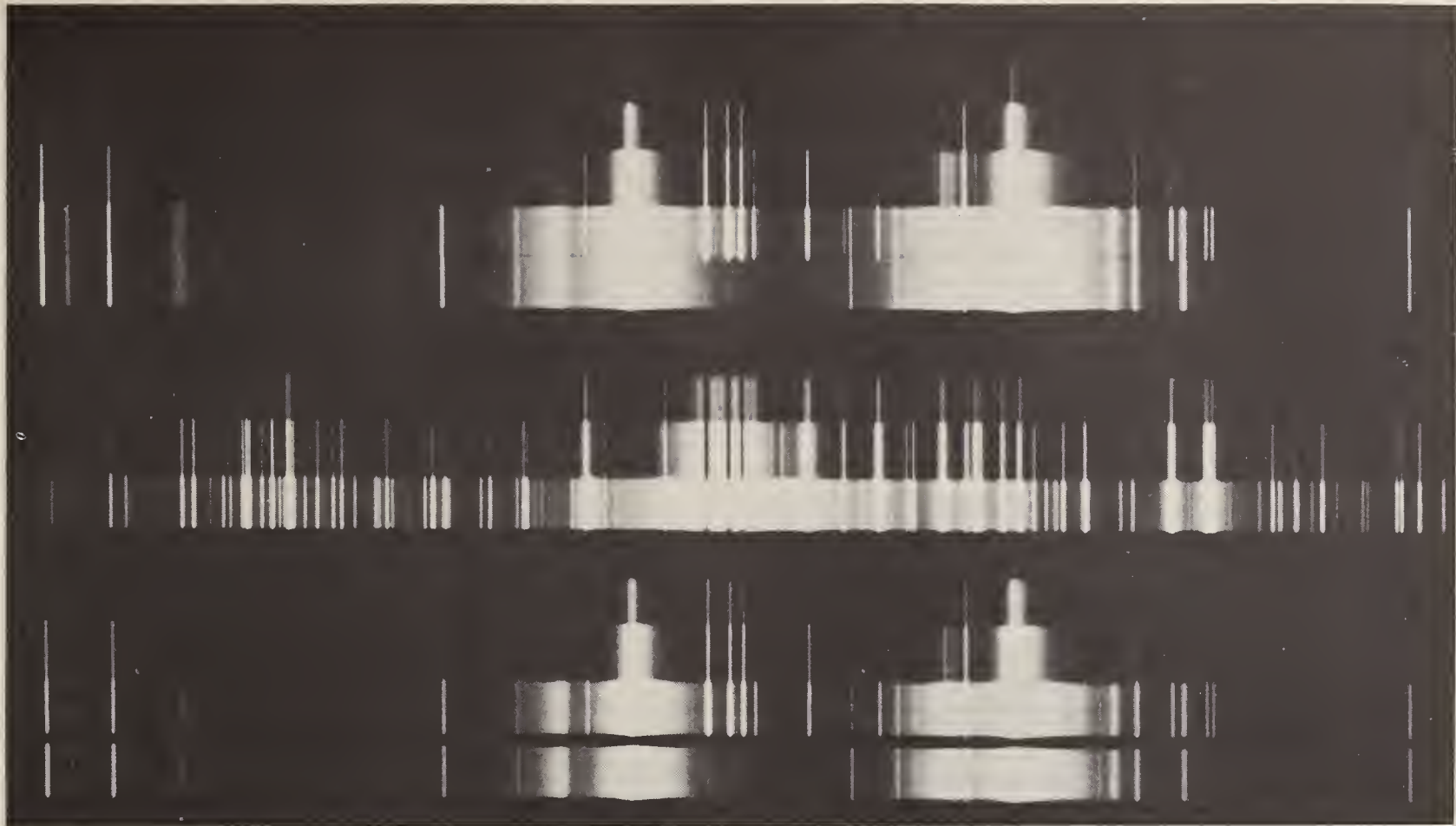


FIGURE 2. Arc spectra of pure manganese (center), and of copper containing 0.1 percent Mn, (above and below), all through a rotating step sector. Spectral range 3960 to 4105 A.

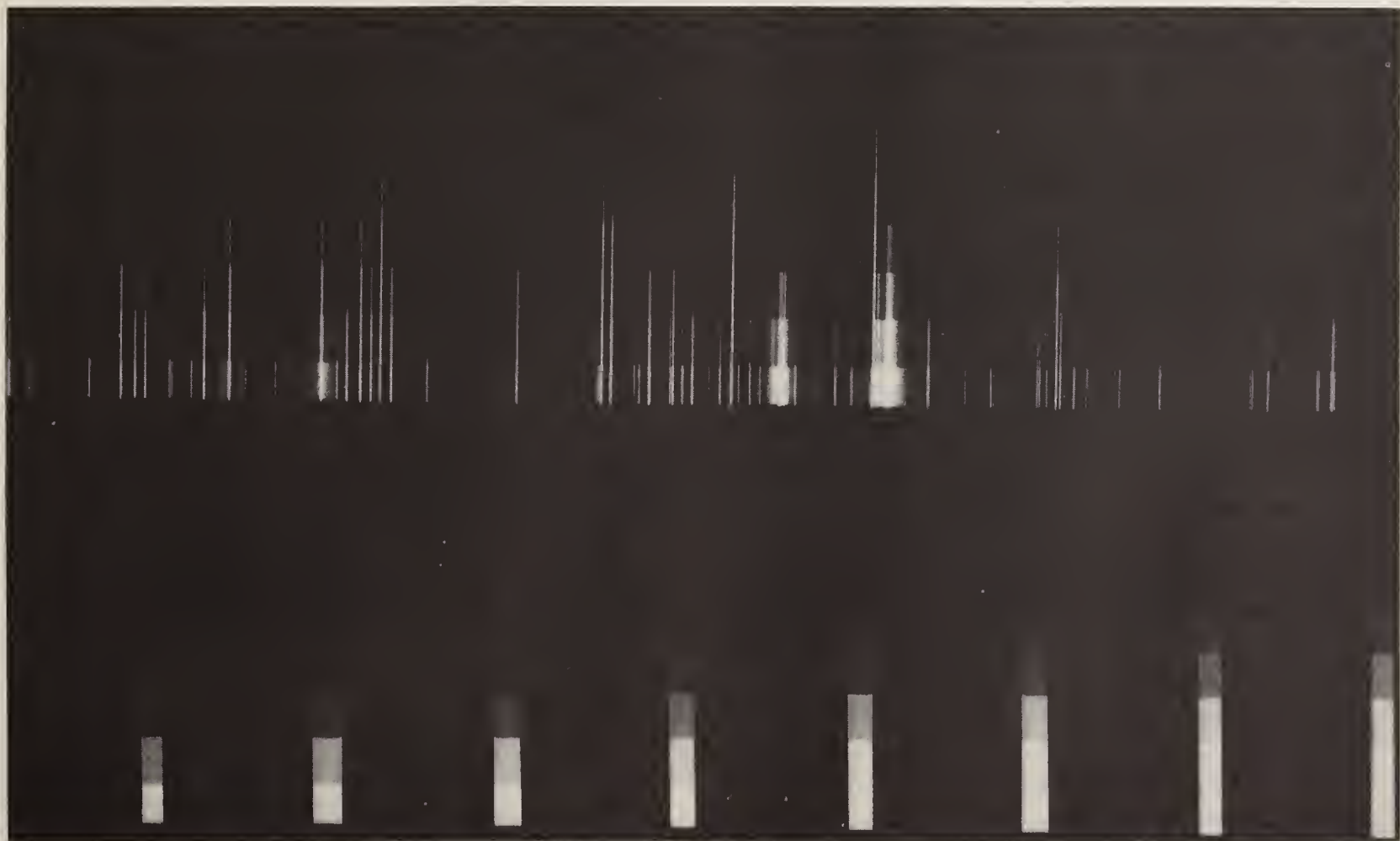


FIGURE 3. Energy calibration of copper lines. Above, arc spectrum of copper through rotating step sector. Spectral range 3400 to 3850 A. Below, standard-lamp spectrum at 50 Å intervals through same step sector.

cited in a carbon arc, was photographed on every plate so that any lines blended with copper could be interpolated with proper estimates of their relative intensities. Comparison of relative intensities in copper and in carbon matrices also supplied new information on successive spectra, I and II, especially of rare-earth spectra. Similar data for copper itself were obtained by using pressed electrodes of pure silver powder to which 0.1 atomic percent of copper was added, plus the same quantities of gold and zinc to serve as internal standards.

Further details of experimental materials, apparatus, and procedure are given in the following paragraphs.

### 2.3. Arc Electrodes

For this investigation materials of high purity were acquired, preferably in the form of metal powders, although some elements, not available in pure powdered metal form, were obtained as oxides. In every case the proper amount was added to powdered copper to produce a mixture in which there was one atom of the added element to each 1000 atoms of copper. These mixtures were homogenized by mechanical shaking and then compressed into solid cylindrical pellets in an hydraulic press at 5000 psi. The pellets were  $\frac{1}{4}$  in. in diameter,  $\frac{1}{4}$  in. in length, and weighed about 1.5 gram. Two of a kind were mounted in massive water-cooled clamps in an arc stand and a direct current of 10 amperes passed between them from a 220 v line with ballast resistance. A 3-mm gap was maintained between the electrodes during the exposures which varied in duration from 1 sec to 5 min depending on spectrographic efficiency and sensitivity of photographic plates in different spectral regions.

The arc was imaged on the collimator of a concave-grating spectrograph by means of a quartz lens immediately in front of the slit to obtain uniform illumination along its length and collect light from all parts of the arc. Rotating step sectors were operated immediately in front of the collecting lens, one with 5 to 1 ratio was used for all line-intensity spectrograms, but a 2 to 1 step was used for the energy calibration of copper lines.

### 2.4. Spectrograph

The dispersing apparatus was a 6-in. grating with 15,000 lines per inch, and 22 ft radius of curvature in a Wadsworth-type mounting to give stigmatic images on photographic plates. All observations were made in the first-order spectrum in which the reciprocal dispersion was 5A/mm, and the practical resolving power about 50,000 with a slit width of 30  $\mu$ .

### 2.5. Photographic Plates

In order to determine, relative to copper, the intensities of all lines of 70 chemical elements diluted 1000 fold it was necessary to make many hundreds of spec-

trograms, and to employ 4 varieties of photographic plates to cover the wavelength range 2000 to 9000 A. The spectral range 2000 to 3000 A was recorded on Eastman 103-0 Ultraviolet Sensitive plates, 2600 to 4900 A on Eastman 33 plates, 4600 to 6900 A on Eastman II-F plates, and 6600 to 9000 A on Eastman I-N plates. Each plate was developed for 4 min in a rocking tray containing D-19 developer at 70 °F.

The exposure times in each spectral range were chosen by trial to obtain a suitable continuous background in the first step of the rotating step sector. Because of variations in spectral sensitivity of photographic materials and in spectrographic efficiency two exposures of the contaminated-copper arcs were usually made on each plate, with exposure durations in the ratio 2 to 1, and the sectored comparison spectrum of the contaminant was placed between them. Measurements were usually confined to the exposures which showed the optimum background in the first step of the rotating sector.

### 2.6. Energy Calibration of Copper Lines

In order to determine the factors necessary to convert the estimates of apparent intensities of the lines of 70 elements relative to copper into true relative intensities, it was necessary to determine the true relative intensities of selected reference lines in the spectrum of copper. The energy calibration of copper lines was performed as follows:

A G.E. tungsten ribbon filament lamp (type F339-85, 30 amp, 6v) equipped with a fused quartz window served as the reference standard of spectral energy distribution in the wavelength range 3300 to 9000 A. The brightness temperature of the filament at 6500 A was measured at two values of filament current by Henry Shenker in the National Bureau of Standards Pyrometry Laboratory. The true temperature  $T$  of the filament was determined from the brightness temperature by means of the following equation obtained from Wien's law

$$\frac{1}{T} = \frac{1}{T_b} + \frac{\lambda}{C_2} \ln A$$

where  $C_2 = 1.438$  cm-deg and  $A$  is the product of the emissivity of tungsten (0.427) and the transmittance of the quartz window (0.916) at 6500 A.

TABLE 1. *Temperature of tungsten lamp*

Current	Brightness temperature	True temperature
<i>amp</i>	$^{\circ}K$	$^{\circ}K$
38.00	2492	2787
40.00	2567	2881

The energy distribution from blackbodies operated at these temperatures was taken from tables prepared by Stair and Smith [19] in the 2300 to 3500 A range, by Skogland [20] in the 3200 to 7600 A range and by

Lowan and Blanch [21] in the 7200 to 10000 Å range. The data from these tables were adjusted to a common basis and multiplied by the emissivity of tungsten and the transmittance of fused quartz at intervals increasing from 50 Å in the ultraviolet to 200 Å in the infrared. The emissivity of tungsten was taken from a weighted mean curve of published values to which reference is made by Stair and Smith [19]. The transmittance of fused quartz was calculated from data on its index of refraction published by Sosman [22]. The final product, representing the relative energy distribution of the radiation emerging from the quartz window of the lamp, was plotted on a convenient scale to permit interpolation to any wavelength in the range 2300 to 10000 Å.

Spectrograms of the pure copper arc and of the tungsten lamp were made under conditions identical with those described above except that for these a 2 to 1 step sector with 8 steps was used for closer calibration (fig. 3). Microphotometer measurements of transmittance were made in each step of the standard-lamp spectrum at intervals of 50 Å and a family of calibration curves of transmittance versus log exposure (hereafter referred to as log  $J$ ) was drawn up for each plate. The exposure of the standard-lamp  $J_s$  was read from the calibration curve for each wavelength at a transmittance of 40 percent (where the curve is linear) and then divided by the calculated intensity  $I_s$  at that wavelength.  $I_s$  is the calculated intensity emitted by the standard-lamp. A standardization curve of  $\log J_s/I_s$  versus  $\lambda$  was plotted for each plate. Calibration curves of transmittance versus log  $J$  were then drawn from measurements on each of the selected copper lines and the log exposure ( $\log J_{Cu}$ ) of each copper line at a transmittance of 40 percent was read from each curve.  $\log J_s/I_s$  was then subtracted from the average of numerous values of  $\log J_{Cu}$  to give  $\log I_{Cu}$  which is the log of the true relative intensity of the copper line. The values of  $\log I_{Cu}$  from plates in adjacent wavelength regions were adjusted to a common basis by means of lines common to both plates. The plot of  $\log J_s/I_s$  versus  $\lambda$  is the relative response function of the plate-spectrograph combination and as such was itself useful in the infrared where the copper spectrum lacks lines suitable for use as an intensity reference.

From 2 to 24 determinations were made on each of 202 lines of Cu I between 2800 and 8100 Å with an

average of about 9 determinations per line. The values of  $I_{Cu}$  obtained by this procedure below 3300 Å were systematically low because of the rapid decline in intensity from the standard lamp in the direction of short wavelengths. The intensity from the lamp at 5500 Å is about 40 times the intensity at 3300 Å and about 300 times the intensity at 2800 Å. This fact introduces possible errors from scattered light of the intense visible radiation which tends to raise  $J_s$  and consequently depress  $I_{Cu}$ .

The spectrum of copper is composed of sharp lines and diffuse lines. Since the microphotometer measurements were made at the peaks of the lines rather than integrated over their widths, the measured intensities of the two groups of lines are on different relative scales, the scale of the diffuse lines being smaller than that of the sharp lines. The reference lines selected for calibration of the estimates of apparent intensity are all sharp lines.

The random error of the photometric procedure, including microphotometer error and irregularities of response of the "N" plates was determined from 92 measurements of apparent relative intensities in spectra of the standard lamp on two plates. The standard deviation of individual measurements from the mean was found to be about 1.5 percent. It is probable, therefore, that the uncertainties in these intensity measurements of the copper lines lie entirely in the systematic errors discussed above and in the random fluctuations of the arc under study.

Since the ribbon filament lamp was too faint in the region from 2000 to 3300 Å to serve as a standard, recourse was taken to a Hanovia hydrogen arc lamp. Output from this lamp was compared by R. Stair in the Radiometry Section of the Bureau with a standard tungsten-in-quartz lamp and a standard mercury arc in the region from 2500 to 3800 Å; this provided an independent overlapping calibration which carried us down to 2500 Å.

The intensity numbers below 2500 Å become less accurate as the short wavelength limit is approached. Lacking any reliable energy calibration for shorter waves, the intensity estimates from 2500 to 2000 Å were necessarily adjusted by judicious extrapolation, guided by the declining densities of background in the spectrograms, caused by the increasing absorption in the apparatus and in the air at shorter wavelengths.

### 3. Results

Because these relative intensities of 39,000 lines of 70 elements are based on empirical detectability they will be generally applicable to spectrochemical analysis provided that proper corrections are made on account of different excitation in different matrices. Chemical elements differ in volatility, electron emission, spectral

excitation, and spectral background, and consequently their spectral detectability in different mixtures or matrices depends on certain controlling factors. One of the important factors is the atomic ionization potential which ranges from 3.9 v for Cs to 11.3 v for C, and for the investigated 70 elements has an average value of 7.3

v. By mixing these 70 elements with copper, which has an ionization potential of 7.7 v, we obtained excitation conditions very near the average for all. To convert our intensity numbers from copper to any other matrix would require the empirical determination of the proper conversion factor for each element.

It should be pointed out that sensitivity of detection in spectrochemical analysis is commonly given in percent by weight. In order to find the weight percent from the atomic percent given in the tables the following simple relation applies,

$$C_w = \frac{C_a A_x}{A_{Cu}}$$

where  $C_w$  is the concentration in percent by weight,  $C_a$  is the atomic percent (0.1 in this case),  $A_{Cu}$  is the atomic weight of copper, and  $A_x$  is the atomic weight of the element  $X$ .

Although our original intention was to determine the relative strengths of many spectral lines from different chemical elements for purposes of quantitative spectrochemical analysis we believe that the results may also interest theoretical spectroscopists and astrophysicists. For instance, if our intensity numbers, based on concentration detectability and relative energy calibration, actually express relative energies then all may be converted to oscillator strengths, or to relative  $gf$ -values, or even to absolute  $f$ -values, if the proper conversion factors can be found.

Because of the low concentration of each element in the copper arc from which the spectra were observed, the lines were extraordinarily free from self absorption. This fact suggests that these emission intensities could be converted into relative  $gf$ -values, provided that a valid excitation temperature can be assigned to the copper arc.

The temperature of the copper arc can be determined by comparing the observed relative intensities of the lines of an element with the relative  $gf$ -values of those lines [23], provided that the arc can be shown to be in local thermodynamic equilibrium for the energy states under consideration. A preliminary investigation of this sort has been carried out by using relative  $gf$ -values determined by R. B. King and his coworkers for Ti I [24], Ti II [25], V I [26], Cr I [27], Fe I [28], [29] and Ni I [30] in the region above 3000 Å. Figure 4 is a typical example of the correlation of intensities and  $gf$ -values indicating the temperature of the copper arc. The comparison shows that our copper arc is sufficiently in equilibrium to yield a temperature which may be useful in calculating approximate  $gf$ -values of some utility from our intensity numbers. A preliminary value of  $5000 \text{ }^\circ\text{K} \pm 300 \text{ }^\circ\text{K}$  has been obtained as the average temperature of the 10 amp, 220 v, copper arc.

Because our intensity data represent single (sometimes two) personal subjective estimates of photographic densities in sectorized spectrograms there is

no possibility of deriving statistically any probable errors or standard deviations for individual values. However, an estimate of the accuracy or reliability of our data may be obtained by comparing them with quantitative results published by other investigators. For example, figure 4 shows the ratios of our intensities to the relative  $f$ -values (or intensities) reported by King and King [24] who measured the total absorptions of Ti I lines in furnace absorption spectra; they stated [28] that "The average deviations of the individual intensity measures from the mean values vary from 4 to 15 percent for different lines" measured between 4 and 16 times on different plates. Each little circle plotted in figure 4 represents a Ti I multiplet of 1 to 12 lines. The average of 59 deviations from the mean of all is 25 percent.

A second indication of the reliability of our intensities is obtained by comparing our values with the relative intensities of lines in multiplets of five elements (Cr, Fe, Mn, Ti, V) measured with photographic densitometry by Frerichs [31] to test the sum rules. Such a comparison in 21 different multiplets indicates deviations ranging from 5 to 22 percent, with an overall average of 14 percent.

A third estimate of the errors in our data results from their comparison with photoelectric intensity measurements in the iron arc by Crosswhite [32], who claims an accuracy of the order of 1 percent. The average difference between intensities of 330 iron lines (3175 to 5658 Å) common to these two sets of observations is  $\pm 27$  percent, but some of this difference may be due to temperature if this is not the same in both arcs.

Other comparisons could be made but the above three are different and typical; they suggest that the average

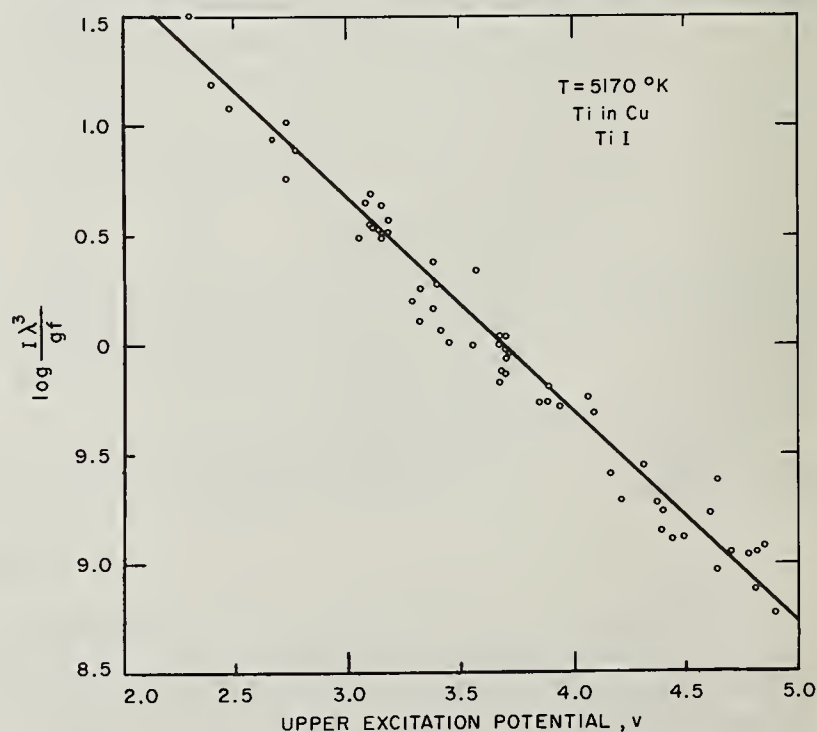


FIGURE 4. Plot of  $\log \text{intensity } \lambda^2$  over  $gf$  versus upper excitation potential of Ti I lines. The temperature of the arc is derived from the slope of the line which best fits the points.



error of our spectral-line intensities within a spectrum of each element is probably between 15 and 25 percent. The uniformity of the intensity scale between the spectra of the various elements is more difficult to assess. Considerable care was taken to obtain spectrograms under comparable conditions for all of the elements; however, differences in volatilities of the elements or their oxides, and differences in ease of excitation may possibly result in shifts of intensity scales between elements. An inspection of the intensities of the strongest lines of the elements indicates that the values are generally in the same order as sensitivity of detection of the elements where these are known. Although no high precision was expected in our mass-production of intensities it is emphasized that reasonably uniform, quantitative values are now available for 39,000 lines emitted by 70 chemical elements.

The tables of spectral-line intensities resulting from this investigation are presented in two parts. In part I the data are arranged by element in alphabetical order of chemical name. The heading of each table by element states the atomic symbol, atomic number, atomic weight, ratio of atomic weight to that of copper, the electron configuration and term symbol of the normal state of each spectrum and the corresponding ionization potential expressed in kaysers ( $\text{cm}^{-1}$ ). Following the heading is a selected list of references. Under *Wavelengths* are listed all of the sources from which the wavelengths used in the table were compiled. Under *Classification* or *Spectrum Assignments* are listed the sources from which the assignment of spectrum and energy levels were obtained. A few spectra showed bands of metallic oxides. References to data about these bands are given under *Molecular Spectra*. In addition a few selected references to published experimental intensity measurements are given under *Intensities*.

Following the references there is abstracted from the main table a list of the strong lines arranged in order of decreasing intensity and giving, in addition to the data found in the main table, the electron configurations and spectral term designations of the energy levels that produce each line. These lists of the strong lines generally contain 2 percent or more of the lines in the main table.

Electron configurations and spectral term designations of quantum numbers are of unusual interest in the production of the strongest spectral lines, or *raies ultimes*. According to well-known rules governing the relative intensities of lines in multiplets, the strongest line arises from transitions between levels having the largest  $J$  and  $L$  values when  $\Delta J = \Delta L = 1$ . A rule relating to *raies ultimes* was expressed [33] a quarter of a century ago as follows: "A *raie ultime* in any spectrum originates with a simple interchange of a single electron between  $s$  and  $p$  states, usually preferring con-

figurations in which only one electron occurs in such states". The above simple rules for the strongest lines appear to be valid for all spectra.

Then comes the main table, listing in order of wavelength, for every line of an element which appears on our plates, the intensity, character, wavelength, spectrum, and energy levels. The calibrated intensity numbers in the first column represent the relative radiant power emitted by our arc at each wavelength. Lines which differ in profile from a normal sharp symmetrical shape are described in the second column, with the notation suggested in the Transactions of the Joint Commission for Spectroscopy [34] as follows:

- $b$  — band head,
- $c$  — complex,
- $d$  — unresolved double line,
- $h$  — hazy,
- $l$  — shaded longward,
- $s$  — shaded shortward,
- $w$  — wide.

The wavelengths in column 3 are taken from the places noted in the list of references and are given to the nearest 0.01 Å. They are all normal air wavelengths, even those below 2000 Å. Column 4 gives the spectrum, I, II, or III (respectively from neutral, singly ionized and doubly ionized atoms) in which the line occurs or the molecule from which a band head originates and column 5 the numerical values, rounded off to the nearest wavenumber, of the levels between which the transition occurs. These data are taken from the *Classification* reference.

The wavelength of a doubly classified line appears before the first pair of energy levels and the second pair follows immediately. In these tables all energy levels are given in vacuum wavenumber units,  $\text{cm}^{-1}$ , for which the name kayser ( $K$ ) has been proposed [35]. For all spectral lines explained as transitions between energy levels this serves as a mutual check since the wavelengths in normal air, when converted to vacuum wavenumbers by a conversion table [36], will coincide within one unit with the difference between the two energy levels. Furthermore these numbers serve as an index to the term designation in "Atomic Energy Levels" [37] where electron configurations, quantum numbers, and magnetic splitting factors are given.

A comparison of the excitation energies of any two classified lines may be made by directly comparing their larger energy levels in kaysers, and adding the ionization potentials in the case of lines from II or III spectra. This direct and simple procedure avoids the labor of converting all energy levels from kaysers to electron volts by means of the relation  $1 \text{ ev} = 8066 K$ .

In part II the intensity data are arranged in two tables in order of increasing wavelengths. In table 1 the strong lines of each element which were abstracted from the main tables in part I are here ar-

ranged in order of wavelength. Following this is table 2 in which the individual main tables of part I have been consolidated into a single table arranged by wavelength. This table contains about 39,000 lines of 70 elements. The intensities in the table are on a scale of relative radiant power and the scale is the same from element to element. Following the intensity numbers are given the wavelength, the element symbol, and the spectrum. The intensity of a double line appears before the first wavelength and the second wavelength follows immediately.

This investigation has extended over a period of 28 years, and represents a very considerable amount of intermittent labor contributed mainly by a relatively small number of individuals. The program was initiated by Meggers and Scribner, the latter prepared

diluted-element mixtures, electrodes and spectrograms, while the former identified wavelengths, supplied many line classifications, and estimated relative intensities of some fifty thousand lines. In the production of the mixtures and the copper electrodes and spectrograms valuable assistance was given by Harriet E. Brown. Corliss contributed the copper calibration, the conversion of apparent intensities to relative radiant powers, and prepared the final tables. Mrs. Ruth Peterson carefully prepared and checked all the data on IBM cards so that it could be printed automatically. Valuable advice and assistance on the IBM machine operations was given by William Bozman. To all our able and reliable assistants the authors extend their sincere appreciation and thanks for cheerful and conscientious cooperation.

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WASHINGTON, D. C., January 1, 1961.

**Tables of Spectral-Line Intensities**  
**Arranged by Elements**



# ALUMINUM

Al,  $Z=13$ ,  $M=26.98$ , Ratio  $\frac{\text{Al}}{\text{Cu}}=0.425$

Al I Normal state of valence electrons  $3s^2 3p^1 {}^2P_{0\frac{1}{2}}^{\circ}=0$ . I.P.= 48279 K

Al II Normal state of valence electrons  $3s^2 {}^1S_0=0$ . I.P.=151860 K

## References

Wavelengths:

G. R. Harrison, Massachusetts Institute of Technology Wavelength Tables (John Wiley & Sons, New York, 1939).

Classification:

Al I, F. Paschen, Ann. Physik **12**, 516 (1932).

Intensities:

Y. I. Ostrovsky, Optika i Spektroskopiya **2**, 673 (1957).

## Relative intensity of aluminum lines observed in an arc of copper containing 0.1 atomic percent of aluminum

### *Strong lines of aluminum*

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
900	3961.53	I	112-25348	$3s^2 3p^1 {}^2P_{1\frac{1}{2}}^{\circ} - 3s^2 4s^1 {}^2S_{0\frac{1}{2}}$
650	3092.71	I	112-32437	$3s^2 3p^1 {}^2P_{1\frac{1}{2}}^{\circ} - 3s^2 3d^1 {}^2D_{2\frac{1}{2}}$
	3092.84	I	112-32435	$3s^2 3p^1 {}^2P_{1\frac{1}{2}}^{\circ} - 3s^2 3d^1 {}^2D_{1\frac{1}{2}}$

## Aluminum — All Observed Lines

Intensity and Character	Wave- length in A	Spec- trum	Energy Levels in K	Intensity and Character	Wave- length in A	Spec- trum	Energy Levels in K
7	d	2269.09	I	4	2575.41	I	112-38929
		2269.21	I	15	2652.49	I	0-37689
18		2367.06	I	20	2660.39	I	112-37689
36		2373.13	I	320	3082.16	I	0-32435
7		2373.36	I	650	d	3092.71	I
						3092.84	I
1.8		2378.41	I	450	3944.03	I	0-25348
24		2567.99	I	900	3961.53	I	112-25348
48		2575.10	I				

# ANTIMONY

Sb,  $Z=51$ ,  $M=121.76$ , Ratio  $\frac{Sb}{Cu}=1.916$

Sb I Normal state of valence electrons  $5s^2 5p^3 \ ^4S_{3/2}=0$ . I.P. = 69700 K

Sb II Normal state of valence electrons  $5s^2 5p^2 \ ^3P_0=0$ . I.P. = 133328 K

## References

Wavelengths and classification:

Sb I, W. F. Meggers and C. J. Humphreys, J. Research NBS **28**, 463 (1942).

## Relative intensity of antimony lines observed in an arc of copper containing 0.1 atomic percent of antimony

### *Strong lines of antimony*

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
600	2598.05	I	8512-46991	$5s^2 5p^3 \ ^2D_{3/2} - 5s^2 5p^2 6s^1 \ ^2P_{0/2}$
320	2598.09	I	9854-48332	$5s^2 5p^3 \ ^2D_{5/2} - 5s^2 5p^2 6s^1 \ ^4P_{2/2}$
140	2528.52	I	9854-49391	$5s^2 5p^3 \ ^2D_{3/2} - 5s^2 5p^2 6s^1 \ ^2P_{1/2}$
	2877.92	I	8512-43249	$5s^2 5p^3 \ ^2D_{1/2} - 5s^2 5p^2 6s^1 \ ^4P_{0/2}$

## Antimony — All Observed Lines

Intensity and Character	Wave- length in A	Spec- trum	Energy Levels in K	Intensity and Character	Wave- length in A	Spec- trum	Energy Levels in K
2.5	2029.49	I	16396-65653	1.8	2474.57	I	18464-58863
5	2039.77	I	9854-58863	18	2478.32	I	16396-56733
14	2049.57	I	8512-57287	3.5	2480.44	I	16396-56699
55	2068.33	I	0-48332	3.0	2510.54	I	8512-48332
10	2098.41	I	8512-56152	320	2528.52	I	9854-49391
2.5	2118.48	I	18464-65653	1.2	2554.64	I	18464-57597
5	2127.39	I	0-46991	8	2574.06	I	16396-55233
10	2139.69	I	8512-55233	600	2598.05	I	8512-46991
5	2141.83	I			2598.09	I	9854-48332
10	2144.86	I	8512-55121	34	2612.31	I	18464-56733
38	2175.81	I	0-45945	32	2652.60	I	18464-56152
7	2179.19	I	9854-55728	38	2670.64	I	8512-45945
2.5	2201.32	I	16396-61809	14	2682.76	I	18464-55728
7	2208.45	I	9854-55121	5	2692.25	I	16396-53528
5	2220.73	I	8512-53528	17	2718.90	I	18464-55233
2.5	2224.93	I	8512-53443	5	2727.23	I	18464-55121
7	2262.51	I	16396-60581	90	2769.95	I	9854-45945
2.0	2288.98	I	9854-53528	7	2851.11	I	18464-53528
7	2293.44	I	9854-53443	140	2877.92	I	8512-43249
4	2306.46	I	16396-59738	50	3029.83	I	16396-49391
45	2311.47	I	0-43249	100	3232.52	I	18464-49391
2.0	2360.50	I	16396-58747	85	3267.51	I	16396-46991
4	2373.67	I	18464-60581	10	3383.15	I	16396-45945
4	2383.64	I	18464-60404	10	3637.83	I	18464-45945
4	2422.13	I	18464-59738	5	3722.79	I	16396-43249
6	2426.35	I	16396-57597	4	4033.55	I	18464-43249
18	2445.51	I	8512-49391				

# ARSENIC

As,  $Z=33$ ,  $M=74.92$ , Ratio  $\frac{\text{As}}{\text{Cu}}=1.179$

As I Normal state of valence electrons  $4s^2 4p^3 \ ^4S_{1/2}^{\circ}=0$ . I.P.= 79165 K  
 As II Normal state of valence electrons  $4s^2 4p^2 \ ^3P_0^{\circ}=0$ . I.P.=163000 K

## References

Wavelengths and Classification:

As I, W. F. Meggers, A. G. Shenstone, and C. E. Moore, J. Research NBS **45**, 346 (1950).

## Relative intensity of arsenic lines observed in an arc of copper containing 0.1 atomic percent of arsenic

### *Strong lines of arsenic*

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
140	2780.22	I	18648-54605	$4s^2 4p^3 \ ^2P_{1/2}^{\circ} - 4s^2 4p^2 5s^1 \ ^2P_{1/2}$
90	2860.44	I	18186-53136	$4s^2 4p^3 \ ^2P_{3/2}^{\circ} - 4s^2 4p^2 5s^1 \ ^2P_{3/2}$

## Arsenic — All Observed Lines

Intensity and Character	Wave- length in A	Spec- trum	Energy Levels in K	Intensity and Character	Wave- length in A	Spec- trum	Energy Levels in K
17	1936.96	I	0-51610	16	2370.77	I	18648-60815
28	1971.97	I	0-50694	18	2381.18	I	10915-52898
20	1989.70	I	10592-60835	9	2437.23	I	10592-51610
6	1990.48	I	10592-60815	36	2456.53	I	10915-51610
3.0	1994.78	I	18186-68301	44	2492.91	I	10592-50694
28	2003.34	I	10915-60815	44	2745.00	I	18186-54605
4	2009.19	I	18648-68403	140	2780.22	I	18648-54605
3.0	2013.32	I	18648-68301	90	2860.44	I	18186-53136
2.0	2165.52	I	18648-64812	20	2898.71	I	18648-53136
44	2288.12	I	10915-54605	3.0	2990.99	I	18186-51610
5	2344.03	I	18186-60835	8	3032.85	I	18648-51610
85	2349.84	I	10592-53136	4	3119.60	I	18648-50694
20	2369.67	I	18648-60835				

# BARIUM

$$\text{Ba, } Z=56, M=137.36, \text{ Ratio } \frac{\text{Ba}}{\text{Cu}}=2.162$$

Ba I Normal state of valence electrons  $5p^6 6s^2 {}^1S_0 = 0$ . I.P.=42032 K  
 Ba II Normal state of valence electrons  $5p^6 6s^1 {}^2S_{0\frac{1}{2}} = 0$ . I.P.=80687 K

## References

### Wavelengths:

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F. Sullivan and K. Burns, Sci. Studies St. Bonaventure Coll. **9**, 7 (1941).

H. N. Russell and C. E. Moore, J. Research, NBS **55**, 299 (1955).

### Classification:

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### Intensities:

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A. M. Kruithof, Physica **10**, 493 (1943).

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## Relative intensity of barium lines observed in an arc of copper containing 0.1 atomic percent of barium

### *Strong lines of barium*

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
6500	4554.03	II	0-21952	$6s^1 {}^2S_{0\frac{1}{2}} - 6p^1 {}^2P_{i\frac{1}{2}}$
2000	4934.09	II	0-20262	$6s^1 {}^2S_{0\frac{1}{2}} - 6p^1 {}^2P_{o\frac{1}{2}}$
2000	6141.72	II	5675-21952	$5d^1 {}^2D_{2\frac{1}{2}} - 6p^1 {}^2P_{i\frac{1}{2}}$
1200	6496.90	II	4874-20262	$5d^1 {}^2D_{1\frac{1}{2}} - 6p^1 {}^2P_{o\frac{1}{2}}$
650	5535.48	I	0-18060	$6s^2 {}^1S_0 - 6s^1 6p^1 {}^1P_1$



Barium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
28	2304.24	II	4874-48259	650	5535.48	I	0-18060
55	2335.27	II	5675-48484	2.0	5680.18	I	9216-26816
6	2347.58	II	5675-48259	50	5777.62	I	13515-30818
6	2528.51	II	20262-59799	9	5800.23	I	13515-30751
10	2634.78	II	21952-59895	7	5805.68	I	9597-26816
3.0	2702.63	I	0-36990	30	5826.28	I	11395-28554
1.8	2771.36	II	21952-58025	280	5853.68	II	4874-21952
18	3071.58	I	0-32547	5	5907.64	I	9034-25957
50	3501.11	I	0-28554	50	5971.70	I	9216-25957
7	3889.33	I	0-25704	50	5997.09	I	9034-25704
140	3891.78	II	20262-45949	50	6019.47	I	9034-25642
3.0	3892.66	I	11395-37077	110	6063.12	I	9216-25704
10	3909.91	I	9034-34603	170	6110.78	I	9597-25957
14	3935.72	I	9216-34617	2000	6141.72	II	5675-21952
3.5	3937.87	I	9216-34603	50	6341.68	I	9216-24980
18	3993.40	I	9597-34631	36	6450.85	I	9034-24532
3.0	3995.66	I	9597-34617	60	6482.91	I	11395-26816
150	4130.66	II	21952-46155	1200	6496.90	II	4874-20262
6	4132.43	I	0-24192	160	6498.76	I	9597-24980
20	4166.00	II	21952-45949	70	6527.31	I	9216-24532
20	4283.10	I	11395-34736	65	6595.32	I	9034-24192
7	4350.33	I	12637-35617	32	6675.27	I	9216-24192
10	4402.54	I	12637-35344	32	6693.84	I	9597-24532
15	4431.89	I	12266-34823	1.6	6771.85	I	23074-37837
3.0	4488.97	I	13515-35785	6	6865.69	I	11395-25957
3.5	4493.64	I	13515-35762	1.2	6867.85	I	22947-37504
13	4505.92	I	12637-34823	140	7059.94	I	9597-23757
5	4523.24	I	13515-35617	19	7120.33	I	9034-23074
13	4524.93	II	20262-42355	0.6	7153.58	I	23757-37732
6500	4554.03	II	0-21952	6	7195.24	I	12266-26160
8	4573.85	I	12637-34494	2.0	7228.84	I	22065-35894
14	4579.64	I	13515-35344	95	7280.30	I	9216-22947
4	4599.75	I	12637-34371	11	7392.41	I	12637-26160
2.0	4619.98	I	12266-33905	2.0	7417.53	I	9597-23074
3.0	4673.62	I	9597-30987	3.0	7459.78	I	22947-36349
13	4691.62	I	13515-34823	17	7488.08	I	9597-22947
3.0	4700.43	I	12637-33905	2.0	7610.48	I	23062-36200
8	4726.45	I	11395-32547	1.0	7636.90	I	23074-36165
40	4899.97	II	21952-42355	4	7642.91	I	23757-36837
1.8	4902.90	I	13515-33905	50	7672.09	I	9034-22065
2000	4934.09	II	0-20262	30	7780.48	I	9216-22065
3.0	4947.33	I	18060-38267	0.8	7839.57	I	24980-37732
2.0	5054.98	I	18060-37837	17	7905.75	I	13515-26160
6	5159.92	I	18060-37435	8	7911.34	I	0-12637
2.0	5267.03	I	18060-37041	6	8210.24	I	18060-30237
22	5424.55	I	12266-30696	40	8559.95	I	11395-23074
1.4	5473.69	I	12637-30751	3.0	8860.98	I	12637-23919
32	5519.05	I	12637-30751	3.5	8914.99	I	12266-23480

# BERYLLIUM

Be,  $Z=4$ ,  $M=9.013$ , Ratio  $\frac{\text{Be}}{\text{Cu}}=0.1418$

Be I Normal state of valence electrons  $2s^2 \ ^1S_0 = 0$ . I.P. = 75192 K  
 Be II Normal state of valence electrons  $2s^1 \ ^2S_{0\frac{1}{2}} = 0$ . I.P. = 146882 K

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### Classification:

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### Molecular Spectra:

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### Intensities:

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## Relative intensity of beryllium lines observed in an arc of copper containing 0.1 atomic percent of beryllium

### *Strong lines of beryllium*

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
480	3130.42	II	0-31935	$2s^1 \ ^2S_{0\frac{1}{2}} - 2p^1 \ ^2P_{1\frac{1}{2}}$
320	3131.07	II	0-31929	$2s^1 \ ^2S_{0\frac{1}{2}} - 2p^1 \ ^2P_{0\frac{1}{2}}$
300	2348.61	I	0-42565	$2s^2 \ ^1S_0 - 2s^1 2p^1 \ ^1P_1$

## Beryllium — All Observed Lines

Intensity and Character	Wave- length in A	Spec- trum	Energy Levels in K	Intensity and Character	Wave- length in A	Spec- trum	Energy Levels in K
5.0	h	2174.94	I	480	3130.42	II	0-31935
		2175.07	I	320	3131.07	II	0-31929
300		2348.61	I	60	3321.01	I	21979-52082
70		2494.56	I		3321.09	I	21980-52082
		2494.58	I	100	3321.34	I	21982-52082
100		2494.73	I	12	4572.67	I	42565-64428
140	c	2650.47	I	7	bl	4708.60	BeO
		2650.55	I	4	h	8254.10	I
		2650.62	I				42565-54677
		2650.64	I				
		2650.64	I				
		2650.70	I				
		2650.78	I				

# BISMUTH

Bi,  $Z=83$ ,  $M=208.99$ , Ratio  $\frac{\text{Bi}}{\text{Cu}}=3.289$

Bi I Normal state of valence electrons  $6s^2 6p^3 \ ^4S_{3/2}=0$ . I.P.= 58790 K  
 Bi II Normal state of valence electrons  $6s^2 6p^2 \ ^3P_0=0$ . I.P.=134600 K

## References

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### Classification:

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### Intensities:

N. N. Sobolev, J. Exptl. Theoret. Phys. (U.S.S.R.) **13**, 130 (1943).

## Relative intensity of bismuth lines observed in an arc of copper containing 0.1 atomic percent of bismuth

### *Strong lines of bismuth*

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
3600	3067.72	I	0-32588	$6s^2 6p^3 \ ^4S_{3/2} - 6s^2 6p^2 7s^1 \ ^4P_{0 3/2}$
400	2897.98	I	11418-45915	$6s^2 6p^3 \ ^2D_{3/2} - 6s^2 6p^2 7s^1 \ ^2P_{0 3/2}$

## Bismuth — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
17	1953.89	I	0-51158	400	2897.98	I	11418-45915
3.5	1959.48	I	0-51019	320	2938.30	I	15437-49461
8	2021.21	I	0-49461	280	2989.03	I	11418-44865
55	2061.70	I	0-48489	70	2993.34	I	11418-44817
10	2110.26	I	0-47371	240	3024.64	I	15437-48489
7	2133.63	I	11418-58272	6	3034.87	I	
3.0	2228.25	I	0-44865	3600	c 3067.72	I	0-32588
14	2230.61	I	0-44817	14	c 3076.66	I	11418-43912
5	2276.58	I	0-43912	55	c 3397.21	I	15437-44865
11	2400.88	I	15437-57075	50	c 3510.85	I	15437-43912
2.5	2515.69	I	11418-51158	38	c 3596.11	I	21660-49461
7	2524.49	I	11418-51019	14	c 4121.53	I	21660-45915
70	2627.91	I	11418-49461	14	c 4121.86	I	
28	c 2696.76	I	11418-48489	60	c 4722.19	I	11418-32588
14	d 2730.50	I	21660-58272				
							4722.55
							4722.83
36	c 2780.52	I	11418-47371				
14	c 2809.62	I	15437-51019	1.0	c 5552.35	I	

# BORON

$$B, Z=5, M=10.82, \text{Ratio } \frac{B}{Cu}=0.1703$$

B I Normal state of valence electrons  $2s^2 2p^1 \ ^2P_{0\frac{1}{2}}=0$ . I.P.= 66930 K  
 B II Normal state of valence electrons  $2s^2 \ ^1S_0=0$ . I.P.=202895 K

## References

Wavelengths:

G. R. Harrison, Massachusetts Institute of Technology Wavelength Tables (John Wiley & Sons, New York, 1939).

Classification:

B I, H. E. Clearman, J. Opt. Soc. Am. **42**, 373 (1952).

**Relative intensity of boron lines observed in an arc of copper containing 0.1 atomic percent of boron**

*Strong line of boron*

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
480	2497.73	I	16-40040	$2s^2 2p^1 \ ^2P_{1\frac{1}{2}} - 2s^2 3s^1 \ ^2S_{0\frac{1}{2}}$

## Boron — All Observed Lines

Intensity and Character	Wave- length in A	Spec- trum	Energy Levels in K	Intensity and Character	Wave- length in A	Spec- trum	Energy Levels in K
7	2088.93	I	0-47857	240	2496.78	I	0-40040
11	2089.59	I	16-47857	480	2497.73	I	16-40040

# CADMIUM

$$\text{Cd, } Z=48, M=112.41, \text{ Ratio } \frac{\text{Cd}}{\text{Cu}}=1.769$$

Cd I Normal state of valence electrons  $4d^{10}5s^2\ ^1S_0 = 0$ . I.P. = 72539 K

Cd II Normal state of valence electrons  $4d^{10}5s^1\ ^2S_{0\frac{1}{2}} = 0$ . I.P. = 136375 K

## References

### Wavelengths:

G. R. Harrison, Massachusetts Institute of Technology, Wavelength Tables (John Wiley & Sons, New York, 1939).

### Classification:

Cd I, A. Fowler, Report on Series in Line Spectra (Fleetway Press, London, 1922).

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### Intensities:

W. Kuhn, Naturwiss. **14**, 48 (1926).

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R. B. King and D. C. Stockbarger, Astrophys. J. **91**, 488 (1940).

C. G. Matland, Phys. Rev. **91**, 436 (1953).

J. P. A. van Hengstum and J. A. Smit, Physica **22**, 86 (1956).

## Relative intensity of cadmium lines observed in an arc of copper containing 0.1 atomic percent cadmium

### *Strong lines of cadmium*

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
1500	2288. 02	I	0-43692	$4d^{10}5s^2\ ^1S_0 - 4d^{10}5s^15p^1\ ^1P_1$
360	3610. 51	I	31827-59516	$4d^{10}5s^15p^1\ ^3P_2 - 4d^{10}5s^15d^1\ ^3D_3$

## Cadmium — All Observed Lines

Intensity and Character	Wave- length in A	Spec- trum	Energy Levels in K	Intensity and Character	Wave- length in A	Spec- trum	Energy Levels in K
60	2144. 38	II	0-46619	5	3133. 17	I	30656-62563
110	2265. 02	II	0-44136	32	3261. 06	I	0-30656
2.0	2267. 47	I	30656-74745	80	3403. 65	I	30114-59486
1500	2288. 02	I	0-43692	250	3466. 20	I	30656-59498
8	2306. 61	I	30656-73996	80	3467. 66	I	30656-59486
4	2312. 84	II	46619-89844	360	3610. 51	I	31827-59516
8	h 2329. 28	I	31827-74745	70	3612. 88	I	31827-59498
5	2572. 93	II	44136-82991	7	3614. 45	I	31827-59486
5	h 2836. 91	I	30114-65354	80	4678. 16	I	30114-51484
8	h 2880. 77	I	30656-65359	140	4799. 92	I	30656-51484
2.0	2881. 23	I	30656-65354	280	5085. 82	I	31827-51484
16	h 2980. 63	I	31827-65367	26	h 6438. 47	I	43692-59220

# CALCIUM

$$\text{Ca, } Z=20, M=40.08, \text{ Ratio } \frac{\text{Ca}}{\text{Cu}}=0.6308$$

Ca I Normal state of valence electrons  $4s^2 \ ^1S_0 = 0$ . I.P.=49305 K  
 Ca II Normal state of valence electrons  $4s^1 \ ^2S_{0\frac{1}{2}} = 0$ . I.P.=95748 K

## References

### Wavelengths:

G. R. Harrison, Massachusetts Institute of Technology, Wavelength Tables (John Wiley & Sons, New York, 1939).

### Classification:

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C. E. Moore, Atomic Energy Levels, NBS Circ. 467, Vol. 1 (1949).

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C. E. Moore, An Ultraviolet Multiplet Table, NBS Circ. 488, Sec. 1 (1950).

### Intensities:

J. W. Schuttevaer, M. J. deBont, and T. H. van den Broek, Physica **10**, 544 (1943).

K. H. Olsen, P. M. Routly, and R. B. King, Astrophys. J. **130**, 688 (1959).

## Relative intensity of calcium lines observed in an arc of copper containing 0.1 atomic percent calcium

### *Strong lines of calcium*

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
4200	3933. 67	II	0-25414	$3p^6 4s^1 \ ^2S_{0\frac{1}{2}} - 3p^6 4p^1 \ ^2P_{1\frac{1}{2}}$
2200	3968. 47	II	0-25192	$3p^6 4s^1 \ ^2S_{0\frac{1}{2}} - 3p^6 4p^1 \ ^2P_{3\frac{1}{2}}$
1100	4226. 73	I	0-23652	$3p^6 4s^2 \ ^1S_0 - 3p^6 4s^1 4p^1 \ ^1P_1$

Calcium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
4	2398.56	I	0-41679	10	h 5188.85	I	23652-42919
3.0	2721.64	I	0-36732	11	5261.70	I	20335-39335
3.5	2994.96	I	15158-48538	13	5262.25	I	20335-39333
2.0	2997.31	I	15210-48564	11	5264.24	I	20349-39340
2.0	2999.64	I	15210-48538	28	5265.56	I	20349-39335
2.0	3000.86	I	15210-48524	48	5270.28	I	20371-39340
7	3006.86	I	15316-48564	16	5349.47	I	21850-40538
3.0	3009.20	I	15316-48538	2.5	h 5512.96	I	23652-41786
20	3158.87	II	25192-56839	12	5581.97	I	20349-38259
50	3179.33	II	25414-56859	70	5588.75	I	20371-38259
9	3181.28	II	25414-56839	10	5590.11	I	20335-38219
5	3624.11	I	15158-42743	36	5594.45	I	20349-38219
10	3630.75	I	15210-42745	24	5598.47	I	20335-38192
10	3644.41	I	15316-42747	12	5601.26	I	20371-38219
12	3706.03	II	25192-52167	12	5602.84	I	20349-38192
15	3736.90	II	25414-52167	22	5857.46	I	23652-40720
4200	3933.67	II	0-25414	34	6102.72	I	15158-31540
1.2	3948.90	I	15158-40474	95	6122.22	I	15210-31540
3.5	3957.05	I	15210-40474	3.0	6161.29	I	20349-36575
2200	3968.47	II	0-25192	140	6162.17	I	15316-31540
14	3973.71	I	15316-40474	3.0	h 6163.76	I	20335-36555
1100	4226.73	I	0-23652	6	h 6166.44	I	20335-36548
24	4283.01	I	15210-38552	7	6169.05	I	20349-36555
22	4289.36	I	15158-38465	14	h 6169.56	I	20371-36575
20	4298.99	I	15210-38465	70	6439.07	I	20371-35897
110	4302.53	I	15316-38552	18	6449.81	I	20335-35835
26	4307.74	I	15210-38418	3.5	6455.60	I	20349-35835
40	4318.65	I	15316-38465	70	6462.57	I	20349-35819
30	4425.44	I	15158-37748	8	6471.66	I	20371-35819
65	4434.96	I	15210-37752	32	6493.78	I	20335-35730
18	4435.69	I	15210-37748	8	6499.65	I	20349-35730
140	4454.78	I	15316-37757	2.0	6572.78	I	0-15210
18	4455.89	I	15316-37752	4	h 6717.68	I	21850-36732
1.0	4456.62	I	15316-37748	19	7148.15	I	21850-35835
1.6	h 4526.94	I	21850-43933	9	7202.19	I	21850-35730
2.5	4578.56	I	20335-42170	6	h 7326.15	I	23652-37298
5	4581.40	I	20349-42171	12	8498.02	II	13650-25414
8	4585.87	I	20371-42171	100	8542.09	II	13711-25414
5	h 4878.13	I	21850-42344	55	8662.14	II	13650-25192
6	h 5041.62	I	21850-41679				

## CARBON

$$\text{C, } Z=6, M=12.011, \text{ Ratio } \frac{\text{C}}{\text{Cu}}=0.1890$$

C I Normal state of valence electrons  $2s^2 2p^2 \ ^3P_0 = 0$ . I.P. = 90878 K  
 C II Normal state of valence electrons  $2s^2 2p^1 \ ^2P_{0\frac{1}{2}} = 0$ . I.P. = 196659 K

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#### Wavelengths:

G. R. Harrison, Massachusetts Institute of Technology Wavelength Tables (John Wiley & Sons, New York, 1939).

#### Classification:

C I, A. Fowler and E. H. Selwyn, Proc. Roy. Soc. (London) [A] **118**, 34 (1928).

#### Intensities:

H. Maecker, Z. Physik **135**, 13 (1953).  
 J. Richter, Z. Physik **151**, 114 (1958).

### Relative intensity of carbon line observed in an arc of copper containing 0.1 atomic percent of carbon

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
10	2478.57	I	21648-61982	$2s^2 2p^2 \ ^1S_0 - 2s^2 2p^1 3s^1 \ ^1P_1$

## CERIUM

$$\text{Ce, } Z=58, M=140.13, \text{ Ratio } \frac{\text{Ce}}{\text{Cu}}=2.205$$

Ce I Normal state of valence electrons  $4f^2 6s^2 \ ^3H_4 = 0$ . I.P.  $\approx 45000$  K  
 Ce II Normal state of valence electrons  $4f^1 5d^1 6s^1 \ ^4H_{3\frac{1}{2}} = 0$ .

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#### Wavelengths:

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#### Classification:

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Relative intensity of cerium lines observed in an arc of copper containing 0.1 atomic percent of cerium

Strong lines of cerium

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
250	4186.60	II	6968-30847	$4f^26s a \ ^4H_{6\frac{1}{2}} - 4f^26p z \ ^4I_{7\frac{1}{2}}$
220	3952.54	II	2642-27935	$11\ ^3_{\frac{3}{2}} - \ ^4H_{4\frac{1}{2}}$
200	3801.53	II	6638-31931	$46\ ^4_{\frac{1}{2}} - \ 159\ ^4_{\frac{1}{2}}$
200	3999.24	II	7234-33531	$^4G_{5\frac{1}{2}} - \ 179\ ^6_{\frac{1}{2}}$
			2382-27380	$^4H_{3\frac{1}{2}} - \ ^4I_{5\frac{1}{2}}$
190	3942.75	II	6913-32269	$^4H_{6\frac{1}{2}} - \ ^4I_{7\frac{1}{2}}$
190	4012.39	II	4523-29439	$^4H_{4\frac{1}{2}} - \ ^4G_{5\frac{1}{2}}$
190	4133.80	II	6968-31152	$4f^26s a \ ^4H_{6\frac{1}{2}} - 4f^26p z \ ^4G_{5\frac{1}{2}}$
170	4460.21	II	3854-26268	$4f^26s a \ ^4H_{3\frac{1}{2}} - 4f^26p z \ ^4H_{3\frac{1}{2}}$
160	3655.85	II	2563-29909	$^4I_{5\frac{1}{2}} - \ ^4H_{4\frac{1}{2}}$
150	4040.76	II	3594-28335	$15\ ^4_{\frac{1}{2}} - \ 117\ ^4_{\frac{1}{2}}$
150	4562.36	II	3854-25766	$4f^26s a \ ^4H_{3\frac{1}{2}} - 4f^26p z \ ^4I_{3\frac{1}{2}}$
140	3942.15	II	0-25360	$^4H_{3\frac{1}{2}} - \ ^4G_{2\frac{1}{2}}$
140	4137.65	II	4166-28327	$4f^26s a \ ^4H_{4\frac{1}{2}} - 4f^26p z \ ^4H_{5\frac{1}{2}}$
140	4289.94	II	2642-25945	$11\ ^3_{\frac{3}{2}} - \ 104\ ^3_{\frac{3}{2}}$
140	4296.67	II	4166-27433	$4f^26s a \ ^4H_{4\frac{1}{2}} - 4f^26p z \ ^4H_{3\frac{1}{2}}$
130	4073.48	II	3854-28396	$4f^26s a \ ^4H_{3\frac{1}{2}} - 4f^26p z \ ^4G_{2\frac{1}{2}}$
120	3882.45	II	2596-28345	$^4F_{1\frac{1}{2}} - \ 119\ ^0_{\frac{1}{2}}$
120	4391.66	II	2596-25360	$^4F_{1\frac{1}{2}} - \ ^4G_{2\frac{1}{2}}$
120	4628.16	II	4166-25766	$4f^26s a \ ^4H_{4\frac{1}{2}} - 4f^26p z \ ^4I_{3\frac{1}{2}}$
110	3560.80	II	5969-34044	$^2I_{3\frac{1}{2}} - \ 187\ ^4_{\frac{1}{2}}$
110	3716.37	II	0-26900	$^4H_{3\frac{1}{2}} - \ ^4H_{3\frac{1}{2}}$
110	4075.71	II	5651-30180	$^4H_{5\frac{1}{2}} - \ ^4I_{6\frac{1}{2}}$
110	4075.85	II	4911-29439	$^2H_{3\frac{1}{2}} - \ ^4G_{5\frac{1}{2}}$
110	4222.60	II	988-24663	$^4H_{4\frac{1}{2}} - \ ^4I_{4\frac{1}{2}}$
100	3854.19	II	1874-27812	$^4H_{3\frac{1}{2}} - \ 112\ ^2_{\frac{1}{2}}$
100	3854.32	II	1874-27811	$^4H_{3\frac{1}{2}} - \ ^4H_{3\frac{1}{2}}$
100	4151.97	II	5514-29592	$4f^26s a \ ^4H_{5\frac{1}{2}} - 4f^26p z \ ^4H_{6\frac{1}{2}}$
100	4471.24	II	5617-27976	$4f^26s a \ ^2H_{4\frac{1}{2}} - 4f^26p z \ ^2H_{4\frac{1}{2}}$
95	3577.46	II	3794-31738	$^4I_{6\frac{1}{2}} - \ ^4H_{5\frac{1}{2}}$
90	3201.71	II	6913-38138	$^4H_{6\frac{1}{2}} - \ 232\ ^5_{\frac{1}{2}}$
90	3272.25	II	5651-36202	$^4H_{5\frac{1}{2}} - \ 213\ ^4_{\frac{1}{2}}$
90	3838.54	II	2642-28686	$11\ ^3_{\frac{3}{2}} - \ 121\ ^2_{\frac{1}{2}}$
90	3878.37	II	1410-27187	$^4I_{4\frac{1}{2}} - \ 107\ ^3_{\frac{1}{2}}$
90	4165.61	II	7341-31340	$4f^26s a \ ^2H_{5\frac{1}{2}} - 4f^26p z \ ^2I_{6\frac{1}{2}}$
85	3709.29	II	4204-31156	$^4H_{6\frac{1}{2}} - \ ^4H_{6\frac{1}{2}}$
85	3709.93	II	988-27935	$^4H_{4\frac{1}{2}} - \ ^4H_{4\frac{1}{2}}$
85	3808.12	II	2382-28634	$^4H_{4\frac{1}{2}} - \ 120\ ^5_{\frac{1}{2}}$
85	3889.99	II	5456-31156	$^4I_{7\frac{1}{2}} - \ ^4H_{6\frac{1}{2}}$
80	3221.17	II	4523-35559	$^4H_{4\frac{1}{2}} - \ ^4G_{5\frac{1}{2}}$
80d	3623.84	II	6390-33977	$43\ ^4_{\frac{1}{2}} - \ 186\ ^3_{\frac{1}{2}}$
80	3660.64	II	988-28298	$^4H_{4\frac{1}{2}} - \ ^4G_{3\frac{1}{2}}$
80	3667.98	II	2880-30135	$^4H_{5\frac{1}{2}} - \ ^4H_{5\frac{1}{2}}$
80	4198.67	II	7341-31152	$4f^26s a \ ^2H_{5\frac{1}{2}} - 4f^26p z \ ^4G_{5\frac{1}{2}}$
80	4198.72	II	4166-27976	$4f^26s a \ ^4H_{4\frac{1}{2}} - 4f^26p z \ ^2H_{4\frac{1}{2}}$
75	4071.81	II	2635-27187	$10\ ^2_{\frac{1}{2}} - \ 107\ ^3_{\frac{1}{2}}$
75	4248.68	II	5514-29044	$4f^26s a \ ^4H_{5\frac{1}{2}} - 4f^26p z \ ^4I_{6\frac{1}{2}}$
75	4572.28	II	5514-27379	$4f^26s a \ ^4H_{5\frac{1}{2}} - 4f^26p z \ ^4I_{5\frac{1}{2}}$
70	3539.09	II	2581-30829	$^2G_{4\frac{1}{2}} - \ 145\ ^3_{\frac{1}{2}}$
70	3786.63	II	1410-27812	$^4I_{4\frac{1}{2}} - \ ^4H_{3\frac{1}{2}}$
70	3848.60	II	4204-30180	$^4H_{6\frac{1}{2}} - \ ^4I_{6\frac{1}{2}}$
70	3853.16	II	0-25945	$^4H_{3\frac{1}{2}} - \ 104\ ^3_{\frac{1}{2}}$
70	3956.28	II	4911-30180	$^2H_{5\frac{1}{2}} - \ ^4I_{6\frac{1}{2}}$
70	4123.87	II	6913-31156	$^4H_{6\frac{1}{2}} - \ ^4H_{6\frac{1}{2}}$
70	4127.37	II	5514-29735	$4f^26s a \ ^4H_{3\frac{1}{2}} - 4f^26p z \ ^4G_{4\frac{1}{2}}$
70	4149.94	II	5819-29909	$38\ ^4_{\frac{1}{2}} - \ ^4H_{4\frac{1}{2}}$
70	4239.91	II	3854-27433	$4f^26s a \ ^4H_{3\frac{1}{2}} - 4f^26p z \ ^4H_{4\frac{1}{2}}$
70	4337.78	II	2635-25682	$10\ ^2_{\frac{1}{2}} - \ 103\ ^1_{\frac{1}{2}}$
70	4418.78	II	6968-29592	$4f^26s a \ ^4H_{6\frac{1}{2}} - 4f^26p z \ ^4H_{6\frac{1}{2}}$

Cerium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
6	2461.48			6	2745.72		
9	2462.97			8	2750.89	II	5651-41992
4	2464.36			3.0	2756.80		
3.0	2473.39			12	2761.42	II	0-36202
3.0	2486.37			7	2762.22	II	8403-44595
4	2498.98			3.0	2762.90	II	6390-42573
6	2513.30			3.0	2767.01		
8	2518.51			4	2780.01	II	2581-38542
3.0	2519.02	II	988-40674	3.0	2781.89	II	988-36924
6	2543.09			3.0	2781.99	II	6638-42573
14	d 2548.68			10	2784.27		
2.0	2551.77			8	2785.35		
2.5	2562.42			8	2790.53		
4	2569.17			11	2791.42		
2.5	2569.88			3.5	2803.04		
5	2573.14			3.0	2810.18	II	2563-38138
2.0	2592.34	II	2635-41198	2.5	2811.87	II	2581-38134
5	2609.50			7	2814.81	II	6518-42034
2.0	2609.90			5	2814.96	II	7059-42573
5	2613.90			5	2817.50	II	5716-41198
6	2635.15			22	2830.90	II	7259-42573
2.5	2647.11			8	2833.31		
2.0	2648.30			3.5	2835.60	II	5943-41198
2.5	2649.33			2.5	d 2837.89	II	6521-41748
24	2651.01				2837.99	II	0-35226
2.5	2656.84			3.0	2839.36	II	2596-37804
6	2666.50	II	3594-41085	1.8	2841.72	II	8281-43461
4	2673.07	II	1410-38810	2.5	2842.52	II	2635-37804
5	2682.73	II	3594-40858	1.8	2842.83		
2.5	2687.99			3.0	2845.45		
2.5	2691.69			3.5	2849.03	II	3363-38453
15	d 2695.96	II	4911-41992	7	2854.67	II	1874-36894
	2696.07	II	1874-38954	7	2854.88	II	2635-37652
10	2706.88	II	4266-41198	3.5	2855.32		
3.0	2708.13	II	5119-42034	3.5	2855.45	II	2642-37652
3.0	2709.41	II	5676-42573	3.5	2855.72	II	2581-37588
9	2715.17	II	2581-39400	6	2858.01		
	2715.24			3.0	2859.52	II	9634-44595
3.0	2717.28			1.8	2861.35	II	988-35926
3.0	2719.98	II	5819-42573	3.5	2861.62	II	2596-37531
10	2723.38			4	2862.79	II	0-34921
3.0	2724.95	II	2635-39322	3.0	2866.81	II	4523-39395
2.5	2729.16	II	5943-42573	3.5	2871.08	II	988-35808
2.0	d 2730.70			2.0	2871.63	II	0-34813
	2730.80	II	5965-42573	20	2874.14		
2.5	2732.04	II	4266-40858	6	2880.64	II	5969-40674
4	2732.17			3.0	2881.13	II	7294-41992
5	2732.83			6	2882.61	II	6518-41198
3.0	2736.33			4	2885.29		
9	2741.96			3.5	2888.70		

Cerium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
3.0	2890.17			10	3003.56	II	2642-35926
1.4	2892.03	II	4266-38833	7	3008.13	II	6638-39872
1.4	2892.15	II	6518-41085	32	3008.79	II	2581-35808
4	2894.09	II	4266-38810	4	3011.88	II	4460-37652
5	2894.22	II	2382-36924	30	3017.20	II	5676-38810
7	2896.73	II	2382-36894	6	3020.88	II	5716-38810
9	2908.42	II	4460-38833	4	3021.04	II	5437-38529
2.5	2912.91	II	10275-44595	2.5	3022.79		
2.5	2915.56	II	3363-37652	5	3023.43	II	4523-37588
3.5	2916.68	II	4266-38542		3023.49	II	8928-41992
8	2918.67	II	2642-36894	3.0	3024.57		
2.0	2918.78	II	4202-38453	3.0	3026.62	II	4202-37232
3.0	2922.37			2.0	3027.63	II	4323-37342
2.0	2922.58	II	4323-38529	5	3028.96	II	6390-39395
6	2925.19	II	2880-37056	14	3030.31	II	5819-38810
2.5	2929.11	II	4323-38453	3.0	3032.73	II	2382-35346
2.0	2934.35	II	4460-38529	6	3033.12	II	4845-37804
3.0	2939.54			17	3037.73	II	4323-37232
3.5	h 2940.79	II	3594-37588	3.5	3039.51	II	5651-38542
5	2944.35			3.5	3044.40	II	5011-37849
4	2950.30			5	3046.71	II	5716-38529
3.5	2955.60	II	7259-41083	3.0	3050.59		
10	2955.94	II	2382-36202	16	3051.98	II	4323-37079
2.5	2956.71	II	0-33812	28	3055.24	II	4511-37232
4	2959.11			26	3056.78	II	2642-35346
9	2964.80	II	5676-39395	3.5	3058.55	II	5119-37804
7	2965.27	II	5119-38833	2.0	3059.74	II	4523-37196
3.5	2970.32	II	3996-37652	55	3063.01	II	7234-39872
8	2972.58	II	4911-38542	5	3068.68	II	4266-36844
4	2974.48			7	3069.64	II	4511-37079
4	2974.61	II	4845-38453	6	3071.11	II	1874-34426
32	2976.91	II	4266-37849	7	3071.62	II	2382-34929
12	2977.46	II	5819-39395	4	3072.39	II	2382-34921
10	2980.41			8	3072.89	II	5119-37652
7	2981.91	II	4323-37849	3.5	3076.25	II	4845-37342
4	2984.56	II	2642-36138	5	3077.33	II	5651-38138
8	2985.82	II	4323-37804	4	3077.64		
	2985.91	II	3363-36844	8	3079.64	II	5676-38138
2.0	2986.67	II	1874-35346	7	3079.91	II	1874-34333
20	2990.87	II	2382-35808	6	3080.64		
3.0	2991.72			8	3082.30	II	3704-36138
2.0	2991.90			26	3083.67	II	6390-38810
9	2994.42	II	4266-37652	20	3084.44	II	5437-37849
26	2995.64	II	5437-38810	16	3090.37	II	7523-39872
4	2998.77	II	4511-37849	6	3090.52	II	2581-34929
3.5	2999.43	II	3594-36924	5	3091.29	II	2581-34921
	2999.48	II	4323-37652	3.5	3095.59	II	5675-37971
6	3000.07	II	2880-36202	14	3096.50	II	4911-37196
13	3002.14	II	3594-36894	5	3096.88	II	1874-34155
15	3002.75	II	4511-37804	3.0	3097.08		

Cerium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
3.5	3102.56	II	3704-35926	18	3199.28	II	5676-36924
30	3103.38	II	3594-35808	4	d 3200.52	II	4323-35559
7	3104.01	II	3996-36202	90	3201.71	II	6913-38138
16	3107.47	II	6638-38810	9	3205.96	II	7012-38195
8	3108.96	II	8928-41083	9	3210.95	II	6518-37652
26	3110.28	II	3996-36138	18	3218.38	II	3363-34426
24	3111.17	II	2635-34768	65	3218.94	II	6913-37971
3.5	3114.05	II	1874-33977	9	3220.87		
3.5	3123.57	II	4511-36517	80	3221.17	II	4523-35559
18	3127.53	II	3594-35559	4	3222.41	II	4202-35226
18	3130.33	II	4266-36202	4	3223.37	II	7818-38833
22	3130.87	II	0-31931	30	3225.67	II	8403-39395
13	3132.59	II	2382-34295	65	3227.11	II	2596-33574
15	3133.33	II	5943-37849	9	3229.12	II	4266-35226
15	3136.72	II	4266-36138	22	3229.36	II	2596-33553
9	3137.60	II	3363-35226	4	3230.08	II	988-31938
4	3138.30	II	3704-35559	44	3231.24	II	3996-34934
9	3142.31	II	988-32802	13	3233.44	II	2635-33553
18	3144.60	II	2635-34426	65	3234.16	II	2642-33553
26	3145.28	II	2642-34426	30	3234.89	II	7234-38138
4	3146.23	II	5119-36894	4	3235.01		
26	3146.41	II	2382-34155	7	3235.67	II	4911-35808
9	3148.46	II	3594-35346	36	3236.74	II	4460-35346
6	3148.65	II	7059-38810	36	3243.37	II	4523-35346
4	3149.43	II	4460-36202	9	3245.17	II	4460-35266
7	3151.13	II	5119-36844	18	3246.67	II	3363-34155
12	3154.51	II	2642-34333	9	3249.19	II	2642-33410
30	d 3155.69	II	4523-36202	4	3249.43	II	4460-35226
	3155.79	II	1874-33553	13	3252.48	II	7234-37971
26	3164.15	II	2382-33977	13	3254.01	II	3704-34426
13	3166.24	II	2581-34155	9	3258.87	II	7294-37971
9	3166.61	II	2596-34166	18	3260.98	II	8176-38833
4	3167.23	II	9634-41198	13	3263.45	II	8176-38810
4	3167.32	II	3996-35559	18	3263.88	II	3704-34333
26	3169.18	II	5651-37196	4	3265.42	II	7523-38138
26	3171.61	II	2635-34155	9	3271.15	II	3594-34155
4	3172.30	II	2642-34155	9	3271.55	II	6638-37196
12	3176.80	II	8403-39872	4	3271.96		
4	3177.14	II	4460-35926		3272.06	II	2596-33149
4	3178.75	II	3363-34813	90	3272.25	II	5651-36202
4	3180.82	II	2382-33812	30	3274.86	II	5676-36202
44	3183.52	II	4523-35926	13	3276.25	II	2635-33149
7	3184.21	II	2581-33977	13	3279.01	II	5437-35926
22	3186.13	II	5819-37196	18	3279.84	II	2382-32863
16	3188.79	II	3996-35346	7	3280.49	II	4460-34934
9	3189.64	II	2635-33977	4	3281.10		
18	3190.34	II	2642-33977	9	3283.35	II	7523-37971
4	3193.33			6	3283.68	II	2635-33080
65	3194.83	II	4911-36202	4	3284.22	II	5119-35559
4	3195.94	II	2596-33876	30	3285.22	II	3996-34426

Cerium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
9	3286.03	II	4511-34934	22	3366.55	II	4460-34155
9	3290.34	II	3594-33977	5	3368.69	II	2642-32318
4	3290.58	II	4845-35226	4	3368.79		
4	3293.59	II	4460-34813	18	3371.17	II	4511-34166
22	3295.29	II	3996-34333	18	3373.46	II	2563-32198
13	3296.19	II	7259-37588	18	3373.73	II	4523-34155
18	3296.88	II	6521-36844	7	3375.78	II	8928-38542
9	3299.99			44	3377.13	II	4911-34514
20	3300.15	II	5819-36112	13	3379.17	II	4460-34044
22	3304.84	II	5676-35926	9	3381.49	II	6638-36202
13	3306.63	II	5969-36202	18	3383.69	II	4266-33811
13	3307.23	II	2635-32863	7	3387.78	II	5716-35226
22	3308.02	II	2581-32802	9	3390.52	II	3594-33080
	3308.09	II	988-31208	9	3393.92	II	4204-33660
9	3309.27	II	5716-35926	6	3394.14	II	4523-33977
13	3311.50	II	3363-33553	3.5	3396.72	II	3746-33177
18	3312.22	II	8897-39079	4	3400.25	II	7523-36924
6	3313.30	II	5965-36138	7	3403.60	II	4202-33574
9	3314.04	II	0-30166	3.5	3404.13		
22	3314.72	II	3996-34155	18	3404.91	II	1874-31235
18	3317.80	II	5676-35808	22	3405.98	II	4460-33812
12	3318.96	II	5437-35559	4	3407.24	II	11743-41083
4	3320.42	II	3704-33812	8	3416.56	II	5965-35226
4	3325.06			13	3416.86	II	988-30246
16	3325.33	II	8131-38195	26	3417.45	II	5676-34929
4	3327.66	II	2596-32638	7	3417.90	II	8403-37652
6	3327.90	II	5676-35716	9	3418.93		
13	3329.00	II	4737-34768	13	3420.18	II	4323-33553
7	3330.48			7	3422.51	II	8928-38138
4	3331.22	II	4323-34333	55	3422.71	II	3594-32802
9	3333.04	II	0-29994	10	3423.85	II	9634-38833
9	3333.66	II	5819-35808	7	3425.34	II	2382-31568
18	3334.46	II	10058-40040	6	3425.94	II	7713-36894
9	3339.51	II	2382-32318	36	3426.21	II	988-30166
7	h 3340.89	II	5011-34934	7	3426.58	II	2563-31738
22	3341.87	II	4511-34426	12	3430.32	II	7059-36202
30	3343.86	II	5819-35716	6	3431.50	II	4911-34044
40	3344.76	II	4266-34155	16	3433.09	II	10275-39395
9	3346.52	II	4460-34333	7	3435.20	I	
13	3349.97	II	5716-35559		3435.21	II	5819-34921
9	3352.28	II	4511-34333	7	3437.81	I, II	
16	3352.94	II	3594-33410	13	3439.83	II	4511-33574
	3352.99	II	2382-32198	26	3441.21	II	2880-31931
7	3353.33	II	6390-36202	13	3442.38	II	4511-33553
18	3355.02	II	1410-31208	6	3442.96	II	5119-34155
16	3356.41	II	3363-33149	8	3446.72	II	2563-31568
22	3357.22	II	4266-34044	7	3451.56	II	5965-34929
18	3360.54	II	11310-41059	4	3454.81	I	
16	3361.76	II	3794-33531	4	3456.67	II	988-29909
9	3364.35	II	988-30703	9	3456.77	II	6638-35559

Cerium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
7	3459.83	II	9634-38529	6	3528.05	II	5819-34155
4	3460.16	II	2140-31033	4	3528.64		
9	3461.34	II	4266-33149	4	3529.04	II	5716-34044
4	3461.79	II	7259-36138	15	3530.02	II	2382-30703
9	3463.22	II	7059-35926	8	3530.95	II	4737-33050
9	3463.76	II	5651-34514	8	3531.59	II	4737-33045
16	3464.21	II	5119-33977	8	3532.61	II	7259-35559
4	3467.78	II	1874-30703	8	3532.88	II	0-28298
9	3468.11	II	4323-33149	55	3534.05	II	4204-32492
7	d 3468.89	II	988-29807	14	3534.44	II	7523-35808
	3469.00	II	9634-38453				
4	3470.41	II	988-29794	8	3535.57	II	2880-31156
7	3474.22	II	3363-32139	10	3536.70	II	10275-38542
9	3475.68	II	1874-30637	6	3537.13		
44	3476.84	II	10642-39395	10	3537.44	II	5716-33977
7	3477.45	II	7059-35808	6	3538.79	II	6518-34768
9	3479.61	II	0-28731	70	3539.09	II	2581-30829
13	d 3480.27	II	0-28725	4	3541.66	II	3704-31931
	3480.38	II	3594-32318	8	3543.28	II	9634-37849
7	3480.98	II	12366-41085	4	3543.52	II	5943-34155
7	3481.16	II	5437-34155	19	3545.60	II	2880-31076
13	3482.14	II	3704-32413	15	3545.78	II	2382-30577
22	3482.35	II	4845-33553	26	3546.19	II	1874-30065
12	3484.74	II	2880-31568	14	3547.00	II	4323-32508
65	3485.05	II	0-28686	6	3548.84	II	9634-37804
16	3488.55	II	7059-35716	8	3551.43		
13	3490.13	II	5651-34295	11	3551.66	II	3704-31851
8	3493.11	II	4460-33080		3551.78	II	4266-32413
9	3493.72	II	3704-32318	5	3552.07	II	3594-31738
7	3495.01	II	3594-32198	22	3552.73	II	2563-30703
9	3495.94	II	4266-32863	10	3554.63		
7	3496.33	II	2642-31235	38	3554.99	II	2581-30703
5	3500.68			6	3556.89		
15	3501.45	II	1874-30425	3.5	3558.71	II	5716-33808
4	3506.25	II	2563-31076	110	3560.80	II	5969-34044
19	3507.95	II	1410-29909	4	3561.54	II	4166-32235
8	3508.47	II	2581-31076	8	3562.09	II	4204-32269
6	3508.71	II	12366-40858	10	3563.82	II	4266-32318
5	3510.69	II	5819-34295	11	3568.13	II	9634-37652
11	3513.79	II	988-29439	8	3569.32	II	5651-33660
	3513.86			4	3570.98	II	2581-30577
55	3517.38	II	7294-35716	11	3572.43		
5	3518.37	II	10115-38529	8	3573.70	II	3594-31568
14	3519.08	II	2635-31043	4	3575.29	II	8176-36138
19	3520.52	II	1410-29807	19	3576.23	II	1410-29365
4	3520.98	II	5651-34044	95	3577.46	II	3794-31738
30	3521.88	II	4911-33297	8	3580.56	II	1874-29794
8	3524.07	II	5965-34333	8	3583.66	II	9634-37531
19	3526.68			10	3584.34	II	4911-32802
11	3527.85	II	0-28338	8	3586.75	II	4266-32139
				4	3587.22	II	5943-33812

Cerium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
18	3587.64	II	5943-33808	38	3653.11	II	2880-30246
8	3588.13	II	7059-34921	60	3653.67	II	3794-31156
19	3588.43	II	5437-33297	28	3654.97	II	2642-29994
30	3590.60	II	5969-33812	160	3655.85	II	2563-29909
6	3594.61	II	0-27812	4	3658.26	II	2581-29909
10	3596.12	II	8403-36202	40	3659.23	II	1410-28731
4	3596.73	II	4523-32318	32	3659.97	II	1410-28725
14	3598.20	II	2382-30166	16	3660.16	II	10275-37588
8	3599.97	II	4737-32508	80	3660.64	II	988-28298
15	3600.54	II	6390-34155	12	3661.73	II	4266-31568
6	3603.36	II	5119-32863	9	3662.99	II	4266-31559
14	3604.20	II	988-28725	8	3663.70	II	4911-32198
36	3607.63	II	5437-33149	5	3664.73	II	5437-32717
50	3609.69	II	7234-34929	7	3665.05	II	3854-31131
11	3610.91	II	7341-35027	8	3666.02	I	
11	3611.34	II	2563-30246	8	3667.28	II	5819-33080
4	h 3611.65	II	7878-35559	80	3667.98	II	2880-30135
8	3612.32	II	4523-32198	14	3668.72	II	0-27250
38	3613.70	II	4266-31931	8	3670.49		
5	3615.63	II	5924-33574	12	3671.94	II	2581-29807
11	3616.20	II	5651-33297	20	3672.17	I, II	
15	3618.58	II	4511-32139	32	3672.79	II	7294-34514
6	3619.92	II	2563-30180	16	3673.64	II	2581-29794
4	3621.15	II	5437-33045	8	d 3674.05	II	9634-36844
40	3622.15	II	6913-34513		3674.15		
6	3622.44	II	3363-30962	8	3676.16	II	2596-29790
80	d 3623.84	II	6390-33977	8	3679.16	II	2635-29807
12	3624.18	II	2581-30166	20	3679.42	II	8176-35346
8	3628.25	II	2581-30135	16	3680.08	II	2642-29807
4	3628.62	I		4	3680.85	II	2635-29794
5	3630.42	II	10115-37652	16	3681.38	II	8403-35559
18	3631.19	II	3704-31235	16	3682.08	II	5651-32802
14	3632.11	II	2642-30166	4	3686.04	I	
4	3633.40	II	0-27515	16	3687.80	II	3594-30703
8	3637.75	II	3594-31076	6	3688.66	II	5943-33045
12	3638.28	II	5819-33297	4	3689.16	II	4460-31559
4	3640.69	II	6518-33977	8	3693.42	II	10275-37342
5	3642.83			4	3693.71	II	8281-35346
4	3644.29	II	5716-33149	24	3694.91	II	2382-29439
12	3645.23	II	5437-32863	6	3695.96		
12	3645.45	II	2642-30065	5	3696.12	II	3996-31043
14	3646.65			10	3697.66	II	7259-34295
32	3646.97	II	2382-29794	5	3698.13	II	4202-31235
24	3647.75	II	7523-34929	9	3698.36	II	6521-33553
24	3647.95	II	8403-35808	11	3698.66	II	2880-29909
4	3649.73	II	4460-31851	12	3699.92	II	4911-31931
8	3650.12	II	2596-29984	10	3702.79	II	3704-30703
16	3650.88			18	3704.98	II	5819-32802
12	3652.11			9	3706.94	II	4202-31171
6	3652.26	II	11949-39322	7	3707.39	II	4166-31131

Cerium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
85	3709.29	II	4204-31156	14	3755.72	II	5617-32235
85	3709.93	II	988-27935	13	3757.22	II	7818-34426
4	3713.99	II	988-27905	13	3757.86	II	2563-29167
9	3714.77			4	3760.40	II	2581-29167
3.0	3715.14			6	3760.69	II	4460-31043
10	3715.47	II	6390-33297	24	3762.98	II	7341-33908
110	3716.37	II	0-26900	7	3763.61	II	4266-30829
9	3716.93	II	7259-34155	55	3764.12	II	2880-29439
6	3717.48			16	3765.04	II	4523-31076
34	3718.19	II	1410-28298	7	3765.89	II	5651-32198
34	3718.38	II	4204-31090	13	3766.51	II	3704-30246
17	3719.80	II	2563-29439	4	3768.00	II	4511-31043
5	3722.10	II	5514-32373	24	3768.76	II	8403-34929
12	3722.29	II	2581-29439	8	3769.04	II	1410-27935
9	3722.76	II	2596-29450	13	3769.94	II	8403-34921
3.5	3723.66	II	4323-31171	17	3770.77		
12	3724.64	II	5011-31851	24	3771.61	II	4323-30829
34	3725.68	II	5969-32802	5	3772.65	II	5819-32318
14	3726.96	II	988-27812	7	3773.21	II	1410-27905
40	3728.02	II	5676-32492	6	3773.44	II	5437-31931
9	3728.18	II	2635-29450	6	3776.15		
65	3728.42	II	5456-32269	20	3776.61	II	3594-30065
4	3729.00	II	4266-31076	11	3777.67	II	1874-28338
6	3729.92	II	3363-30166	3.5	3779.61	II	4511-30962
11	3730.33	II	11742-38542	2.0	3781.10	II	5119-31559
3.0	d 3731.17	I		50	3781.62	II	4266-30703
	3731.26	I		36	3782.53	II	3996-30425
9	3731.88	II	8928-35716	8	3783.04	II	7234-33660
8	3732.46	II	2382-29167	16	3783.58	II	5716-32139
5	d 3732.56	I		70	3786.63	II	1410-27812
	3732.58	II	2581-29365	3.0	3787.46	II	11742-38138
12	3733.52	II	4266-31043	8	3787.57	II	2635-29029
9	3737.52	II	4460-31208	10	3787.91	II	988-27380
13	3737.74	II	6913-33660	3.5	3788.21	II	4845-31235
6	3740.13	II	10115-36844	42	3788.75	II	3794-30180
6	3741.01	II	2642-29365	2.0	3790.34	II	5943-32318
6	3741.73	II	7259-33977	6	d 3790.81		
3.0	h 3742.22	I			3790.88	II	7202-33574
8	d 3744.00	I		7	3791.69	II	7294-33660
	3744.05	II	5437-32139	24	3792.33	II	3704-30065
5	3746.37	II	4523-31208	8	d 3793.52	II	5965-32318
14	3746.40	I		3.5	3793.86	II	7059-33410
26	3748.06	II	5819-32492	8	3794.68	II	6518-32863
14	3750.08	II	6638-33297	14	3795.26	II	3794-30135
12	3751.00	II	3594-30246	4	3796.67	II	7713-34044
20	3751.45	II	10275-36924	8	h 3799.04	II	3594-29909
3.0	3751.76	II	2635-29281		3799.10	II	4323-30637
11	3752.34	II	5676-32318	200	3801.53	II	7234-33531
6	3753.77	II	12763-39395	65	3803.10	II	2880-29167
16	3755.43	II	3363-29984	4	3803.84	II	12260-38542



Cerium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
4	3804.16	II	5651-31931	100	3854.32	II	1874-27811
10	3807.69	II	5676-31931	50	3855.30	II	4204-30135
85	3808.12	II	2382-28634	32	3857.02	II	5819-31738
40	3809.22	II	4911-31156	14	3857.24	II	3363-29281
6	3809.50	II	4460-30703	30	3857.64	II	2382-28298
3.0	3810.10	II	3746-29984	6	3857.82	II	4511-30425
8	3810.90	II	5965-32198	4	3857.94	II	3996-29909
5	3811.62	II	11743-37971	16	3862.47	II	5676-31559
20	3812.21	II	4737-30962	7	3865.39		
3.0	3814.93	II	3704-29909	13	3866.82	II	988-26841
7	3815.01	II	2140-28345	16	3868.14	II	3594-29439
40	3815.83	II	6518-32717	13	h 3868.50	II	5716-31559
4	3816.31	II	5943-32139	5	3869.57	II	9723-35559
38	3817.46	II	4845-31033	13	3870.87	II	5514-31340
8	3818.69	II	4523-30703	3.0	3871.81	II	7259-33079
24	3819.02	II	4460-30637	5	3873.03		
14	3821.27	II	2563-28725	5	3873.26	II	10115-35926
15	3821.70	II	4266-30425	22	3874.68	II	8176-33977
12	3823.70	II	8281-34426	22	3875.04	II	3996-29794
38	3823.90	II	2581-28725	14	3876.14	II	4911-30703
8	3827.21	II	5437-31559	50	3876.97	II	4460-30246
10	3827.38			90	3878.37	II	1410-27187
13	3829.69	II	1410-27515	10	3879.07	II	
14	3830.03	II	6390-32492	5	3879.31	II	5437-31208
38	3830.56	II	7713-33812	5	3879.61	II	12366-38134
40	3831.08			5	3880.41	II	14276-40040
9	3832.23			14	3881.87	II	2581-28335
8	3832.75	II	2642-28725	120	3882.45	II	2596-28345
40	3834.56	II	2563-28634	11	3883.57	II	2596-28338
7	3834.78	II	3996-30065	8	3884.20	II	12457-38195
4	3835.75	II	7234-33297	8	3886.50	II	4523-30246
4	3835.90			18	3888.39	II	5119-30829
22	3836.11	II	1874-27935	10	3889.00	II	4460-30166
9	3837.21	II	2581-28634	6	3889.30	II	3746-29450
90	3838.54	II	2642-28686	6	3889.48	II	2635-28338
10	3839.50	II	7259-33297	85	3889.99	II	5456-31156
10	3841.72	II	10115-36138	17	3890.76	II	2140-27835
4	3842.05	II	7059-33080	17	3890.99	II	2642-28335
16	3843.77	II	8804-34813	4	3891.77	II	4737-30425
5	3845.28	II	3996-29894	14	3893.23	II	5283-30962
8	3845.48	II	10115-36112	6	3893.87	II	7878-33553
18	3846.52	II	8176-34166	6	3894.32	II	4323-29994
20	3848.11	II	4266-30246	50	3895.12	II	3363-29029
70	3848.60	II	4204-30180	48	3896.80	II	4511-30166
8	3849.49			4	3897.43	II	10275-35926
5	3849.57	II	1410-27380	40	3898.27	II	3794-29439
10	3850.12	II	5965-31931	22	3898.94	II	1874-27515
8	3852.11	II	2382-28335	4	3899.39	II	5514-31152
70	3853.16	II	0-25945	6	3900.20	II	8176-33808
100	3854.19	II	1874-27812	10	3901.30	II	5943-31568

Cerium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
5	3901.68	II	9723-35346	40	3938.09	II	4523-29909
16	3903.34	II	4523-30135	4	3939.52	II	8532-33908
7	3903.93	II	12366-37974	4	3939.66	II	1874-27250
20	3904.34	II	4460-30065	55	3940.34	II	2563-27935
4	3904.58	II	7259-32863	7	3940.64	II	3996-29365
14	3906.92	II	12260-37849	22	3940.97	II	3363-28731
55	3907.29	II	8928-34514	140	3942.15	II	0-25360
11	3907.45	II	4166-29750	190	3942.75	II	6913-32269
7	3908.09	II	4845-30425	11	3943.14	II	2581-27935
40	3908.41	II	6913-32492	4	3943.50	II	8804-34155
28	3908.54	II	3704-29281	55	3943.89	II	6390-31738
8	3908.77			5	3944.84	II	10115-35457
2.5	3909.05	II	8403-33977	6	3944.92	II	2563-27905
19	3909.31	II	3594-29167	8	3946.68	II	7818-33149
9	3909.75	II	4166-29736	22	3947.97	II	3363-28686
9	3909.93	II	7234-32802	13	3949.39	II	1874-27187
10	3910.70	II	9634-35198	7	3949.82	I	
10	3911.30	II	6638-32198	13	3950.42	II	5119-30425
16	3912.19	II	4511-30065	5	3950.80		
7	3912.44	II	2382-27935	8	3951.62		
8	3913.99	II	4523-30065	7	3952.11	II	4511-29807
7	3914.95	II	3746-29281	220	3952.54	II	2642-27935
28	3915.52	II	5676-31208			II	6638-31931
28	3916.14	II	4266-29794	24	3953.66	II	3996-29281
10	3916.90	II	2382-27905	11	3953.95	II	4523-29807
5	3917.25	II	3508-29029	22	3955.36		
16	3917.64	II	5119-30637	11	3955.92	II	4523-29794
55	3918.28	II	5617-31131	16	3956.06	II	5819-31090
34	3919.81	II	5651-31156	70	3956.28	II	4911-30180
42	3921.73	II	5716-31208	13	d 3956.77	I	
						II	5437-30703
40	3923.11	II	4511-29994	5	3957.15	II	2642-27905
32	3924.64	II	4511-29984		3957.21	I	
5	3924.80	II	4323-29794	11	3957.97	II	7234-32492
2.5	3927.00	II	7259-32717	16	3958.27	II	5819-31076
8	3927.39	II	2880-28335				
5	3927.57	II	11742-37196	16	3958.87		
11	3928.32	II	4460-29909	13	3959.62	II	4202-29450
5	3929.96	II	5651-31090	11	3959.80	II	4737-29984
8	3930.81	II	7059-32492	7	3960.38	II	5965-31208
55	3931.09	II	1410-26841	55	3960.91	II	2596-27835
22	3931.37	II	2382-27812	11	3962.09	II	7818-33050
16	3931.83			7	3963.37	II	4911-30135
11	3932.15	II	5651-31076	11	3964.18		
22	3933.73	II	5676-31090	28	3964.50	II	2596-27812
5	3934.08	I		55	3967.05	II	2635-27835
2.5	3934.75	II	5617-31024	11	3967.18	II	5437-30637
3.5	3935.93	II	5676-31076	8	3967.53	II	9723-34921
4	3937.15	II	12260-37652	11	3970.04	II	11742-36924
3.5	3937.63	II	5819-31208	4	3970.42	II	9634-34813
3.5	3937.81			12	3970.64	II	2635-27812

Cerium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
32	3971.68	II	3996-29167	4	4009.06	II	7202-32139
8	3971.88	II	2642-27812	10	4010.14	II	6638-31568
19	3972.07	II	6390-31559	7	4011.56	II	5716-30637
5	3973.03			190	4012.39	II	4523-29439
6	3974.00	I		65	4014.90	II	4266-29167
5	3974.19	II	5011-30166	18	4015.88	II	8403-33297
19	3975.07	II	7713-32863	10	4017.60	II	5819-30703
5	3976.78	II	7059-32198	14	4019.04	II	8176-33050
2.5	3977.53	II	8774-33908	10	4019.90	II	8176-33045
11	3977.77	II	5943-31076	17	4022.27	II	9054-33908
55	3978.65	II	4323-29450	2.5	4023.37		
40	3980.88	II	5716-30829	10	4024.35	II	4523-29365
3.0	3981.90	II	5969-31076	60	4024.49	II	3794-28634
8	3982.17	I		17	4025.15	II	3508-28345
40	3982.89	II	6638-31738	5	4027.05	II	6913-31738
22	3983.29	II	4166-29263	12	4027.69		
55	3984.68	II	7713-32802	60	4028.41	II	2563-27380
4	3986.40	II	5965-31043	4	4030.16	II	10115-34921
26	3989.44	II	7259-32318	18	4030.34	II	2382-27187
2.5	3989.76			60	4031.34	II	2581-27380
13	3990.11	II	2880-27935	4	4037.39	II	8774-33536
5	3990.69	II	5651-30703	24	4037.67	II	5943-30703
5	d 3991.22			12	4038.25	II	10870-35626
	3991.33	II	5119-30166	6	4039.89	II	8789-33536
5	3992.13	II	4323-29365	150	4040.76	II	3594-28335
50	3992.39	II	3594-28635	8	4041.27	II	5965-30703
26	3992.91	II	5924-30962	4	4042.14	II	8928-33660
65	3993.82	II	7341-32373	65	4042.58	II	3996-28725
8	3994.57	II	5676-30703	22	d 4045.21	II	6521-31235
2.5	3995.42	II	3704-28725		4045.32	II	10314-35027
5	d 3996.36			44	4046.34	II	4460-29167
	3996.49	II	4266-29281	9	4047.28	II	5283-29984
3.5	3997.48			8	4049.03	II	3996-28686
10	3997.72	II	8804-33812	6	4050.81	II	7059-31738
200	3999.24	II	2382-27380	15	4051.43	II	5119-29794
1.2	4000.68			15	4051.99	II	5965-30637
1.2	4000.80	II	5437-30425	50	4053.51	II	0-24663
8	4001.06	II	5716-30703	32	4054.99	II	2596-27250
16	4001.56	II	5011-29994	6	4055.16	II	6518-31171
10	4001.73	II	3704-28686	8	4055.84	I	
13	4002.81	II	7294-32269	6	4056.90	II	8403-33045
8	4002.97	II	3363-28338	6	4058.24	II	3704-28338
8	4003.17	II	5011-29984	3.5	4058.78	II	3704-28335
65	4003.77	II	7523-32492	8	4060.47		
4	4004.05			3.5	4060.72	I	
7	4004.58	II	7234-32198	2.0	4061.81	I	
26	4005.64	II	988-25945	20	4062.22	II	11016-35626
5	4007.45	II	5119-30065	16	4062.94	II	2581-27187
15	4007.59	II	4845-29790	8	4063.92	II	3746-28345
3	4008.66	II	7259-32198	6	4064.91	II	3704-28298

Cerium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
6	4065.16	II	7259-31851	9	4106.85		
6	4066.50	II	12260-36844		4106.92	II	3996-28338
4	4066.91	I		36	4107.42	II	3996-28335
20	4067.28	II	8532-33111	3.5	4107.80	II	8774-33111
6	4068.44			1.8	4108.26	II	7234-31568
30	4068.84	II	5676-30246	3.0	4109.56	II	3508-27835
4	4070.09	II		14	4110.38	II	8789-33111
5	4070.84	II	12366-36924	5	4110.84	II	2581-26900
6	4071.08	II	5437-29994	18	4111.39	II	5819-30135
75	4071.81	II	2635-27187	2.5	4111.93	II	6390-30703
19	4072.92	II	2642-27187	7	4113.73	II	3996-28298
130	4073.48	II	3854-28396	3.5	4114.15	II	7259-31559
15	4073.74	II	8449-32989	30	4115.37	II	7455-31747
2.0	4074.65	II	1410-25945	18	4117.01	II	10870-35152
110	4075.71	II	5651-30180	14	4117.29	II	5965-30246
110	4075.85	II	4911-29439	14	4117.59	II	10642-34921
15	4076.24	II	6518-31043	55	4118.14	II	5617-29893
30	4077.47	II	2382-26900	18	4119.02	II	4460-28731
38	4078.32	II	7722-32235	22	4119.79	II	8774-33040
19	4078.52	II	7555-31967	22	4119.88	II	2635-26900
6	4079.02	II	7059-31568	32	4120.83	II	2581-26841
10	4079.67	II	7234-31738	36	4123.24	II	5819-30065
19	4080.44	II	2880-27380	36	4123.49	II	7722-31967
48	4081.22	II	3854-28350	70	4123.87	II	6913-31156
65	4083.23	II	5651-30135	36	4124.79	II	5514-29751
8	4083.48	II	9054-33536	3.5	4125.78	II	3704-27935
8	4083.64			4	4126.66	II	4460-28686
32	4085.23	II	5437-29909	70	4127.37	II	5514-29735
6	4086.42	II	4266-28731	18	4127.74	II	4511-28731
18	4087.36	II	4266-28725	14	4128.07	II	3594-27812
5	4087.57	II	8532-32989	13	4128.36	II	7523-31738
3.0	4088.58	II	6638-31090	6	4129.18	II	5969-30180
16	4088.85	II	5716-30166	38	4130.71	II	4523-28725
5	4089.74	II	7294-31738	34	4131.10	II	2642-26841
5	4089.86	II	6518-30962	2.0	4131.86		
9	4090.47	II	6521-30962	7	4132.31	II	5716-29909
9	4090.95	II	6638-31076	4	4132.64	II	6638-30829
3.5	4092.09	II	4204-28634	190	4133.80	II	6968-31152
7	4092.72	II	5819-30246	19	4135.44	II	4511-28686
3.5	4093.29	I		4	4135.89	II	10642-34813
11	4093.96	II	4266-28686	4	4136.77	II	5283-29450
2.5	4098.15	I		6	4136.90	II	5969-30135
6	4098.98	II	5676-30065	19	4137.47	II	5119-29281
3	4099.75	II	8695-33080	140	4137.65	II	4166-28327
32	4101.77	II	6968-31340	19	4138.10		
5	4102.36	II	8928-33297	15	4138.35	II	10870-35027
3.5	4104.43	II	5437-29794	4	4139.43	II	3363-27515
18	4105.00	II	8532-32885	4	4140.75	II	4202-28345
5	4106.13	II	5819-30166	55	4142.40	II	5617-29751
				11	4142.83	II	12763-36894

Cerium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
28	4144.49	II	3854-27976	20	4198.00	II	4911-28725
48	4145.00	II	5617-29735	13	4198.43	II	4523-28335
34	4146.23	II	4523-28634	80	4198.67	II	7341-31152
6	4148.16	II	5965-30065		4198.72	II	4166-27976
20	4148.90	II	8789-32885	24	4201.24	II	7294-31090
					4201.32	II	8403-32198
30	4149.79	II	5716-29807				
70	4149.94	II	5819-29909	65	4202.94	II	3594-27380
30	4150.91			4	4203.51		
100	4151.97	II	5514-29592	5	4204.74	II	6390-30166
4	4152.93			4	4205.16		
16	4153.13	II	1874-25945	2.5	4205.79	II	7059-30829
3.5	4153.93	II	3746-27812	2.5	4205.89	II	10275-34044
6	4155.28			19	4209.41	II	5514-29263
13	4155.53	II	9054-33111	5	4210.00	II	5283-29029
32	4159.03	II	8281-32318	7	4213.04	II	5437-29167
10	4160.11	II	4266-28296	26	4214.04	II	4911-28634
	4160.18	II	7059-31090	22	4217.59	II	8532-32235
8	4161.18	II	7722-31747	4	4221.17		
11	4162.63	II	7059-31076	110	4222.60	II	988-24663
22	4163.52	II	11016-35027	8	4223.88	II	4266-27935
90	4165.61	II	7341-31340	3.0	4224.55		
4	4166.20			7	4227.41	II	5716-29365
11	4166.65	II	4737-28731	55	4227.75	II	5617-29263
44	4166.88			6	4228.30	II	7059-30703
18	4167.80	II	9054-33040	6	4230.12	II	4202-27835
46	4169.77	II	5819-29795	28	4231.75	II	
	4169.88	II	4323-28298	7	4232.05		
4	4171.39	II	5943-29909	10	4232.57	II	5819-29439
8	4172.16	II	2880-26841	6	4233.20		
8	4174.48	II	4737-28686	17	4234.21	II	4202-27812
5	4175.24	II	5965-29909	6	4234.73	II	6638-30246
9	4176.08	II	3996-27935	14	4236.02	II	4737-28338
24	4176.70	II	9054-32989	6	4236.36	II	8774-32373
5	4179.29	II	3594-27515	70	4239.91	II	3854-27433
24	4181.08	II	5119-29029	6	4242.01	II	7523-31090
24	4185.33	II	3363-27250	28	4242.72	II	2382-25945
250	4186.60	II	6968-30847	6	4243.79	I	
38	4187.32	II	4460-28335	22	4245.88	II	5819-29365
3.5	4189.18	II	5943-29807	22	4245.98	II	4266-27812
4	4189.64	II	7294-31156	6	4246.40		
12	4190.63	II	7234-31090	28	4246.71	II	2141-25682
4	4191.03			5	4247.45	II	3363-26900
40	4193.09	II	7234-31075	5	4248.09	II	10275-33808
26	4193.28	II	8532-32373	75	4248.68	II	5514-29044
26	4193.87	II	4460-28298	2.5	4250.66	II	3996-27515
13	4194.91	II	9054-32885	4	4251.60	II	8804-32318
5	4195.82	II	4511-28338	4	4251.86	II	4323-27835
45	4196.34	II	3363-27187	28	4253.36	II	3746-27250
10	4197.51	II	3996-27812	5	4254.70	II	6638-30135
13	4197.67	II	3996-27811	44	4255.78	II	5676-29167

Cerium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
12	4256.16	II	4323-27812	5	4326.83	II	5924-29029
8	4257.12	II	3704-27187	22	4330.45	II	2596-25682
9	4259.75	II	7234-30703	11	4331.76	II	9723-32802
8	4261.16	II	8774-32235	22	4332.71	II	5651-28725
14	4263.43	II	8403-31851	5	4334.87	II	8278-31340
5	4263.95	II	8789-32235	4	4335.49	II	8176-31235
12	4264.37	II	7259-30703	28	4336.26	II	5676-28731
7	4267.22			70	4337.78	II	2635-25682
4	4268.30	II	5943-29365	24	4339.32	II	10870-33908
10	4269.25	II	7818-31235	5	4340.56	II	8176-31208
44	4270.19	II	4523-27935	4	4342.14	II	4911-27935
28	4270.72	II	7722-31131	5	4342.49	II	10275-33297
9	4273.44	II	8804-32198	4	4343.56	I	
15	4275.56	II	4523-27905	16	d 4345.83	II	9634-32638
3.0	4278.25	II	10799-34166			II	4511-27515
14	4278.87	II	2581-25945	5	4346.43		
10	4280.14	II	5924-29281	4	h 4347.60	II	8176-31171
8	4281.00	II	4460-27812			II	4911-27905
6	4281.16	II	4460-27811	50	4349.79	II	4266-27250
20	4285.37	II	7341-30670	40	4352.71	II	4845-27812
14	4288.67	II	2635-25945	12	4353.37	I, II	
14	4289.45	II	3594-26900	2.5	4356.75	II	7234-30180
140	4289.94	II	2642-25945	4	4357.91		
8	4292.58	II	6518-29807	7	4359.07		
8	4292.77	II	4523-27812	7	4360.18	II	6521-29450
5	4294.76	II	10275-33553	5	4360.44	II	4323-27250
14	4296.07	II	8928-32198	2.5	4361.35		
3.0	4296.37	II	6521-29790	9	4361.66	II	4266-27187
140	4296.67	II	4166-27433	4	d 4363.39	II	5819-28731
5	4299.09	II	3996-27250			II	10642-33553
42	4299.36	II	1410-24663	65	4364.66	II	3996-26900
55	4300.33	II	3594-26841	7	4367.00	II	11016-33908
3.0	4300.86			5	4367.56	II	8281-31171
6	4302.65	II	10642-33876	6	4368.23	II	7294-30180
8	4304.28			5	4369.24		
11	4304.72	II	5943-29167	7	4372.40	II	4323-27187
30	4305.14	II	6913-30135	3.5	4373.22	II	5437-28298
55	4306.72	II	4166-27379	2.5	4373.82	II	4523-27380
8	4309.58	II	5969-29167	3.5	4375.17	II	7059-29909
28	4309.74	II	3704-26900	38	4375.92	II	3996-26841
11	4310.70	II	3996-27187	8	4380.06	II	5011-27835
8	4311.59	II	7059-30246	8	4381.78	II	5819-28634
2.5	4313.10	II	5119-28298	65	4382.17	II	5514-28327
4	4314.93	II	6638-29807	5	4386.35	II	7202-29994
7	4315.41	II	7259-30425	12	4386.70	II	4460-27250
10	4317.33	II	8403-31559	50	4386.84	II	1874-24663
4	4317.99			22	4388.01	II	6968-29751
40	4320.72	II	3704-26841	12	4390.28	II	11742-34514
5	4324.60	I		120	4391.66	II	2596-25360
11	4324.79	II	7713-30829	11	4393.19	II	5969-28725

Cerium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
6	4394.78	II	7059-29807	20	4467.54	II	4523-26900
5	4396.58	II	7012-29751	100	4471.24	II	5617-27976
14	4398.79	II	4460-27187	32	4472.72	II	3594-25945
36	4399.20	II	2635-25360	3.0	4474.69	II	8789-31131
5	4400.54	II	2642-25360	50	4479.36	II	4523-26841
5	4400.87	II	5119-27835	50	4483.90	II	6968-29263
4	4403.30	II	11341-34044	12	4484.82		
5	4405.47	II	5119-27812	6	4485.52	II	7878-30166
12	4407.28	II	5651-28335	60	4486.91	II	2382-24663
7	d 4408.87	II	7234-29909	3.0	4488.81	II	8804-31076
25	4410.64	II	10870-33536	3.0	4492.95	II	7341-29592
25	4410.76	II	7455-30120	10	4494.22	II	6390-28634
9	4412.02	II	5676-28335	9	4495.39	II	5011-27250
8	4413.19			10	4496.23	II	8403-30637
5	4413.80	II	7259-29909	18	4497.85	II	7722-29949
22	4416.90	II	4266-26900	6	4500.34	II	9723-31938
70	4418.78	II	6968-29592	1.8	4501.10	I	
5	4419.30	II	5676-28298	7	4506.42	I	
3.5	4423.44	I		5	4508.08	II	5011-27187
14	4423.68	II	8532-31131	6	d 4509.14	II	7092-29263
22	4427.07	II	3363-25945		4509.26	II	7722-29892
34	4427.92	II	4323-26900	4	4510.17	II	7818-29984
22	4428.44	II	4266-26841	3.5	4510.92	II	8928-31090
46	4429.27	II	8774-31345	6	4511.64	II	
5	4430.00			8	4515.86	II	8532-30670
4	4432.72	II	11742-34295	2.5	4518.02	I	
5	4432.92	II	5283-27835	7	4519.59	II	10870-32989
3.5	4433.73	II	8281-30829	3	4521.96	I	
8	4437.61	II	6638-29167	1.6	4522.08	II	7059-29167
6	4439.24	II	11016-33536	55	4523.08	II	4166-26268
9	4440.88	II	6518-29029	60	4527.35	II	2581-24663
11	4443.75	II	5437-27935	60	4528.47	II	6968-29044
34	4444.39	II	7455-29949	6	4531.31	I	
32	4444.70	II	8532-31024	3.0	4532.01	I	
4	4446.15			8	4532.49		
2.0	4447.69	I		2.0	4534.22		
55	4449.34	II	4911-27380	6	4536.89	II	12260-34295
7	4449.64			5	4537.88	II	7878-29909
44	4450.73	II	5514-27976	8	4539.07	II	11016-33040
4	4452.55			60	4539.75	II	2642-24663
4	4453.16	II	4737-27187	15	4544.96	II	3363-25360
6	4454.99	II	4460-26900	2.5	4545.87	II	5943-27935
6	4455.66			3.0	4546.06	I	
3.0	4457.78	II	8403-30829	4	4548.88	I	
170	4460.21	II	3854-26268	5	4549.64	II	11016-32989
32	4461.14	II	7341-29751	5	4550.30	II	9054-31024
30	4463.41	II	7722-30120	18	4551.30	II	5969-27935
4	4464.17	II	7341-29735	1.6	4552.07	I	
10	4464.69	II	8278-30670	1.6	4553.06	I	
3.0	4465.44			2.0	4554.56	II	3996-25945

Cerium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
5	4555.43			2.5	4666.71	II	4523-25945
1.8	4556.22			8	4669.50	II	
5	4558.60	II	4911-26841	6	4670.74	II	5437-26841
46	4560.28	II	7341-29263	5	4670.91	I	
22	4560.96	II	5514-27433	6	4674.49	I	
150	4562.36	II	3854-25766	13	4680.13	II	8532-29893
2.0	4563.38	II	6390-28298	2.5	4680.99	II	11016-32373
4	4565.24	I		24	4684.61	II	7294-28634
30	4565.84	II	8774-30670	5	4685.23	II	7012-28350
3	4569.66			6	4686.81		
75	4572.28	II	5514-27379	7	4688.89	I	
6	4572.79	II	11949-33812	1.6	4689.50	II	8928-30246
4	4576.48	II	9723-31568	2.0	4690.17	II	7012-28327
5	4578.78			2.5	4690.50	II	8278-29592
6	4579.28			4	4690.71	I	
2.5	4581.09	I		4	4692.06	II	5943-27250
30	4582.50	II	5617-27433	6	4694.88	II	6518-27812
1.6	4583.10	I		6	4696.52	I	
9	4591.12	II	8928-30703	6	4701.45		
60	4593.93	II	5617-27379	6	4702.01		
4	4597.17			4	4707.01	I	
1.6	4599.02			5	4707.28	I	
2.5	4601.37	II	10646-32373	4	4707.94	II	7092-28327
1.6	4604.21	II	8281-29994	2.0	4710.00		
2.5	4605.48	II	9317-31024	18	4714.00	II	8928-30135
30	4606.40	II	7341-29044	9	4714.81	II	8532-29735
5	4608.49	I		8	4717.88	II	5651-26841
4	4610.47	I		3.0	4722.30	II	4511-25682
6	4611.56	II	12366-34044	3.0	4723.31	II	5676-26841
5	4613.02	II	7059-28731	1.4	4724.32	I	
5	4615.20	I		3.5	4724.85	I	
30	4624.90	II	9054-30670	10	4725.09	II	4202-25360
120	4628.16	II	4166-25766	1.4	4727.59	I	
3	4630.82			7	4730.13	II	7202-28338
12	4632.32	I		9	4733.52	II	10115-31235
2.5	4633.60	II	7059-28634	3.0	4733.95	I	
3	h 4636.74	II	5819-27380	3.5	4734.70	I	
5	4640.88	I		2.0	4735.35	II	7523-28634
5	4641.06	I		28	4737.28	II	8789-29893
6	4643.17	I		3.5	4739.12	II	7202-28298
5	4644.20	II	8281-29807	9	4739.53	II	10058-31152
3	4647.28			4	4741.64	II	8281-29365
3	4647.38	II	5676-27187	8	4744.82		
5	4649.89	I		14	4747.14	II	11743-32802
8	4650.52	I		1.4	4749.50	II	12763-33812
9	4654.29	II	4202-25682	2.0	4750.84	I	
4	4659.40			2.0	4751.53		
2.5	4659.94	II	7713-29167	2.5	4752.24	II	12260-33297
3.0	4663.24			2.0	4752.58	I	
2.5	4665.28			5	4755.54	II	5819-26841



Cerium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
10	4757.84	II	7713-28725	3.0	4897.08	I	
1.4	4759.92	II	8804-29807	3.0	4898.21	I	
6	4763.90	II	8278-29263	7	4899.90	I	
2.0	4764.72	I		2.5	4901.68	I	
9	4768.77	II	7012-27976	2.5	d 4904.88	I	
20	4773.94	II	7455-28396	1.8	4908.12	I	
3.0	4775.08	I		4	4914.94	II	7092-27433
2.5	4780.23	II	11949-32863	5	4915.32	I	
3.5	4783.94			4	4915.67	I	
2.5	4784.78	I		2.5	4919.89	I	
3.0	4786.54	I		4	4920.78	I	
4	4787.14			2.0	4921.92	I	
5	4788.43	I		4	4924.26	I	
3.0	4789.69	II	5969-26841	2.0	4924.89		
4	4793.16			2.0	4928.09	II	7092-27379
6	4800.90			2.5	d 4930.54	I	
4	4805.93	I			4930.72	I	
2.5	4807.68	I		6	4939.13	I	
3.0	4808.50	I		3.0	4939.60		
4.0	4820.03	I		2.0	4940.34		
2.5	4820.61	I		12	4943.45	II	9726-29949
10	4822.54	I		3.0	4943.84	II	7713-27935
3.5	4834.04	I		10	4944.62	II	8131-28350
4	4835.63	II	7722-28396	3.0	4948.67	I	
6	4836.67	I		4	4949.55		
2.5	4837.49	I		2.0	4951.92		
4	4843.03	I		2.0	4954.04	I	
2.5	4844.29			2.0	4955.97	I	
8	4845.52	I		3.0	4960.90		
5	4846.57	II	7722-28350	2.0	4961.49	II	5617-25766
12	4847.75	I		2.0	4965.18	I	
5	4849.91	I		3.0	4966.39	I	
1.8	4850.19			3.0	4968.40		
4	4852.62	I		3.0	4970.67	I	
3.5	4853.61	I		14	4971.48	II	
3.5	4858.72	II	9317-29893	3.0	4971.94	I	
6	4859.48	I		5	4972.24	I	
2.5	4861.73	I		3.0	4974.10	I	
8	d 4863.20	CeO		5	4977.23	II	7294-27380
	4863.26	I		6	d 4984.51		
3.0	4868.64	I		10	4986.42	II	8278-28327
6	4874.01	II	8928-29439	7	4987.54	I	
3.0	4874.35	I		4	4988.69	I	
2.5	4881.54	I		6	4991.02	II	11310-31340
16	4882.46	II		5	4992.40	I	
1.8	4886.13			14	4994.61	I	
4	4889.59	I		5	4998.13	I	
2.5	4891.90	II	10799-31235	5	5002.80		
2.0	4892.86	I		2.5	5004.78		
8	4893.97	II	10704-31131	2.5	5006.43		

Cerium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
22	5009.09	I	8449-28396	14	5112.69	I	11310-30847
11	5011.77	II		10	5115.22	I	
4	5012.51	I		7	5115.63	I	
6	5013.76	I		17	5117.18	II	
2.0	5014.28			2.0	5117.95	II	
4	5016.51	I	8424-28327	5	5118.87		
7	5021.44	I		5 h	5119.49		
13	5022.87	II		7	5120.77	I	
2.5 h	5025.13			5	5121.35		
2	5027.29	II		7	5122.39	I	
7	5028.30	I	11341-31208	3.0	5122.67	I	
2.5 h	5030.64			7	5125.01	I	
4	5031.74	I		2.5 h	5128.01		
4	5031.97	II		18	5129.58	I	
5	5033.81	I		6	5134.47	I	
5 h	5036.62	I	8131-27976	4 d	5135.32	I	
13	5037.77	II		5	5137.12	I	
7 d	5039.75	I		2.5	5137.76		
	5039.93			2.5	5138.02	I	
13	5040.86	I		2.0	5139.76	I	
5 d	5042.09	I	9772-29592	5	5140.50	I	10314-29735
2.5	5043.21			12	5147.55	II	
19	5044.01	II		7	5149.65	I	
7	5048.82	I		11	5149.99	I	
3.5	5050.99	I		7	5150.41	I	
2.5	5053.27	I		7	5153.95		
3.5	5053.53	I		2.0	5154.39		
6	5054.17	I		30	5159.69	I	
4	5055.78	I		30	5161.48	I	
5	5063.92	I		6	5163.27	II	
10	5065.88	I		8	5164.39	I	
4	5067.15			2.0	5169.25		
4	5071.49	I		3.5	5169.72	I	
13	5071.77	I		20	5174.54	I	
8	5074.71	I		2.0	5177.73	I	
26	5075.30	II	7202-26900	3.0	5178.69	I	
7	5076.47	II	11458-31152	8	5180.89	I	
8	5077.82			2.5	5181.75	I	
50	5079.68	II	11166-30847	5	5181.94	I	
7	5080.48	I		4	5183.20	I	
2.5	5083.54	I		40	5187.45	II	9772-29044
2.5	5084.17	I		2.0	5188.53		
2.0	5084.45			8	5188.65	I	
4	5089.61			4	5189.25		
4	5090.86			30	5191.68	II	7012-26268
5	5091.75	I		2.0	5194.75	I	
3.5	5093.38			4	5200.12	I	
2.5 h	5097.24	I		6	5200.42	I	
2.5	5099.40	I		6	5201.39	I	
5	5111.60	I					

Cerium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
10	d 5202.46	I		3.5	5275.78	II	10314-29263
	5202.59	I		3.0	5276.26		
6	5203.28	I		1.8	5277.54	I	
6	5204.27	I		1.6	5278.43		
4	5204.73	I		1.8	5281.38	I	
3.5	5205.14	I		3.5	5286.84	I	
4	5205.52	II	10058-29263	5	5290.94	I	
3.5	5208.74			1.8	5291.31		
3.0	5208.90	I		1.8	5292.40		
3.0	5210.34	II	7713-26900	7	5294.07	I	
3.5	5211.04	I		1.8	5294.87		
20	5211.92	I		14	5296.60	I	
4	5216.38	I		3.5	5298.29	I	
5	5221.92	I		1.8	5299.10		
5	5222.95	I		1.6	5302.19		
28	5223.49	I		1.6	5303.15		
4	5226.36	II	7713-26841	3.5	5303.35	I	
19	5229.75	I		2.5	5308.32	I	
5	5230.14	I		7	5308.55	I	
6	5230.84	I		1.4	5309.93		
15	5232.91	II	10646-29751	3.5	5313.93	I	
2.0	5233.79	I		3.5	5314.40	I	
6	5234.01	II	8278-27379	2.5	5314.90	I	
2.5	5235.77	II	11949-31043	2.5	5314.99	I	
5	5237.05	II	10646-29735	2.0	5317.58	I	
6	5238.49	I		4	5323.32		
2.0	5238.91			14	5328.05	I	
1.8	5239.83	II	9317-28396	4	5329.50	I	
2.0	5240.09			20	5330.58	II	7012-25766
7	5243.08	I		3.0	5332.24		
10	5244.51	I		1.8	5333.83		
2.0	5245.28	I		1.8	5334.67		
28	5245.92	I		8	5335.71	I	
2.0	5249.18	I		7	5336.18	I	
3.5	5249.62	I		1.8	5337.70		
4	5251.03			2.5	d 5340.70		
8	5251.98			1.8	5345.10		
8	5252.62	II	9317-28350	2.5	5346.53		
2.0	5253.40			3.5	5347.81	I	
6	5254.84	I		1.6	5349.20		
3.0	5255.95			4	5350.60		
3.0	5258.40	II	5651-24663	2.0	5351.30		
3.0	5259.93	I		4	5352.20		
9	5261.71	I		48	5353.53	II	7092-25766
9	5264.21	I		6	5355.18	I	
14	5265.71	II	10058-29044	2.5	5355.62	I	
5	5269.52	I		1.6	5355.96		
3.5	5271.06	I		5	5357.20	I	
13	5271.88	I		2.0	5359.30	I	
36	5274.24	II	8424-27379	2.5	5359.48	II	11341-29994

Cerium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
3.0	5359.95	I		1.6	5436.09		
1.6	5362.68			3.0	5437.90		
8	5363.33	I		2.0	5438.43	I	
1.6	5366.90	d		2.5	5445.43	I	
2.5	5367.56			2.5	5446.20	I	
1.6	5368.08			3.0	5446.45		
4	5369.12	I		15	5449.22	I	
2.5	5370.32			2.5	5450.04	I	
2.0	5371.60	I		3.5	5451.72	I	
2.5	5378.32			4	5453.95	I	
3.0	5379.89	I		5	5456.41	I	
1.2	5380.11			4	5457.21	I	
4	5382.61	I		1.6	5457.89		
1.6	5384.08			3.0	5458.81	I	
8	5386.35	I		6	5459.21	II	13028-31340
6	5386.76			6	5460.09	I	
5	5391.88	I		6	5464.20	II	11455-29751
32	5393.39	II	8897-27433	10	5465.34	I	
6	5394.84			15	5468.37	I	
4	5395.24	I		15	5472.30	II	10058-28327
3.0	5395.70	I		3.0	5472.83		
16	5397.64	I		6	5473.53	d	
1.6	5397.96			1.6	5477.43	I	
2.5	5399.04	I		3.0	5478.60	I	
4	5399.57	I		2.0	5481.18		
3.0	5401.21	I		6	5482.00	I	
1.6	5402.54			3.0	5483.38	h	
4	5404.23			3.0	5491.15	I	
1.6	5406.61			5	5498.19	I	
2.0	5407.66			1.0	5506.09		
1.6	5408.36			1.4	5506.45	I	
30	5409.22	d	8897-27379	3.0	5510.68	I	
1.6	5411.56			28	5512.09	II	8131-26268
2.0	5411.75	I		1.4	5513.11	h	11458-29592
3.0	5414.09	I		2.0	5514.23		
1.6	5417.84	II	8928-27380	3.0	5516.08	II	13028-31152
3.5	5418.70	I		2.0	5517.40		
12	5420.38	I		1.0	5517.86		
2.0	5421.33			6	5518.49	II	9317-27433
2.5	5422.20			4	5522.46	I	
2.5	5423.42	I		1.4	5526.09		
1.6	5426.37	I		3.5	5526.85		
1.6	5426.61			2.5	5527.18	I	
2.5	5427.25	I		10	5535.24	I	
1.4	5428.28			4	5537.54	I	
2.0	5429.50			3.0	5540.58		
4	5430.24	I		3.0	5542.71	d	
2.0	5430.54			2.0	5544.65	I	
3.0	5431.33			2.0	5546.52		
2.5	5433.34	I		1.4	5547.48	h	

Cerium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
7	5548.82	I	10314-28327	1.2	5623.75	I	11310-29044
3.5	5550.04	II		1.2	5625.23		
2.0	5550.64			1.2	5628.21		
1.4	5551.41	I		3.0	5632.48		
1.0	5552.30	I		5	5633.09	I	
12	5556.25	I		2.0	5634.49	I	
6	5556.95			5	5637.39	II	
1.4	5558.66			3.5	5638.19	I	
6	5559.22	I		1.2	5638.41		
1.4 h	5560.06			1.2	5638.63	I	
1.6 h	5561.46	II	11760-29735	2.0	5640.11		
1.4 h	5562.21	I		1.2	5640.79		
5	5563.03			3.5	5646.58	I	
4	5564.24	I		5	5650.60	I	
18	5564.96	I		1.2	5652.96		
3.0	5565.28			20	5655.13	I	
14	5565.97	I		1.2	5656.21		
2.0	5566.50			1.2	5659.78	I	
5	5567.81	I		1.2	5663.18		
1.4 h	5569.29			1.4	5663.48	I	
2.0	5572.19	I		6	5663.99	I	
1.4 h	5575.08			2.0	5664.68		
2.0	5577.28			1.0	5665.38		
3.5	5578.27			10	5668.94	II	
3.0	5578.89	I		26	5669.97	I	
8	5582.74	I		1.2	5671.41		
3.5	5584.72	I		3.5	5671.87	I	
2.0 h	5586.72			2.5	5675.10	I	
1.4	5588.12			6	5676.88		
3.0	5588.33	I		1.2	5677.25		
1.0	5589.25			13	5677.76	I	
1.0	5590.13			1.2	5678.98		
1.4	5590.53	I		1.8	5680.27		
3.0	5593.72	I		1.2	5682.78	I	
7	5594.94	I		1.4	5683.14		
11	5595.87	I		3.0	5683.77	II	
3.5	5597.95	I		5	5685.86		
2.5	5598.96	I		1.2	5687.82		
26	5601.30	I		2.5	5688.49	I	
4	5606.46	I		1.2	5691.47		
1.2	5609.45	I		2.5	5692.13	I	
8	5610.26	II	8449-26268	13	5692.94	I	
5	5610.92	I		2.5	5695.74		
3.5	5613.70	II	11455-29263	8	5695.84	I	
8	5614.72	I		32	5697.00	I	
1.8	5615.98	I		40	5699.23	I	
1.0	5616.53			6	5702.39	I	
1.8	5620.39	I		4	5703.23		
1.0	5622.67			1.8	5709.06	I	
1.4	5623.00			1.0	5710.07		

Cerium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
5	5711.45	II	11760-29263	6	5810.72	I	
1.8	5712.29	I		1.2	5811.83		
4	5715.29	II	12457-29949	13	5812.93	I	
4	5716.50			1.2	5815.47		
1.2	5718.36	I		3	5817.78	II	8176-25360
1.2	5718.59			5	5820.40	I	
26	5719.04	I		6	5822.99	I	
1.0	5719.56	I		1.2	5823.46		
3.5	5721.96	I		1.4	5830.03	I	
1.0	5725.85	I		2.0	5830.13		
1.8	5726.14			2.0	5831.39		
2.0	5727.25			10	5831.93	I	
1.8	5729.38			2.0	5834.24	I	
1.8	5733.94	I		10	5835.84	I	
2.0	5735.69	I		8	5838.16	I	
10	5743.53	I		3.5	5839.38	I	
2.0	5744.69			1.2	5843.11	I	
1.2	5746.49	I		4	5843.75	I	
1.0	5748.29			2.0	5845.98		
1.8	5748.95	I		3.5	5848.34		
1.2	5752.52			1.2	5848.86		
4	5758.24	I		6	5851.06	I	
4	5758.30			3.5	5853.07		
1.0	5760.58			2.5	5853.36	I	
1.2	5763.00			3.5	5853.67	I	
2.5	5764.77			5	5857.13	I	
2.5	5765.34	I		2.5	5858.15	I	
8	5768.90	II	10646-27976	2.0	5858.56	II	10314-27379
2.5	5769.95	I		5	5859.39	I	
3.5	5770.44	I		10	5862.51	I	
1.4	5771.98	II	10058-27379	1.2	5870.85		
3.5	5772.22	I		8	5871.61	I	
5	5772.88	I		1.4	5873.88	I	
15	5773.12	I		2.5	5878.08		
2.5	5773.59	I		4	5878.90	I	
2.0	5775.00	I		2.0	5888.50		
1.4	5775.80			1.4	5892.48	I	
4	5782.44			4	5893.19	I	
1.4	5782.81	I		1.2	5897.72		
1.4	5783.99	II	11760-29044	1.4	5898.10		
5	5784.85	I		1.2	5899.70		
1.2	5786.86			1.2	5900.67	I	
1.4	5787.22			4	5901.32	I	
13	5788.13	I		2.5	5906.01	I	
1.2	5791.32			1.2	5907.49		
1.8	5791.68			6	5909.86	I	
1.0	5794.78	I		6	5910.13	I	
4	5796.06			5	5912.91	I	
2.0	5799.80			1.2	5914.84	I	
10	5804.42	I		5	5920.44	I	

Cerium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
2.5	5924.05	I		2.5	6034.59		
2.0	5924.87			3.5	6035.49	II	13028-29592
6	5926.30	I		12	6043.39	II	9726-26268
9	5928.34	I		3.0	6045.43		
2.0	5929.50			6	6047.39	I	
3.0	5929.84	I		2.0	6051.80	II	
2.5	5932.16	I		2.5	6057.49	I	
1.8	5933.58			3.5	6057.99	I	
10	d 5934.44			2.5	6066.71	I	
10	5937.72	I		1.0	6068.63		
2.0	5938.44	I		6	6069.47	I	
25	5940.85	I		4	6072.00	I	
30	5941.54			3.5	6076.60		
3.0	5942.66	I		1.8	6077.14	I	
3.0	5944.88	I		1.8	6080.37		
2.5	5947.64	I		1.8	6081.28	I	
2.5	5950.61	I		4	6088.92		
1.2	5951.21	I		3.5	6093.20	I	
2.5	d 5956.84			5	6098.34	II	14276-30670
3.5	5959.70			1.2	6099.79	I	
2.5	d 5960.81			3.0	6108.74	II	13527-29893
1.2	5963.36	I		1.8	h 6111.95		
1.8	5964.64			1.6	6118.55		
8	5966.26	I		1.8	6118.89	I	
3.0	5972.10			1.0	6119.74	I	
1.2	5972.80	I		5	6123.67	I	
8	5975.87	II	10704-27433	1.0	6124.31	I	
4	5975.98	I		1.0	6130.13		
2.0	5979.40	I		4	d 6132.00		
1.2	5981.20			2.0	6135.52		
5	5989.38	I		1.0	6137.23		
5	5992.66	I		2.5	6139.03	I	
8	d 5995.35	II	10704-27379	1.6	6142.91	I	
2.0	5997.05	II		4	6143.36	II	
1.2	6000.18	I		2.5	6146.42	I	
6	6001.89			2.0	6147.85	I	
1.2	6003.66			1.0	6149.58		
6	6005.86	I		2.5	6151.73	I	
1.6	6006.21	I		2.0	6159.82		
6	6006.81	I		2.0	6162.17	I	
2.0	6007.36			2.0	6165.47		
8	6013.42	I		1.6	6172.87		
2.5	6016.57	I		2.0	6175.29		
1.0	6018.79	I		4	6186.16	I	
1.0	6020.60	I		1.0	6186.92		
12	6024.19	I		1.6	6187.91	I	
1.6	6027.16	I		1.6	6195.25	I	
1.2	6031.25	I		2.0	6195.55	I	
2.5	6033.58	II		2.0	6198.05		
3.5	6034.20	II	11760-28327	4	6208.99		

Cerium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
1.0	6209.56	I		0.9	6461.89	I	
1.0	6211.06	I		2.0	6466.90	II	14276-29735
1.0	h 6212.50			3.0	6467.42	I	
1.2	6216.84			0.6	6468.97	II	
1.0	6223.25	I		4	6473.71		
1.0	6228.23	I		1.8	6490.99	I	
5	6229.00	I		0.6	6494.93		
2.5	6232.45	II	9726-25766	1.2	6503.27	II	
3.0	6237.46	I		0.8	h 6504.06	I	
1.4	6238.70	I		1.2	6507.16		
1.4	d 6241.91	I		0.8	6509.01	I	
1.4	6242.91			2.5	6513.60	II	
1.6	6253.62	I		2.0	6517.30	I	
1.0	6256.35			0.6	6519.12		
1.4	6257.99			0.6	6530.68	I	
1.6	6264.26			0.6	6534.50		
1.0	6270.29			0.8	6537.48	II	
5	6272.05	II	12457-28396	2.0	6551.72	I	
1.6	6276.46	I		5	6555.67		
1.6	h 6286.40			0.6	6560.75		
3.5	6295.57	I		0.8	6563.47		
3.0	6299.51	II	15282-31152	0.8	6565.71		
2.5	6300.21	I		1.0	6573.65	I	
1.4	6306.63	I		0.5	6577.47	I	
3.5	6310.02	I		2.5	6579.11		
0.9	h 6318.00			0.7	6599.61	I	
0.9	6331.98	I		0.7	6605.39	I	
2.5	6335.37	I		1.6	6606.33	I	
1.2	6337.21	I		1.6	6606.86	II	
1.4	6340.69	I		3.0	6612.06		
3.5	6343.96	II		1.4	6623.00	I	
0.6	6353.52			4.0	6628.88	I	
0.6	6360.22			1.8	6650.89		
3.5	6371.11	II	12705-28396	0.8	h 6651.42	I	
0.6	6372.99	I		3.0	6652.77	II	
0.9	h 6386.16	I		1.4	6661.41	I	
3.0	6386.86	I		1.8	6665.65	I	
0.8	6390.32	I		1.4	6675.54	II	12457-27433
2.5	6393.02	II		1.8	6679.81	I	
1.2	6395.12			2.0	6686.59		
1.2	6396.26	I		3.5	6700.70	I	
0.9	h 6399.91	I		7	d 6704.38	I	
1.2	6425.30	II		1.4	6706.03	I	
3.5	6430.07			0.4	6710.16	I	
2.0	6434.40	I		1.0	6713.48	I	
2.5	6436.41	I		1.2	6720.32	II	
0.9	6439.97	I		0.4	6726.52		
2.0	6446.15			2.0	6728.71	I	
0.6	6451.98			2.0	6729.54	I	
3.5	6458.05	I		0.6	6733.21	II	



Cerium — All Observed Lines

Intensity and Character	Wave-length in A	Spectrum	Energy Levels in K	Intensity and Character	Wave-length in A	Spectrum	Energy Levels in K
2.0	6744.70	II	13527-28350	1.2	7018.75	I	
1.4	6746.89			2.0	7031.04	I	
1.4	6749.44	I		1.8	h 7049.73	I	
0.6	6755.08	II	13527-28327	2.0	7054.50		
0.8	6764.65	I		1.8	7058.68		
0.8	6767.65	I		1.8	7060.01		
0.5	6770.15			6	7061.75		
4	6774.29	II		1.8	7064.50		
5	6775.59	I		6	7086.36		
1.4	6778.28	I		1.8	7105.04		
1.2	6780.21			1.2	7113.15		
1.2	6780.74	I		1.8	7115.08	II	14276-28327
0.8	6793.81			1.2	7120.84		
0.7	6801.75			1.0	7123.46		
0.7	6803.29	I		1.6	7124.73		
2.4	6807.83	I		1.2	7132.06		
1.4	6808.89	I		1.2	7136.08		
0.8	h 6811.66			2.5	7141.42		
1.2	6815.29			1.2	7141.68		
2.0	6818.25	I		3.0	7150.23	II	15282-29263
1.0	6826.43	I		1.6	7151.67		
1.0	6829.37			2.5	7155.24		
1.4	6829.75			2.5	7156.99		
0.8	h 6834.21			1.2	7174.98		
0.7	6839.94			1.2	7177.43		
1.2	d 6844.26			1.2	7182.29		
	6844.49			1.0	7186.21		
1.0	6846.78	II		2.5	7189.40	II	13527-27433
1.8	6847.25	I		1.6	7191.72	I	
1.2	6853.60			1.8	7201.54		
1.6	6856.55			2.5	7201.87		
0.7	d 6885.51			1.6	7203.52		
	6885.72			2.0	7210.66		
1.4	6893.69			0.9	7213.90		
1.0	6894.57	I		3.0	7217.34		
1.4	6898.48			2.5	7235.69	CeO	
1.2	6899.10			3.5	7238.36	II	12457-26268
0.8	6904.58			2.0	7241.66	CeO	
0.5	6909.31			4	7252.72	I	
1.2	6919.27	II	13527-27976	2.0	7262.64		
4	6924.83	I			1.8	h 7277.91	I
1.4	6939.44	I		1.0	7279.94		
0.6	h 6970.40			1.8	7296.16		
2.5	6973.50	II		3.0	7301.43		
1.4	6983.83			3.0	7313.45		
4	6986.04			4	7329.92		
2.5	6999.92	I		2.5	7330.67		
1.0	7013.36			2.0	7343.45		
1.0	7014.80			1.0	7345.63		
1.2	7017.24	I		1.0	h 7361.89	II	12366-25945

Cerium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
1.0	7362.42			0.7	7752.85		
1.0	7363.12			0.8	7762.95		
1.0	7372.53			0.9	7769.74		
1.0	7383.72			0.8	7785.04		
1.4	7390.45	II	0-13527	1.6	7797.70	I	
1.0	7393.40			0.6	7806.79		
4	7397.76	I		1.2	7812.69		
1.8	7401.26			1.4	7835.88		
2.0	7417.94			0.6	7838.40		
1.0	7421.00			2.0	7842.60	I	
1.8	7424.70	CeO		3.5	7844.94		
2.0	7433.08			2.5	7850.02		
1.8	7438.58			2.5	7851.20		
1.0	7440.49			3.5	7857.54		
2.0	7444.44			2.0	7864.51		
1.0	h 7458.40			1.6	7866.04		
1.4	7462.31			0.8	d 7874.16		
1.6	7472.41			2.5	7898.96	I	
1.0	7478.69			1.8	7913.52		
2.5	7486.55			1.6	7927.30	CeO	
1.4	7500.68			1.6	7927.71	I	
1.0	7508.16	I		1.6	7934.48		
1.4	h 7509.43	I		0.8	7953.57		
1.8	7527.44			1.4	7972.11		
1.8	7527.68			1.2	7972.34	II	988-13527
1.6	7533.70			3.0	d 8002.56		
1.4	7539.53				8002.69		
1.6	7551.24			5	8025.56	II	0-12457
2.0	7562.44	I		0.8	8030.69		
1.6	7562.86			0.8	8031.43		
1.6	h 7563.52	I		1.0	8040.01		
1.4	7586.01			0.8	h 8066.90		
1.6	7603.10			2.5	8070.70		
4	7616.10			0.8	8079.36		
1.2	7632.56			1.0	8090.66		
2.0	7646.09			1.6	8094.43		
1.6	7647.91			2.5	8120.38	I	
1.2	h 7663.38			1.0	8171.41	I	
1.2	7670.76	I		0.8	8175.59		
1.2	7678.12			0.8	8199.20		
2.0	7682.48			1.4	8220.71	I	
4	7689.17			1.2	8223.62	I	
1.4	7702.84			1.2	8224.28		
0.9	7717.68			1.0	8239.48		
0.9	h 7724.60			1.6	8241.54		
1.6	7732.34	I		1.2	8245.20	I	
0.8	7741.44			0.8	8246.82		
0.7	7743.78			1.0	8250.64	II	1410-13527
0.6	7746.66			2.0	8261.09	I	
2.5	7748.34	I					

Cerium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
0.8 d	8300.58			2.0	8539.08	II	
	8300.72			1.4 h	8564.58	I	
1.4	8310.24	I		1.2 h	8567.48	I	
1.2	8312.37			1.6	8612.65	I	
0.8 h	8327.65			1.6 h	8647.66	I	
0.9 h	8355.16			1.8 h	8702.38	II	3794-15282
1.4	8396.40			1.2	8716.66	II	988-12457
0.9 d	8405.24	II	2382-14276	4	8772.14	II	2880-14276
2.5	8418.24			1.4	8782.17		
1.8	8495.82	II		2.0	8810.86	I	
0.9 h	8511.34	II		5	8891.20	I	
1.4 h	8523.34	I					

# CESIUM

$$\text{Cs, } Z=55, M=132.91, \text{ Ratio } \frac{\text{Cs}}{\text{Cu}}=2.092$$

Cs I Normal state of valence electrons  $5p^6 6s^1 {}^2S_{0\frac{1}{2}}=0$ . I.P.= 31407 K  
 Cs II Normal state of valence electrons  $5p^6 {}^1S_0=0$ . I.P.=202263 K

## References

### Wavelengths:

G. R. Harrison, Massachusetts Institute of Technology Wavelength Tables (John Wiley & Sons, New York, 1939).

### Classification:

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### Intensities:

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 M. Beutell, Ann. Physik **36**, 533 (1939).

## Relative intensity of cesium lines observed in an arc of copper containing 0.1 atomic percent of cesium

### *Strong lines of cesium*

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
1500	8521. 10	I	0-11732	$5p^6 6s^1 {}^2S_{0\frac{1}{2}} - 5p^6 6p^1 {}^2P_{\frac{1}{2}}$
800	8943. 50	I	0-11178	$5p^6 6s^1 {}^2S_{0\frac{1}{2}} - 5p^6 6p^1 {}^2P_{\frac{3}{2}}$

## Cesium — All Observed Lines

Intensity and Character	Wave- length in A	Spec- trum	Energy Levels in K	Intensity and Character	Wave- length in A	Spec- trum	Energy Levels in K
40	4555. 36	I	0-21947	20	hs	6723. 28	I 11178-26048
20	4593. 18	I	0-21766	20	hs	6973. 29	I 11732-26069
3.0	hs	5663. 8	I 11178-28829	3.5		6983. 49	I 11732-26048
2.5	hs	5844. 7	I 11732-28836	4		7609. 01	I 11178-24317
8	hs	6010. 33	I 11178-27811	6	hl	8015. 71	I 14500-26971
1.4	h	6034. 09	I 11732-28300	8	hl	8079. 02	I 14597-26971
12	hs	6212. 87	I 11732-27823	1500		8521. 10	I 0-11732
0.8		6217. 27	I 11732-27811	55		8761. 38	I 11178-22589
2.5	h	6354. 98	I 11178-26911	800		8943. 50	I 0-11178
3.0	h	6586. 51	I 11732-26911				

## CHROMIUM

$$\text{Cr, } Z=24, M=52.01, \text{ Ratio } \frac{\text{Cr}}{\text{Cu}}=0.819$$

Cr I Normal state of valence electrons  $3d^5 4s^1 {}^7S_3 = 0$ . I.P. = 54570 K  
 Cr II Normal state of valence electrons  $3d^5 {}^6S_{5/2} = 0$ . I.P. = 133060 K

### References

#### Wavelengths:

G. R. Harrison, Massachusetts Institute of Technology Wavelength Tables (John Wiley & Sons, New York, 1939).

Supplemented by lines from Kiess (below).

#### Classification:

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Cr II, C. C. Kiess, J. Research, NBS **47**, 385 (1951).

#### Intensities:

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### Relative intensity of chromium lines observed in an arc of copper containing 0.1 atomic percent of chromium

#### Strong lines of chromium

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
2400	3578.69	I	0-27935	$4s^1 a^7 S_3 - 4p^1 y^7 P_4^o$
2100	3593.49	I	0-27820	$4s^1 a^7 S_3 - 4p^1 y^7 P_3^o$
1700	4254.35	I	0-23499	$4s^1 a^7 S_3 - 4p^1 z^7 P_4^o$
1600	3605.33	I	0-27729	$4s^1 a^7 S_3 - 4p^1 y^7 P_2^o$
1300	4274.80	I	0-23386	$4s^1 a^7 S_3 - 4p^1 z^7 P_3^o$
900	5208.44	I	7593-26788	$4s^1 a^5 S_2 - 4p^1 z^5 P_3^o$
850	4289.72	I	0-23305	$4s^1 a^7 S_3 - 4p^1 z^7 P_2^o$
700	5206.04	I	7593-26796	$4s^1 a^5 S_2 - 4p^1 z^5 P_2^o$
440	5204.52	I	7593-26802	$4s^1 a^5 S_2 - 4p^1 z^5 P_1^o$
360	3017.57	I	8095-41225	$4s^2 a^5 D_3 - 4p^1 y^5 F_4^o$
360	3021.56	I	8308-41393	$4s^2 a^5 D_4 - 4p^1 y^5 F_3^o$
280	2835.63	II	12497-47752	$4s^1 a^5 D_{3/2} - 4p^1 z^5 F_{5/2}^o$
240	2986.47	I	8308-41782	$4s^2 a^5 D_4 - 4p^1 y^5 D_4^o$
200	2677.16	II	12304-49646	$4s^1 a^5 D_{3/2} - 4p^1 z^5 D_{3/2}^o$
			12497-49838	$4s^1 a^5 D_{3/2} - 4p^1 z^5 D_{5/2}^o$
190	2843.25	II	12304-47465	$4s^1 a^5 D_{3/2} - 4p^1 z^5 F_{3/2}^o$
190	4351.77	I	8308-31280	$4s^2 a^5 D_4 - 4p^1 z^5 F_5^o$
180	3014.76	I	7811-40971	$4s^2 a^5 D_1 - 4p^1 y^5 F_2^o$
170	2986.00	I	8095-41575	$4s^2 a^5 D_3 - 4p^1 y^5 D_3^o$
160	3919.16	I	8308-33816	$4s^2 a^5 D_4 - 4p^1 z^5 D_4^o$
160	3963.69	I	20520-45741	$4s^1 a^5 G_6 - 4p^1 y^5 H_7^o$
160	4344.51	I	8095-31106	$4s^2 a^5 D_3 - 4p^1 z^5 F_4^o$

## Chromium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
22	2055.52	II	0-48632	3.0	2690.26	I	8095-45255
18	2061.49	II	0-48491	32	2691.04	II	12497-49646
12	2065.42	II	0-48399	4	2693.52	II	30219-67334
3.0 h	2364.71	I	0-42275	4	2697.91	II	30299-67354
6	2383.33	I	8308-50253			II	39825-76879
9	2408.62	I	8308-49812	20	2698.41	II	12304-49352
17	2496.31	I	7927-47975	20	2698.69	II	11962-49006
11	2502.53	I	8095-48043	2.0	2700.60	I	8095-45113
19	2504.31	I	8095-48014	13	2701.99	I	8308-45306
5	2508.11	I	7927-47786	2.0	2702.53	I	24200-61191
6	2508.98	I	7927-47772	8	2703.48	I	8308-45286
4	2513.62	I	8095-47866		2703.55	II	30392-67369
11	2516.92	I	8095-47814	4	2703.86	II	12033-49006
8	2518.71	I	8095-47786	2.0	2705.43	I	24056-61008
40	2519.52	I	8308-47986	7	2708.79	II	33521-70427
19	2527.12	I	8308-47866	4	2709.31	II	33418-70317
4	2530.45	I	8308-47814	16	2712.31	II	12148-49006
7	2534.34	II	12497-51943	5	2716.18	I	8308-45113
5	2545.64	I	7751-47022	6	2717.51	II	31083-67871
16	2549.54	I	7811-47022	5	2718.43	II	31532-68306
4	2553.06	I	7811-46968	19	2722.75	II	12033-48750
8	2557.15	I	7927-47022	2.0	2724.04	II	31169-67868
13	2560.69	I	7927-46968	48 h	2726.51	I	7593-44259
15	2571.74	I	8095-46968	5	2727.26	II	31219-67876
10	2577.65	I	8095-46878	32 h	2731.91	I	7593-44187
5	2588.20	I	8095-46720	19 h	2736.47	I	7593-44126
38	2591.85	I	8308-46878	8	2739.38	I	23934-60428
4	2603.57	I	8308-46705	8	2740.10	II	12148-48632
4	2622.86	I	8308-46422	11	2741.07	I	24056-60528
2.5	2625.32	I	8095-46174	11	2742.03	II	12033-48491
2.0	2626.60	I	8308-46368	11	2742.17	I	24200-60657
2.0	2629.82	I	8095-46109	28	2743.64	II	11962-48399
4	2642.12	I	24200-62037	4	2746.21	II	29952-66355
28	2653.59	II	12033-49706			II	38315-74718
28	2658.59	II	11962-49565	12 h	2748.29	I	7751-44126
8	2661.73	II	12148-49706	38	2748.98	II	12033-48399
36	2663.42	II	12304-49838	44	2750.73	II	12148-48491
8	2663.68	II	11962-49493	5	2751.60	I	7927-44259
50	2666.02	II	12148-49646	32	2751.87	II	12304-48632
32	2668.71	II	12033-49493	12 h	2752.88	I	7811-44126
40	2671.81	II	12148-49565	4	2754.28	II	31086-67380
32	2672.83	II	12304-49706	2.5	2754.90	I	24834-61123
200	2677.16	II	12304-49646	2.5	2755.27	I	
		II	12497-49838	2.5	2756.75	I	24897-61161
4	2678.16	I	7927-45255	17	2757.10	I	7927-44187
36	2678.79	II	12033-49352	40	2757.72	II	12148-48399
2.0	2680.34	II	40415-77714	7	2758.98	II	38270-74505
26	2687.09	II	12148-49352	9	2759.39	II	31219-67449
7	2688.04	I	8095-45286	5	2759.73	II	31169-67394
6	2688.29	II	30157-67344	10 h	2761.76	I	7927-44126

## Chromium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
85	2762.59	II	12304-48491	55	2867.65	II	11962-46824
2.5	2763.06	I	27817-63998	24	2870.44	II	19798-54626
9	h 2764.35	I	8095-44259	12	2871.63	I	8095-42908
85	2766.54	II	12497-48632	18	2873.48	II	12033-46824
2.5	2767.54	I	25038-61161	10	2873.82	II	19631-54418
28	h 2769.92	I	8095-44187	36	2875.99	II	20024-54785
2.0	2771.45	I	23934-60005	26	2876.24	II	12148-46906
5	2778.06	II	39825-75810	20	2877.98	II	12304-47041
2.5	2779.14	I	25106-61078	8	2878.45	II	12497-47228
9	2780.30	II	33521-69478	14	2879.27	I	7927-42648
		II	38363-74319				
70	2780.70	I	8308-44259	11	2880.87	II	19798-54500
8	2785.70	II	33619-69506	3.5	2881.14	I	24056-58754
4	2787.63	II	30865-66727	19	2887.00	I	7811-42439
4	2787.84	I		6	2888.74	II	36273-70880
				80	2889.29	I	
10	2792.16	II	33694-69498	6	2889.82	II	32854-67449
6	2798.67	II		6	2891.42	I	24200-58775
8	2800.77	II	33694-69388	42	2893.25	I	8095-42648
9	2812.01	II	33619-69171	22	2894.17	I	7751-42293
		II	38563-74114	6	2896.46	II	32854-67369
						II	40228-74743
7	2818.36	II	33521-68993				
5	2822.01	II	33418-68844	24	2896.75	I	7927-42439
20	2822.37	II	30392-65813	6	d 2897.67	II	35608-70108
2.5	2826.75	I	27817-63183		2897.73	II	32845-67344
20	2830.47	II	30299-65618	10	2898.54	II	31219-65710
8	2834.26	II	34631-69903	9	2899.21	I	7811-42293
280	2835.63	II	12497-47752	6	2899.48	II	32855-67334
5	2836.48	II	35608-70852	3.0	2903.97	II	31118-65543
6	2838.79	II	38270-73486	6	2904.68	I	24940-59358
13	2840.02	II	30219-65420	20	2905.49	I	7811-42218
190	2843.25	II	12304-47465	30	2909.05	I	7927-42293
2.5	2846.02	I	27704-62830	30	2910.90	I	8095-42439
5	2849.29	I	27817-62903	28	2911.14	I	8308-42648
		II	30299-65384	5	2911.68	II	35569-69903
140	2849.84	II	12148-47228	7	2913.73	I	25177-59488
14	2851.36	II	30157-65218	2.5	2915.23	II	35611-69903
6	2853.22	II	30219-65257	2.5	2915.46	II	39825-74114
		II	42898-77935	10	2921.24	II	40202-74424
6	2855.07	II	32855-67871	7	2921.82	II	31169-65384
		II	35569-70585	7	2927.08	II	38563-72717
100	2855.68	II	12033-47041	9	2928.15	II	30308-64449
10	2856.77	II	19631-54626	11	2928.30	II	31219-65257
8	2857.40	II	19798-54785			II	38509-72649
70	2858.91	II	12497-47465	3.0	2929.44	II	36273-70399
50	2860.93	II	11962-46906	4	2930.85	II	29952-64063
90	2862.57	II	12304-47228	3.0	2932.70	II	31169-65257
85	2865.11	II	12148-47041	6	2933.97	II	31083-65157
6	2865.33	II	19528-54418	10	2935.14	II	30865-64924
70	2866.74	II	12033-46906	5	2940.22	II	42987-76988
10	2867.10	II	19631-54500	7	2946.84	II	34813-68738

## Chromium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
6	2953.36	II	29952-63802	11	3065.07	I	24940-57557
5	2953.71	II	34631-68477	3.5	3067.16	II	21824-54418
6	2961.73	II	30308-64062	11	3073.68	I	25177-57702
		II	33694-67449	7	3077.83	I	25106-57587
5	2966.05	II	31219-64924	3.5	3095.86	I	21841-54133
55	2967.64	I	8095-41782	3.5	3109.34	I	24834-56986
55	2971.11	I	7927-41575	3.5	3110.86	I	24897-57033
24	2971.91	II	30392-64031	30	3118.65	II	19528-51584
55	2975.48	I	7811-41409	6	3119.25	I	25038-57088
3.5	2976.72	II	30865-64449	5	3119.71	I	24940-56986
22	2979.74	II	30299-63849	55	3120.37	II	19631-51670
40	2980.79	I	7751-41289	3.5	3122.60	II	33694-65710
13	2985.32	II	30219-63707	60	3124.94	II	19798-51789
55	2985.85	I	7927-41409		3125.02	II	34659-66650
170	2986.00	I	8095-41575	15	3128.70	II	19631-51584
240	2986.47	I	8308-41782	75	3132.06	II	20024-51943
75	2988.65	I	7593-41043	18	3136.68	II	19798-51670
18	2989.19	II	30157-63601	18	3147.23	II	20024-51789
55	2991.89	I	7811-41225			II	33619-65384
26	2994.07	I	7593-40983	11	3148.44	I	23934-55686
34	2995.10	I	7593-40971	13	3155.15	I	24056-55741
80	2996.58	I	7927-41289	13	3163.76	I	24200-55799
24	2998.79	I	7593-40930	30	3180.70	II	20513-51943
120	3000.89	I	8095-41409	4	3181.43	II	20520-51943
85	3005.06	I	8308-41575	8	h 3188.01	I	24092-55451
18	3013.03	I	7751-40930	28	3197.08	II	20520-51789
90	3013.71	I	7811-40983	3.0	3198.11	I	24092-55353
90	3014.76	I	7811-40971	4	3208.59	II	20513-51670
180	3014.92	I	7927-41083	22	3209.18	II	20518-51670
90	3015.19	I	7751-40906	18	3217.40	II	20513-51584
360	3017.57	I	8095-41225	4	3229.20	I	27817-58775
55	3018.50	I	7811-40930	3.5	3234.06	II	34631-65543
30	3018.82	I	7927-41043	8	3237.73	I	23934-54811
55	3020.67	I	7811-40906	15	3245.54	I	23934-54736
360	3021.56	I	8308-41393	16	3251.84	I	24056-54799
140	3024.35	I	7927-40983	16	3257.82	I	24200-54887
11	3026.65	II	35708-68738	12	3259.98	I	24200-54866
22	3029.16	I	7927-40930	4	3295.43	II	33694-64031
90	3030.24	I	8095-41086	3.0	3307.02	II	33619-63849
18	3031.35	I	7927-40906	7	3324.06	II	19631-49706
						II	38509-68583
3.5	3032.93	II	21823-54785	3.5	3326.59	I	24940-54993
50	3034.19	I	8095-41043	4	3328.35	II	19528-49565
70	3037.04	I	8308-41225	4	3329.05	I	25177-55207
10	3039.78	I	24200-57088	12	3336.33	II	19528-49493
70	3040.85	I	8095-40971				
	3040.91	II	34631-67506	16	3339.80	II	19631-49565
7	3041.74	II	35611-68477	14	3342.59	II	19798-49706
14	3050.14	II	34813-67589	4	3343.34	I	24897-54799
90	3053.88	I	8308-41043	12	3346.02	I	24200-54078
3.0	3059.52	II	21825-54500	12	3346.74	I	24056-53927



## Chromium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
12	3347.84	II	19631-49493	9	3481.30	I	21841-50557
8	3349.07	I	24282-54133	7	3481.54	I	24200-52915
7	3349.32	I	25038-54887	7	3494.97	I	24056-52660
4	3351.60	I	25038-54866	5	3495.38	II	19798-48399
7	3351.97	I	0-29825	10	3510.54	I	24200-52678
7	h 3353.03	I	31055-60871	5	3511.84	II	20024-48491
	3353.13	II	20024-49838	15	3550.64	I	25771-53927
22	3358.50	II	19798-49565	10	3558.52	I	25206-53299
20	3360.30	II	25034-54785	16	3566.16	I	25360-53394
8	3361.77	II	25047-54785	16	3573.64	I	21848-49823
7	3362.21	I	20519-50253	10	3574.04	I	21840-49812
55	3368.05	II	20024-49706	42	h 3574.80	I	21857-49823
4	3376.40	I	31048-60657		3574.94	I	21848-49812
7	3378.34	II	25034-54626	2400	3578.69	I	0-27935
4	3379.17	I	20517-50102	20	h 3584.33	I	25771-53663
4	3379.37	II	25043-54626	16	3585.30	II	21823-49706
12	3379.83	II	25047-54626	2100	3593.49	I	0-27820
18	3382.68	II	19798-49352	44	3601.67	I	21841-49598
12	3391.43	II	19528-49006	5	3602.57	I	21848-49598
7	3392.99	II	25036-54500	11	3603.74	I	21848-49589
					3603.78	II	21824-49565
9	3393.84	II	25043-54500	1600	3605.33	I	0-27729
7	3394.30	II	25047-54500	5	3608.40	I	31049-58754
4	3402.40	II	25036-54418	5	3609.48	I	20521-48218
22	3403.32	II	19631-49006	5	3610.05	I	20517-48210
		II	25043-54418				
45	3408.76	II	20024-49352	9	3612.61	I	31055-58728
26	3421.21	II	19528-48750	11	3615.64	I	0-27650
34	3422.74	II	19798-49006	17	3632.84	I	20524-48043
18	3433.31	II	19631-48750	44	3636.59	I	20524-48014
34	3433.60	I	20519-49635	80	3639.80	I	20519-47986
7	3434.11	I	20524-49635	11	3640.39	I	20523-47986
20	3436.19	I	20524-49618	9	3641.47	I	20521-47975
9	3441.12	I	20521-49573	28	3641.83	I	20524-47975
18	3441.44	I	20524-49573	6	3646.16	I	20524-47942
4	3443.79	I	23934-52963	11	3648.53	I	20517-47918
22	3445.62	I	20524-49538	28	3649.00	I	20521-47918
4	3447.02	I	20517-49520	22	3653.91	I	20517-47877
22	3447.43	I	20521-49520	28	3656.26	I	20524-47866
9	3447.76	I	20524-49520	6	3662.84	I	20521-47814
24	3453.33	I	20517-49467	16	3663.21	I	20524-47814
5	3453.74	I	20521-49467	6	3665.98	I	20524-47794
16	3455.60	I	20524-49454	10	3666.64	I	20521-47786
13	3460.43	I	24282-53172	6	3668.03	I	20517-47772
8	3465.25	I	20521-49371	7	3676.32	I	24092-51287
5	3467.02	I	24282-53117	4	3677.68	II	21823-49006
9	3467.72	I	24056-52885	6	3677.89	II	21824-49006
6	3469.59	I	24304-53117	4	3679.82	I	20521-47689
2	3472.76	I	21841-50628	2.0	3681.69	I	24092-51247
3	3472.91	I	23934-52720	13	3685.55	I	20519-47645
5	3473.61	I	21848-50628	14	3686.80	I	20524-47640

## Chromium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
14	3687.25	I	20517-47629	4	3883.66	I	24277-50019
8	3687.54	I	20521-47631			I	31355-57097
2.0	3688.46	I	20517-47621	48	3885.22	I	7811-33542
8	3712.95	II	21824-48750	32	3886.79	I	8095-33816
4	3716.53	I	31393-58292	5	3891.93	I	23934-49621
14	3730.81	I	0-26796	22	3894.04	I	7751-33424
16	3732.03	I	0-26787	3.5	3897.65	I	
10	3742.97	I	20519-47229	3.0	3902.11	I	
50	3743.58	I	20524-47229	30	3902.92	I	7927-33542
60	3743.88	I	20519-47222	5	3903.16	I	7811-33425
9	3744.49	I	20524-47222	80	3908.76	I	8095-33672
6	3748.61	I	20521-47190	10	hd 3911.82	I	27729-53284
36	3749.00	I	20524-47190		3912.00	I	27820-53375
5	3757.17	I	20517-47126	10	3915.84	I	24282-49812
24	3757.66	I	20521-47126	16	3916.24	I	7811-33338
5	3758.04	I	20524-47126	3.0	3917.60	I	23163-48682
2.0	3767.43	I	20519-47055	160	3919.16	I	8308-33816
22	3768.24	I	20517-47047	50	3921.02	I	7927-33424
8	3768.73	I	20521-47047	2.5	3926.65	I	36578-62038
8	3788.86	I	24277-50663	50	3928.64	I	8095-33542
8	3790.45	I	24286-50661	34	3941.49	I	8308-33672
11	3791.38	I	24286-50655	2.5	3951.10	I	24286-49589
11	3792.14	I	24300-50663	3.5	3952.40	I	24304-49598
10	3793.29	I	24300-50655	3.0	3953.16	I	24300-49589
11	3793.88	I	24304-50655	160	3963.69	I	20520-45741
7	3794.61	I	24282-50628	10	3969.06	I	20519-45707
12	3797.13	I	24300-50628	130	3969.75	I	20524-45707
17	3797.72	I	24304-50628	7	3971.26	I	21848-47022
44	3804.80	I	24282-50558	130	3976.66	I	20524-45663
9	3806.83	I	27817-54078	7	3978.68	I	21841-46968
9	3807.93	I	24304-50557	3.5	3979.80	I	21848-46968
15	3815.43	I	21841-48042	7	3981.23	I	21857-46968
6	3818.48	I	20524-46705	80	3983.91	I	20521-45615
15	3819.56	I	21841-48014	16	3984.34	I	20524-45615
6	3823.52	I	7751-33897	13	3989.99	I	31393-56449
11	3826.42	I	21848-47975	80	3991.12	I	20517-45566
11	3830.03	I	27825-53927	13	3991.67	I	20521-45566
32	3841.28	I	21841-47866	16	3992.84	I	21841-46878
16	3848.98	I	21841-47814	3.5	3993.97	I	21848-46878
12	3849.36	I	24282-50253	13	4001.44	I	31378-56362
24	3850.04	I	21848-47814	10	4012.47	II	45670-70585
12	3852.22	I	7811-33762	2.5	4014.67	I	31378-56280
16	3854.22	I	21848-47786	7	4022.26	I	31355-56210
9	3855.29	I	21857-47788	6	4025.01	I	20521-45359
12	3855.57	I	24282-50211	10	4026.17	I	20524-45354
22	3857.63	I	21857-47772	7	4027.10	I	20524-45349
6	3874.53	I	24300-50102	7	4030.68	I	31352-56155
		I	27825-53628	16	4039.10	I	31048-55799
55	3883.29	I	31352-57097	13	4048.78	I	31049-55741
				10	4058.77	I	31055-55686

## Chromium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
3.5	4065.72	I	20524-45113	3.5	4238.96	I	24282-47866
		I	33113-57702	5	4240.70	I	24056-47630
7	4066.94	I	21841-46422			I	24940-48515
		I	25039-49621	1700	4254.35	I	0-23499
3.0	4074.86	I	35934-60468	6	4255.50	I	24200-47693
3.5	4076.06	I	33060-57587	5	4261.35	I	23499-46959
3.5	4077.09	I	21848-46368	9	4263.14	I	31048-54498
3.5	4077.68	I	33040-57557	2.5	4271.06	I	25038-48445
3.5	4104.87	I	20521-44875	3.5	4272.91	I	23386-46783
		I	23934-48288	1300	4274.80	I	0-23386
3.5	4109.58	I	21848-46174	7	4280.40	I	31049-54405
3.5	4120.61	I	21848-46109	850	4289.72	I	0-23305
3.5	4121.82	I	24056-48310	3.5	4291.96	I	27597-50890
3.0	4122.16	I	21857-46109	7	4295.76	I	21841-45113
3.5	4123.39	I	24200-48446	6	4297.74	I	31055-54317
12	4126.52	I	20519-44746	3.0	4300.51	I	27704-50950
3.0	4127.30	I	33113-57335	4	4301.18	I	27817-51060
3.5	4127.64	I	21857-46077	2.5	4305.45	I	23305-46525
3.5	4131.36	I	31009-55207	3.0	4319.64	I	23305-46449
2.5	4152.78	I	31028-55102	5	4325.08	I	23934-47048
10	4153.82	I	20524-44591	65	4337.57	I	7811-30859
7	4161.42	I	35934-59957	95	4339.45	I	7927-30965
12	4163.62	I	20524-44534	32	4339.72	I	7751-30787
6	4165.52	I	35884-59884	5	4340.13	I	21841-44875
3.5	4169.84	I	33113-57088	160	4344.51	I	8095-31106
3.0	4170.20	I	33060-57033	6	4346.83	I	24056-47055
3.5	4172.77	I	37234-61192	32	4351.05	I	7811-30787
14	4174.80	I		190	4351.77	I	8308-31280
2.5	4175.94	I	24286-48226	48	4359.63	I	7927-30859
14	4179.26	I	25106-49028	6	4363.13	I	23934-46847
3.0	4184.90	I	24897-48786	44	4371.28	I	8095-30965
2.5	4186.36	I	31049-54929			I	35884-58755
3.0	4190.13	I	23163-47022	6	4373.25	I	7927-30787
7	4191.27	I	20521-44373	9	4374.16	I	24200-47055
3.0	4192.10	I	32097-55945	6	4375.33	I	24056-46905
7	4193.66	I	31048-54887	4	4381.11	I	21848-44667
6	4194.95	I	31055-54887	44	4384.98	I	8308-31106
3.5	4197.23	I	31048-54866	5	4387.50	I	24092-46878
7	4198.52	I	31055-54866			I	24200-46986
5	4203.59	I	20517-44300	6	4391.75	I	8095-30859
3.5	4204.47	I	32097-55875	5	4403.50	I	32097-54800
3.0	4208.36	I	31055-54811	2.0	4410.30	I	24300-46968
9	4209.37	I	31049-54799	5	4411.09	I	24304-46968
3.5	4209.76	I	25038-48786	3.0	4412.25	I	8308-30965
3.5	4211.35	I	24304-48043	4	4413.87	I	28637-51287
3.5	4216.36	I	24304-48014	5	4424.28	I	24282-46878
7	4217.63	I	24282-47986	2.0	4428.50	I	24304-46878
3.5	4221.57	I	24834-48515	4	4430.49	I	24282-46847
		I	31055-54737			I	28682-51247
3.5	4222.73	I	24300-47975	4	4432.18	I	23163-45719

## Chromium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
9	4458.54	I	24282-46705	4	4601.02	I	20524-42252
		I	28637-51060	20	4613.37	I	7751-29421
2.5	4459.74	I	24304-46720	50	4616.14	I	7927-29585
2.5	4465.36	I	24300-46688	6	4619.55	I	24092-45734
2.5	4482.88	I	27176-49477	7	4621.96	I	20524-42154
						I	31048-52678
3.5	4488.05	I	24092-46368				
4	4489.47	I	28682-50950	6	4622.49	I	28637-50264
5	4492.31	I	27223-49477	2.0	4622.76	I	24092-45719
55	4496.86	I	7593-29825	46	4626.19	I	7811-29421
4	4498.73	I	23512-45734	2.0	4632.18	I	28682-50264
6	4500.30	I	24834-47048	3.5	4637.18	I	20521-42080
4	4501.11	I	23512-45722	4	4637.77	I	20524-42080
		I	28679-50890	4	d 4639.52	I	25089-46637
1.8	4501.79	I	23512-45719		4639.70	I	28637-50184
2.0	4506.85	I	33763-55945	130	4646.17	I	8308-29825
8	4511.90	I	24897-47055	2.0	4646.81	I	25011-46525
1.0	4514.37	I	33763-55908	2.0	4648.13	I	20517-42026
3.0	4514.53	I	23499-45643	2.0	4648.87	I	20521-42026
2.0	4521.14	I	33763-55875			I	28679-50184
2.0	4526.11	I	24897-46986	3.0	4649.46	I	20524-42026
						I	28682-50184
32	4526.47	I	20519-42606				
6	d 4527.34	I	20524-42606	48	4651.28	I	7927-29421
	4527.47	I	24092-46174	70	4652.16	I	8095-29585
2.0	4529.85	I	20519-42589	3.0	4654.74	I	24971-46449
32	4530.74	I	20524-42589	1.6	4656.19	I	24897-46368
4	4535.15	I	20521-42565	3.5	4663.33	I	25011-46449
20	4535.72	I	20524-42565	6	4663.83	I	25089-46525
3.5	4539.79	I	20517-42539	8	4664.80	I	25206-46637
20	4540.50	I	20521-42539	3.0	4665.90	I	28679-50105
20	4540.72	I	25038-47055	1.8	4666.22	I	23934-45358
3.0	4541.07	I	20524-42539	6	4666.51	I	25360-46783
1.6	4541.51	I	24834-46847	4	4669.34	I	25549-46959
2.0	4542.62	I	24897-46905	3.5	4680.54	I	25089-46449
12	4544.62	I	20517-42515	1.6	4680.87	I	24940-46298
		I	24300-46298	6	4689.37	I	25206-46525
2	4545.34	I	20521-42515	5	4693.95	I	24056-45354
50	4545.96	I	7593-29585	2.0	4695.15	I	24056-45349
4	4556.17	I	25106-47048			I	35808-57101
1.8	4558.66	II	32854-54785	5	4697.06	I	21841-43125
1.6	4564.17	I	38538-60441	20	d 4698.46	I	25360-46637
					4698.62	I	21848-43125
10	4565.51	I	7927-29825				
8	4569.64	I	25177-47055	3.0	4700.61	I	21857-43125
10	4571.68	I	20519-42387	16	4708.04	I	25549-46783
1.8	4575.12	I	27176-49027	20	4718.43	I	25772-46959
30	4580.06	I	7593-29421	4	4723.10	I	24834-46000
2.0	4586.14	I	25106-46905	4	4724.42	I	24897-46058
30	4591.39	I	7811-29585	4	4727.15	I	24200-45349
6	4595.59	I	33763-55517	2.0	4729.72	I	
4	4600.10	I	20519-42252	10	4730.71	I	24834-45966
40	4600.75	I	8095-29825	12	4737.35	I	24897-46000

## Chromium — All Observed Lines

Intensity and Character	Wave-length in A	Spectrum	Energy Levels in K	Intensity and Character	Wave-length in A	Spectrum	Energy Levels in K
1.6	4745.31	I	21841-42908	24	5247.56	I	7751-26802
6	4752.08	I	33763-54800	5	5254.92	I	27500-46525
28	4756.11	I	25038-46058	5	5255.13	I	27935-46959
4	4764.29	I	28637-49621	1.6	5261.75	I	29825-48824
1.8	4766.63	I	28679-49653	44	5264.15	I	7811-26802
2.5	4767.86	I	28682-49650	2.5	5265.16	I	27650-46637
16	4789.32	I	20519-41393	15	5265.72	I	7811-26796
8	4792.51	I	25106-45966	3.0	5272.01	I	27820-46783
10	4801.03	I	25177-46000	2.5	5273.44	I	27825-46783
9	4829.38	I	20524-41225	8	h 5275.17	I	23305-42256
1.2	4836.86	I	25038-45707			I	27223-46174
1.4	4861.20	I	20521-41086	3.0	h 5275.69	I	23305-42255
6	4861.84	I	20524-41086	6	h 5276.03	I	23305-42253
12	4870.80	I	24834-45358	1.6	5280.29	I	27176-46109
3.0	4885.78	I	20521-40983	0.8	5287.19	I	27729-46637
1.6	4885.96	I	24897-45358	28	5296.69	I	7927-26802
11	4887.01	I	24897-45354	6	h 5297.36	I	23386-42258
1.6	4888.53	I	20521-40971	55	5298.27	I	7927-26796
3.0	4903.24	I	20517-40906	7	5300.75	I	7927-26788
22	4922.27	I	25038-45349	1.4	5304.21	I	27935-46783
9	4936.33	I	25106-45358	2.0	5312.88	I	27820-46637
6	4942.50	I	7593-27820	2.0	5318.78	I	27729-46525
9	4954.81	I	25177-45354	28	h 5328.34	I	23499-42261
3.0	4964.93	I	7593-27729	6	h 5329.17	I	23499-42258
5	5013.32	I	21841-41782	1.4	h 5329.72	I	23499-42256
1.4	5051.90	I	7593-27382	1.2	5340.44	I	27729-46449
1.4	5065.91	I	21841-41575	0.8	5344.76	I	27820-46525
3.5	5067.71	I	21848-41575	65	5345.81	I	8095-26796
3.5	5072.92	I	7593-27300	32	5348.32	I	8095-26787
2.5	5110.75	I	21848-41409	2.5	5386.98	I	27176-45734
1.4	5113.13	I	21857-41409	1.8	5387.57	I	27163-45719
1.4	5123.46	I	8308-27820	0.8	5390.39	I	27176-45722
4	5139.65	I	27597-47048	3.5	5400.61	I	27223-45734
1.2	5144.67	I	21857-41289	1.8	5405.00	I	27223-45719
6	5166.23	I	27704-47055	120	5409.79	I	8308-26787
3.0	5177.43	I	27650-46959	1.0	5442.41	I	27597-45966
6	5184.59	I	27500-46783	1.6	5463.97	I	27704-46000
6	5192.00	I	27382-46637	1.6	5480.50	I	27817-46058
1.0	5193.49	I	27597-46847	2.0	5628.64	I	27597-45358
7	5196.44	I	21848-41086	0.6	5642.36	I	31106-48824
3.0	5200.19	I	27300-46525	1.0	h 5649.37	I	30965-48661
440	5204.52	I	7593-26802	2.0	5664.04	I	27704-45354
700	5206.04	I	7593-26796	0.6	h 5681.20	I	
900	5208.44	I	7593-26788	0.6	h 5682.48	I	30965-48559
1.6	5214.13	I	27176-46349	2.0	5694.73	I	31106-48661
2.5	5221.75	I	27223-46368	3.5	5698.33	I	31280-48824
7	5224.94	I	27825-46959	2.0	5702.31	I	27817-45349
1.0	5226.89	I	21857-40983	1.0	5712.64	I	36578-54078
1.6	5238.97	I	21848-40930	2.0	5712.78	I	24282-41782
2.5	5243.40	I	27382-46449	0.6	5719.82	I	24304-41782

## Chromium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
0.6	5746.43	I	28679-46077	0.9	h	6882.38	I 27729-42255
		I	31048-48445	2.0	h	6883.03	I 27729-42253
0.6	5753.69	I	36552-53927	2.5	h	6924.13	I 27820-42258
1.0	h 5781.20	I	24282-41575	1.6	h	6925.20	I 27820-42256
		I	26796-44089	3.0	h	6978.48	I 27935-42261
0.5	h 5781.81	I	23934-41225	1.2	h	6979.82	I 27935-42258
		I	26802-44093	0.7		7185.52	I 31393-45306
2.0	h 5783.11	I	28679-45966	0.6	h	7236.20	I 41393-55209
		I	26802-44089	9		7355.90	I 23305-36896
2.5	h 5783.93	I	26796-44081	14		7400.21	I 23386-36896
2.0	h 5785.00	I	26787-44069	16		7462.31	I 23499-36896
1.6	h 5785.82	I	26802-44081	1.2	h	7942.04	I 35398-47986
5	h 5787.99	I	26796-44069	0.5	h	8163.18	I 35398-47645
15	h 5791.00	I	26787-44051	0.9		8348.28	I 21841-33816
3.0	6330.10	I	7593-23386	0.6		8450.26	I 21841-33672
1.8	6362.87	I	7593-23305	0.3		8455.24	I 21848-33672
1.8	6661.08	I	33816-48824	0.6		8548.86	I 21848-33542
1.0	6669.26	I	33672-48661	4		8947.15	I 25039-36212
0.5	h 6881.62	I	27729-42256	2.0		8976.83	I 24898-36034

# COBALT

Co,  $Z=27$ ,  $M=58.94$ , Ratio  $\frac{\text{Co}}{\text{Cu}}=0.928$

Co I Normal state of valence electrons  $3d^7 4s^2 {}^4F_{4/2}=0$ . I.P.= 63438 K  
 Co II Normal state of valence electrons  $3d^8 {}^3F_4=0$ . I.P.=137572 K

## References

### Wavelengths:

G. R. Harrison, Massachusetts Institute of Technology Wavelength Tables (John Wiley & Sons, New York, 1939).

Supplemented by references for Co I and Co II (below).

### Classification:

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Co II, J. H. Findlay, Phys. Rev. **36**, 5 (1930); N. E. Hager Jr., unpublished material (1951).

### Intensities:

L. S. Ornstein and T. Bouma, Phys. Rev. **36**, 679 (1930).

R. B. King, B. R. Parnes, M. H. Davis, and K. H. Olsen, J. Opt. Soc. Am. **45**, 350 (1955).

Y. I. Ostrovskii and N. P. Penkin, Optika i Spektroskopiya **5**, 345 (1958).

## Relative intensity of cobalt lines observed in an arc of copper containing 0.1 atomic percent of cobalt

### Strong lines of cobalt

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
1300	3453. 50	I	3483-32431	$4s^1 b {}^4F_{4/2}-4p^1 y {}^4G_{5/2}$
700	3405. 12	I	3483-32842	$4s^1 b {}^4F_{4/2}-4p^1 y {}^4F_{4/2}$
600	3502. 28	I	3483-32028	$4s^1 b {}^4F_{4/2}-4p^1 y {}^4D_{3/2}$
550	3443. 64	I	4143-33173	$4s^1 b {}^4F_{3/2}-4p^1 y {}^4G_{3/2}$
550	3569. 38	I	7442-35451	$4s^1 a {}^2F_{3/2}-4p^1 y {}^2F_{3/2}$
500	3474. 02	I	0-28777	$4s^2 a {}^4F_{4/2}-4p^1 z {}^4F_{3/2}$
460	3529. 81	I	4690-33467	$4s^1 b {}^4F_{2/2}-4p^1 y {}^4F_{3/2}$
440	3506. 32	I	4143-32465	$4s^1 b {}^4F_{3/2}-4p^1 y {}^4G_{4/2}$
420	3412. 34	I	4143-32654	$4s^1 b {}^4F_{3/2}-4p^1 y {}^4D_{2/2}$
420	3412. 34	I	4143-33440	$4s^1 b {}^4F_{3/2}-4p^1 y {}^2G_{4/2}$
420	3587. 19	I	8461-36330	$4s^1 a {}^2F_{2/2}-4p^1 y {}^2F_{2/2}$
400	3526. 85	I	0-28346	$4s^2 a {}^4F_{4/2}-4p^1 z {}^4F_{4/2}$
340	3894. 08	I	8461-34134	$4s^1 a {}^2F_{2/2}-4p^1 y {}^2G_{3/2}$
320	3462. 80	I	5076-33946	$4s^1 b {}^4F_{1/2}-4p^1 y {}^4F_{2/2}$
320	3465. 80	I	0-28845	$4s^2 a {}^4F_{4/2}-4p^1 z {}^4G_{3/2}$
300	3489. 40	I	7442-36092	$4s^1 a {}^2F_{3/2}-4p^1 y {}^2D_{2/2}$
300	3512. 64	I	4690-33151	$4s^1 b {}^4F_{2/2}-4p^1 y {}^4D_{1/2}$
300	3518. 35	I	8461-36875	$4s^1 a {}^2F_{2/2}-4p^1 y {}^2D_{1/2}$
300	3845. 47	I	7442-33440	$4s^1 a {}^2F_{3/2}-4p^1 y {}^2G_{4/2}$
280	3409. 18	I	4143-33467	$4s^1 b {}^4F_{3/2}-4p^1 y {}^4F_{3/2}$
280	3433. 04	I	5076-34196	$4s^1 b {}^4F_{1/2}-4p^1 y {}^4F_{1/2}$

## Cobalt — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
2.0	2174.60	I	0-45971	4	2370.51	I	816-42988
3.0	2245.13	II	4029-48556	3.0 h	2371.44	I	17234-59389
1.6	2268.17	I	4143-48217	6	2371.86	I	1407-43555
1.6	2274.49	I	0-43952	1.6	2372.83	I	1407-43538
5	2276.53	I		2.5	2373.38	I	
1.6	2283.52	II	4029-47807	3.0	2375.18	II	4950-47039
1.6	2284.85	I	816-44568	4	2377.22	I	5076-47129
26	2286.16	II	3350-47078	38	2378.62	II	3350-45379
5	2287.81	I	4143-47839	28	2380.48	I	816-42811
1.6	2291.46	I	4690-48317	3.0	2381.75	II	
2.0	2292.00	II	17772-61388	36	2383.46	II	4029-45972
2.0	2293.39	II	4561-48151	28	2384.86	I	0-41918
2.0	2295.23	I	0-43555	20	2386.36	II	4561-46453
1.6	2296.05	I	5076-48616	3.0	2387.46	I	4690-46563
3.5	2296.71	I	4690-48217	70	2388.92	II	3350-45198
1.6	2303.97	I	3483-46873	14	2389.54	II	4950-46786
2.5	2304.18	I	816-44202	3.5	2391.37	I	
3.0	2305.18	I	816-44183	5	2392.60	II	
24	2307.86	II	4029-47346	5	2393.90	II	4561-46321
24	2309.02	I	0-43295	3.0 h	2397.03	I	
16	2311.60	II	4561-47807	14	2397.39	II	9813-51512
16	2314.05	II	4950-48151	1.4	2400.84	I	4690-46330
13	2314.98	II	5204-48388	28 d	2402.06	I	816-42434
4	2316.16	I	1407-44568		2402.17	I	1809-43426
5	2316.86	I	1407-44556	10	2404.17	II	5204-46786
24	2323.14	I	816-43848	3.0	2406.27	I	4143-45688
8	2324.32	II	4029-47039	140	2407.25	I	0-41529
6	2325.55	I	1407-44394	7	2407.67	II	10708-52230
8	2326.14	II	4561-47537	8	2408.75	II	4950-46453
8	2326.48	II	3350-46321	6	2410.51	I	14036-55509
1.6	2329.10	II	18338-61260	140	2411.62	I	816-42269
6	2330.35	II	4950-47848	42	2412.76	I	1809-43243
16	2335.99	I	1407-44202	3.0	2413.19	I	5076-46502
8	2337.94	II		3.0	2413.58	I	14399-55819
20	2338.67	I	1809-44556	14	2414.06	II	4561-45972
6	2339.05	I	816-43555	140	2414.46	I	1407-42811
8	2344.26	II	5204-47848	140	2415.30	I	1809-43200
8	2346.16	I	816-43426	4	2416.90	II	11322-52684
12	2347.39	II	4950-47537	4	2417.05	I	
2.5	2350.28	I	4690-47225	28	2417.65	II	4029-45379
2.0	2351.39	I	1407-43922	20	2419.12	I	
22	2352.85	I	3483-45971	3.5	2420.73	II	
30	2353.42	I	816-43295	6	2422.56	I	13796-55061
		II	4561-47039	3.5	2423.62	II	5204-46453
9	2355.48	I	1407-43848	130	2424.93	I	0-41226
8	2358.18	I	1809-44202	2.0	2425.59	I	4690-45905
1.6	2361.53	II	5204-47537	5	2427.00	I	
30	2363.79	II	4029-46321	3.5	2428.29	II	4029-45198
15	2365.07	I	0-42269	13	2428.60	I	
6	2369.68	I	4143-46330	3.5	2429.23	I	816-41969



## Cobalt — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
120	2432.21	I	816-41918	10	2544.86	I	4143-43426
26	2435.09	I		1.2	2546.74	II	24412-63665
25	2435.83	I	0-41041	18	2548.34	I	7442-46672
100	2436.66	I	1407-42434	12	2549.30	I	1407-40622
2.5	2436.98	II	4950-45972	12	2553.00	I	4690-43848
90	2439.05	I	1809-42797	16	2553.37	I	4143-43295
20	2441.05	I	17234-58187	16	2555.07	I	5076-44202
2.5	2449.16	II	4561-45379	10	2556.76	I	4143-43243
4	2450.00	II	10708-51512	12	2559.41	II	11322-50382
10	2456.24	I	3483-44183	50	2562.15	I	1809-40828
1.2	2460.21	I	15184-55819	16	2564.04	II	10708-49698
20	2460.81	I	1809-42434	60	2567.35	I	1407-40346
2.5	2462.12	I	13796-54399	5	2572.24	I	4690-43555
3.5	2463.78	I	1407-41983	3.5	2573.40	I	4690-43538
3.5	2464.20	II	9813-50382	4.0	2573.54	I	4143-42988
2.0	2464.62	I	1407-41969	50	2574.35	I	816-39649
12	2467.69	I	1407-41918	1.8	2574.86	II	13405-52230
20	2470.28	I	3483-43952	1.8	2575.73	I	1809-40622
5	2473.90	I	816-41226	40	2580.33	II	9813-48556
20	2476.64	I	3483-43848	6	2580.84	I	4690-43426
18	2483.61	I	4143-44394	16	2582.24	II	11322-50036
1.2	2485.36	II	9813-50036	6	2585.34	I	8461-47129
4	2486.44	II	10708-50914	16	2587.22	II	10708-49348
3.0	2493.93	I	8461-48546	8	2590.59	I	7442-46032
5	2494.73	I	3483-43555	6	2591.69	I	4690-43264
16	2495.55	I	4143-44202	4	2594.16	I	1809-40346
16	2496.71	I	4143-44183	3.0	2600.98	I	3483-41918
1.2	h 2500.50	I		5	2606.12	I	5076-43436
1.2	2502.28	I	7442-47394	2.0	2610.76	I	4143-42434
24	2504.52	I	3483-43399	5	2613.49	I, II	
24	2506.46	II	9813-49698	4	2614.13	I	1407-39649
15	2506.88	I	4690-44568	8	2614.36	II	17772-56011
12	2507.68	I	4690-44556	6	2616.26	I	8461-46672
90	2511.02	I	3483-43295	4	2617.86	I	5076-43264
1.2	2512.40	II	24075-63865	5	2622.06	I	4143-42269
4	2512.90	I	7442-47225	5	2622.43	I	4690-42811
5	2513.12	I	4143-43922	14	2627.64	I	3483-41529
36	2517.87	I	4690-44394	7	2632.24	II	18032-56011
12	2519.82	II	10708-50382	3.0	2644.78	I	8461-46260
180	2521.36	I	0-39649	16	2646.42	I	4143-41918
12	2524.96	II	11322-50914	40	2648.64	I	3483-41226
48	2528.62	II	9813-49348	4	2649.94	I	8461-46186
120	2528.97	I	816-40346	5	2650.27	I	5076-42797
30	2530.13	I	4690-44202	8	2663.53	II	9813-47346
36	2532.18	I	5076-44556	6	2675.98	I	5076-42434
2.5	2535.36	I	7442-46873	6	2679.76	I	8461-45767
120	2535.96	I	1407-40828	9	2685.34	I	4690-41918
36	2536.49	I	4143-43555	3.0	2694.68	II	10708-47807
8	2541.94	II	10708-50036	10	2695.85	I	4143-41226
90	2544.25	I	1809-41102	3.0	2705.85	I	13796-50742

## Cobalt — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
10	2715.99	I	16468-53276	26	d 3154.68	I	16471-48160
7	2731.12	I	16471-53075		3154.79	I	15184-46873
12	2740.46	I	7442-43922	22	3158.78	I	816-32465
10	2745.10	I	16778-53196	8	3177.27	I	
5	2761.37	I	4143-40346	8	3188.37	I	15774-47129
10	2764.19	I	3483-39649	6	3219.15	I	816-31871
7	2766.22	I	17234-53374	8	3232.87	I	16471-47394
7	2778.82	I	15184-51160	14	3243.84	I	15184-46003
2.0	2796.23	I	5076-40828	16	3247.18	I	15184-45971
3.0	2797.08	I	8461-44202	24	3254.21	I	15184-45905
5	2803.77	I	4690-40346	16	3260.82	I	16471-47129
8	2815.56	I	4143-39649	8	3271.78	I	15774-46330
1.2	2820.01	I	8461-43911	32	3283.46	I	16778-47225
4	2837.15	I	16778-52014	5	3287.19	I	15774-46186
3.0	2850.04	I	8461-43538	8	3307.15	I	15774-46003
4	2862.61	I	1407-36330	12	3314.08	I	14036-44202
1.4	2872.50	I	8461-43264	15	3319.48	I	23612-53728
10	2886.44	I	816-35451	15	3322.20	I	16471-46563
3.0	2899.82	I	16471-50945	12	3325.24	I	16196-46260
1.4	2903.20	I	16468-50903	22	3326.99	I	23612-53660
5	2927.67	I	16778-50925	44	3334.14	I	3483-33467
1.6	2928.81	I	0-34134	12	3339.78	I	23856-53789
5	2929.51	I	16468-50593	10	3342.73	I	16778-46685
1.4	2957.68	I	16778-50579	12	3346.94	I	23856-53725
36	2987.16	I	0-33467	7	3348.11	I	16471-46330
36	2989.59	I	0-33440	38	3354.38	I	4143-33946
1.6	2995.15	I	17234-50611	7	3361.56	I	24628-54367
6	3000.55	I	816-34134	7	3362.80	I	24628-54356
17	3013.60	I	0-33173	36	3367.11	I	3483-33173
36	3017.55	I	816-33946	7	3370.33	I	4690-34352
6	3026.37	I	15184-48217	7	3373.23	I	18390-48026
3.0	3034.43	I	1407-34352	60	3385.22	I	4143-33674
11	3042.48	I	816-33674	70	3388.17	I	4690-34196
160	3044.00	I	0-32842	140	3395.38	I	4690-34134
22	3048.89	I	1407-34196	700	3405.12	I	3483-32842
6	3060.05	I	15774-48444	280	3409.18	I	4143-33467
90	3061.82	I	816-33467	420	3412.34	I	4143-33440
2.5	3062.20	I	816-33463	140	3412.63	I	0-29295
3.5	3064.37	I	816-33440	32	3414.74	I	5076-34352
48	3072.34	I	1407-33946	170	3417.16	I	4690-33946
34	3082.62	I	0-32431	14	3424.51	I	16778-45971
42	3086.78	I	1809-34196	5	3428.23	I	24628-53789
17	3089.60	I	816-33173	160	3431.58	I	816-29949
14	3098.20	I	1407-33674	280	3433.04	I	5076-34196
17	3121.42	I	0-32028	5	3438.91	I	26450-55521
6	3121.57	I	816-32842	100	3442.93	I	1407-30444
22	3137.33	I	1809-33674	550	3443.64	I	4143-33173
17	3139.94	I	816-32654	7	3446.09	I	25938-54948
26	3147.06	I	1407-33173	260	3449.17	I	4690-33674
6	3152.71	I	16196-47905	130	3449.44	I	3483-32465

## Cobalt — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
1300	3453.50	I	3483-32431	11	3611.70	I	18775-46455
65	3455.23	I	1809-30743	4	3615.39	I	15774-43426
7	3456.93	I	816-29735	2.5	3620.43	I	18390-46003
19	3461.18	I	25569-54452	2.0	3624.33	I	14399-41983
320	3462.80	I	5076-33946	4	3624.96	I	5076-32654
320	3465.80	I	0-28845	55	3627.81	I	4143-31700
6	3471.38	I	25569-54367	8	3631.39	I	816-28346
500	3474.02	I	0-28777	7	3632.84	I	23184-50703
			4690-33467	8	3634.71	I	23208-50712
4	3478.56	I	18390-47129	4	3636.72	I	15774-43264
6	3483.41	I	4143-32842	11	3639.44	I	15774-43243
24	3485.37	I	25139-53822	7	3641.79	I	16471-43922
300	3489.40	I	7442-36092	8	3643.18	I	16471-43911
6	3490.74	I		6	3647.66	I	1809-29216
30	3491.32	I	1809-30444	10	3649.35	I	23184-50579
150	3495.69	I	5076-33674	8	3652.54	I	1407-28777
30	3496.68	I	4143-32733	3.5	3654.45	I	15774-43130
600	3502.28	I	3483-32028	3.0	3656.97	I	4690-32028
36	3502.62	I	1407-29949	15	3662.16	I	18390-45688
440	3506.32	I	4143-32654	14	3676.55	I	23184-50376
180	3509.84	I	4690-33173	20	3683.05	I	16778-43922
90	3510.43	I	816-29295	4	3684.48	I	16778-43911
300	3512.64	I	4690-33151	3.5	3690.72	I	16468-43555
240	3513.48	I	816-29270	12	3693.11	I	16778-43848
300	3518.35	I	8461-36875	12	3693.48	I	16471-43538
20	3520.08	I	816-29216	15	3702.24	I	23208-50211
170	3521.57	I	3483-31871	36	3704.06	I	8461-35451
240	3523.43	I	5076-33449	3.0	3707.47	I	16471-43436
400	3526.85	I	0-28346	12	3708.82	I	16471-43426
170	3529.03	I	1407-29735	2.5	3712.18	I	16468-43399
460	3529.81	I	4143-32465	1.2	3726.66	I	13796-40622
120	3533.36	I	1809-30103	15	3730.48	I	15184-41983
17	3543.26	I	15184-43399	20	3732.40	I	15184-41969
6	3548.44	I	13796-41969	10	3733.49	I	16778-43555
34	3550.60	I	1407-29563	5	3734.14	I	16471-43243
6	3552.99	I	15774-43911	8	3735.93	I	16778-43538
6	3558.78	I	4690-32782	12	3745.50	I	7442-34134
70	3560.89	I	5076-33151	6	3749.94	I	16471-43130
55	3564.95	I	4690-32733	2.5	3751.63	I	16778-43426
550	3569.38	I	7442-35451	2.0	3754.35	I	20501-47129
100	3574.96	I	4690-32654	6	3755.45	I	16778-43399
160	3575.36	I	816-28777	1.4	3760.39	I	14036-40622
3	3578.08	I	18390-46330	3.0	3774.60	I	16778-43264
3	d 3578.90	I	14036-41970	1.6	3777.54	I	16778-43243
		I	14036-41969	3.0	3808.11	I	3483-29735
65	3585.16	I	4143-32028	3.0	3814.46	I	15774-41983
420	3587.19	I	8461-36330	6	3816.33	I	15774-41970
120	3594.87	I	1407-29216	5	3816.47	I	15774-41969
100	3602.08	I	1809-29563	2.5	3841.46	I	7442-33467
50	3605.36	I	4143-31871	60	3842.05	I	7442-33463

## Cobalt — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
300	3845.47	I	7442-33440	2.5	4052.92	I	28845-53512
28	3861.16	I	8461-34352	1.2	4057.20	I	1809-26450
240	3873.12	I	3483-29295	3.5	4058.19	I	4143-28777
120	3873.96	I	4143-29949	3.5	4058.60	I	16196-40828
12	3876.84	I	3483-29270	15	4066.37	I	7442-32028
34	3881.87	I	4690-30444	6	4068.54	I	15774-40346
5	3884.62	I	8461-34196	12	4086.31	I	15184-39649
2.5	3885.29	I	7442-33173	36	4092.39	I	7442-31871
1.2	3892.12	I	20501-46186	1.4	4104.75	I	18775-43130
1.2 h	3893.07	I	18775-44455	24	4110.54	I	8461-32782
340	3894.08	I	8461-34134	120	4118.77	I	8461-32733
24	3894.98	I	5076-30743	190	4121.32	I	7442-31700
1.2	3898.49	I	15184-40828	1.2	4158.42	I	23184-47225
1.2 h	3904.05	I	28845-54452	2.0	4162.17	I	28845-52864
6	3906.29	I	4143-29735	1.2	4187.25	I	16471-40346
7	3909.93	I	0-25569	4	4190.71	I	0-23856
6	3917.11	I	18390-43911	1.0	4234.00	I	0-23612
3.5	3922.75	I	8461-33946	2.5	4252.31	I	816-24326
1.4	3925.16	I	21216-46685	1.0	4285.79	I	1407-24733
1.2 h	3929.25	I	28346-53789	1.0	4331.24	I	27497-50579
1.4	3933.91	I	4690-30103	2.0	4339.62	I	20501-43538
65	3935.97	I	7442-32842	1.0	4371.13	I	16778-39649
7	3940.89	I	5076-30444	1.0	4373.63	I	28346-51204
11	3941.73	I	3483-28845	0.8	4391.57	I	24326-47091
9	3945.33	I	7442-32782	1.0	4417.40	I	24733-47365
2.0	3952.33	I	3483-28777	0.8	4421.34	I	23612-46223
16	3952.92	I	7442-32733	0.7	4431.62	I	23208-45767
9	3957.94	I	4690-29949	0.8	4445.72	I	25041-47528
2.0	3961.00	I	21216-46455	2.5	4466.89	I	24326-46707
4.5	3969.12	I	20501-45688	4	4469.56	I	23856-46223
3.5	3972.53	I	28346-53512	1.6	4471.55	I	24733-47091
4	3973.15	I	15184-40346	0.9	4478.32	I	25041-47365
4	3974.73	I	4143-29295	0.8	4483.93	I	25233-47528
1.2	3977.18	I	18775-43911	0.7	4494.76	I	28471-50712
6	3978.66	I	4143-29270	1.6	4517.11	I	25233-47365
5	3979.52	I	816-25938	10	4530.96	I	23612-45676
2.0	3987.12	I	4143-29216	3.0	4533.99	I	25041-47091
3.0	3990.30	I	15774-40828	2.5	4543.81	I	21920-43922
3.0	3991.54	I	29270-54316	4	4549.66	I	24733-46707
3.0	3991.69	I	4690-29735	6	4565.59	I	24326-46223
2.0	3994.54	I	5076-30103	0.7 h	4570.02	I	29295-51170
260	3995.31	I	7442-32465	0.7	4580.14	I	7442-29270
42	3997.91	I	8461-33467	8	4581.60	I	23856-45676
3.0	4013.94	I	16196-41102	1.6 h	4594.63	I	29295-51053
1.0	4019.30	I	4690-29563	1.6 h	4596.90	I	29295-51042
15	4020.90	I	3483-28346	0.6	4623.04	I	25740-47365
1.0	4023.40	I	15774-40622	0.8 h	4625.78	I	29949-51561
3.0	4027.04	I	1407-26232	5	4629.38	I	24628-46223
4	4035.55	I	28845-53618	7	4663.41	I	25269-46707
16	4045.39	I	8461-33173	4	4682.38	I	25740-47091

## Cobalt — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
3.5	4693.21	I	26063-47365	0.9	5332.67	I	28777-47524
0.9	4698.38	I	26250-47528	0.9	5333.65	I	32431-51174
0.7	4727.94	I	3483-24628	0.9	5334.84	I	32431-51170
0.6	4734.83	I	26250-47365	1.4	5341.33	I	33440-52156
4	4749.68	I	24628-45676	6	5342.71	I	32431-51143
0.7	4754.36	I	26063-47091	3.0	5343.39	I	32465-51174
0.9	4768.08	I	25740-46707	0.8	5347.49	I	33467-52162
3.0	4771.11	I	25269-46223	0.8	5349.09	I	33467-52156
3.0	4776.32	I	26598-47528	6	5352.05	I	28845-47524
4	4780.01	I	26450-47365	3.0	5353.48	I	33440-52114
9	4792.86	I	26232-47091	1.6	5359.18	I	33467-52121
6	4813.48	I	25938-46707	2.5	5362.77	I	34134-52775
8	4840.27	I	25569-46223	4	5369.58	I	14036-32654
0.9	4843.46	I	26450-47091	0.7	5381.10	I	15774-34352
17	4867.88	I	25139-45676	1.0	5381.75	I	34196-52772
1.6	4882.72	I	26232-46707	1.6	5407.51	I	33674-52162
1.2	4899.52	I	16471-36875	0.8	5436.99	I	33173-51561
1.2	5108.89	I	31700-51268	2.5	5444.57	I	32842-51204
2.0	5122.77	I	29563-49078	0.8	5452.30	I	30743-49078
1.6	5125.69	I	31700-51204	2.0	5454.56	I	32842-51170
2.0	5126.20	I	29216-48719	0.8	5469.30	I	15184-33463
2.0	5133.45	I	31700-51174	1.0	5470.46	I	30444-48719
4	5146.74	I	28777-48202	1.0	5477.08	I	29949-48202
2.0	5154.05	I	31871-51268	5	5483.34	I	13796-32028
2.0	5156.34	I	32733-52121	1.0	5483.96	I	29295-47524
2.5	5176.08	I	16778-36092	0.9	5489.65	I	32842-51053
6	5212.71	I	28346-47524	0.5	5495.67	I	27497-45688
6	5230.22	I	14036-33151	1.4	5523.29	I	18775-36875
5	5235.21	I	17234-36330	0.8	5524.98	I	33173-51268
6	5247.93	I	14399-33449	2.0	5530.77	I	13796-31871
1.2	5250.00	I	33674-52717	0.4	5558.82	I	28471-46455
1.0	5254.65	I	32028-51053	1.8	5590.73	I	16471-34352
2.0	5257.62	I	32028-51042	0.7	5636.12	I	33463-51201
1.0	5265.82	I	29216-48202	2.0	5647.22	I	18390-36092
3.0	5266.30	I	29735-48719	0.4	5659.11	I	16468-34134
5	5266.49	I	16468-35451	0.5	5830.08	I	28777-45925
3.0	5268.52	I	30103-49078	1.4	5890.48	I	16468-33440
2.0	h 5276.19	I	33173-52121	1.4	5915.54	I	17234-34134
5	h 5280.65	I	29270-48202	0.7	5935.39	I	15184-32028
1.0	5283.49	I	33173-52095	0.6	5946.49	I	29563-46375
0.8	5287.57	I	29295-48202	0.8	h 5984.08	I	14036-30743
0.9	5287.81	I	32654-51561	2.0	5991.88	I	16778-33463
3.0	5301.06	I	13796-32654	1.0	6000.67	I	29216-45877
0.5	5310.20	I	33946-52772	0.7	h 6006.36	I	35451-52095
2.0	h 5312.66	I	33946-52764	0.7	h 6007.67	I	36330-52971
1.2	5316.78	I	32465-51268	0.7	h 6049.10	I	36330-52857
0.4	5321.72	I	33674-52460	2.0	6082.44	I	28346-44782
1.8	h 5325.28	I	32431-51202	0.8	6086.65	I	27497-43922
0.6	5325.95	I	33946-52717	1.4	6093.13	I	14036-30444
2.5	5331.47	I	14399-33151	1.0	6116.98	I	14399-30743

## Cobalt — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
1.0	6122.65	I	28777-45106	1.2	7457.36	I	31700-45106
1.4	6189.00	I	13796-29949	0.4	7533.48	I	32654-45925
0.8	6230.97	I	14399-30444	1.0	7553.99	I	31871-45106
1.0	6249.51	I	16468-32465	0.3	7564.96	I	39649-52864
0.7 h	6257.58	I	29949-45925	0.5	7586.72	I	23153-36330
0.6	6273.03	I	32782-48719	0.4 h	7590.57	I	16778-29949
2.0	6282.63	I	14036-29949	0.8 h	7606.30	I	32782-45925
0.7	6320.41	I	35451-51268	0.8 h	7610.24	I	21216-34352
0.7 h	6347.83	I	35451-51200	1.8	7712.68	I	20501-33463
0.6	6395.20	I	30743-46375	0.5	7734.23	I	33449-46375
1.0	6417.82	I	18775-34352	0.4	7743.27	I	31871-44782
0.6	6429.91	I	17234-32782	1.2	7838.17	I	32028-44782
5	6450.24	I	13796-29295	0.5	7840.05	I	33173-45925
2.5	6455.00	I	29295-44782	0.4	7855.85	I	33151-45877
0.9 h	6477.88	I	30444-45877	0.3	7869.90	I	33173-45877
0.7 h	6490.34	I	16468-31871	0.3	7871.39	I	33674-46375
0.4	6551.44	I	15184-30444	1.6	7908.71	I	32465-45106
1.8	6563.42	I	16468-31700	0.6	7926.55	I	34134-46746
0.8	6595.90	I	29949-45106	2.0	7987.38	I	16778-29295
1.8	6632.44	I	18390-33463	3.0	8007.27	I	33440-45925
0.6	6678.81	I	15774-30743	0.6	8022.13	I	33463-45925
2.0	6771.06	I	15184-29949	0.8	8029.26	I	32654-45106
2.5	6814.94	I	15774-30444	1.2	8043.33	I	33946-46375
2.5	6872.40	I	16196-30743	1.4	8056.06	I	33467-45877
0.5	6937.81	I	21920-36330	0.3	8066.49	I	34352-46746
2.0	7016.61	I	16196-30444	2.0	8093.96	I	32431-44782
0.9	7027.81	I	31700-45925	0.4	8116.41	I	32465-44782
5	7052.89	I	15774-29949	0.3	8152.11	I	32842-45106
1.2	7054.04	I	21920-36092	1.0	8193.03	I	33674-45877
11	7084.99	I	15184-29295	0.8	8208.66	I	34196-46375
0.9	7113.56	I	31871-45925	2.0	8372.84	I	32842-44782
0.8	7134.32	I	32733-46746	0.7	8378.39	I	33173-45106
1.0	7154.71	I	16471-30444	0.4 h	8574.57	I	21780-33440
1.0	7159.18	I	32782-46746	1.0	8575.35	I	22475-34134
0.5	7193.60	I	32028-45925	0.3	8586.74	I	33463-45106
0.7	7285.28	I	23153-36875	0.8	8589.73	I	33467-45106
0.8	7354.59	I	15184-28777	0.4	8661.09	I	21920-33463
1.2	7388.70	I	21920-35451	0.7	8819.15	I	41529-52864
1.8	7417.38	I	16471-29949				

COPPER

Cu,  $Z=29$ ,  $M=63.54$ , Ratio  $\frac{Cu}{Cu} = 1.000$

Cu I Normal state of valence electrons  $3d^{10} 4s^1 \ ^2S_{0\frac{1}{2}}=0$ . I.P.= 62317 K

Cu II Normal state of valence electrons  $3d^{10} \ ^1S_0 = 0$ . I.P.=163666 K

References

Wavelengths:

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Classification:

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Cu II, A. G. Shenstone, Phil. Trans. Roy. Soc. (London) [A] **235**, 195 (1936).

Intensities:

R. B. King and D. C. Stockbarger, Astrophys. J. **91**, 488 (1940).

G. D. Bell, M. H. Davis, R. B. King, and P. M. Routly, Astrophys. J. **127**, 775 (1958).

Relative intensity of copper lines observed in an arc of silver containing 0.1 atomic percent of copper

*Strong lines of copper*

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
5000	3247.54	I	0-30784	$3d^{10}4s^1 \ ^2S_{0\frac{1}{2}} - 3d^{10}4p^1 \ ^2P_{1\frac{1}{2}}$
2500	3273.96	I	0-30535	$3d^{10}4s^1 \ ^2S_{0\frac{1}{2}} - 3d^{10}4p^1 \ ^2P_{0\frac{1}{2}}$

Copper — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
3.5	1999.69	II	21929-71920	24	2961.16	I	11203-44963
2.0	2024.34	I	0-49383	4	2997.36	I	13245-46598
1.5	2035.84	II	23998-73102	7	3010.84	I	11203-44406
2.0	2037.12	II	22847-71920	6	3036.10	I	13245-46173
4	2043.79	II	21929-70842	4	3063.41	I	13245-45879
1.5	2112.09	II	26265-73596	2.5	3093.99	I	11203-43514
6	2135.98	II	21929-68731	8	3194.10	I	13245-44544
2.0	2138.53	I	11203-57949	2.5	3208.23	I	13245-44406
6	2165.09	I	0-46173	5000	3247.54	I	0-30784
8	2178.94	I	0-45879	2500	3273.96	I	0-30535
6	2181.72	I	0-45821	4	3279.82	I	13245-43726
2.0	2192.26	II	22847-68448	8	3307.95	I	40909-71131
10	d 2199.58	I	11203-56651	7	3337.84	I	11203-41153
	2199.75	I	13245-58691	3.5	3599.13	I	43514-71291
4	2214.58	I	11203-56344	3.5	3602.03	I	43514-71268
3.5	2225.70	I	0-44916	2.0	h 4022.63	I	30535-55388
8	2227.78	I	13245-58119	4	4275.11	I	39019-62403
10	2230.08	I	11203-56030	2.0	4530.78	I	30784-52849
4	2247.00	II	21929-66419	8	4651.12	I	40909-62403
5	2293.84	I	11203-54784	40	5105.54	I	11203-30784
2.0	2369.89	II	26265-68448	20	5153.24	I	30535-49935
6	2441.64	I	0-40944	100	5218.20	I	30784-49942
36	2492.15	I	0-40114	16	5220.07	I	30784-49935
40	2618.37	I	11203-49383	4	h 5292.52	I	43514-62403
5	2700.96	II	73353-110366	10	5700.24	I	13245-30784
8	2766.37	I	13245-49383	40	5782.13	I	13245-30535
50	2824.37	I	11203-46598	20	7933.13	I	30535-43137
5	2882.93	I	11203-45879	40	,8092.63	I	30784-43137

## DYSPROSIUM

Dy,  $Z=66$ ,  $M=162.51$ , Ratio  $\frac{\text{Dy}}{\text{Cu}}=2.558$

Dy I Normal state of valence electrons  $4f^{10} 6s^2 5I_8 = 0$ . I.P.  $\approx 50000$  K

Dy II Normal state of valence electrons  $4f^{10} 6s^1 6I_{8\frac{1}{2}} = 0$ .

### References

#### Wavelengths:

Below 5500 Å:

A. Gatterer and J. Junkes, *Spektren der Seltenen Erden* (Specola Vaticana, Vatican, 1945).

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G. Eberhard, *Publ. Astrophys. Observatory Potsdam* **20**, Teil 3, 1 (1909).

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A. S. King, *Astrophys. J.* **72**, 221 (1930).

A. S. King and C. E. Moore, *Astrophys. J.* **98**, 33 (1943).

G. R. Harrison, *Massachusetts Institute of Technology Wavelength Tables* (John Wiley & Sons, New York, 1939).

Above 5500 Å:

C. C. Kiess, *Sci. Papers BS* **18**, 695 (1923).

#### Spectrum Assignments:

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A. S. King, unpublished material.

Supplemented by assignments from our plates.

#### Classification:

Dy II, C. H. Corliss and E. L. R. Corliss, unpublished material cited by W. F. Meggers, *J. Opt. Soc. Am.* **36**, 431 (1946).

#### Molecular Spectra:

DyO, G. Piccardi, *Spectrochim. Acta* **1**, 532 (1941).

### Relative intensity of dysprosium lines observed in an arc of copper containing 0.1 atomic percent of dysprosium

#### *Strong lines of dysprosium*

Intensity	Wavelength Å	Spectrum	Energy levels K	Term combination
2000	3531.70	II	0-28307	$4f^{10}6s^1 6I_{8\frac{1}{2}} - 4f^{10}6p^1 6K_{9\frac{1}{2}}$
1300	4211.72	I		
1100	3968.42	II	0-25192	$4f^{10}6s^1 6I_{8\frac{1}{2}} - 25192^{\circ}7\frac{1}{2}$
1000	3645.41	II	828-28252	$4f^{10}6s^1 4I_{7\frac{1}{2}} - 28252^{\circ}8\frac{1}{2}$
1000	4045.99	I		
950	4186.78	I		
850	3944.70	II	0-25343	$4f^{10}6s^1 6I_{8\frac{1}{2}} - 25343^{\circ}8\frac{1}{2}$
650	4000.48	II	828-25818	$4f^{10}6s^1 4I_{7\frac{1}{2}} - 25818^{\circ}8\frac{1}{2}$
600	3872.13	II	0-25818	$4f^{10}6s^1 6I_{8\frac{1}{2}} - 25818^{\circ}8\frac{1}{2}$
600	4077.98	II	828-25343	$4f^{10}6s^1 4I_{7\frac{1}{2}} - 25343^{\circ}8\frac{1}{2}$
550	4194.85	I		
500	3536.03	II		
500	3898.54	II	4756-30399	$4f^{10}6s^1 4I_{6\frac{1}{2}} - 30399^{\circ}7\frac{1}{2}$
480	3385.03	II		
480	3407.79	II	0-29336	$4f^{10}6s^1 6I_{8\frac{1}{2}} - 29336^{\circ}8\frac{1}{2}$
460	4167.99	I		
400	3460.97	II	0-28885	$4f^{10}6s^1 6I_{8\frac{1}{2}} - 28885^{\circ}7\frac{1}{2}$
400	3494.49	II	828-29437	$4f^{10}6s^1 4I_{7\frac{1}{2}} - 29437^{\circ}7\frac{1}{2}$
400	3523.98	II	4341-32710	$4f^{10}6s^1 6I_{7\frac{1}{2}} - 32710^{\circ}7\frac{1}{2}$
400	3534.96	II	828-29109	$4f^{10}6s^1 4I_{7\frac{1}{2}} - 29109^{\circ}7\frac{1}{2}$
400	3538.50	II	0-28252	$4f^{10}6s^1 6I_{8\frac{1}{2}} - 28252^{\circ}8\frac{1}{2}$
400	3550.22	II		
400	3576.25	II	4756-32710	$4f^{10}6s^1 4I_{6\frac{1}{2}} - 32710^{\circ}7\frac{1}{2}$
400	3694.81	II	828-27886	$4f^{10}6s^1 4I_{7\frac{1}{2}} - 27886^{\circ}7\frac{1}{2}$
400	3757.37	II	828-27435	$4f^{10}6s^1 4I_{7\frac{1}{2}} - 27435^{\circ}7\frac{1}{2}$
360	3630.25	II		
360	4218.09	I		
360	4221.10	I		
340	3393.59	II	828-30287	$4f^{10}6s^1 4I_{7\frac{1}{2}} - 30287^{\circ}8\frac{1}{2}$
340	3445.58	II	0-29014	$4f^{10}6s^1 6I_{8\frac{1}{2}} - 29014^{\circ}8\frac{1}{2}$
320	4103.34	II	828-25192	$4f^{10}6s^1 4I_{7\frac{1}{2}} - 25192^{\circ}7\frac{1}{2}$
300	3585.08	II	0-27886	$4f^{10}6s^1 6I_{8\frac{1}{2}} - 27886^{\circ}7\frac{1}{2}$
300	4215.15	I		
280	3786.21	II		



Dysprosium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
5	2356.91	II		9	2800.34	II	
1.6	2381.95			8	2800.54	II	
3.5	2387.36	II		8	2801.40	II	
4	2392.15			6	2810.85	II	
6	2402.29	II		3.5	2811.10	II	
8	2410.01	II		6	2811.43	II	
6	2422.75	II		4	2815.24	II	
13	2439.82	II		22	2816.39	II	
5	2455.16	II		10	2825.44	II	
6	2460.00	II		4	2828.37	II	
5	2471.41	II		3.5 d	2835.15	II	
6	2480.92	II			2835.33	II	
9	2490.62	II		4	2837.00	II	
5	2510.32	II		4	2837.61	II	
9	2513.57	II		4	2842.05	II	
9	2517.60	II		5	2848.94		
7	2543.83	II		6	2856.42	II	
5	2545.13	II		1.2	2857.00	II	
8	2552.31	II		3.0	2857.12	II	
10	2557.94	II		3.5	2859.73	II	
5	2560.19	II		4	2860.17	II	
5	2566.25	II		5	2860.65	II	
12	2585.30	I		10	2862.70	I	
5	2591.51	II		6	2866.28	II	
4	2592.54	II		5	2867.61	II	
7	2600.18	II		2.0	2869.82	II	
7	2600.78	II		7	2876.41	II	
4	2608.67	II		14	2877.88	II	
20	2623.70	I		6	2878.72	II	
24	2634.81	II		6	2881.08	II	
6	2642.16	I		8	2884.29	II	
6	2645.32	II		5	2884.83	II	
6	2668.07	I		9	2885.51	II	
4	2676.84	II		5	2890.46	II	
3.5	2677.32	II		9	2890.75	II	
6	2689.29	II		5	2891.03	II	
6	2692.85	II		9	2900.83	II	
4	2709.02	II		8	2904.69	II	
4	2727.18	II		14	2906.39	II	
6	2729.51	II		5	2909.36	II	
4	2735.79	I		2.5	2909.72	II	
3.0	2739.33	II		2.5	2909.89	II	
6	2740.72	II		2.5	2913.73	II	
16	2755.75	II		28	2913.96	II	
4	2757.09	II		5	2918.65	II	
5	2766.51	II		5	2927.08	II	
5	2772.40	II		5	2930.99	II	
8	2772.60	II		8	2934.31	II	
3.0	2779.57	II		18	2934.52	II	
4	2791.44	II		8	2941.05	II	

Dysprosium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
10	2944.56	II	0-33382	7	3056.97	II	0-31826
6	2946.32	II		6	3059.48	II	
7	2946.77	II		8	3060.00	II	
11	2947.06	II		20	3060.65	II	
11	2947.22	II		9	3061.37	II	
18	2948.30	II		6	3061.51	II	
12	2950.32	II		8	3062.19	II	
8	2952.12	II		28	3062.62	II	
4	2953.03	II		16	3066.99	II	
10	2953.71	II		6	3070.44	II	
6	2957.75	II		24	3071.92	II	
6	2962.37	II		20	3073.55	II	
16	2964.63	I		4	3075.19	II	
4	2964.73	II		8	3076.90	II	
3.0	2975.57	II		10	3078.36	II	
6	2975.82	II		16	3078.69	II	
8	2977.42	II		11	3079.34	II	
3.5	2979.63	II		7	3080.92	II	
8	2985.93	II		10	3082.52	II	
2.5	2987.88	II		6	3084.66	II	
3.5	2988.71	II		9	3093.10	II	
5	2989.78	II		7	3093.80	II	
6	2991.35	II		9	3095.73	II	
5	2991.61	II		20	3101.91	II	
4	2992.41	II		16	3103.24	II	
3.5	2995.44	II		14	3103.84	II	
6	3002.38	II		13	3104.99	II	
8	3003.76	II		30	3109.75	II	
4	3008.83	II		6	3110.75	II	
10	3015.06	II		3.5	3117.50	II	
16	3015.69	II		14	3120.17	II	
13	3016.97	II		12	3126.17	II	
12	3025.61	II		24	3128.39	II	
28	3026.16	II		60	3135.36	II	
6	3027.57	II		26	3140.63	II	
15	3029.83	II		36	3141.12	II	
8	3030.41	II		10	3142.29	II	
6	3031.18	II		7	3143.17	II	
7	3033.18	II		16	3143.81	II	
9	3036.70	II		10	3145.21	II	
44	3038.29	II		18	3146.15	II	
3.5	3042.08	II		9	3147.50	II	
20	3043.15	II		11	3151.88	II	
12	3043.45	II		9	3152.20	II	
5	3044.56	II		11	3152.35	II	
4	3046.38	II		9	3153.30	II	
15	3047.60	II		110	3156.51	II	
11	3049.14	II		6	3157.53	II	
13	3051.46	II		11	3160.50	II	
13	3052.32	II		10	3161.02	II	

Dysprosium — All Observed Lines

Intensity and Character	Wave-length in A	Spectrum	Energy Levels in K	Intensity and Character	Wave-length in A	Spectrum	Energy Levels in K
60	3162.81	II		44	3245.16	II	
9	d 3164.05	II		18	3248.37	II	
11	3167.42	II		8	3250.99	II	
7	h 3167.77	II		110	3251.28	II	
7	3168.10	II		15	3251.90	II	
9	3168.92	I		18	3252.20	II	
90	3169.97	II		7	3253.91	II	
16	3170.73	II		7	3254.47	II	
7	3170.92	II		26	3256.26	II	
6	3171.38	II		7	3257.35	II	
12	3174.88	II		15	3260.01	II	
36	3177.87	II		13	3260.70	II	
20	3178.35	II		13	3261.22	II	
7	3181.92	II		15	3266.00	II	
6	3183.19	II		18	3266.21	II	
7	d 3184.19	II	828-32218	22	3269.12	II	
18	3184.77	II		7	3272.08	II	
30	3186.37	II		18	3272.74	II	
22	3187.67	II		11	3275.89	II	
6	3188.66	II		9	3279.49	II	
6	3192.98	II	0-31307	14	3279.67	II	828-31307
30	3193.31	II		80	3280.08	II	
12	3205.46	II		7	3281.63	II	
22	3206.39	II		44	3282.79	II	
7	3206.62	II		9	3282.89	II	
20	3207.10	II		7	3284.37	II	
26	3208.81	II		8	3286.58	II	
12	3212.03	II		18	3287.97	II	
7	3212.43	II		12	3288.65	II	
7	3212.67	II		9	3291.12	II	
17	3214.63	II		18	3293.83	II	
42	3215.19	II		18	3296.31	II	
75	3216.62	II		12	3297.62	II	
7	3217.36	II		7	3300.90	II	
14	3220.45	II		18	3305.40	II	
22	3221.50	II		18	3305.51	II	
15	3221.62	II		22	3306.19	II	
26	3223.29	II		40	3308.79	II	
22	3225.08	II	828-31826	100	3308.88	II	
30	3225.98	II		9	3310.97	II	
7	3226.05	II		46	3312.72	II	
13	3226.38	II		11	3313.30	II	
15	3228.97	II		70	3316.34	II	
15	3229.36	II		22	3317.11	II	
10	3229.95	II		9	3318.15	II	
13	3232.64	II		90	3319.88	II	0-30113
44	3235.89	II		24	3326.18	II	
26	3236.64	II		8	d 3326.43	II	
13	3240.88	II		12	3327.08	II	
9	h 3243.78	II		7	3327.30	II	

Dysprosium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
8	3328.79	II		24	3405.65	II	
9	3331.23	II		10 h	3406.81	II	
12	3334.14	II		34	3407.16	II	
6	3334.44	II		480	3407.79	II	0-29336
17	3339.50	II		38	3408.14	II	
70	3341.00	II		9	3409.44	II	
12	3341.42	II		13	3410.72	II	
24	3341.87	II	4341-34256	10	3411.21	II	
18	3347.81	II		10	3411.51	II	
24	3352.70	II		120	3413.78	II	828-30113
46	3353.59	II		48	3414.83	II	4341-33617
11	3355.07	II		11	3415.68	II	
17	3356.22	II		24	3417.15	II	
12	3358.26	II		24	3418.13	II	
17	3358.61	II		70	3419.63	II	
22	3359.48	II		8	3420.81	II	
8	3360.64	II		14	3421.32	II	
12	3365.80	II		12	3422.58	II	
46	3368.10	II		24	3422.86	II	
14	3370.86	II		10	3423.25	II	
14	3371.69	II		8 h	3423.82	II	
14	3371.81	II		48	3425.06	II	
12	3372.75	II		8	3425.35	II	
8	3374.28	II		10 h	3429.01	II	
16	3375.75	II		38	3429.45	II	
8	3376.01	II		24	3431.79	II	
16	3376.36	II		20	3432.57	II	
12	3376.62	II		12	3432.86	II	
14	3377.11	II		170	3434.37	II	0-29109
8	3378.20	II		8	3435.27	II	
16	3378.42	II		12	3435.92	II	
9	3378.88	II		12	3436.07	II	
8	3381.56	II		8	3436.95	II	
9 h	3384.10	II		30	3438.96	II	
480	3385.03	II		12	3439.32	II	
19	3386.59	II		8	3440.45	II	
55	3388.87	II	4756-34256	50	3440.94	II	
9	3389.44	II		120	3441.45	II	828-29769
13 d	3391.14	II		10 h	3442.52	II	
19	3391.98	II		8	3443.46	II	
8	3393.39	II		12	3444.26	II	
340	3393.59	II	828-30287	340	3445.58	II	0-29014
13	3394.00	II		75	3447.00	II	
120	3396.17	II	0-29437	15	3447.27	II	
8	3398.35	II		15	3447.78	II	
8	3399.34	II		40	3449.90	II	
10	3402.00	II		10	3450.22	II	
13	3403.27	II		240	3454.35	II	
10	3403.45	II		40	3454.52	II	
19	3404.98	II		120	3456.57	II	

Dysprosium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
10	3458.99	II	0-28885	17	3521.13	II	4341-32710
20	3460.40	II		8	3522.28	II	
10	3460.64	II		26	3522.86	II	
400	3460.97	II		400	3523.98	II	
8	3461.29	II		15	3524.61	II	
17	3463.36	II	4756-33617	8	3524.92	II	4341-32705
18	3463.88	II		24	3525.75	II	
8	3467.86	II		12	3526.61	II	
65	3468.44	II		17	3526.92	II	
8	3468.78	II		5	3528.93	II	
12	3470.18	II	0-28307	18	3529.02	II	828-29109
50	3471.14	II		2000	3531.70	II	
50	d 3471.53	II		13	3534.46	II	
	3471.61	II		400	3534.96	II	
34	3473.70	II		500	3536.03	II	
20	3474.30	II	0-28252	26	3536.56	II	828-2914
120	3477.06	II		26	3537.69	II	
8	3477.94	II		400	3538.50	II	
8	3478.47	II		36	3539.36	II	
8	3480.42	II		10	3539.62	II	
20	3480.83	II	828-29437	14	3540.67	II	828-28885
10	3482.09	II		150	3542.32	II	
20	3484.67	II		8	3542.87	II	
17	3485.90	II		36	3544.23	II	
12	3487.21	II		36	3544.36	II	
15	3487.59	II	828-29336	130	3546.84	II	828-2885
10	3488.97	II		10	3547.53	II	
12	3490.63	II		8	3547.89	II	
20	3494.14	II		30	3548.19	II	
400	3494.49	II		13	3548.72	II	
50	3496.33	II	828-29014	12	3549.26	II	828-2914
8	3497.12	II		400	3550.22	II	
36	3497.82	II		17	3551.12	II	
75	3498.67	II		200	3551.59	II	
20	3498.94	II		8	3553.19	II	
13	d 3499.82	II	828-29336	12	3555.96	II	828-2885
	3499.92	II		10	3557.62	II	
36	3501.45	II		40	h 3558.21	II	
20	3501.86	II		40	3559.27	II	
20	3502.09	II		26	3560.13	II	
24	3503.18	II	828-29336	200	3563.14	II	828-28885
75	3504.52	II		50	3563.69	II	
75	3505.45	II		20	3564.24	II	
24	3505.84	II		8	3565.65	II	
120	3506.81	II		18	3569.67	II	
26	3511.69	II	828-29336	9	3571.34	I	828-2885
26	3512.56	II		8	3571.68	II	
26	3512.70	II		70	3573.83	II	
50	3517.27	II		130	3574.18	II	
10	3519.76	II		10	3576.01	II	

Dysprosium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
400	3576.25	II	4756-32710	14	3619.47	II	
8	3576.60	II		18	3619.96	II	
150	3576.89	II	4756-32705	50	3620.18	II	
75	3577.98	II		9	3620.56	II	
14	3579.12	II		42	3624.25	II	
8	3579.42	II		100	3629.43	II	
40	3580.03	II		360	3630.25	II	
17	3582.01	II		20	3630.47	II	
36	3584.43	II		10	3630.64	II	
300	3585.08	II	0-27886	40	3632.79	II	
130	3585.77	II		20	3633.03	II	
50	3586.11	II	4341-32218	10	3633.77	II	
32	3590.05	II		8	3634.15	II	
26	3590.67	II		10	3634.32	II	
100	3591.43	II		36	3635.26	II	
50	3591.81	II		16	3636.22	II	
50	3592.12	II		32	3637.27	II	4341-31826
9	3593.15	II		20	3639.86	II	
20	3594.57	II		100	3640.24	II	4756-32218
160	3595.05	II		8	3640.80	II	
14	3595.30	II		36	3643.89	II	0-27435
36	3596.06	II		1000	3645.41	II	828-28252
9	3596.49	II		32	3645.86	II	
20	3597.29	I		16	3646.60	II	
10	3597.95	II		14	3646.85	I	
10	3598.27	II		16	3648.40	II	
10	3599.06	II		90	3648.79	II	
9	3599.48	II		10	3654.17	II	
16	3600.34	II		12	3654.87	II	
50	3600.39	II		10	3655.60	II	
32	3602.82	II		14	3661.75	II	
13	3603.15	II		60	3664.61	II	
8	3604.36	II		16	3665.20	II	
160	3606.13	II		34	3666.85	I	
9	3606.35	II		13	3668.90	II	
12	3606.90	II		13	3671.69	II	
10	3609.25	II		85	3672.31	II	4756-31979
10	3611.15	I		36	3672.66	II	
26	3612.77	II		34	3673.15	II	0-27217
20	3613.06	II		120	3674.09	II	
26	3614.08	II		20	3674.45	II	
9	3614.70			10	3676.00	II	
9	3614.94			190	3676.56	II	
12	3616.06	II		55	3678.48	I	
10	3616.35	II		70	3684.83	I	
12	3617.24	II	4341-31979	110	3685.81	I	
10	3617.65	II		10	3688.36	II	
9	3617.74	II		14	3693.84	I	
26	3618.08	II		12	3694.41	II	
40	3618.45	II		400	3694.81	II	828-27886

Dysprosium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
12	3696.94	II		13	3783.96	I	
32	3697.31	II		28	3785.42	II	
85	3698.18	II		280	3786.21	II	
20	3700.59	II		10	3786.83	I	
46	3701.62	II		11	3787.26	II	
28	3707.42	II	4341-31307	140	3788.46	II	828-27217
38	3707.57	II		60	3791.86	II	
38	3708.20	II		10	3801.93	II	
10	3708.36	II		44	3804.14	II	
36	3710.08	II		10	3804.33	II	
10	3710.73	II		50	3806.26	II	
28	3711.65	II		9	3807.90		
14	3713.84	II		24	3809.05	II	
9	3715.27	II		18	3809.84		
8	3715.54	II		15	3809.95		
14	3716.93	II		40	3812.30	I	
8	3717.29	I		14	3813.13		
7	3718.10	II		40	3813.67	II	
140	3724.42	II	4341-31183	20	3816.21		
8	3725.90	I		120	3816.78	II	
26	3727.99	I		16	3817.49		
10	3730.60	II		10	3818.74		
80	3739.33	I		10	3819.44		
9	3739.81	II		8	3821.49		
100	3747.82	II		9	3821.85		
11	3750.33	II		24	3822.57	II	
14	3751.80	II		8	3824.00		
120	3753.50	II	0-26634	60	3825.65	II	
120	3753.76	II		16	3829.75		
8	3754.77	II		8	3831.03		
100	3757.05	I		18	3831.64	II	
400	3757.37	II	828-27435	13	3832.91		
8	3758.97	II		200	3836.50	II	4341-30399
55	3767.63	I		14	3838.67	II	
28	3771.08	I		32	3840.91	I	
8	3771.38	I		120	3841.32	II	
14	3772.65	I		28	3842.02	I	
55	3773.05	I		28	3844.30	I	
20	3773.31	II		36	3846.33	II	
6	3773.74	I		36	3846.99	I	
32	3774.75	I		28	3849.38	II	
8	3776.93	II		100	3853.03	II	4341-30287
19	3777.45	I		36	3858.41	I	
8	3779.09	II		18	3865.45	II	
13	3779.23	II		32	3866.59	II	
8	3780.33	I		8	3867.84	II	
8	3780.93	I		48	3868.46	II	
36	3781.48	I		140	3868.81	I	
16	3782.88	II		26	3869.43	II	
13	3783.59	II		70	3869.87	II	4341-30175

Dysprosium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
18	3871.64	II		44	3950.40	II	
600	3872.13	II	0-25818	7	3953.13	II	
100	3874.00	II	828-26634	34	3954.56	II	
7	3875.15	II		7	3956.24	I	
40	3879.10	II	4341-30113	65	3957.79	II	
26	3882.00	II		7	3959.35	II	
9	3887.55	I		30	3962.58	I	
16	3888.45	II		9	3963.16		
16	3889.01	II		7	3963.80	II	
24	3891.85	II		9	3966.39	I	
24	3892.87	I		26	3967.50	I	
7	3894.51	I		1100	3968.42	II	0-25192
14	3895.34	II		13	3971.15	I	
500	3898.54	II	4756-30399	7	3972.39	I	
22	3899.15	I		13	3973.87	I	
8	3901.35	I		220	3978.57	II	
7	3903.30	I		22	3979.47	II	4756-29878
13	3904.21	II		9	3981.37	I	
9	3905.56	II		110	3981.92	II	
9	3905.95	I		130	3983.67	II	4341-29437
10	3912.52	I		65	3984.24	II	
7	3912.86	II		7	3984.70	II	
11	3913.62	I		7	3987.04	II	
13	3913.98	II		10	3988.90	I	
44	3914.86	II	4341-29878	6	3990.34	II	
44	3915.58	II	4756-30287	44	3991.33	II	
44	d 3917.30	I		14	3993.60	I	
	3917.37	I		7	3994.53	I	
9	3918.53	II		7	3996.01	I	
11	3919.13	I		130	3996.70	II	4756-29769
26	3923.39	II		9	3998.08	II	
9	3924.46	II		650	4000.48	II	828-25818
34	3927.88	I		34	4005.86	I	
11	3929.32	II		26	4006.09	I	
44	3930.15	I		8	4007.75	II	
15	3931.28	II		10	4010.08	II	
170	3931.55	II	4341-29769	44	4011.32	II	
9	3932.05	II		44	4013.80	I	
26	3932.22	II		44	4014.72	II	
30	3932.97	II	4756-30175	17	4015.18	II	
26	3934.17	II		13	4020.88	II	
13	3936.03	II		30	4023.70	I	
7	3936.30	II		20	4024.45	II	
34	3936.71	I		20	4024.87	I	
11	3937.16	I		34	4027.79	II	
22	3938.00	II		42	d 4028.32	II	
17	3938.15	I			4028.42	I	
44	3942.52	II	4756-30113	7	4031.08	I	
850	3944.70	II	0-25343	42	4032.44	II	
34	3946.92	II		13	4032.84	I	



Dysprosium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
34	4033.67	II	4341-29109	20	4134.14	I	4756-28885
34	4036.34	II		8	4134.73	I	
20	4038.51	II		12	4138.54	I	
15	4038.84	I		10	4139.56	I	
26	4041.98	II		38	4141.51	II	
1000	4045.99	I	4756-29437	100	4143.10	II	
7	4047.73	I		80	4146.07	I	
7	4048.35	II		6	4147.95	I	
20	4048.90	I		12	h 4152.43	II	
11	4049.35	I		8	4153.11	I	
130	4050.58	II	4756-29437	6	4154.23	I	
20	4053.86	I		10	4159.34	I	
42	4055.15	II		6	4160.24	I	
10	4057.40	II		6	4162.25	I	
7	4060.58	II		460	4167.99	I	
8	4072.65	II	4341-28885	6	4169.24	II	
200	4073.15	II		6	4170.55	I	
10	4074.02	II		30	4171.93	I	
600	4077.98	II		4171.99	I		
6	4079.27	I		11	d 4176.64	I	
7	4083.10	I	828-25343	4176.81	I		
15	4085.14	I		4	4181.25	I	
30	4085.36	I		20	4183.61	I	
15	4087.22	II		75	4183.73	I	
7	4087.38	I		950	4186.78	I	
7	4089.49	I	828-25192	26	4190.90	I	
15	4091.53	II		180	4191.60	I	
10	4091.77	II		550	4194.85	I	
7	4093.66	I		26	4195.22	I	
32	4096.12	I		65	4198.02	I	
8	4096.69	I	828-25192	55	4201.32	I	
8	4099.87	I		55	4202.25	I	
6	4101.94	II		19	4205.03	I	
320	4103.34	II		30	4206.54	II	
70	4103.88	I		11	4207.68	I	
16	4105.05	II	4756-29109	36	4211.23	I	
6	4106.38	II		1300	4211.72	I	
120	4111.34	II		150	4213.18	I	
10	4113.05	I		7	4214.38	I	
16	4119.33	II		300	4215.15	I	
40	4124.65	II	0-24316	360	4218.09	I	
12	4126.12	I		360	4221.10	I	
32	4128.29	II		6	4222.01	I	
28	4129.13	I		44	4222.22	I	
80	4129.44	II		6	4224.68	I	
28	4130.42	I	0-23766	220	4225.14	I	
10	4131.04	II		55	4232.03	I	
6	4132.85	II		6	4234.83	I	
14	4133.38	II		55	4239.85	I	
32	4133.86	I		6	4243.43	I	

Dysprosium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
36	4245.92	I	828-24316	5	4567.07	I	828-22467
11	4247.36	II		5	4573.85	II	
6	4248.44	II		34	4577.80	I	
36	4256.33	II		6	4587.93	II	
7	4258.14	I		170	4589.37	I	
6	4267.90	I		5	4591.78	II	
6	4268.29	I		80	4612.28	I	
20	4276.74	I	4	4613.83	I	4341-25773	
7	4279.76	I	4	4614.83	I		
10	4291.94	I	5	4617.26	II		
30	d 4294.94	II	11	4620.03	II		
	4295.04	I	4	4662.76	I		
6	4298.90	I	9	4664.68	II		
6	4302.72	II	7	4673.62	II		
85	4308.67	II	4	4682.02	II		
5	4313.90	I	4	4689.77	II		
6	4322.55	II	10	4698.71	II		
11	4325.14	II	9	4721.23	I		
26	4325.88	I	7	4727.14	II		
8	4326.39	I	18	4731.85	II		
10	4328.90	II	4	4745.79	II	4341-25343	
13	4339.68	II	6	4755.01	II		
5	d 4346.33	II	5	4760.02	II		
13	4347.69	I	6	4771.94	I		
16	4358.46	II	5	4774.80	I		
5	4361.39	II	12	h 4775.80	I		
8	4364.22	II	8	4786.94	II		
13	4366.73	I	10	4791.30	I		
26	4374.24	II	3.0	4800.68	I		
26	4374.80	II	5	4807.95	I		
10	4375.33	II	4	4810.23	I	828-23203	
5	4384.30	II	5	4812.79	I		
6	4389.78	I	8	4819.05	I		
11	4394.98	II	9	4824.99	I		
44	4409.38	II	8	4828.91	I		
5	4426.87	I	5	4829.69	II		
5	4431.00	II	7	4832.41	I		
12	4444.61	I	3.5	4833.78	II		
60	4449.71	II	8	4841.78	I		
9	4455.59	II	4	4856.24	II		
20	4468.17	II	4	4868.05	II		
5	4484.37	I	4	4875.92	I		
5	4503.26	II	9	4880.16	I		
5	4516.94	I	4	4884.53	I		
5	4518.53	II	10	4888.08	I		
8	d 4527.63		4	4889.32	II		
	4527.76	II	8	4890.11	II		
8	4541.70	II	5	4893.69	I		
5	4555.24	I	3.0	4899.25	I		
11	4565.11	I	7	4916.42	I		

Dysprosium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
6	4922.21	II	0-20166	5	5297.83	II	4341-22855
8	4923.15	II		2.0	5301.59	I	
60	4957.36	II		5	5309.02	II	
3.0	4959.60	I		6	5324.70	II	
3.5	4973.58	I		3.0	5337.43	II	
5	4985.53	I		8	5340.31	I	
6	5003.86	I		4	5352.13	I	
7	5004.26	II		4	5368.20	II	
3.0	5010.59	I		2.0	5369.26	II	
3.0	5017.99	II		2.5	5385.65	II	
9	5022.12	I	11	5389.58	II	4341-22855	
4	5023.99	I	5	5395.58	I		
3.0	5024.51	I	2.5	h 5398.26			
5	5027.85	I	3.0	5399.94	II		
6	5032.98	I	6	5404.16	I		
20	5042.62	I	10	5419.13	I		
3.0	5047.25	I	2.0	5420.75	I		
6	h 5050.17	I	9	5423.31	I		
2.0	5053.22	II	4	5424.24	I		
4	5053.29	I	5	5426.71	II		
3.0	5055.42	I	4	5443.35	II	4341-22467	
12	5070.65	I	12	5451.09	I		
15	5077.65	I	4	5455.45	II		
10	5090.38	II	3	5469.11	II		
10	5110.31	I	2.0	5471.90	II		
16	h 5120.01	I	3.5	5496.84	I		
4	5135.01	I	3.0	5502.80	I		
24	5139.60	II	3.5	5506.52	I		
5	5161.00	II	3.0	5515.40	II		
5	5164.14	II	4	5528.03	I		
6	5165.37	I	1.6	5542.19	I	828-20166	
14	5169.67	II	8	5547.28	I		
2.5	5172.81	II	2.0	5562.50	I		
10	5185.14	I	5	d 5600.71	II		
5	5188.48	II	3	5605.64	I		
36	5192.89	II	4	5613.24	I		
12	5197.66	II	2.5	5627.49	I		
4	5205.69	I	13	5639.53	I		
6	5246.93	II	2.0	5641.52	II		
2.0	5248.12	II	7	h 5646.02	I		
2.0	5258.39	II	10	5652.01	I	4341-22467	
9	5259.91	I	1.4	5666.42	I		
16	5260.57	I	1.8	5671.25	I		
7	bl 5263.3	DyO	1.8	5677.69	I		
8	5267.13	I	3.0	5685.60	I		
6	5272.25	II	3.5	h 5693.67	II		
6	5275.31	II	3.0	h 5694.10			
6	5279.71	II	3.5	cw 5694.54	II		
7	5282.07	I	3.5	5698.75	II		
3.5	5284.99	II	3.0	5702.92	I		

Dysprosium — All Observed Lines

Intensity and Character	Wave-length in A	Spectrum	Energy Levels in K	Intensity and Character	Wave-length in A	Spectrum	Energy Levels in K
1.4	5705.95	II		1.0	6460.86	I	
9 h	5718.48	I		1.2	6468.60	II	
3.5 h	5725.84	II		1.4	6474.94	I	
7 h	5728.64	II		2.5	6483.62	II	
3.0 h	5738.73	II		3.5	6486.64	I	
6	5740.19	I		1.0	6548.28	II	
7	5745.54	I		2.5	6558.02	I	
3.0	5750.50	I		20	6579.38	I	
3.0	5758.82	I		1.8	6594.16	II	
10 h	5832.01	II		0.8 h	6611.76	I	
7 h	5833.85	II		0.9	6639.25	I	
5 h	5834.86	I		2.0	6643.41	I	
3.5 h	5844.41	II		1.0	6654.27	II	
3.0	5845.65	II		3.0	6658.40	I	
5 h	5848.05	II		4	6661.69	I	
5	5855.56	II		10	6667.90	I	
7 h	5868.10	II		1.2	6670.21	I	
5	5915.17	II		1.4	6700.66	II	
2.5	5924.54	II		1.0 h	6713.18	I	
9	5945.81	I		0.8 h	6724.79	I	
6 l	5964.50	I		0.8 h	6736.17	I	
15	5974.50	I		0.9 h	6743.77	II	
3.0	5984.86	I		4	6747.98	I	
1.2	5985.99	I		1.0 h	6750.29	I	
18	5988.57	I		1.4	6757.69	I	
1.8	6000.86	I		6	6765.96	I	
1.8	6003.26	I		0.8	6787.43	I	
3.0 h	6005.75	II		1.0	6790.38	I	
3.0 h	6006.54	II		1.1	6794.30	I	
3.0 h	6006.97			1.1 h	6803.20	II	
4.0	6008.92	I		1.1	6805.64	I	
8	6010.80	I		1.2	6807.36	II	
3.0	6017.27	I		1.6	6818.24	I	
3.0	6031.00	I		1.2	6827.16	I	
3.0 bl	6042.49			0.6	6828.41	II	
3.0	6058.16	I		24	6835.44	I	
4	6085.04	I		0.5 h	6843.80	I	
17	6088.24	I		1.0	6845.84	I	
3.0	6127.15	I		0.6 h	6852.10	I	
3.0	6133.63	I		11	6853.00	I	
3.0	6158.32	I		3.0	6856.50	I	
13	6168.43	I		0.5 h	6886.48	II	
2.5	6196.23	II		3.0	6888.90	I	
34	6259.09	I		0.6	6894.58	I	
4	6260.38	I		0.6	6895.55	I	
1.8	6343.34	I		2.0	6897.98	II	
5	6386.81	I		9	6899.34	II	
3.0	6396.61	II		3.0	6906.57	II	
6	6421.93	I		1.0	6912.27	II	
1.6 h	6436.57	II		0.9 h	6925.48	I	

Dysprosium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
2.0	6929.54	I		1.4	7381.60	I	
1.0	6932.62	II		1.4 h	7403.17	I	
0.6	6939.72	I		0.4	7403.99	I	
0.8	6942.17	I		1.6	7407.62	I	
0.6 h	6945.35	I		3.5	7412.42	I	
4	6950.29	II		8	7426.99	II	
1.6	6951.49	I		0.8 h	7428.62	I	
0.9	6953.00	II		1.4	7451.08	II	
0.6	6957.63	I		3.0	7457.05	II	
6	6958.08	I		0.5 h	7459.97	I	
0.9	6970.51	I		1.0	7483.01	I	
2.0 h	6982.47	I		0.5	7509.59	I	
2.0	6991.31	I		2.5	7516.59	II	
7	6998.10	I		1.0 h	7533.14	I	
0.5 h	7014.66	II		8	7543.76	I	
3.0	7017.43	I		2.5 h	7553.03	I	
0.5 h	7036.38	I		0.8 h	7557.81	I	
1.0	7037.61	I		4	7559.81	I	
5	7055.95	II		6	7562.96	II	
1.4 h	7062.33	I		3.0 h	7577.47	II	
3.5	7075.15	II		0.5	7587.76	I	
0.5 h	7100.61	II		4 h	7591.36	I	
0.7	7101.70	II		0.8 h	7594.95	I	
2.5	7109.30	II		0.6	7609.25	I	
1.6	7120.93	II		2.0 h	7611.54	I	
1.4	7121.31	I		0.8 h	7616.21	I	
0.4	7141.52	II		1.6 h	7617.73	I	
0.7	7149.31	II		0.8 h	7635.29	II	
0.9 h	7156.51	I		0.8 h	7639.25	I	
2.0	7175.16	II		5 h	7641.15	I	
0.4 h	7198.75	I		2.5	7645.87	I	
0.4 h	7206.89	I		2.0	7646.66	I	
1.6	7213.32	I		0.6	7648.12	II	
0.4	7222.62	I		1.4	7661.47	I	
0.4	7223.00	I		12	7662.35	I	
2.5 h	7230.11	I		1.6	7666.78	II	
0.6 h	7234.72	II		1.4 h	7676.74	I	
2.0	7250.04	I		0.5	7693.85	I	
1.0	7261.76	I		0.7	7696.50	I	
1.2	7273.60	II		0.9	7711.93	II	
0.4	7279.97	I		5	7715.35	I	
1.4	7288.26	II		0.7 h	7721.08	I	
0.4 h	7300.31	I		7	7729.78	II	
0.3 h	7314.74	II		0.7 h	7739.38	II	
2.5	7345.18	II		0.6	7750.14	I	
0.4	7349.66	I		3.0	7751.61	II	
0.4 h	7354.42	II		0.8	7757.34	I	
0.7	7361.58	II		0.6	7760.07	I	
1.6	7370.26	II		0.6	7780.92	I	
3.0	7376.06	I		1.2	7790.05	I	

Dysprosium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
5	7812.08	I		0.7	8388.48	I	
0.6	7814.69	I		5	8391.96	II	
1.0	7832.79	I		1.8	8405.80	II	
1.0	h 7835.55	II		3.0	8416.61	II	
1.2	7864.32	II		3.5	8438.57	II	
1.2	7865.00	I		1.4	8444.44	II	
4	7909.36	I		0.7	8472.48	II	
0.7	7934.89	I		0.6	8480.50	II	
0.5	7962.72	I		0.7	8490.17	I	
1.6	7968.63	I		1.4	8510.77	II	
1.4	7973.14	I		0.6	8517.68	II	
1.8	7982.80	II		1.0	8525.73	II	
0.6	8004.46	II		0.6	h 8528.28	II	
1.2	8008.68	II		1.2	8548.96	II	
1.4	h 8025.33	I		1.4	8557.74	II	
0.9	h 8027.21	I		1.0	8567.93	II	
0.9	8040.01	I		1.2	8575.54	II	
0.6	8047.23	I		1.6	8629.95	I	
0.6	8050.93	I		1.4	8635.6	II	
1.2	8116.90	II		4	8655.90	II	
0.5	8140.74	II		2.5	8657.71	II	
0.6	8144.28	II		1.0	h 8667.32	II	
2.0	8147.25	I		1.0	8672.51	I	
0.6	h 8169.03	II		2.5	8678.37	II	
4	8198.75	II		0.8	8685.1	I	
15	8201.55	II		1.6	8696.90	II	
0.5	8208.30	II		1.6	h 8715.88	II	
1.2	h 8216.98	II		3.0	8750.30	II	
1.6	8218.58	II		1.8	8780.74	I	
0.9	8233.55	II		7	8791.37	II	
0.6	8243.95	II		1.0	8832.67	II	
3.0	8265.50	I		2.0	8832.92	II	
0.6	8323.81	I		3.5	8850.21	II	
5	8326.04	I		7	8905.62	II	

# ERBIUM

$$\text{Er, } Z=68, M=167.27, \text{ Ratio } \frac{\text{Er}}{\text{Cu}}=2.633$$

Er I Normal state of valence electrons  $4f^{12} 6s^2 {}^3H_6=0$ . I.P.  $\approx 50000$  K

Er II Normal state of valence electrons  $4f^{12} 6s^1 {}^4H_{6\frac{1}{2}}=0$ .

## References

Wavelengths:

Below 6880 Å:

A. Gatterer and J. Junkes, *Spektren der Seltenen Erden*, (Specola Vaticana, Vatican, 1945).

Supplemented by: J. M. Eder, *Wien Ber.* **125**, IIa, 383 (1916).

Above 6880 Å:

J. M. Eder, *Wien Ber.* **124**, IIa, 707 (1915).

About 60 lines above 6600 Å were measured on our plates.

Spectrum assignments were all made from our plates.

Classification:

Er I, (normal state) I. J. Spalding, unpublished material (May 1960).

Er II, J. R. McNally and K. L. Vander Sluis, *J. Opt. Soc. Am.* **49**, 200 (1959).

## Relative intensity of erbium lines observed in an arc of copper containing 0.1 atomic percent of erbium

*Strong lines of erbium*

Intensity	Wavelength Å	Spectrum	Energy levels K	Term combination
1100	4007.97	I		
850	3906.34	II		
750	3372.76	II	0-29641	$f^{12}s^1 {}^4H_{6\frac{1}{2}}-29641\frac{7}{2}$
700	3692.64	II	440-27514	$f^{12}s^1 {}^2H_{5\frac{1}{2}}-27514\frac{6}{2}$
650	3499.11	II	440-29011	$f^{12}s^1 {}^2H_{5\frac{1}{2}}-29011\frac{4}{2}$
600	3862.82	I		
550	4151.10	I		
420	3896.25	II	440-26099	$f^{12}s^1 {}^2H_{5\frac{1}{2}}-26099\frac{6}{2}$
340	3892.69	I		
320	3830.53	II	0-26099	$f^{12}s^1 {}^4H_{6\frac{1}{2}}-26099\frac{6}{2}$
300	3616.58	II	0-27643	$f^{12}s^1 {}^4H_{6\frac{1}{2}}-27643\frac{5}{2}$
280	4087.65	I		
260	3264.79	II	0-30621	$f^{12}s^1 {}^4H_{6\frac{1}{2}}-30621\frac{6}{2}$
260	3937.02	I		
260	3944.41	I		
260	3973.60	I		
240	4020.52	I		
220	3230.59	II		
220	3312.42	II	440-30621	$f^{12}s^1 {}^2H_{5\frac{1}{2}}-30621\frac{6}{2}$
220	3392.00	II		
220	3973.04	I		
170	3385.08	II	440-29973	$f^{12}s^1 {}^2H_{5\frac{1}{2}}-29973\frac{6}{2}$
170	3938.65	II		
160	3786.84	II		

Erbium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
2.5	2341.82	II	0-42387	5	2614.54	II	440-42387
4	2358.51	II		6	2616.87	II	
3.5	2377.83	II	8	2621.72	II		
4	2383.28	II	14	2624.18	II		
5	2386.58	II	4	2627.77	II		
6	2387.17	II	3.5	2637.81	III		
6	2396.38	III	4	2647.14	II		
5	2397.30	II	3.5	2651.35	II		
2.5	2400.30	II	7	2653.73	II		
2.0	2404.41	II	4	2654.11	II		
2.5	2410.53	II	7	2655.25	II		
5	2420.28	II	7	2656.10	II		
5	2425.23	II	6	2657.00	II		
7	2427.28	II	8	2665.04	II		
4	2439.45	II	9	2666.30	II		
13	2446.39	II	0-40864	48	2670.26	II	
4	2458.03	II	440-40778	32	2672.26	II	
4	2459.75	II		10	2675.35	II	
4	2460.71	II		4	2688.40	II	
6	2464.63	III		4	2689.93	II	
3.5	2467.26	II		6	2698.39	III	
2.0	2477.59	II		2.5	2700.67	II	
4	2478.32	II		6	2701.69	II	
3.5	2485.17	II		6	2711.53	II	
4	2487.47	II		10	2712.12	II	
6	2491.56	II		6	2713.25	II	
4	2492.27	II	3.0	2716.60	II		
6	2493.27	II	6	2720.74	II		
9	2499.67	I	6	2721.59	II		
8	2503.48	II	18	2726.22	II		
6	2507.64	II	12	2730.10	II		
5	2513.94	II	8	2731.53	II		
2.5	2520.95	II	26	2739.30	II		
5	2534.99	II	30	2750.18	II		
10	2537.02	II	6	2750.90	II		
6	2544.90	II	22	2754.96	II		
11	2547.28	II	60	2755.64	II		
4	2564.78	II	11	2765.61	II		
5	2579.59	II	12	2766.38	II		
9	2581.56	II	50	2769.98	II		
28	2586.73	II	9	2774.61	II		
11	2587.03	II	22	2778.97	II		
3.5	2587.34	II	6	2779.59	II		
3.5	2591.91	II	10	2781.18	II		
13	2592.57	II	6	2781.57	II		
12	2595.03	II	4	2782.12	II		
8	2602.66	I	15	2784.95	II		
8	2604.86	I	12	2786.11	II		
3.0	2606.69	II	6	2787.41	II		
6	2612.37	II	18	2787.71	II		



Erbium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
3	2788.34	II	0-35672	3.0	2882.60	II	
5	2788.45	II		8	2886.12	II	
6	2792.52	III		10	2887.11	II	
5	2793.85	II		10	2888.16	II	
8	2799.54	II		5	2893.49	II	
3.5	2799.73	II		15	2893.91	II	
22	2802.53	II		5	2895.93	II	
10	2802.88	II		6	2896.56	II	
8	2803.55	II		30	2896.97	II	
30	2804.37	II		38	2897.52	II	
15	2806.75	II	7150-42386	8	2903.45	II	
10	2818.85	II		100	2904.47	II	
2.5	2819.35	II		12	2906.50	II	
4	2819.83	II		10	2908.53	II	
40	2820.19	II		20	2909.55	II	
4	2820.47	II		150	2910.36	II	
5	2824.33	II		7	2911.05	II	
5	2824.91	II		3.0	2912.27	II	
3.0	2825.67	II		4	2912.79	II	
6	2829.38	II		10	2914.65	I	
8	2830.41	II	440-34563	26	2915.61	II	
4	2831.21	II		4	2918.88	II	
26	2833.93	II		10	2919.28	II	
6	2837.12	II		8	2920.23	II	
38	2838.72	II		8	2923.29	II	
10	2840.63	II		6	2927.33	II	
5	2841.91	II		15	2927.72	II	
12	2845.87	II		16	2928.28	II	
6	2846.28	II		11	2928.44	II	
4	2847.02	II		34	2929.25	II	
8	2848.08	II	0-34972	10	2929.72	II	440-34563
26	2848.37	II		12	2930.64	II	
5	2848.92	II		8	2931.58	II	
15	2850.66	II		6	2931.69	II	
24	2855.41	II		3.5	2932.43	II	
12	2858.57	II		3.0	2932.62	II	
30	2859.83	II		8	2934.53	II	
4	2860.26	II		6	2934.64	II	
4	2862.61	II		5	2939.32	II	
3.0	2866.36	II		6	2939.48	II	
3.0	2869.22	II	440-34397	12	2941.17	II	
3.0	2870.53	II		9	2941.71	II	
9	2871.68	II		14	2942.20	II	
6	2872.84	II		10	2944.06	II	
15	2873.81	II		26	2945.27	II	
11	2874.81	II		4	2946.42	II	
8	2877.23	II		22	2946.62	II	
5	2878.54	II		15	2948.80	II	
6	2878.90	II		3.0	2949.22	II	
3.0	2879.25	II		8	2950.05	II	

Erbium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
9	2951.24	II	7150-40864	8	3010.29	II	0-33106
6	2955.34	II		9	3011.16	II	
5	2955.60	II		22	3012.47	II	
6	2956.42	II		6	3013.77	II	
8	2956.95	II		3.0	3013.95	II	
9	2958.88	II		3.0	3014.62	II	
6	2960.11	II		22	3016.84	II	
12	h 2962.49	II		12	3017.73	II	
15	2963.70	II		10	3019.76	II	
8	2963.90	II		5	3020.33	II	
6	2964.24	II		6	3022.71	II	
150	2964.52	II		28	3025.92	II	
6	2964.88	II		26	3028.28	II	
6	2965.21	II		36	3031.31	II	
8	2965.86	II		30	3036.21		
6	2966.17	II		7	3048.41	II	
8	2967.93	II		5	3049.18	II	
6	2968.42	II		9	3049.29	II	
40	2968.76	II		7	3049.98	II	
15	2970.07	II		7	3050.84	II	
6	2970.98	II		7	3053.77	II	
5	2971.26	II		20	3054.41	II	
8	d 2971.59	II		5	3061.28	II	
	2971.71	II		14	3061.69	II	
15	2972.27	II		6	3064.84	II	
15	2973.73	II		7	3064.97	II	
20	2974.47	II		22	3066.23	II	
22	2975.68	II		12	3069.23	II	
4	2979.95	II		44	3070.75	II	
11	2983.06	II		55	3072.53	II	
14	2983.24	II		60	3073.34	II	
26	2983.79	II		7	3078.23	II	
13	2985.50	I		20	3078.87	II	
4	2987.32	II		7	3081.38	II	
3.0	2988.22	II		70	3082.08	II	
14	2989.29	II	60	3084.03	II		
8	2989.56	II	6	3087.12	II		
3.0	2994.10	II	7	3087.79	II		
11	2994.48	I	7	3088.75	II		
4	2995.44	II	15	3093.14	II		
9	2996.37	II	12	3095.88	II		
8	2997.89	II	36	3099.19	II		
7	2998.05	II	7	3099.60	II		
120	3002.39	II	15	3102.69	II		
30	3002.64	II	7	3104.46	II		
9	3003.84	II	22	3106.79	II		
6	3005.05	II	15	3110.88	II		
15	3008.17	II	30	d 3113.54	II		
4	3009.46	II	8	3115.10	II		
5	3009.70	II	13	3115.52	II		

Erbium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
15	3116.94	II	0-32074	24	3232.03	II	
15	3118.83	II		32	3237.98	II	
8	3119.05	II		14	3240.48	II	
15	3121.90	II	0-32023	18	3243.25	II	
75	3122.67	II		9	3243.48	II	
8	3123.09	II		32	3249.34	II	
15	3125.19	II		9	3256.34	II	
15	3125.65	II		9	3258.48	II	
6	3127.38	II		55	3259.06	II	
8	3131.07	II		18	3262.81	II	
13	3132.03	II	0-31919	260	3264.79	II	0-30621
28	3132.51	II		9	3266.63	II	
46	3132.78	II		42	3267.14	II	
8	3135.62	II		32	3269.41	II	
13	3137.85	II		9	3273.33	II	
16	3138.49	II		9	3277.70	II	0-30500
40	3141.13	II	440-32267	24	3278.22	II	
7	3141.81	II		70	3279.33	II	
8	3142.80	II		70	3280.22	II	
8	3143.63	II		18	3286.18	II	
24	3144.33	II		46	3286.77	II	
16	3144.51	II		14	3287.97	II	
13	3150.53	II		9	3291.27	II	
14	3152.37	II		9	3301.94	II	
40	3154.28	II		32	d 3303.95	II	
19	3160.34	II	440-32074	9	3304.07	II	
6	3161.35	II		36	3305.58	II	
6	3164.52	II		8	3307.46	II	
19	3167.09	II		220	3312.42	II	440-30621
8	3171.52	II		9	3313.49	II	
8	3172.62	II		18	3313.66	II	
16	3175.52	II		18	3314.44	II	
8	3179.62	II		8	3314.95	II	
32	d 3181.68	II		55	3316.39	II	
85	3181.92	II		15	3317.52	II	
40	3183.42	II	440-31844	8	3318.24	II	
24	3185.26	II		9	3318.78	II	0-30123
16	3187.79	II		75	3323.20	II	
12	3192.63	II		28	3329.67	II	
30	3200.57	II		75	3332.71	II	
12	3203.42	II		8	3336.76	II	
8	3203.95	II		36	3337.26	II	
22	3205.15	II		28	3337.80	II	
8	3208.05	II		24	3340.03	II	
26	3214.45	II		9	3340.49	II	
85	3220.73	II		9	3341.62	II	
60	3223.31	II		28	3341.85	II	
20	3227.16	II		15	3343.70	II	
8	3229.93	II		9	3344.37	II	
220	3230.59	II		130	3346.04	II	440-30318

Erbium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
15	3346.35	II		16	3438.32	II	
12	3347.64	II		8	3438.47	II	
16	3347.86	II		75	3441.15	II	440-29492
18	3348.14	II	0-29859	38	3442.65	I	
6	3348.76	II		10	3443.72	II	
46	3350.06	II		26	3446.88	I	
34	3350.27	II	5133-34972	10	3447.53	II	
18	3351.33	II		16	3448.07	II	5404-34397
9	3356.22	II		16	3453.68	I	
18	3358.16	II		18	3461.40	II	
15	3361.03	II		24	3462.58	I	
9	3361.67	II		26	3464.53	II	
140	3364.09	II		48	3469.48	I	
19	3366.70	I		26	3469.74	II	0-28812
140	3368.07	II	440-30123	95	3471.72	II	
44	3370.59	II		10	3477.94	II	
750	3372.76	II	0-29641	60	3479.44	II	
95	3374.16	II	0-29628	28	3480.44	II	
9	3376.10	II		10	3484.56	II	
8	3377.00	II		19	3485.17	II	
7	3379.01	II		95	3485.82	II	440-29120
13	3381.08	II		34	3486.83	II	
28	3381.32	II		26	3489.36	I	
22	3382.06	I		14	3492.54	II	
170	3385.08	II	440-29973	34	3496.87	II	
15	3389.62	II		650	3499.11	II	440-29011
44	3389.74	II	0-29492	60	3502.78	I	
220	3392.00	II		26	3505.07	II	7150-35672
9	3394.12	II		28	3505.70	I	
9	3394.39	II		38	3508.40	II	
19	3394.86	II		19	d 3508.81		
34	3396.06	II			3508.94		
28	3396.84	II	5133-34563	48	3514.91	II	
19	3398.28	II	440-29859	38	3518.17	II	
9	3401.21	II		20	3522.52	I	
38	3401.83	II		60	3524.92	II	
7	3406.96	II		26	3526.81	I	
18	3408.69	II		10	3531.27		
15	3409.88	II		60	d 3539.57		
18	3417.28	II		24	3542.99		
34	3417.64	II		26	3545.84		
19	3420.18	II		26	3547.51		
19	3422.87	I		30	3548.23		
26	3425.08	II	440-29628	20	3549.55		
48	3428.41	II		80	3549.85		
19	3429.91	II		14	3551.79		
14	3431.06	I		30	3553.18	II	
26	3433.12	II	0-29120	20	3554.29		
14	3434.64	II		10	3556.04		
10	3437.65	II		16	3556.37		

Erbium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
10	3556.80			44	3652.86	II	7195-34563
20	3557.07			3.0	3656.34	II	
150	3558.02			12	3659.56	I	
50	3558.72			10	3660.78	II	
100	3559.89	II		10	3662.03	II	
20	3563.49			16	3662.86	I	
30	3565.15			32	3664.44	I	
20	3569.25			42	3669.01	II	7150-34397
20	3569.91			7	3675.18	II	7195-34397
16	3570.60			17	3676.51	II	
90	3570.74			17	3678.95	I	
14	3573.85	II	5133-33106	6	3680.09	II	
30	3578.31			44	3682.71	II	
19	3579.44			28	3684.01	I	
100	3580.49	II	440-28361	34	3684.27	II	5133-32267
36	3586.64			14	3689.12	II	
20	3587.77	II		700	3692.64	II	440-27514
20	3588.35			40	3696.25	II	
60	3590.73	I		14	3696.91	II	
40	3595.83	I		9	3697.24	I	
60	3599.51	II		34	3697.68	I	
100	3599.84	II		48	3700.72	II	
20	3604.72	II		17	3701.56	II	
50	3604.89	II		3.0	3702.50	II	
16	3605.69	I		9	3705.77	I	
20	3607.21	I		14	3706.52	I	
40	3607.45	I		46	3707.63	II	
300	3616.58	II	0-27643	3.0	3710.76	II	5133-32074
50	3617.82	II		9	3711.81	II	
50	3618.92	II		46	3712.39	II	
10	3625.28	II		11	3715.96	I	
70	3628.04	I		9	3717.26	II	
30	3629.39	I		28	3719.31	I	
20	3630.08	II		9	3721.45	II	5404-32267
14	3630.30	II		6	3723.66	II	
14	3631.79	I		15	3724.38	II	
44	3632.07	II		8	3724.45	II	
10	3632.79	II		20	3724.92	II	
26	3633.26	I		120	3729.55	II	
100	3633.56	II	0-27514	40	3731.27	II	
50	3634.67	I		5	d 3731.78	II	
20	3636.30	I		4	3732.17	I	
24	3637.16	II	5133-32619	17	3734.46	II	
140	3638.69	I		24	3734.59	II	0-26769
24	3641.26	II		6	3735.68	I	
6	3641.89	II		48	3738.18	II	
80	3645.93	II		16	3740.28	II	
6	3646.79	II	7150-34563	30	3741.09	II	
46	3650.39	II		80	3742.65	II	5133-31844
32	3652.57	II		18	3744.99	II	

Erbium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
12	3745.11	II		28	3851.60	II	7150-33106
5	3745.72	II		60	3855.93		
80	3747.53	I		48	3858.39	II	7195-33106
5	3748.99	I		600	3862.82	I	
17	3750.53	II		20	3864.81		
3.0	3751.97	II		4	3868.22		
48	3756.05	I		12	3874.73		
3.0	3756.35	II		8	3875.87		
20	3761.94			120	3880.60	II	
20	3766.16	II		100	3882.87	II	7150-32896
6	3767.76	II		8	3884.08	I	
14	3768.79			4	3885.38	II	
24	3771.10	II		12	3887.16	II	
10	3772.47	II		20	3888.09	II	
8	3774.83	I		12	3889.82	II	
10	3775.28	I		32	3890.60	II	
20	3775.66	II		340	3892.69	I	
14	3777.62	II		13	3895.81	II	
10	3778.26	II		420	3896.25	II	440-26099
12	3778.64	I		20	3899.04	I	
36	3781.03	II	5404-31844	65	3902.75	II	
6	3783.85			4	3903.86	II	
160	3786.84	II		20	3903.99	I	
6	3787.42			20	3904.59	II	
50	3787.90	II	0-26392	100	3905.44	I	
10	3791.16			850	3906.34	II	
8	3791.53			8	3908.42	I	
50	3791.84	II		9	3910.50	I	
44	3792.81	I		9	3911.58	II	
50	3797.07	II	440-26769	4	3911.92	II	
7	3798.24			11	3912.43	II	0-25552
16	3798.65	I		4	3915.70	II	
6	3803.68	I		7	3915.98	I	
4	3806.11			22	3918.05	I	
7	3807.09	II		17	3918.38	II	
140	3810.33	I		22	3921.89	II	
7	3817.73			65	3932.28	II	7195-32619
8	3818.71			260	3937.02	I	
6	3827.36			170	3938.65	II	
320	3830.53	II	0-26099	7	3938.92	II	
10	3832.30			4	3939.36	II	
7	3832.46			12	3942.56	I	
7	3835.65			12	3943.21	II	
18	3837.66			260	3944.41	I	
10	3838.39			44	3948.07	II	
8	3839.39			9	3950.96	I	
3.5	3842.99			20	3951.50	I	
7	3848.32			26	3956.43	I	
8	3849.32			4	3959.91	II	
48	3849.91			13	3961.21	I	

Erbium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
9	3963.36	II		11	4094.66	II	
7	3964.52	I		85	4098.11	I	
22	3966.35	I		28	4100.58	II	
13	3969.45	II		5	4104.00	II	5133-29492
220	3973.04	I		5	4106.63		
260	3973.60	I		10	4109.34	I	
110	3974.72	II		11	4112.63	II	
22	3976.74	I		26	4116.36	I	
65	3977.03	I		26	4118.55	I	
4	3979.14	II		11	4123.05	II	
13	3980.17	II		11	4124.80	I	
13	3980.61	I		48	4131.50	I	
90	3982.33	I		44	4142.92	II	
9	3983.15	II		550	4151.10	I	
22	3987.53	I		5	4160.30		
65	3987.66	I		15	4164.82	I	
18	3991.16	I		10	4171.68		
4	3994.87	II		11	4172.17	I	
5	3995.26	II		11	4185.45	I	
13	d 3999.16	II		22	4189.99	II	
18	4004.07	I		80	4190.71	I	
1100	4007.97	I		11	4194.70	I	
18	4008.19	II		5	4197.39	I	
22	4009.16	II	0-24936	10	4205.32	I	
12	4009.77	I		110	4218.43	I	
90	4012.58	I		16	4220.99	I	
4	4012.98	II		5	4223.47	I	
28	4015.61	II		5	4223.72	II	
9	4016.36	I		26	4230.20	II	
240	4020.52	I		5	4232.47	I	
36	4021.55	I		11	4234.76	II	5404-29011
9	4021.96	II		6	4235.17	I	
15	4036.12	I		5	4237.03	I	
14	4037.69	I		16	4251.93	II	
6	4039.61	I		5	4263.64	I	
18	4043.03	II		5	4264.85	I	
80	4046.97	I		5	4269.93	I	
22	4048.35	II	7150-31844	11	4276.45	II	
16	4049.48	II		55	4286.56	I	
75	4055.47	II		5	4288.50	I	
44	4059.51	I		26	4298.91	I	
55	4059.81	II		5	4301.26	I	
11	4072.39	I		26	4301.61	II	440-23681
11	4074.02	II		11	4303.81	II	5133-28361
34	4077.88	I		5	4306.34	I	
44	4081.21	II	440-24936	9	4319.94	II	
11	4083.09	I		10	4328.81	I	
280	4087.65	I		4	4330.27	II	
6	4091.78	I		9	4331.35	I	
17	4092.90	I		5	4335.03	I	

Erbium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
4	4338.99	II		2.5	4624.78	II	
11	4340.92	I		13	4630.90	II	
15	4348.33	I		9	4640.61	II	
4	4351.63	I		3.0	4656.68	II	
9	4369.38	II		9	4665.43	II	
5	4378.35	II		2.5	4667.59	II	
5	4380.64	I		3.5	4671.58	I	
13	4382.17	I		25	4673.16	I	
24	4384.71	II		46	4675.62	II	
24	4386.40	I		12	4679.07	II	
5	4388.37	II		3.0	4688.63	II	
6	4397.42	I		6	4697.17	II	
8	4403.14	II		3.0	4702.19	II	
65	4409.35	I		2.5	4708.69	I	
6	4413.75	I		3.0	d 4718.71	II	
5	4414.34	I		22	4722.71	I	
14	4418.71	I		8	4724.54	II	
46	4419.62	II		14	4729.04	I	
9	4422.47	II		8	4731.60	II	
26	4424.57	I		4	4736.97	II	
30	4426.77	I		6	4745.28	I	
4	4432.21	I		12	4751.55	II	
9	4437.67	I		16	4759.66	II	
4	4448.62	II		6	4762.66	II	
8	4459.26	II		9	4795.50	II	
8	4473.50	II		18	4820.34	II	
7	4484.47			3.0	4828.67	I	
2.5	4488.89			2.0	4829.51	I	
4	4489.08			8	4831.14	II	
10	4496.38			2.0	4834.74	II	
16	4500.75	II	0-22212	6	4842.04	I	
3.5	4503.27	II		8	4848.83	II	
3.0	4512.18	I		3.0	4851.64	II	
3.0	4518.64	I		4	4853.12	II	
6	4519.46	II		3.0	4854.42	II	
10	4522.72	I		13	4857.43	I	
3.0	4526.92	II		5	4858.47	II	
3.0	4531.11	II		3.5	4861.60	II	
10	d 4552.13	II		14	4872.10	II	
4	4555.71	I		3.0	4872.49	II	
13	4563.28	II		3.0	4878.33	II	7150-27643
3.0	4563.92	I		2.5	4879.90	II	
4	4566.38	II		3.0	4886.30	II	
3.0	4569.31	I		3.0	4888.86	I	
6	4592.93	I		3.0	4896.96	II	
3.5	4596.73	I		9	4898.16	II	
6	4598.13	I		24	4900.10	II	
5	4602.06	I		6	4903.63	II	
80	4606.62	I		3.0	4904.42	II	
6	4611.28	II		3.0	4917.06	I	



Erbium — All Observed Lines

Intensity and Character	Wave-length in A	Spectrum	Energy Levels in K	Intensity and Character	Wave-length in A	Spectrum	Energy Levels in K
3.0	4925.04	I		2.5	5256.47	II	
5	4925.43	II		3.0	5257.02	II	
2.0	4926.97	II		4.0	5264.75	II	
2.5	4927.36	II		9	5272.90	I	
8	4928.86	I		6	5277.70	I	
24	4934.07	I		3.0	5279.33	II	
14	4944.36	I		5	5302.30	II	
20	4951.74	II		6	5333.02	I	
5	4953.60	II		3.0	5333.36	II	
3.0	4954.67	II		3.0	5334.20	II	
4	4966.63	II		2.5	5343.93	II	
7	4966.99	I		3.5	5344.50	II	
6	4969.87	I		10	5348.04	I	
14	4976.41	I		5	5350.44	I	
4	4990.32	I		4	5368.85		
5	4992.36	II		4	5395.87	II	
10	5000.38	II		7	5414.66	II	
28	5007.25	I		2.0	5422.80	II	
10	5008.97	II		2.0	5451.30	h	
5	5024.28	II		4	5454.27	II	
16	5028.32	I		20	5456.60	I	
13	5028.90	II		4	5462.45	II	
4	5029.76	II		10	5468.32	I	
22	5035.94	I		2.0	5477.45	II	
24	5042.05	II		9	5485.93	II	
14	5043.86	I		3.0	5497.41	II	
14	5044.89	I		3.0	5516.00	I	
4	5045.99	II		9	5593.43	I	
6	5052.67	I		5	5601.19	I	d
8	5070.34	II		5	5609.94	I	h
14	5077.63	II		7	5611.82	I	
8	5080.51			8	5622.02	I	
7	5119.63	II		9	5626.52	II	
13	5124.56	I		3.5	5636.22	I	
15	5127.40	II		10	5640.34	I	
13	5131.52	I		2.5	5641.43	I	
15	5133.83	II		2.5	5658.48	h	II
7	5143.58	II		8	5664.95	I	
4	5144.09	II		5	5665.44	II	
6	5163.83	II		6	5675.49	I	
19	5164.77	II		1.6	5695.55	II	
14	5172.75	I		3.0	5710.89	II	
3.0	5179.48	II		6	5717.48	I	
18	5188.90	II		8	5719.53	I	
17	5206.52	I		6	5726.99	I	
7	5212.91	II		2.5	5733.42	II	
3.5	5215.13	II		2.5	5736.58	I	
3.5	5218.24	II		2.5	5736.96	I	
5	5229.32	II		11	5739.18		
16	5255.95	II		4	5740.62	I	

Erbium — All Observed Lines

Intensity and Character	Wave-length in A	Spectrum	Energy Levels in K	Intensity and Character	Wave-length in A	Spectrum	Energy Levels in K
7	5748.65	I		3.0	6183.20	II	
6	5752.53	I		40	6221.01		
8	5757.62	II		4	6230.90	I	
32	5762.79	I		6	6262.56	I	
8	5769.92	I		5	6267.94	I	
5	5782.81			7	6268.86	I	
8	5784.64	I		4	6274.96	I	
2.5	5791.12	II		3.5	6286.86	I	
8	5800.77	I		2.0	6288.61	I	
2.5	5806.13	II		5	6299.41	I	
3.0	h 5814.28	I		15	6308.79	I	
48	5826.79	I		6	6326.11	I	
1.2	5833.95	II		2.5	6347.17	II	
5	5835.82	I		1.2	6351.57	II	
1.6	5839.95	I		5	6388.19	II	
2.0	5841.14	I		1.6	6398.13	I	
11	5850.06	I		1.2	6413.59	II	
13	5855.32	I		2.0	h 6423.10		
1.4	5860.73	II		2.5	6432.50	I	
1.6	5871.67	II		1.8	6441.31	II	
16	5872.35	I		0.8	6451.52	I	
2.0	5873.52	I		0.8	6454.02	II	
13	5881.14	I		1.6	6481.77	I	
3.0	5886.48	II		3.0	6485.87	I	
3.0	5902.09	II		6	6492.35	I	
6	5906.07	I		1.4	6520.51	I	
5	5909.25	I		2.5	6541.53	I	
2.0	5916.46	I		1.2	6556.31	II	
4	5933.50	I		2.0	6557.78	I	
1.6	5937.20	II		7	6583.46	I	
2.5	5946.36	I		1.8	6593.52	I	
6	5968.70	I		8	6601.10	I	
3.0	5975.50	I		1.4	6616.75	II	
4	6006.80	II		1.6	6637.62	I	
1.6	h 6007.95	II		1.2	d 6648.98	I	
					6649.02	I	
2.5	6008.76	II		1.2	6663.51	I	
6	6014.83	I		1.5	6687.20	I	
4	6015.76	II		0.8	6690.02	II	
8	6022.56	I		0.8	6701.80	II	
2.5	6032.14	II		1.2	6720.99	I	
2.5	6045.65	II		3.0	6721.93	I	
2.5	6048.13	II		1.5	6722.76	II	
5	6054.84	I		8	6759.87	I	
8	6061.26	I		1.4	6761.69	II	
7	6076.44	II		2.5	6762.96	I	
1.6	6105.20	II		1.2	6764.52	I	
4	6116.00	I		1.2	6766.62	I	
4	6125.32	I		1.0	6768.44	II	
1.4	6149.30	II		2.0	6768.94	II	
3.5	6170.05	II					

Erbium — All Observed Lines

Intensity and Character	Wave-length in A	Spectrum	Energy Levels in K	Intensity and Character	Wave-length in A	Spectrum	Energy Levels in K
3.0	6773.40	I		3.0	7556.24	I	
1.8	6776.14	II		0.7 h	7574.11		
1.6	6779.86	I		0.6 h	7590.44		
2.0	6780.73	I		1.2	7597.26		
0.9	6787.90	I		0.7	7607.15		
4	6790.93	I		1.2	7613.48	I	
1.6	6796.93	II		0.7	7623.45		
2.0	6803.87	II		1.8 h	7645.62		
2.5	6825.46	I		0.9	7650.58		
2.5	6825.99	I		2.5	7654.43	II	
1.4	6835.92	I		1.4 h	7658.02		
8	6848.11	I		2.5	7659.23	I	
1.0	6857.21	I		0.5	7665.63		
6	6865.20	I		4	7680.00	I	
1.2	6873.12	I		1.0	7722.12	II	
2.0	6873.74	I		0.9	7726.18	II	
1.8	6874.77	I		1.2 h	7747.38		
3.0	6880.01	I		2.5	7754.61	I	
1.2	6884.13	I		0.5	7762.09		
0.8	6892.45	I		1.0	7796.59	I	
1.6	6897.53	II		4	7797.42	I	
1.0	6908.26	I		1.0	7838.70	I	
1.4	6926.08	I		1.2	7843.95	I	
0.7	6926.29	I		1.8	7847.52	I	
2.0	6938.36	I		0.6	7875.31	I	
0.7	6944.95	II		0.6	7879.32	I	
2.0	6951.87	I		2.0	7899.54	I	
1.0	6973.03	I		0.9	7913.11		
0.8	6989.32	I		4	7921.78	I	
2.5	7001.44	I		3.5	7937.73	I	
1.4	7058.52	I		0.9	7952.98	I	
1.4 h	7065.00	I		1.4	7964.57	I	
1.2	7070.96	II		0.9	7979.09		
2.0	7101.23	I		0.9	7980.95		
0.9	7109.60	I		0.6	8023.11		
1.2	7155.37	II		1.4	8036.04	I	
0.6	7161.89	I		1.4	8181.90	I	
1.6 h	7196.99	I		4	8312.90	I	
0.8 h	7264.96	II		2.0	8328.63	II	
0.8 h	7284.03			0.6	8367.62	II	
1.6	7329.79	II		6	8410.00	I	
2.0	7355.34			1.2	8466.11	II	
1.2	7356.40			4	8472.39	I	
2.0	7428.65			1.6	8517.66	II	
6	7459.53	I		2.0	8521.35	II	
1.0	7460.42			2.5	8768.58	I	
13	7469.46	I		1.2 h	8776.59	I	
2.5	7532.32			1.0	8866.89		
0.7 h	7539.14						

# EUROPIUM

$$\text{Eu, } Z=63, M=152.0, \text{ Ratio } \frac{\text{Eu}}{\text{Cu}}=2.392$$

Eu I Normal state of valence electrons  $4f^7 6s^2 {}^8S_{3/2}=0$ . I.P.=45740 K  
 Eu II Normal state of valence electrons  $4f^7 6s^1 {}^9S_4=0$ . I.P.=90716 K

## References

Wavelengths:

A. S. King, *Astrophys. J.* **89**, 377 (1939).

Classification:

Eu I, H. N. Russell and A. S. King, *Astrophys. J.* **90**, 155 (1939).

Eu II, H. N. Russell, W. Albertson, and D. N. Davis, *Phys. Rev.* **60**, 641 (1941).

## Relative intensity of europium lines observed in an arc of copper containing 0.1 atomic percent of europium

### *Strong lines of europium*

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
4000 cw	4205. 05	II	0-23774	$4f^7 6s^1 a {}^9S_4 - 4f^7 6p^1 z {}^9P_3$
3400 cw	3819. 67	II	0-26173	$4f^7 6s^1 a {}^9S_4 - 4f^7 6p^1 z {}^9P_5$
2800 cw	3930. 48	II	1669-27104	$4f^7 6s a {}^7S_3 - 4f^7 6p^1 z {}^7P_3$
2400 cw	3907. 10	II	1669-27256	$4f^7 6s^1 a {}^7S_3 - 4f^7 6p^1 z {}^7P_2$
2200 cw	4129. 70	II	0-24208	$4f^7 6s^1 a {}^9S_4 - 4f^7 6p^1 z {}^9P_4$
2000 cw	3971. 96	II	1669-26838	$4f^7 6s^1 a {}^7S_3 - 4f^7 6p^1 z {}^7P_4$
1700 cw	3724. 94	II	0-26839	$4f^7 6s^1 a {}^9S_4 - 4f^7 6p^1 z {}^7P_4$
900 cw	4435. 56	II	1669-24208	$4f^7 6s^1 a {}^7S_3 - 4f^7 6p^1 z {}^9P_4$
750	4594. 03	I	0-21761	$4f^7 6s^2 a {}^8S_{3/2} - 4f^7 6s^1 6p^1 y {}^8P_{4\frac{1}{2}}$
650	4627. 22	I	0-21605	$4f^7 6s^2 a {}^8S_{3/2} - 4f^7 6s^1 6p^1 y {}^8P_{3\frac{1}{2}}$
550	3688. 42	II	0-27104	$4f^7 6s^1 a {}^9S_4 - 4f^7 6p^1 z {}^7P_3$
550	4661. 88	I	0-21445	$4f^7 6s^2 a {}^8S_{3/2} - 4f^7 6s^1 6p^1 y {}^8P_{2\frac{1}{2}}$
420	2727. 78	II	0-36649	$4f^7 6s^1 a {}^9S_4 - 4f^6 6s^1 6d^1 y {}^9P_5$
340	2813. 94	II	0-35527	$4f^7 6s^1 a {}^9S_4 - 4f^6 6s^1 6d^1 y {}^9P_4$
320	2906. 68	II	0-34394	$4f^7 6s^1 a {}^9S_4 - 4f^6 6s^1 6d^1 y {}^9P_3$
200	4522. 57	II	1669-23774	$4f^7 6s^1 a {}^7S_3 - 4f^7 6p^1 z {}^9P_3$
200	2820. 78	II	0-35441	$4f^7 6s^1 a {}^9S_4 - 108_3$
190	2802. 84	II	1669-37337	$4f^7 6s^1 a {}^7S_3 - 4f^6 6d^2 y {}^7P_2$
160	6645. 11	II	11128-26173	$4f^7 5d^1 a {}^9D_6 - 4f^7 6p^1 z {}^9P_5$
120	7370. 22	II	10643-24208	$4f^7 5d^1 a {}^9D_3 - 4f^7 6p^1 z {}^9P_4$
110	3212. 81	I	0-31116	$4f^7 6s^2 a {}^8S_{3/2} - 113_{3\frac{1}{2}}$
100	3334. 33	I	0-29982	$4f^7 6s^2 a {}^8S_{3/2} - 106_{3\frac{1}{2}, 4\frac{1}{2}}$

Europium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
2.0	2499.39	II	1669-41667	28	2862.57	II	0-34923
2.5	2554.78	II	16861-55991	2.5	2864.42	II	11128-46029
2.5	2559.18	II	17004-56067	6	2876.06	II	1669-36429
15	2564.17	II	17004-55991	10	2878.87	I	0-34726
10	2568.17	II	17141-56067	8	2887.85	II	0-34618
2.5	2574.76	II	17141-55968	20	2892.54	I	0-34562
22	2577.14	II	16861-55652	14	2893.03	I	0-34556
2.5	2581.86	II	17248-55968	36	2893.83	I	
2.5	2604.61	I				II	0-34546
3.0	2635.50	II	0-37932	320	2906.68	II	0-34394
95	2638.77	II	1669-39554	16	2908.99	I	0-34366
36	2641.27	II	0-37849	3.0	2917.44	II	1669-35936
4	2653.61	II		85	2925.04	II	1669-35847
60	2668.34	II	1669-39135	6	2947.29	II	0-33920
10	2673.42	II		20	2952.68	II	1669-35527
24	2678.29	II	1669-38996	3.0	2958.91	I	0-33786
24	2685.66	II	0-37224	3.5	2959.47	II	0-33780
55	2692.03	II	1669-38805	26	2960.21	II	1669-35441
70	2701.14	II	0-37011	30	2991.33	II	0-33420
80	2701.90	II	0-37000	3.5	2995.22	II	1669-35046
24	2705.28	II	0-36954	4	3006.26	II	1669-34923
18	2709.99	I	0-36890	3.5	3022.15	I	
70	2716.98	II	1669-38464	3.0	3040.77	II	1669-34546
7	2723.96	I	0-36700	32	3054.94	II	1669-34394
420	2727.78	II	0-36649	12	3058.98	I	0-32681
19	2729.33	II	0-36628	3.5	3069.11	II	24208-56781
38	2729.44	II	1669-38296	3.5	3076.07	II	
5	2731.37	I	0-36601	22	3077.36	II	0-32486
4	2732.61	I	0-36584	3.5	3089.35	II	
8	2735.25	I	0-36549	12	3097.45	II	1669-33944
16	2740.62	II	1669-38146	32	3106.18	I	0-32185
7	2743.28	I	0-36442	95	3111.43	I	0-32130
12	2744.26	II	0-36429	12	3130.73	II	
4	2745.61	I	0-36411	4	3132.16	I	
7	2747.29	II	1669-38058	5	3149.88	II	
8	2747.83	I	0-36381	9	3173.61	II	0-31501
9	2752.17	II	1669-37994	4	3185.54	I	0-31383
48	2781.89	II	1669-37606	44	3210.57	I	0-31138
190	2802.84	II	1669-37337	110	3212.81	I	0-31116
22	2811.75	II	1669-37224	44	3213.75	I	0-31107
3.0	2813.08	II		5	3235.13	I	0-30902
340	2813.94	II	0-35527	10	3241.40	I	0-30842
55	2816.18	II	1669-37168	5	3246.03	I	0-30798
200	2820.78	II	0-35441	5	3247.32	II	
40	2828.72	II	1669-37011	11	3247.55	I	0-30784
12	2829.30	II	1669-37003	11	3266.39	II	23774-54380
14	2833.26	II	1669-36954	16	3272.77	II	23774-54321
8	2843.96	II	1669-36821	22	3277.78	II	23774-54274
6	2852.05	II		16	3301.95	II	24208-54484
26	2859.67	II	1669-36628	5	3304.50	II	

Europium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
15	3308.02	II	24208-54429	550	3688.42	II	0-27104
15	3313.33	II	24208-54380	5	3710.87	II	10643-37584
7	3319.89	II	24208-54321	8	3713.45	II	10082-37003
10	3321.86	II	11128-41223	8	3714.90	II	10313-37224
9	3322.26	I	0-30091	3.0	3716.94	II	
100	3334.33	I	0-29982	3.0	3717.69	II	
5	3338.75	II	26838-56781	3.5	3719.16	I	14564-41444
12	3350.40	I	0-29839	1700	3724.94	II	0-26839
4	3351.56	II		4	3729.68	II	
4	3354.38	II		4	3729.74	II	11128-37932
5	3367.64	II	10082-39768	1.8	3732.20	I	14068-40854
15	3369.06	II	10643-40317	4	3738.08	II	
7	3380.25	II	24208-53783	30	3741.31	II	11128-37849
8	3390.78	II		9	3743.56	II	9923-36628
20	3391.99	II	10082-39554	22	3761.12	II	10643-37224
30	3396.58	II	26838-56271	8	3765.93	II	10082-36628
5	3419.84	II		3.5	3774.10	I	16612-43101
7	3423.09	II		5	3781.40	II	
16	3425.02	II	11128-40317	3.5	3788.76	II	27104-53490
5	3426.44	II	9923-39099	4	3791.50	II	10643-37011
5	3435.05	II		11	3799.01	II	10313-36628
7	3435.20	II		6	3801.36		
4	3435.72	II		8	3807.54	II	
5	3440.82	II	27256-56311	10	3811.33	I	14068-40298
16	3441.00	II	10082-39135	10	3815.50	II	
5	3445.18	II	10082-39099	3400	3819.67	II	0-26173
9	3457.05	I	0-28918	10	3826.68	II	26838-52963
5	3457.56	II	10082-38996	12	3844.23	II	10643-36649
14	3461.38	II	9923-38805	16	3865.57	I	15582-41444
9	3467.88	I	0-28828	4	3872.72	I	15582-41396
8	3477.07	I		6	3877.27	II	
8	h 3505.30	II	1669-30189	13	3884.75	I	14564-40298
50	cw 3521.09	II	26173-54565	2.0	3896.78	I	
8	3531.15	II	26173-54484	2.0	3900.18	I	
5	3532.23	II	27256-55559	6	3900.51	I	13222-38852
7	3538.08	II	26173-54429	2400	3907.10	II	1669-27256
16	3542.15	II	9923-38146	4	3915.24	II	
9	3543.85	II		4	3916.00	I	
5	3549.71	II		20	3917.29	I	13049-38569
19	3552.52	II	10643-38784	2.0	3917.70	II	9923-35441
8	3589.27	I	0-27853	3.5	3918.52	I	13779-39291
5	3591.31	II		9	3919.09	II	
16	3603.20	II	10313-38058	3.5	3928.87	II	10082-35527
8	3611.57	II	10313-37994	2800	3930.48	II	1669-27104
5	3616.15	II	26838-54484	3.5	3941.56	II	
10	3622.54	II	11128-38725	2.0	h 3942.21	II	10082-35441
10	3632.18	II	10082-37606	4	3942.94	II	
5	3673.19	II	27104-54321	8	3943.08	II	23774-49128
5	3674.63	II	10643-37849	2.0	3944.59	II	
5	3678.26	II	27256-54435	2.0	3945.67	II	

## Europium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
2.0	3949.13	II		3.0	4247.06	II	
4	3949.60	I	13049-38361	3.0	4253.80	II	
3.0	3950.76	II		2.0	4270.24	II	
3.5	3951.33	II		10	4298.73	I	13779-37035
4	3955.75	I	15582-40854	6	4329.36	I	13457-36549
2.5	3957.92	II		5	4329.97	I	13779-36867
2.0	3963.61	I	15952-41175	4	4330.61	II	
8	3964.90	II	10313-35527	2.5	4331.18	I	12924-36006
10	3966.59	II		6	4337.68	I	13457-36504
3.0	3967.18	I	14068-39268	16	4355.09	II	26173-49128
2000	3971.96	II	1669-26838	1.8	4361.57	II	
4	3978.42	I	13457-38586	3.5	4369.47	II	
2.0	3979.63	II		3.0	4372.20	II	
3.5	3986.60	I	13457-38534	5	4383.17	II	26838-49647
2.5	3988.24	II		6	4387.88	I	13222-36006
2.0	3993.93	II		1.4	4405.27	II	16861-39554
3.5	3995.98	II		3.5	4407.07	II	
4	4003.71	II		1.2	4419.66	II	
12	4011.69	II	24208-49128	8	4434.81	II	27104-49647
10	4017.58	II	10643-35527	900	4435.56	II	1669-24208
8	4039.19	I		5	4464.97	II	27256-49647
3.0	4078.24	I	13779-38292	1.6	4485.15	II	26838-49128
8	4085.38	II	9923-34394	200	4522.57	II	1669-23774
5	4096.80	II	10643-35046	3	4535.59	I	15952-37994
4	4106.88	I	12924-37266	750	4594.03	I	0-21761
6	4112.04	II	10082-34394	1.4	4602.63	I	16080-37800
3.0	4119.30	II		650	4627.22	I	0-21605
5	4127.28	I	16080-40302	550	4661.88	I	0-21445
2200	4129.70	II	0-24208	2.0	4713.59	I	15680-36890
2.0	4136.59	II		1.8	4740.50	I	13457-34546
2.5	4137.07	I	16080-40245	3.0	4792.59	I	13457-34317
2.0	4141.02	II		2.5	4829.30	I	15680-36381
4	4141.72	II		4	4830.33	I	17341-38037
2.0	4151.52	II	10313-34394	2.5	4840.47	I	17341-37994
3.0	4151.64	II		4	4849.64	I	15952-36567
2.0	4157.72	I	13049-37094	7	4867.62	I	13779-34317
7	4172.80	II		2.5	4884.05	I	16080-36549
2.0	4175.16	II		6	4894.68	I	16080-36504
7	4182.22	I	13222-37126	4	4900.86	I	14068-34467
2.5	4195.36	II		10	4907.18	I	14068-34440
2.5	4196.18	II		12	4911.40	I	14068-34423
4000	4205.05	II	0-23774	3.5	4953.52	I	15891-36073
3.0	4221.08	II		3.5	4960.21	I	15891-36045
2.5	4223.88	II		3.5	4962.55	I	15952-36098
6	4227.40	II		3.0	4975.76	I	17945-38037
5	4229.33	II		12	5013.17	I	14564-34506
5	4232.45	II		11	5022.91	I	14564-34467
6	4237.51	II		7	5029.54	I	14564-34440
3.0	4238.69	II		6	5033.55	I	15952-35813
3.0	4244.74	I	13049-36601	5	5067.95	I	13222-32948

## Europium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
5	h 5092.69	I	16612-36242	2.0	5533.25	I	13049-31116
6	h 5096.44	I	19447-39063	2.0	5542.54	I	17341-35378
11	5114.37	I	13049-32596	13	5547.44	I	12924-30945
6	5124.77	I	15891-35398	10	5570.33	I	13779-31726
11	5129.10	I	13457-32948	13	5577.14	I	13457-31383
6	5130.08	I	15891-35378	5	5579.63	I	14564-32481
14	5133.52	I	12924-32398	8	5580.03	I	13222-31138
18	5160.07	I	13222-32596	6	5586.24	I	13049-30945
14	5166.70	I	13049-32398	5	5586.83	I	13222-31116
4	5193.74	I	17341-36589	1.2	5592.25	I	12924-30801
13	5199.85	I	17341-36567	1.2	5599.80	I	13049-30902
7	5200.96	I	15952-35174	1.2	5605.86	I	17341-35174
8	5206.44	I	16612-35813	2.5	5618.81	I	13222-31014
50	5215.10	I	13779-32948	4	5622.44	I	14068-31849
20	5223.49	I	13457-32596	5	5632.54	I	13049-30798
8	5239.24	I	13049-32130	14	5645.80	I	0-17707
13	5266.40	I	13779-32762	1.0	5651.11	I	17707-35398
26	5271.96	I	15582-34545	4	5673.85	I	13222-30842
7	5272.48	I	13457-32418	1.8	5681.10	I	13222-30819
10	5282.82	I	15582-34506	1.8	5684.24	I	19447-37035
3.5	5287.25	I	13222-32130	4	5730.87	I	13457-30902
4	5289.25	I	17707-36608	4	5739.00	I	19447-36867
8	5291.26	I	19273-38167	22	5765.20	I	0-17341
4	5293.68	I	15582-34467	12	5783.69	I	14564-31849
8	5294.64	I	17707-36589	1.0	5792.72	I	19631-36890
6	5303.85	I	16612-35461	4	5800.27	I	13779-31014
2.0	h 5350.41	I	17945-36630	11	5818.74	II	9923-27104
5	h 5351.69	I	15421-34102	40	cw 5830.98	I	13779-30924
2.5	5352.84	I	17945-36622	1.8	5845.77	I	19447-36549
6	5355.10	I	16612-35280	1.8	5860.97	I	19447-36504
36	5357.61	I	13457-32117	1.0	5864.77	I	19364-36411
4	5360.83	I	15138-33786	6	5872.98	II	10082-27104
8	5361.61	I	16080-34726	1.0	5895.31	I	19544-36502
7	5376.94	I	16612-35205	1.8	5902.97	I	19764-36700
8	5392.94	I	15249-33786	0.8	5909.94	I	15680-32596
30	5402.77	I	13222-31726	5	5915.74	I	15582-32481
3.0	5405.33	I	16612-35107	0.8	5925.30	I	19712-36584
3.0	5411.86	I	17341-35813	1.8	5926.52	I	16080-32948
3.5	5421.07	I	16612-35053	3.0	5942.72	I	19462-36285
6	5426.94	I	15680-34102	1.8	5953.49	I	19794-36586
2.5	5443.56	I	15421-33786	1.8	5953.84	II	10313-27104
25	5451.51	I	13779-32117	2.0	5954.28	I	19794-36584
17	5452.94	I	13049-31383	6	5963.76	I	15421-32185
2.5	5457.62	I	19273-37591	22	5966.07	II	10082-26838
6	5472.32	I	13457-31726	32	cw 5967.10	I	13457-30211
8	5488.65	I	12924-31138	1.0	h 5968.43	I	19631-36381
3.0	5495.20	I	12924-31116	2.0	5971.69	I	19544-36285
1.0	5500.83	I	15952-34126	11	5972.75	I	15680-32418
8	5510.52	I	14068-32210	1.0	5980.47	I	19364-36081
2.0	5526.63	I	13049-31138	1.8	5983.14	I	15421-32130



## Europium — All Observed Lines

Intensity and Character	Wave-length in A	Spectrum	Energy Levels in K	Intensity and Character	Wave-length in A	Spectrum	Energy Levels in K
1.8	5983.78	I	19364-36072	0.8	6470.70	I	14068-29518
16	5992.83	I	16080-32762	1.2	6483.02	I	15421-30842
4	6004.36	I	15138-31788	3.0	6501.55	I	15421-30798
1.0	h 6005.61	I	15680-32327	4	6519.59	I	15680-31014
4	h 6012.20	I	15582-32210	1.0	6522.72	I	15891-31217
7	6012.56	I	15249-31876	0.5	h 6549.12	I	15952-31217
4	6015.58	I	19462-36081	5	6567.87	I	15680-30902
28	6018.15	I	0-16612	3.0	6593.79	I	15680-30842
4	6023.15	I	15138-31736	1.2	h 6603.55	I	15680-30819
11	6029.00	I	15421-32003	160	6645.11	II	11128-26173
4	6044.66	I	15249-31788	3.0	6685.21	I	14564-29518
28	6049.51	II	10313-26838	11	6693.96	I	16080-31014
9	6057.36	I	15680-32185	0.8	h 6701.06	I	19447-34366
6	6075.58	I	15421-31876	1.4	h 6710.45	I	21761-36659
2.0	6077.38	I	15680-32130	3.5	6744.88	I	16080-30902
16	6083.84	I	13779-30211	3.5	h 6782.54	I	16080-30819
16	6099.35	I	13222-29613	1.6	h 6787.48	I	15891-30619
4	6108.15	I	19364-35732	16	6802.72	I	14068-28764
8	6118.78	I	16080-32418	13	6816.06	I	15952-30619
4	6124.67	I	15680-32003	1.3	h 6834.30	I	21445-36073
22	6173.05	II	10643-26838	2.0	6840.93	I	21605-36219
7	6178.76	I	19273-35453	2.0	h 6844.83	I	16612-31217
17	cw 6188.13	I	13457-29613	1.6	h 6847.04	I	21445-36045
9	6195.07	I	13049-29186	42	6864.54	I	0-14564
1.0	h 6207.60	I	16080-32185	2.5	6898.21	I	21605-36098
1.0	6230.51	I	15680-31726	7	h 6903.67	I	21761-36242
6	h 6233.73	I	16080-32117	1.6	h 6910.17	I	21605-36073
3.5	6250.47	I	12924-28918	3.5	h 6914.82	I	21761-36219
16	6262.25	I	13222-29186	20	7040.20	I	14564-28764
3.5	6266.95	I	0-15952	2.0	7074.54	I	16080-30211
1.0	h 6285.95	I	12924-28828	55	7077.10	II	10082-24208
4	6291.34	I	0-15891	17	7106.48	I	0-14068
11	6299.77	I	13049-28918	1.0	7164.66	I	21445-35398
15	6303.41	II	10313-26173	5	7175.55	I	15680-29613
1.6	h 6313.78	I	13779-29613	95	7194.81	II	10313-24208
1.0	6318.58	I	19631-35453	95	7217.55	II	9923-23774
5	6335.82	I	13049-28828	1.8	h 7224.68	I	21445-35282
8	cw 6350.04	I	12924-28667	2.5	7258.72	I	21605-35378
4	6355.89	I	13457-29186	5	7262.77	I	15421-29186
4	6369.25	I	13222-28918	1.8	h 7281.53	I	21445-35174
3.5	6382.73	I	15138-30801	1.0	h 7297.56	I	21761-35461
5	6383.86	I	15138-30798	90	7301.17	II	10082-23774
8	cw 6400.93	I	13049-28667	1.8	7310.46	I	21605-35280
2.5	6406.11	I	13222-28828	2.0	7313.63	I	15249-28918
12	6410.04	I	12924-28520	9	cw 7336.18	I	15891-29518
9	6411.32	I	15249-30842	0.6	7346.25	I	21445-35053
3.5	6428.29	I	15249-30801	0.6	7356.65	I	21445-35034
55	6437.64	II	10643-26173	1.8	7362.25	I	15249-28828
1.2	6439.93	I	15421-30945	9	cw 7369.60	I	15952-29518
8	6457.96	I	15421-30902	120	7370.22	II	10643-24208

Europium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K		
0.6	7387.36	I	16080-29613	1.4	h	7803.32	I	15952-28764	
2.0	7389.16	I	15138-28667	1.4		7818.21	I	19631-32418	
1.8	h	7404.41	I	21605-35107	6		7887.99	I	17945-30619
50	7426.57	II	10313-23774	1.2		8015.47	I	19712-32185	
3.5	h	7436.59	I	21761-35205	4	cw	8209.80	I	17341-29518
1.4	7470.53	I	15138-28520	2.5	cw	8226.81	I	16612-28764	
0.9	h	7491.00	I	21761-35107	1.0	h	8464.71	I	17707-29518
8	cw	7528.70	I	17341-30619	3.5	cw	8642.67	I	19447-31014
0.9	h	7533.02	I	15249-28520	1.2		8727.77	I	19447-30902
1.0	7547.32	I	15421-28667	1.0		8782.46	I	19631-31014	
26	7583.91	I	15582-28764	2.0	cw	8790.88	I	19447-30819	
10	cw	7742.57	I	17707-30619	3.0		8870.30	I	19631-30902
12	7746.19	I	16612-29518						

# GADOLINIUM

$$\text{Gd, } Z=64, M=157.26, \text{ Ratio } \frac{\text{Gd}}{\text{Cu}}=2.475$$

Gd I Normal state of valence electrons  $4f^7 5d^1 6s^2 {}^9D_{3/2}^{\circ}=0$ . I.P.= 49700 K  
 Gd II Normal state of valence electrons  $4f^7 5d^1 6s^1 {}^{10}D_{3/2}^{\circ}=0$ . I.P.=100000 K

## References

Wavelengths:

A. S. King, *Astrophys. J.* **97**, 323 (1943).

Classification:

Gd I and Gd II, H. N. Russell, *J. Opt. Soc. Am.* **40**, 550 (1950).

Molecular Spectra:

GdO, A. Gatterer and J. Junkes, *Spektren der Seltenen Erden* (Specola Vaticana, Vatican, 1945).

## Relative intensity of gadolinium lines observed in an arc of copper containing 0.1 atomic percent of gadolinium

### *Strong lines of gadolinium*

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
850	3768. 39	II	633-27162	$4f^7 6s 5d^1 a {}^{10}D_{3/2}^{\circ} - 4f^7 5d^1 6p^1$ z ${}^{10}F_{4/2}$
700	3422. 47	II	1935-31146	$4f^7 6s 5d^1 a {}^{10}D_{5/2}^{\circ} - 4f^7 5d^1 6p^1$ z ${}^{10}F_{7/2}$
600	3646. 19	II	1935-29353	$4f^7 6s 5d^1 a {}^{10}D_{3/2}^{\circ} - 4f^7 5d^1 6p^1$ z ${}^{10}F_{6/2}$
550	3350. 47	II	1159-30997	$4f^7 6s 5d^1 a {}^{10}D_{5/2}^{\circ} - 4f^7 5d^1 6p^1$ z ${}^{10}D_{6/2}$
550	3362. 23	II	633-30367	$4f^7 6s 5d^1 a {}^{10}D_{3/2}^{\circ} - 4f^7 5d^1 6p^1$ z ${}^8D_{5/2}$
550	3584. 96	II	1159-29045	$4f^7 6s 5d^1 a {}^{10}D_{5/2}^{\circ} - 4f^7 5d^1 6p^1$ z ${}^{10}D_{4/2}$
500	3796. 37	II	262-26595	$4f^7 6s 5d^1 a {}^{10}D_{3/2}^{\circ} - 4f^7 5d^1 6p^1$ z ${}^{10}F_{3/2}$
500	3850. 97	II	0-25960	$4f^7 6s 5d^1 a {}^{10}D_{2/2}^{\circ} - 4f^7 5d^1 6p^1$ z ${}^{10}F_{1/2}$
440	3358. 62	II	262-30027	$4f^7 6s 5d^1 a {}^{10}D_{3/2}^{\circ} - 4f^7 5d^1 6p^1$ z ${}^8D_{4/2}$
440	3545. 80	II	1159-29353	$4f^7 6s 5d^1 a {}^{10}D_{5/2}^{\circ} - 4f^7 5d^1 6p^1$ z ${}^{10}F_{6/2}$
440	3743. 47	II	1159-27865	$4f^7 6s 5d^1 a {}^{10}D_{5/2}^{\circ} - 4f^7 5d^1 6p^1$ z ${}^{10}F_{6/2}$
440	4225. 85	I	1719-25376	$4f^7 6s^2 5d^1 a {}^9D_{5/2}^{\circ} - 4f^7 6s^1 5d^1 6p^1$ y ${}^9F_7$
420	3852. 45	II	262-26212	$4f^7 6s 5d^1 a {}^{10}D_{3/2}^{\circ} - 4f^7 5d^1 6p^1$ z ${}^{10}F_{2/2}$
400	3549. 36	II	1935-30101	$4f^7 6s 5d^1 a {}^{10}D_{5/2}^{\circ} - 4f^7 5d^1 6p^1$ z ${}^{10}D_{5/2}$
380	3654. 62	II	633-27988	$4f^7 6s 5d^1 a {}^{10}D_{3/2}^{\circ} - 4f^7 5d^1 6p^1$ z ${}^8P_{3/2}$
360	3813. 97	II	0-26212	$4f^7 6s 5d^1 a {}^{10}D_{2/2}^{\circ} - 4f^7 5d^1 6p^1$ z ${}^{10}F_{2/2}$
320	3850. 69	II	633-26595	$4f^7 6s 5d^1 a {}^{10}D_{4/2}^{\circ} - 4f^7 5d^1 6p^1$ z ${}^{10}F_{3/2}$
300	3100. 50	II	1935-34179	$4f^7 6s 5d^1 a {}^{10}D_{5/2}^{\circ} - 4f^7 5d^1 6p^1$ y ${}^{10}P_{5/2}$
300	3656. 15	II	1159-28502	$4f^7 6s 5d^1 a {}^{10}D_{5/2}^{\circ} - 4f^7 5d^1 6p^1$ z ${}^{10}P_{5/2}$
300	3687. 74	II	2857-29966	$4f^7 6s 5d^1 a {}^8D_{1/2}^{\circ} - 4f^7 5d^1 6p^1$ z ${}^8D_{2/2}$
280	3439. 99	II	1935-30997	$4f^7 6s 5d^1 a {}^{10}D_{5/2}^{\circ} - 4f^7 5d^1 6p^1$ z ${}^{10}D_{6/2}$
280	3463. 98	II	3444-32304	$4f^7 6s^2 a {}^8S_{3/2}^{\circ} - 4f^7 5d^1 6p^1$ y ${}^8P_{4/2}$
280	3783. 05	I	999-27425	$4f^7 6s^2 5d^1 a {}^9D_{5/2}^{\circ} - 4f^7 6s^1 5d^1 6p^1$ x ${}^9P_4$
260	3664. 60	II		
260	3712. 70	II	3082-30009	$4f^7 6s^1 5d^1 a {}^8D_{2/2}^{\circ} - 4f^7 5d^1 6p^1$ z ${}^8D_{3/2}$
260	4078. 70	I	533-25044	$4f^7 6s^2 5d^1 a {}^9D_{3/2}^{\circ} - 4f^7 6s^1 5d^1 6p^1$ y ${}^9D_5$
240	4053. 64	I	999-25661	$4f^7 6s^2 5d^1 a {}^9D_{3/2}^{\circ} - 4f^7 6s^1 5d^1 6p^1$ y ${}^9D_6$
240	4058. 22	I	215-24850	$4f^7 6s^2 5d^1 a {}^9D_{3/2}^{\circ} - 4f^7 6s^1 5d^1 6p^1$ y ${}^9D_4$
240	4098. 61	II	6605-30997	$4f^7 5d^2 a {}^{10}F_{7/2}^{\circ} - 4f^7 5d^1 6p^1$ z ${}^{10}D_{6/2}$
240d	{	II	11067-34179	$4f^7 5d^2 a {}^{10}P_{3/2}^{\circ} - 4f^7 5d^1 6p^1$ y ${}^{10}P_{5/2}$
I		533-23644	$4f^7 6s^2 5d^1 a {}^9D_{3/2}^{\circ} - 4f^7 6s^1 5d^1 6p^1$ y ${}^9F_4$	

Gadolinium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
7	2468.22	II	8551-49054	4	2918.52	II	
4	2471.58	II	8885-49332	8	2923.32	II	5340-39537
2.5	2485.67	II	9329-49547	3.0	2924.25	II	
5	2487.46	II	9143-49332	3.0	2928.34	II	2857-36996
8	2488.72	II	8885-49054	3.0	2947.80	II	3082-36996
4	2493.29	II	9452-49547	6	2948.01	II	5340-39251
2.5	2496.35	II	9452-49498	3.0	2952.43	I	
3.0	2499.04	II	9329-49332	3.0	2955.60	II	
2.0	2543.68	II	3444-42745	6	2960.93	II	3082-36845
2.0	2586.13	II	3972-42628	11	2963.60	II	
2.0	2661.50	II	11492-49054	7	2965.43	II	4841-38553
5	2720.50	II		2.5	2972.74	II	3082-36711
30	2750.22	II	3427-39777	48	2980.15	II	633-34179
40	2764.08	II	2857-39025	3.0	2983.74	II	
3.5	2768.51	II	3427-39537	3.5	2991.52	II	3427-36845
28	2769.81	II	3444-39537	8	2993.04	II	3444-36845
20	2770.17	II	3082-39170	100	2999.04	II	262-33596
1.8	2770.98	II	633-36711	32	3002.86	II	
4	2778.76	I	215-36192	6	3003.58	II	3427-36711
4	2779.14	II	2857-38828	9	3005.09	II	
38	2781.40	II	3082-39025	6	3009.37	II	3427-36647
6	2787.68	I	533-36395	3.0	3009.65	II	4841-38058
34	2791.96	II	3444-39251	180	3010.13	II	0-33212
9	2794.66	II	2857-38629	7	3010.90	II	3444-36647
80	2796.93	II	3427-39170	11	3012.19	II	4841-38030
5	2808.38	II	3427-39025	3.5	3022.10	II	
65	2809.72	II	3444-39025	160	3027.60	II	1159-34179
14	2810.93	II	3972-39537	10	3028.98	II	4841-37846
4	2814.01	II		4	3030.65	II	
26	2833.75	II	3972-39251	180	3032.84	II	633-33596
3.0	2836.69	II		140	3034.05	II	262-33212
6	2837.00	II	3082-38320	5	3040.34	II	4852-37734
48	2840.23	II	3972-39170	11	3043.01	I	999-33852
12	2841.33	II	3444-38629	14	3046.48	I	533-33348
3.5	2853.91	II		24	3053.57	II	3972-36711
5	2856.52	II	4027-39025	9	3059.92	I	215-32886
1.6	2859.78	II	4213-39170	90	3068.64	II	633-33212
10	2862.48	II	4852-39777	6	3069.42	I	215-32785
5	2865.06	II	3427-38320	48	3072.56	II	10092-42628
3.5	2866.33	II		55	3076.92	II	0-32491
3.5	2871.75	II	4213-39025	13	3077.08	II	3972-36461
40	2881.33	II	4841-39537	180	3081.99	II	1159-33596
3.5	2882.13	II	4484-39170	8	3083.35	II	262-32685
11	2885.60	II		12	3084.01	II	
3.5	2903.75	I	1719-36147	6	3085.06	II	
40	2905.31	II	4841-39251	8	3087.05	I	0-32384
3.0	2906.26	II	4852-39251	24	3089.95	II	10392-42745
3.0	2907.44	II		12	3092.06	II	10633-42965
15	2910.53	II	3972-38320	40	3098.64	II	0-32263
5	2913.08	II	4852-39170	16	3098.90	II	0-32260

Gadolinium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
300	3100.50	II	1935-34179	11	3259.25	II	10803-41476
10	3101.18	II	10392-42628	55	3266.73	I	533-31136
20	3101.91	II	262-32491	26	3267.64	I	215-30809
50	3102.55	II	8551-40773	14	3268.34	II	262-30850
11	3108.36	II	10803-42965	11	3274.18	II	10392-40925
15	3111.19	I	1719-33852	11	3279.53	II	10908-41392
14	3113.17	II	10633-42745	10	3281.61	II	10633-41097
10	3118.60	II	10908-42965	26	3282.25	I	999-31457
10	3119.01	I	533-32585		3282.30	II	10803-41260
44	3119.94	II	262-32304	44	3291.48	I	1719-32092
9	3120.18	II	8885-40925	38	3292.21	II	8885-39251
5	3123.69	II		44	3294.08	I	533-30882
32	3123.99	II	262-32263	34	3313.73	II	3427-33596
10	3124.25	II	262-32260	20	3315.59	II	3444-33596
8	3127.25	I	999-32967	9	3316.56	II	
11	3128.56	II	9143-41097	19	3320.44	II	9143-39251
8	3129.96	II	9452-41392	13	3329.34	II	9143-39170
11	3130.81	II	9329-41260	44	3330.34	II	
9	3133.09	II	0-31908	140	3331.38	II	0-30009
40	3133.85	II	8885-40785	85	3332.13	II	8551-38553
18	3135.03	II	262-32150	9	3334.06	II	
16	3136.93	I	0-31869	110	3336.18	II	0-29966
16	3137.30	I	0-31865	9	3336.98	II	8551-38510
10	3138.71	I	533-32384	60	3345.98	II	0-29878
8	3142.90	II	9452-41260	20	3350.10	II	9329-39170
20	3143.13	II	4841-36647	550	3350.47	II	1159-30997
80	3145.00	II	1159-32946	22	3357.61	I	533-30308
32	3145.52	II	9143-40925	28	3358.43	II	3444-33212
20	3146.88	II	9329-41097	440	3358.62	II	262-30027
100	3156.53	II	633-32304	80	3360.71	II	262-30009
20	3158.63	I	215-31865	550	3362.23	II	633-30367
14	3160.69	II	633-32263	28	3364.24	II	
100	3161.37	II	1935-33558	20	3365.59	II	262-29966
8	3167.20	I	999-32564	15	3367.66	II	10092-39777
8	3169.47	II		15	3369.62	II	8885-38553
9	3171.09	II	1159-32685	10	3373.84	I	0-29631
22	3190.28	I	533-31869	22	3374.69	II	3972-33596
9	3193.17	II	5340-36647	22	3379.76	II	10392-39971
22	3199.30	I	1719-32967	10	3380.01	II	
16	3199.58	I	533-31778	22	3380.52	II	9452-39025
11	3203.41	I	999-32207	9	3390.88	II	9452-38934
7	3206.47	II	18369-49547	110	3392.53	II	633-30101
5	3215.26	I	999-32092	15	3393.63	II	10633-40092
70	3223.74	II	1935-32946	55	3395.12	II	10092-39537
	3223.78	I	1719-32730	22	d 3397.22	I	1719-31147
					3397.32	I	0-29426
11	3225.46	II		20	3399.41	II	3082-32491
16	3226.32	II	8551-39537	55	3399.99	II	2857-32260
22	3232.78	I	533-31457	11	3401.07	II	633-30027
9	3238.62	II	10392-41260	55	3402.07	II	10392-39777
10	3250.19	II	10633-41392				

## Gadolinium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
11	3403.08	II	9452-38828	100	3491.95	II	0-28629
9	3405.04	II	10803-40162	170	3494.40	II	633-29242
20	3406.92	I	533-29877	9	3497.09	I	533-29120
110	d 3407.56	II	10633-39971	10	h 3501.58	II	
	3407.61	II	4841-34179	8	3503.21	II	10633-39170
26	3409.30	II	3427-32750	140	3505.51	II	3972-32491
22	3411.02	I	999-30308	80	3512.22	II	3444-31908
11	3412.02	II	9329-38629	110	3512.50	II	10092-38553
22	3413.27	II	10803-40092	85	3513.65	I	999-29451
140	3416.95	II	3427-32685	9	3516.78	II	
13	3417.33	II	10908-40162	10	3517.89	II	10092-38510
140	3418.73	II	0-29242	9	3522.45	II	
700	3422.47	II	1935-31146	100	3524.20	II	262-28629
40	3422.75	II	1159-30367	11	3525.15	I	999-29359
110	3423.90	I	999-30197	44	3528.54	II	3972-32304
	3423.92	II	0-29198	10	3534.24	II	
85	3424.59	II	2857-32049	15	3537.15	II	
40	3425.93	II	3082-32263	55	3542.77	II	5340-33558
10	3426.34	II	9143-38320	440	3545.80	II	1159-29353
22	3428.47	II	10092-39251	400	3549.36	II	1935-30101
11	3430.24	II	10633-39777	9	3553.72	II	10803-38934
15	3430.98	II		140	3557.05	II	4841-32946
70	3432.99	II	2857-31977	55	3558.19	II	8551-36647
170	3439.21	II	3082-32150	44	3558.47	II	4852-32946
85	3439.78	II	3427-32491	20	3564.05	II	4213-32263
280	3439.99	II	1935-30997	9	3564.64	II	
11	3441.79	II	3444-32491	11	d 3567.12	II	10803-38828
40	3449.62	II	262-29242	11	3567.65	II	4027-32049
140	3450.38	II	3972-32946	10	3569.57	II	4484-32491
110	3451.23	II	3082-32049	9	3570.41	II	
55	3454.14	II	1159-30101	70	3571.93	II	0-27988
90	3454.90	II	262-29198	34	3574.74	II	10092-38058
20	3455.27	I	1719-30652	10	3576.77	II	4027-31977
20	3457.05	II		40	3578.36	II	4213-32150
22	3461.95	II	3427-32304	10	3579.55	II	10392-38320
22	3463.00	II	1159-30027	15	3580.62	II	10908-38828
280	3463.98	II	3444-32304	100	3581.91	II	8551-36461
10	3466.50	II	5340-34179	10	3583.65	I	215-28112
34	3466.95	II	3427-32263	550	3584.96	II	1159-29045
170	3467.27	II	3427-32260	9	3586.58	II	
15	3468.08	II	3082-31908	15	3587.19	II	633-28502
170	3468.99	II	3444-32263	8	3588.21	I	0-27861
8	3469.31	II	3444-32260	55	3590.47	II	4841-32685
140	3473.22	II	262-29045	9	3591.44	II	4213-32049
15	3476.31	II		13	3591.91	II	4852-32685
220	3481.28	II	4841-33558	110	3592.71	II	8885-36711
170	3481.80	II	3972-32685	20	3593.44	II	4484-32304
50	3482.60	II	3444-32150	11	3596.84	I	999-28793
22	3486.20	I	533-29209	55	3600.96	II	8885-36647
11	3491.74	II		10	3602.00	II	10092-37846

Gadolinium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
110	3604.87	I	1719-29451	4	3703.51	II	
28	3605.26	II		6	3709.13	II	6605-33558
26	3605.66	II	262-27988	260	3712.70	II	3082-30009
13	3607.12	II		200	3713.57	I	215-27136
85	3608.75	II	9143-36845	4	3715.23	II	
85	3610.76	II	10633-38320	10	3715.92	I	215-27119
22	3610.91	II		140	3716.36	II	262-27162
8	3612.88	II		200	3717.48	I	533-27425
55	3613.39	II	9329-36996	180	3719.45	II	
28	d 3614.21	II	5897-33558		3719.53	II	3972-30850
	3614.42	I					
44	3617.16	II	10392-38030	24	3722.07	II	13926-40785
40	3620.46	II		6	3723.69	II	13926-40773
19	3622.81	II		42	3725.47	I, II	
28	3624.89	II		9	3726.57	I	215-27042
17	3625.26	II	8885-36461	150	3730.84	II	3082-29878
17	d 3626.32	II	9143-36711	26	3732.32	I	1719-28504
	3626.41	II		22	3732.45	II	633-27418
26	3629.51	II	9452-36996	22	3732.67	I	533-27316
9	3630.25	II		50	3733.08	II	
				10	3736.44	I	1719-28475
13	3630.88	II		48	3739.76	I	999-27731
34	3634.76	II	9143-36647	32	3740.02	II	
22	3639.05	II		9	3741.91	II	
26	3640.18	II	4841-32304	440	3743.47	II	1159-27865
34	3641.39	II	10392-37846	4	3744.14	I	
85	3645.62	II	3427-30850	60	3744.83	I	1719-28415
600	3646.19	II	1935-29353	4	3746.44	II	
10	3648.48	I	1719-29120	12	3748.88	II	11067-37734
30	3649.44	II	9452-36845	10	3751.10	I	215-26866
44	3650.95	II	9329-36711	8	3755.24	II	
16	3651.19	II		8	3755.56	II	10092-36711
60	3652.54	II		22	3757.74	II	
380	3654.62	II	633-27988	100	3757.94	I	533-27136
300	3656.15	II	1159-28502	140	3758.31	II	3427-30027
20	3658.19	I	533-27861	80	3759.00	II	0-26595
10	3661.66	II		10	3759.98	I	
140	3662.26	II	0-27298	10	3760.47	I	7562-34147
260	3664.60	II		60	3760.71	II	3444-30027
8	3668.32	II		28	3760.92	II	3427-30009
200	3671.20	II	633-27865	85	3762.20	I	999-27572
100	3674.05	I	215-27425	15	3763.00	II	1935-28502
34	3679.21	I	533-27705	20	3763.33	II	3444-30009
200	3684.13	I	0-27136	36	3764.20	II	
70	3686.33	II		16	3764.60	II	10092-36647
300	3687.74	II	2857-29966	85	3767.04	II	3427-29966
20	3694.03	II		850	3768.39	II	633-27162
13	3696.76	II		60	3769.45	II	3444-29966
10	3696.93	I	0-27042	140	3770.69	II	
200	3697.73	II	262-27298	24	3771.26	I	533-27042
130	3699.73	II	2857-29878	20	3773.45	I	7654-34147

## Gadolinium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
16	3774.30	II		420	3852.45	II	262-26212
20	3776.83	I	7235-33705	13	3854.18	II	4027-29966
10	3779.83	II		44	3855.56	II	1935-27865
100	3782.34	II		13	3858.45	I	6976-32886
280	3783.05	I	999-27425	15	3861.14	II	
6	3783.73	II		23	3863.05	II	
17	3787.15	I		12	3864.79	I	999-26866
110	3787.56	II	3972-30367	150	3866.99	I	1719-27572
19	3790.63	I		13	3867.26	II	4027-29878
75	3791.17	II	10092-36461	13	3871.54	II	633-26455
8	3791.72	II	4484-30850	13	3872.62	II	3427-29242
48	3792.39	II		23	3873.57	I	6976-32785
8	3795.25	II	2857-29198	15	3874.46	I	533-26336
16	3795.75	I	999-27337	20	3875.46	II	4213-30009
12	3795.93	II		10	3881.84	II	3444-29198
500	3796.37	II	262-26595	6	3884.66	II	
16	3798.39	II	10392-36711	7	3887.16	II	633-26352
70	3801.29	II		7	3887.73	I	533-26248
15	3802.85	II		14	3888.93	I	
20	3804.39	I	7427-33705	8	3890.42	I	
20	3805.09	II		5	3890.85	II	
55	3805.52	II		4	3892.72	I	7103-32785
15	3807.65	II	10392-36647	140	3894.70	II	0-25669
4	3810.25	II		16	3895.23	II	4213-29878
360	3813.97	II	0-26212	42	3895.79	II	
42	3814.74	II		6	3897.32	I	7235-32886
75	3816.64	II	262-26455	70	3902.40	II	3427-29045
42	3818.75	II		28	3902.71	I	999-26615
6	3821.51	II	3082-29242	22	3904.29	I	215-25821
12	3822.17	II	4841-30997	42	3905.65	I	1719-27316
12	3824.15	I	7562-33705	6	3907.12	I	
34	3826.05	II	3972-30101	4	3909.25	I	
22	3827.33	II		6	3909.94	I	
22	3829.40	II		4	3911.62	I	
18	3830.98	II		7	3912.75	I	7235-32785
36	3831.80	II	262-26352	6	3913.78	II	12776-38320
20	3832.97	I	533-26615	200	3916.51	II	4841-30367
32	3834.99	II		11	3918.06	II	
95	3836.91	II	3972-30027	11	3918.24	II	4852-30367
4	3838.90	I	999-27041	42	3923.25	II	4484-29966
100	3839.64	II	3972-30009	10	3926.68	I	7427-32886
12	3840.26	I	215-26248	11	3932.98	II	
120	3842.20	II		110	3934.79	I	533-25940
140	3843.28	I	1719-27731		3934.82	II	262-25669
8	3843.80	II	4841-30850	20	3935.38	I	0-25403
140	3844.58	II	1159-27162	7	3938.11	II	
12	3845.47	II	4852-30850	10	3938.97	II	
15	3846.49	I	6976-32967	42	3941.80	I	1719-27081
320	3850.69	II	633-26595	55	3942.63	I	215-25572
500	3850.97	II	0-25960	25	3943.24	I	0-25353



Gadolinium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
20	3943.62	I	7235-32585	28	4017.25	I	7562-32448
130	3945.54	I	999-26337	40	4017.71	I	6976-31859
		I	0-25338	28	4019.73	I	533-25403
5	3949.25	II		28	4022.33	II	
28	3952.00	II	1159-26455	100	4023.14	I	1719-26568
55	3953.37	I	533-25821	75	4023.35	I	533-25381
110	3957.67	II	4841-30101	20	4027.61	I	999-25821
10	3958.68	I	0-25254	100	4028.15	I	6976-31795
70	3959.44	II	4852-30101	80	4030.88	I	6976-31778
	3959.52	II	5897-31146	65	4033.49	I	7235-32020
17	3960.11	I	6976-32221	32	4035.40	I	215-24989
5	3962.10	II		24	4036.84	I	7235-32000
20	3963.66	II		130	4037.33	II	5340-30101
7	3965.04	I	7235-32448	65	4037.90	II	4484-29242
55	3966.28	I	1719-26925	10	4039.49	II	
55	3968.26	II	1159-26352	16	4039.67	II	
70	3969.00	I	215-25403	6	4042.76	II	
25	3969.29	II	4841-30027	38	4043.71	I	7427-32150
6	3970.18	I		4	4044.02	I	533-25254
13	3971.06	II	4852-30027	150	4045.01	I	0-24715
42	3971.75	II	4027-29198	12	4045.15	II	4484-29198
8	3972.17	II		25	4046.84	II	
36	3972.71	I	0-25165	25	4047.09	I	7654-32356
55	3973.98	II	4852-30009	15	4047.81	II	
28	3974.81	I	1719-26870	10	4048.60	II	
11	3975.11	II		25	4049.20	I	7562-32252
70	3979.33	I	215-25338	120	4049.43	II	5340-30027
14	3983.01	II	5897-30997	200	4049.86	II	
42	3987.21	II	3972-29045	25	4050.37	I	7654-32336
44	3987.84	I	0-25069	75	4053.29	II	
9	3989.25	II		240	4053.64	I	999-25661
30	3992.69	I	533-25572	75	4054.72	I	0-24656
20	3993.21	II	633-25669	240	4058.22	I	215-24850
60	3994.16	II	4213-29242	10	4059.37	II	13926-38553
65	3996.32	II		60	4059.88	I	7235-31859
30	3997.76	II	8551-33558	25	4061.30	II	
6	4000.18	I	6786-31778	60	4062.59	II	
44	4001.26	II	4213-29198	180	4063.39	II	
6	4001.96	II		50	4063.59	II	4027-28629
6	4003.85	II	11492-36461	24	4066.04	I	7562-32150
24	4004.94	II		48	4068.35	I	7427-32000
10	4006.96	I	215-25165	24	4068.74	I	7562-32133
30	4008.33	I	999-25940	70	4070.29	II	4484-29045
28	4008.91	II			4070.39	II	3427-27988
10	4009.22	II		60	4073.20	II	3444-27988
14	4013.43	I	7427-32336	28	4073.76	II	6605-31146
28	4013.80	II		120	4078.44	II	4841-29353
8	4013.95	II	3082-27989	260	4078.70	I	533-25044
14	4015.22	I	7235-32133	18	4080.53	I	215-24715
19	4015.58	I	1719-26615	48	4083.70	I	6976-31457

## Gadolinium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
6	4084.68	II		220	4184.25	II	3972-27865
140	4085.56	II	5897-30367	8	4188.10	II	3427-27298
24	4087.69	II		4	4188.82	I	
60	4090.41	I	215-24656	6	4190.20	I	
4	4091.75	I	7427-31859	200	4190.78	I	999-24854
100	4092.71	I	1719-26146	70	4191.07	II	3444-27298
24	4093.72	I	7427-31848	70	4191.63	I	999-24850
24	4094.48	II	4213-28629	7	4193.15	II	
240	4098.61	II	6605-30997	10	4197.07	II	12892-36711
48	4098.90	II	4852-29242	42	4197.68	II	
60	4100.26	I	999-25381	8	4202.52	II	
9	4104.99	I	7103-31457	55	4204.86	II	4213-27988
7	4108.40	II	12662-36996	5	4208.08	I	6550-30308
4	4110.43	II		120	4212.00	II	3427-27162
14	4110.60	II		90	4215.02	II	3444-27162
36	4111.44	II		60	4217.20	II	5340-29045
12	4111.74	II		4	4223.02	II	18955-42628
6	4112.94	I	7562-31869	6	4224.27	I	7480-31147
4	4113.77	II		30	4225.03	I	1719-25381
7	4115.38	II	12704-36996	15	4225.15	II	4841-28502
6	4119.21	I		450	4225.85	I	1719-25376
6	4119.38	II		20	4227.14	II	4852-28502
5	4125.78	I	8499-32730	20	4229.80	II	13076-36711
4	4127.72	II	12776-36996	7	4232.47	II	
200	4130.37	II	5897-30101	6	4232.93	I	
25	4131.48	II		5	4235.07	II	8885-32491
100	4132.28	II	4852-29045	8	4235.88	II	
70	4134.16	I	533-24715	60	4238.78	II	
38	4137.10	II		9	4241.28	II	13076-36647
4	4138.03	I	6976-31136	17	4243.84	II	
11	4140.45	II	4484-28629	14	4245.34	I	7103-30652
4	4141.02	II	12704-36845	19	4246.57	II	9143-32685
4	4144.25	I		6	4250.28	I	6786-30308
26	4148.86	I	1719-25815	160	4251.73	II	3082-26595
5	4149.48	I	7235-31328	80	4253.37	II	4484-27988
4	4150.61	II		60	4253.61	II	
3.5	4151.63	II		75	4260.12	I	533-24000
10	4153.51	II	12776-36845	150	4262.09	I	6786-30242
18	4154.86	II	8885-32946			II	5897-29353
18	4157.78	I	999-25044	60	4266.60	I	999-24430
3.5	4158.48	I		44	4267.00	I	215-23644
50	4162.73	II	3972-27988	15	4268.73	II	8885-32304
26	4163.09	II	5340-29353	5	4270.28	I	6786-30197
26	4167.16	II	3427-27418	5	h 4273.29	I	
	4167.27	I	999-24989	28	4274.17	I	0-23390
12	4170.11	II	3444-27418	5	h 4278.22	II	
11	4171.71	I	11830-35795	85	4280.49	II	2857-26212
11	4173.56	II	12892-36845	4	4282.79	II	
220	4175.54	I	1719-25661	40	4285.82	I	6550-29877
9	4182.77	I	7235-31136	28	4286.12	I	1719-25044

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Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
5	4289.88	II		90	4373.83	I	533-23390
50	4296.08	II	4027-27298	8	4376.07	I	6786-29631
13	4296.30	II	13378-36647	18	4378.56	I	7562-30395
20	4297.17	II		13	4380.64	II	9329-32150
4	4298.43	II		9	4382.06	II	4484-27298
40	4299.29	I	6378-29631	13	4383.12	II	9452-32260
12	4304.90	II		4	4386.20	I	
100	4306.34	I	0-23215	3.0	4387.17	I	
3.0	4307.87	II		17	4387.67	II	3427-26212
24	4309.29	I	7947-31147	17	4389.88	I	7103-29877
8	4310.98	II	3972-27162	17	4390.00		
170	4313.84	I	215-23390	14	4390.95	II	3444-26212
48	4314.40	I	7480-30652	6	4391.44	II	9143-31908
48	4316.05	II	5340-28502	26	4392.06	I	7480-30242
6	4316.27	II	9143-32304	2.5	4394.72	II	6605-29353
34	4320.52	I	7103-30242	17	4397.51	II	
70	4321.11	II	4852-27988	3.0	4400.18	II	9329-32049
	4321.20	I	1719-24854	8	4400.76	I	7480-30197
12	4322.20	II	3082-26212	130	4401.86	I	1719-24430
12	4324.06	II	9143-32263	48	4403.14	I	7947-30652
240	d 4325.57	II	11067-34179	24	4406.67	II	11492-34179
	4325.69	I	533-23644	24	4408.25	II	4484-27162
4	4326.32	II	17817-40925	20	4409.25	I	8498-31172
180	4327.12	I	0-23104	48	4411.16	I	533-23196
		II	2857-25960	2.5	4413.44	I	6976-29628
11	4328.94	I	7103-30197	80	4414.16	I	8498-31147
34	4329.58	I	6786-29877	65	4414.73	I	999-23644
32	4330.61	II	4213-27298	32	4419.03	II	3972-26595
22	4331.38	I	6550-29631	13	4421.24	II	10600-33212
7	4333.24	I		130	4422.41	I	215-22821
3.5	4335.29	II	17725-40785	4	4424.10	II	9452-32049
3.5	d 4336.63	I		11	4425.01	I	
	4336.78	I		5	4426.15	II	3082-25669
13	4337.51	I	6378-29426	4	4427.61	II	9329-31908
		II	17725-40773	100	4430.63	I	0-22564
3.5	4340.60	I		8	4431.76	I	7947-30505
42	4341.28	II	3427-26455	4	4433.64	II	10633-33182
85	4342.18	II	4841-27865	22	d 4436.10	I	
95	4344.30	II	4852-27865		4436.22	II	13926-36461
200	4346.46	I	999-24000	15	4438.27	II	5340-27865
85	4346.62	I	215-23215	3.0	4444.98	I	
20	4347.31	II	10600-33596	7	4446.49	II	3972-26455
7	4353.79	I		2.5	4449.02	I	
3.0	4354.06	II		2.5	4449.41	I	
5	4359.15	II	4484-27418	3.5	4452.73	I	12487-34938
3.0	4359.64	II	9329-32260	3.5	4453.93	II	8551-30997
15	4360.92	II	3427-26352	2.0	d 4458.32	I	
15	4369.15	I			4458.41	I	
28	4369.77	II	3082-25960	3.0	4461.36	I	7427-29835
18	4370.18	I	6550-29426	10	4462.83	I	

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Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
5	4463.25	II	10092-32491	26	4579.59	I	
28	4464.74	I		8	4581.09	II	5340-27162
28	4466.55	II	4213-26595	38	4581.29	I	999-22821
	4466.60	I	6976-29359	9	4582.38	II	10092-31908
48	4467.08	I		12	4582.53	II	8551-30367
~7	4467.23	II	10803-33182	38	4583.07	I	7480-29294
10	4471.29	II	10392-32750	8	4584.26	I	10576-32384
6	4473.28	I	215-22564	15	4586.99	I	
65	4474.13	I		20	4596.98	II	4213-25960
80	4476.12	I	0-22335	30	4597.91	II	4852-26595
20	4478.80	II	4841-27162	38	4598.90	I	7103-28842
26	4481.06	II	4852-27162	32	4601.05	II	4484-26212
20	4483.33	II	8551-30850	22	4602.93	I	999-22718
20	4484.70	I		5	h 4606.06	I	
2.5	4485.48	I	533-22821	3.0	4608.03	II	19402-41097
6	4486.35	II	18641-40925	2.5	4608.58	I	533-22226
26	4486.90	I	1719-24000	5	h 4611.04	I	
6	h 4488.40	II	10908-33182	48	4614.50	I	6786-28451
46	4497.13	I	999-23229	8	bl 4615.6	GdO	
20	4497.32	I		6	4619.14	I	10222-31865
16	4498.28	II	3444-25669	13	4624.42	I	6550-28169
2.5	4503.79	I	999-23196	40	4636.64	I	6550-28112
40	4506.21	I	533-22718	10	4639.00	II	8551-30101
13	4506.33	II	4027-26212	16	4640.04	I	
5	4506.93	II	3427-25609	16	4646.00	I	11830-33348
5	4509.08	II	10092-32263	16	4647.64	II	1719-23229
13	4514.50	II	11067-33212	16	d 4648.59	I	
8	4516.98	I			4648.70	I	10360-31865
100	4519.66	I	215-22335	40	4653.54	I	6378-27861
6	4520.07	II	10633-32750	8	4654.99	II	8551-30027
5	4521.30	II	4484-26595	4	4664.27	II	17817-39251
7	4521.94	II	18677-40785	5	4666.45	II	11067-32491
28	4522.82	II	11492-33596	13	h 4670.87	I	
14	4524.12	I		5	4678.25	I	
9	4536.97	I		16	4679.18	I	12487-33852
85	4537.81	I	533-22564	24	4680.04	I	7480-28842
20	4540.02	II	18753-40773	6	4683.07	I	7103-28451
28	4542.03	I	215-22226	40	4683.33	I	7947-29294
6	4544.23	I	7427-29426	6	h 4686.41	I	
22	4548.00	I		13	4688.12	I	533-21858
6	4550.95	II	5897-27865	8	4691.16	I	6550-27861
4	4554.99	II	10803-32750	65	4694.33	I	8498-29795
11	4558.08	II	4027-25960	16	4695.49	I	
2.5	4559.62	I		40	4697.42	I	6378-27660
4	d 4561.08	I		16	4703.13	I	
2.5	4564.59	I	10884-32785	19	4709.78	I	999-22226
3.0	h 4570.98	II	10392-32263	5	4711.98	II	8885-30101
8	4572.20	I	6976-28842	3.0	4712.80	II	
12	4573.81	I	0-21858	10	4721.46	I	
24	4575.91	I	7947-29795	14	4728.47	II	8885-30027

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Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
8	4728.64	I	533-21675	6	bl	GdO	
20	4732.60	II	8885-30009	8		II	9452-29878
4	4734.43	II	5340-26455	7		I	6976-27337
24	4735.75	I	6550-27660	3.0		I	7235-27572
6	4738.11	I		4		I	10222-30556
38	4743.65	I	6786-27861	6		II	17725-38030
10	4745.82	I	7103-28169	8		I	
3.0	h	4749.15	I	6		I	
3.0	d	4755.35	II	26		I	11830-32092
		4755.50	II	8		I	
4	4758.26	I	533-21543	8		I	10884-31136
30	4758.70	I	7103-28112	20		I	12487-32730
10	4760.74	I	1719-22718	4		I	
12	4763.82	I	10884-31869	6		I	10360-30556
44	4767.24	I	7480-28451	3.0		I	11830-32020
6	d	4780.99	I	10		I	1719-21905
		4781.13	I	6		I	
17		4781.92	I	3.5		I	
3.5	d	4783.47	I	6		I	
		4783.56	I	12		I	11297-31457
			11830-32730			II	8885-29045
28	4784.62	I	7947-28842				
10	4786.75	I	7562-28448	3.5		I	
4	4786.91	II	9143-30027	2.5		II	19402-39537
4	4791.15	II	9143-30009	2.0		II	17725-37846
13	4801.05	II	9143-29966	9		I	10576-30695
3.0			4852-25669	5		I	6976-27081
3.5			11492-32304	1.8		I	
2.5			8551-29353	5		II	18319-38320
20			8498-29294	7		I	10884-30882
4	h	4808.01	I	6		II	8551-28502
			13926-34719				
5	4816.83	I	11830-32585	5		I	11830-31778
30	4821.69	I		70		I	8498-28433
4	4829.94	I		3.0		II	10092-30009
8	4834.23	II	9328-30009	2.5		I	7562-27476
12	4835.26	I	999-21675			II	9329-29242
10	4848.10	I		5		II	9143-29045
4	4856.17	I		6		II	13076-32946
6	4856.72	I		3.5		II	9329-29198
7	4859.22	I	10884-31457	7		I	11297-31136
7	4861.78	I	11297-31859	1.8		II	
10	4862.59	I	10576-31136	6		II	12892-32685
16	4865.02	II	9329-29878	2.5		II	
8	4870.04	I		2.5		II	9452-29198
11	4871.50	I	10360-30882	3.0		II	
3.0			9452-29966	4		I	
8	4881.08	I	11297-31778	4		II	12776-32491
6	4881.36	I	12487-32967	3.0		I	
2.5	4881.92	II	18151-38629	5		I	
8	4883.19	I	10222-30695	5		I	
2.5	4889.19	I		9		II	13926-33558

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Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
6	5096.06	II	8885-28502	3.0	5272.37	I	
12	5098.38	II	13076-32685	5	5272.91	I	6378-25338
5	5100.94	II	12892-32491	5	5282.48	I	10576-29502
85	5103.45	I	7947-27536	26	5283.08	I	7947-26870
17	5108.91	II	13378-32946	3.0	5298.58	I	10222-29090
3.0	5123.65	II		26	5301.67	I	7480-26337
11	5125.56	II	11492-30997	20	5302.76	I	6550-25403
6	5130.28	II	12776-32263	5	5306.70	I	6976-25815
6	5135.59	I		26	5307.30	I	7103-25940
7	5136.04	I	7103-26568	4	5311.84	I	
8	5140.84	II	12704-32150	2.0	5315.79	II	
7	5141.50	I	7480-26925	3.0	5316.80	II	
7	5142.68	I	7427-26866	4	5321.25	I	6550-25338
1.4	5149.38	II	13076-32491	12	5321.50	I	6378-25165
3.0	5149.84	II	12892-32304	26	5321.78	I	6786-25572
80	5155.84	I	7480-26870	3.0	5322.37	I	10222-29006
5	5156.76	II	12662-32049	4	5322.69	I	10576-29359
7	5158.48	I	7235-26615	10	5327.32	I	10360-29126
4	5160.90	II	12892-32263	6	5328.30	I	10222-28985
7	5163.70	I	6976-26337	4	5331.92	I	
5	5164.54	II	11492-30850	16	5333.30	I	10884-29628
4	5171.69	I	0-19331	5	5337.53	I	10360-29090
18	5176.28	II	8551-27865	3.0	5341.17	I	7103-25821
3.5	5178.10	II	13378-32685	3.0	5341.81	I	1719-20434
4	5178.84	II	19947-39251	28	5343.00	I	11297-30007
3.5	5179.92	II	11067-30367	8	5345.13	I	6550-25254
4	5186.92	II	12704-31977	7	5345.68	I	999-19701
5	5187.24	II	12776-32049	19	5348.67	I	6378-25069
5	5187.88	I	6550-25821	28	5350.38	I	12487-31172
5	5191.08	II	12892-32150	22	5353.26	I	11830-30505
38	5197.77	I	7103-26337	4	5357.79	II	9329-27988
4	5199.21	II	13076-32304	4	5359.18	I	
2.5	5200.55	II	19947-39170	5	5361.66	I	10360-29006
5	5210.49	II	13076-32263	9	5365.38	I	10576-29209
8	5217.48	I	999-20160	3.0	5367.70	I	10360-28985
26	5219.40	I	6786-25940	3.0	5368.79	I	7947-26568
7	5220.30	II	10092-29242	3.0	5369.61	I	10884-29502
12	5233.93	I	7235-26336	9	5369.92	I	6786-25403
2.0	5244.38	I		14	5370.63	I	10222-28837
6	5246.87	I	15665-34719		5370.74	I	6550-25165
30	5251.18	I	8498-27536	3.5	5372.22	II	11492-30101
11	5252.14	I	11067-30101	4	5384.15	I	10884-29451
		II	6786-25821	4	5385.39	I	
8	5254.75	I	6378-25403	8	5389.50	I	10576-29126
13	5255.80	I	6550-25572	2.5	5411.20	I	10884-29359
2.0	5260.81	I		2.0	5412.64	II	
3.0	5263.81	I	533-19525	8	5413.20	I	7103-25572
2.0	5268.01	I	7947-26925	4	5413.39	I	6786-25254
6	5268.78	I	533-19507	8	5415.69	I	7480-25940
2.0	5271.79	I	6976-25940	2.5	5419.88	II	10600-29045

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Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
4	5421.19	I	1719-20160	2.0	5686.66	I	215-17795
4	5436.30	I	7947-26337	3.5	5692.13	I	7480-25044
2.5	5441.58	I	8499-26870	36	5696.22	I	533-18084
2.0	5447.74	II		9	5701.35	I	215-17750
6	5453.46	I	11297-29628	6	5709.42	I	0-17510
3.0	5455.31	I	10884-29209	3.5	5710.32	I	14669-32176
4	5469.72	I	7103-25381	2.0	5721.99	II	13378-30850
		II	8885-27162	4	5724.75	I	11830-29294
2.0	5475.72	I	6786-25044	11	5733.86	II	11067-28502
2.0	5480.23	I	10884-29126	4	5735.98	I	7947-25376
2.0	5482.01	I	10884-29120	4	5744.66	I	215-17618
2.0	5493.42	I	7947-26146	8	5746.36	I	533-17931
2.5	5498.75	I	7480-25661	3.5	5749.41	II	10600-27988
3.5	5499.97	I	11830-30007	3.5	5751.88	I	0-17381
3.5	5500.43	II	11067-29242	8	d 5754.17	I	7480-24854
2.5	h 5505.11	I		2.0	5771.20	II	
2.0	5515.61	I		1.6	5774.56	II	9143-26455
2.5	5521.75	I	6550-24656	7	5776.02	I	12487-29795
1.8	5524.60	II		22	5791.38	I	533-17795
2.0	5533.37	I	6976-25044	6	h 5796.80	I	
2.5	5538.32	II		5	5802.92	I	533-17761
2.5	5539.81	II		2.5	5807.05	II	12662-29878
2.0	5545.01	II	10600-28629	5	hs 5807.72	I	6786-24000
2.5	d 5548.20	I	12487-30505	5	h 5809.22	I	15852-33061
1.8	5550.21	I	6976-24989	5	5815.85	II	12776-29966
2.0	5559.73	I	1719-19701	6	hs 5819.51	I	
3.0	5560.69	II	11067-29045	4	5820.99	II	12704-29878
2.5	5572.53	I	7103-25044	4	h 5823.97	I	215-17381
3.5	5576.13	I	6786-24715	5	5840.47	II	12892-30009
5	5583.68	II	8551-26455	2.0	5845.71	II	12776-29878
1.2	5586.16	II	10092-27988	20	5851.63	I	999-18084
2.0	5586.32	I	7480-25376	5	5855.24	II	12892-29966
5	d 5591.85	I	14669-32548	26	5856.22	I	999-18070
3.5	5594.13	I	14036-31907	4	5856.96	II	9143-26212
1.8	5597.21	II	11492-29353	5	5860.73	II	8551-25609
2.0	5614.45	I	1719-19525	6	5877.26	II	11492-28502
2.5	5616.21	II	8551-26352	5	5886.46	I	
18	5617.91	I	0-17795	4	5897.62	II	13076-30027
1.6	5621.43	II	18677-36461	5	5904.07	II	13076-30009
6	5629.55	I	215-17974	10	5904.56	I	999-17931
10	5632.25	I	0-17750	16	5911.45	II	
3.0	5633.49	I	7103-24850	6	5913.55	II	
24	5643.24	I	215-17931	5	5916.77	I	7103-24000
2.5	5644.84	II	8885-26595	8	5930.29	I	6786-23644
1.2	h 5653.33	I	7654-25338	8	5936.84	I	6550-23390
3.5	bl 5664.42	GdO		6	5937.71	I	6378-23215
3.0	5677.45	I	14298-31907	5	h 5940.95		
5	bl 5680.89	GdO		5	h 5942.78		
3.5	5683.33	I		5	5951.60	II	11067-27865
2.5	5684.11	GdO		5	5956.48	II	8885-25669

Gadolinium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
8	5977.25	I	6378-23104	3.5	6643.98	I	18014-33061
10	h 5988.02	I	15852-32548	1.2	6646.85	I	11297-26337
8	5999.08	I	6550-23215	1.2	6653.55	I	18509-33535
6	6000.96	I		1.2	6679.56	II	
7	h 6001.87	I		4	6681.23	II	11492-26455
5	6004.57	II	13378-30027	1.2	6692.86	I	10884-25821
5	6008.71	I		0.7	6694.92	II	
5	6021.13	I	6786-23390	1.0	6702.12	II	18641-33558
5	6080.65	II	13926-30367	1.2	6704.18	II	13076-27988
40	6114.07	I	1719-18070	1.6	6718.14	II	18677-33558
5	6180.42	II	13927-30104	2.0	6727.83	II	11492-26352
10	bl 6182.68	GdO		10	6730.73	I	999-15852
10	bl 6200.86	GdO		6	6752.67	II	18753-33558
10	bl 6211.71	GdO		1.6	6753.91	II	
10	bl 6220.93	GdO		1.0	6772.03	I	
5	bl 6231.62	GdO		1.6	6783.39	I	11830-26568
7	bl 6241.66	GdO		3.0	6786.33	II	
5	b 6252.12	GdO		1.2	6787.18	I	
5	bl 6262.64	GdO		1.4	6814.56	I	7235-21905
4	b 6273.00	GdO		3.0	6816.49	I	999-15665
8	6289.73	II		2.0	6820.90	I	
3.0	6292.87	I	999-16886	12	6828.25	I	533-15174
7	6305.15	II	10600-26455	4	6846.60	II	11067-25669
3.0	6309.11	II		1.0	6849.89	I	20160-34755
2.5	6317.19	I	999-16825	3.5	6857.13	II	17725-32304
3.5	6331.35	I	18014-33804	1.8	6864.25	I	
1.6	6333.75	I	6550-22335	2.5	6887.63	II	
1.6	6336.34	I	6786-22564	1.6	6900.73	II	17817-32304
2.5	6346.65	II	10600-26352	12	6916.57	I	215-14669
2.5	h 6351.72	I	17795-33535	2.5	6920.62	II	17817-32263
1.6	6363.23	I	16196-31907	1.8	6924.99	II	
3.5	6380.95	II	13378-29045	2.5	6926.49	I	10222-24656
1.6	6382.19	II		2.0	6945.98	II	17870-32263
2.0	6408.55	I	1719-17319	1.8	6957.74	II	
2.0	6422.42	II		1.8	6959.24	II	18319-32685
1.6	6424.52	I	7654-23215	1.6	6964.33	I	10360-24715
1.8	h 6470.29	I	18084-33535	1.8	6971.66	II	18151-32491
1.4	6480.11	II	13926-29353	1.4	6976.35	II	
3.5	h 6538.15	I	16886-32176	1.2	6978.27	II	
2.0	6549.25	I	17931-33195	3.0	h 6980.86	I	20434-34755
5	6564.78	I	17319-32548	0.9	h 6983.53	I	11830-26146
1.2	6568.00	II	17725-32946	6	6985.89	II	
1.2	6573.80	I	17750-32958	1.2	6988.75	II	18641-32946
3.5	6591.60	I	1719-16886	9	6991.92	I	0-14298
1.8	6593.42	I	17795-32958	2.5	6993.18	I	10360-24656
1.2	6610.04	II	13378-28502	7	6996.76	II	17972-32260
1.0	6628.43	I	16825-31907	2.0	7000.75	II	17870-32150
6	6634.36	II	10600-25669	5	7006.16	II	18677-32946
4	6640.08	I	1719-16775	1.4	7016.60	I	7427-21675
1.2	6642.76	I	12487-27536	1.0	7017.73	II	18245-32491



## Gadolinium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
3.0	7037.26	II		1.8	7377.27	II	
1.0	7045.02	II		0.9	7377.77	I	11830-25381
2.0	7051.00	II	17972-32150	1.8	7380.28	I	11830-25376
1.0	7052.79	I	999-15174	1.2	7385.97	II	18955-32491
1.8	7054.62	II	18319-32491	1.8	7394.90	II	13076-26595
1.4	7058.02	II	18096-32260	1.8	7430.19	I	1719-15174
1.4	7068.09	II		0.6	7432.57	II	
1.0	7069.93	II		0.7	7434.46	I	
2.5	7071.00	I	10576-24715	5	7441.85	I	0-13434
2.5	7073.63	I	1719-15852	6	7464.36	I	533-13926
0.7	7084.18	I	17795-31907	0.8	7489.44	II	
		II	18151-32263	0.8	7505.35	II	12892-26212
1.0	7085.52	II	18151-32260	8	7562.97	I	215-13434
0.7	7093.90	I	18084-32176	1.4	7563.19	II	
2.0	7098.11	I	11297-25381	0.8	7566.10	I	11830-25044
2.0	7098.73	I	215-14298	1.4	7588.20	I	12487-25661
0.8	7099.44	I	12487-26568	1.4	7611.78	I	11297-24430
1.0	7100.71	I	10576-24656	3.0	7621.96	I	10884-24000
0.5	7101.73	II	17972-32049	3.0	7650.32	I	10576-23644
1.4	h 7116.77	II	18001-32049	3.5	7672.56	I	10360-23390
3.0	7118.86	II	18641-32685	1.4	7676.06	I	11830-24854
5	7122.57	I	0-14036	1.0	7677.16	I	19525-32548
1.2	7133.16	II	18245-32260	1.0	h 7683.36	I	19165-32176
1.8	7135.73	II		1.8	7694.45	I	10222-23215
0.8	h 7141.17	II	18151-32150	0.6	7717.66	I	7480-20434
0.9	7146.13	II	17988-31977	11	7733.50	I	999-13926
2.5	7147.31	II		0.9	7738.09	II	
0.8	7150.77	I	7562-21543	0.4	h 7748.37	II	19402-32304
1.8	7158.28	I	10884-24850	5	7749.30	I	533-13434
0.8	7164.30	II		1.4	7755.97	I	12487-25376
24	7168.37	I	1719-15665	1.4	7766.48	I	
3.0	7172.26	II	13926-27865	1.0	h 7787.22	II	
0.6	7173.40	II	17972-31908	1.2	7834.46	I	10884-23644
4	7189.57	II	18245-32150	1.0	7838.84	II	
0.8	7191.49	II		1.6	h 7844.87	I	10360-23104
1.8	7197.08	II	18369-32260	1.4	7845.80	I	19165-31907
0.8	h 7198.63	I	7562-21450	5	7846.35	II	
1.8	7201.41	II		5	7856.93	I	6976-19701
1.4	7228.02	I	10884-24715	0.7	7867.73	I	
3.5	7233.45	I	215-14036	2.0	7869.72	I	11297-24000
0.9	7242.24	II	18245-32049	0.6	7884.39	I	7480-20160
2.0	7252.70	II	13378-27162	0.6	h 7908.06	II	17725-30367
4	7262.66	I	533-14298	0.9	7910.08	I	10576-23215
2.0	7291.35	I	215-13926	3.5	7930.25	II	
0.6	7301.22	II		0.9	h 7963.25	II	
3.0	7313.28	I	999-14669	0.5	7966.66	I	6976-19525
2.5	7324.89	II		0.8	7978.15	I	6976-19507
1.2	7327.07	I	20160-33804	0.9	7993.82	I	10884-23390
2.0	7373.81	I	11297-24854	0.9	8006.26	I	7947-20434
2.0	7376.41	I	11297-24850	0.9	8010.53	II	

Gadolinium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
0.9	8019.82	I	7235-19701	1.4	8445.47	I	7562-19400
0.6	8037.40	I		1.8 h	8527.88	I	7562-19285
0.8	8048.08	I	7103-19525	0.7	8559.11	I	10884-22564
1.8	8077.59	I	7103-19480	0.8	8561.72	I	7653-19331
0.4	8089.96	II	19947-32304	0.6 h	8579.77	II	
0.5 h	8144.00	I		0.6	8615.97	II	
2.5	8146.15	I	7235-19507	0.8 h	8659.66	II	
0.6 h	8185.90	I	7947-20160	1.2 h	8661.48	I	
0.7	8209.07	I		3.0	8668.63	I	6976-18509
1.6	8218.08	I	7235-19400	0.7	8674.86	I	11297-22821
1.4	8275.42	I	7427-19507	0.9	8752.77	I	11297-22718
0.7 h	8315.02	II		1.6	8770.36	I	11830-23229
1.0	8316.38	II		1.8	8784.85	I	6550-17931
1.4	8349.73	I	7427-19400	1.4	8795.76	I	11830-23196
0.6	8374.76	I	10884-22821	3.0 h	8832.06	II	
0.6	8377.79	I	11297-23229	2.0 h	8849.14	I	6786-18084
1.6	8398.30	I	7427-19331	2.5 h	8867.31	I	7235-18509
1.0	8442.58	II					

# GALLIUM

Ga,  $Z=31$ ,  $M=69.72$ , Ratio  $\frac{\text{Ga}}{\text{Cu}}=1.097$

Ga I Normal state of valence electrons  $4s^2 4p^1 {}^2P_{0\frac{1}{2}}^\circ=0$ . I.P.= 48380 K  
 Ga II Normal state of valence electrons  $4s^2 {}^1S_0=0$ . I.P.=165458 K

## References

Wavelengths:

G. R. Harrison, Massachusetts Institute of Technology Wavelength Tables (John Wiley & Sons, New York, 1939).

Classification:

Ga I, A. Fowler, Report on Series in Line Spectra, (Fleetway Press, London, 1922).  
 R. A. Sawyer and R. J. Lang, Phys. Rev. **34**, 712 (1929).

Intensities:

Y. I. Ostrovskii and N. P. Penkin, Optika i Spektroskopiya **4**, 719 (1958).

## Relative intensity of gallium lines observed in an arc of copper containing 0.1 atomic percent of gallium

*Strong lines of gallium*

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
2000	4172.06	I	826-24788	$4s^2 4p^1 {}^2P_{1\frac{1}{2}}^\circ - 4s^2 5s^1 {}^2S_{0\frac{1}{2}}$
1000	4032.98	I	0-24788	$4s^2 4p^1 {}^2P_{0\frac{1}{2}}^\circ - 4s^2 5s^1 {}^2S_{0\frac{1}{2}}$

## Gallium — All Observed Lines

Intensity and Character	Wave- length in A	Spec- trum	Energy Levels in K	Intensity and Character	Wave- length in A	Spec- trum	Energy Levels in K
0.6	2294.20	I	0-43574	34	2659.87	I	0-37585
2.0	2338.28	I	826-43578	80	2719.65	I	826-37585
1.8	2371.32	I	0-42158	500	2874.24	I	0-34782
8	2418.70	I	826-42158	950	2943.64	I	826-34787
75	2450.07	I	0-40803	150	2944.18	I	826-34782
130	h 2500.17	I	826-40811	1000	4032.98	I	0-24788
12	2500.70	I	826-40803	2000	4172.06	I	826-24788
2.5	2624.82	I	826-38913				

# GERMANIUM

Ge,  $Z=32$ ,  $M=72.60$ , Ratio  $\frac{\text{Ge}}{\text{Cu}}=1.143$

Ge I Normal state of valence electrons  $4s^2 4p^2 {}^3P_0 = 0$ . I.P. = 63600 K  
 Ge II Normal state of valence electrons  $4s^2 4p^1 {}^2P_{0\frac{1}{2}} = 0$ . I.P. = 128518 K

## References

### Wavelengths:

G. R. Harrison, Massachusetts Institute of Technology Wavelength Tables (John Wiley & Sons, New York, 1939), from 2000 to 5000 A.

C. W. Gartlein, Phys. Rev. **31**, 782 (1928), below 2000 A.

C. C. Kiess, J. Research NBS **24**, 1 (1940), above 5000 A.

### Classification:

Ge I, K. R. Rao, Proc. Roy. Soc. (London) [A] **124**, 465 (1929).

C. C. Kiess, J. Research NBS **24**, 1 (1940).

## Relative intensity of germanium lines observed in an arc of copper containing 0.1 atomic percent of germanium

### Strong lines of germanium

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
1200	2651.18	I	1410-39118	$4s^2 4p^2 {}^3P_2 - 4s^2 4p^1 5s^1 {}^3P_2$
850	2709.63	I	557-37452	$4s^2 4p^2 {}^3P_1 - 4s^2 4p^1 5s^1 {}^3P_0$
750	3039.06	I	7125-40020	$4s^2 4p^2 {}^1D_2 - 4s^2 4p^1 5s^1 {}^1P_1$
650	2754.59	I	1410-37702	$4s^2 4p^2 {}^3P_2 - 4s^2 4p^1 5s^1 {}^3P_1$

## Germanium — All Observed Lines

Intensity and Character	Wave- length in A	Spec- trum	Energy Levels in K	Intensity and Character	Wave- length in A	Spec- trum	Energy Levels in K
11	1954.49	I	557-51705	90	2497.96	I	0-40020
8	1961.40	I	7125-58091	70	2533.23	I	557-40020
14	1970.26	I	1410-52148	2.5	2556.30	I	16367-55474
8	1987.64	I	1410-51705	28	2589.19	I	1410-40020
26	1998.25	I	1410-51437	500	2592.54	I	557-39118
13	2019.05	I	557-50069	6	2644.19	I	16367-54175
24	2041.69	I	0-48962	1200	2651.18	I	1410-39118
16	2043.76	I	1410-50323	550	2651.58	I	0-37702
5	2054.45	I	1410-50069	500	2691.34	I	557-37702
2.5	2057.23	I	7125-55718	850	2709.63	I	557-37452
10	2065.20	I	557-48962	40	2740.43	I	16367-52847
34	2068.65	I	557-48882	650	2754.59	I	1410-37702
7	2086.00	I	557-48480	7	2793.94	I	16367-52148
36	2094.23	I	1410-49144	8	2829.01	I	16367-51705
5	2105.80	I	1410-48882	750	3039.06	I	7125-40020
2.5	2124.75	I	7125-54175	60	3067.01	I	16367-48962
20	2198.70	I	7125-52592	20	3124.82	I	7125-39118
2.0	2256.00	I	7125-51437	110	3269.49	I	7125-37702
4	2314.20	I	7125-50323	70	4226.57	I	16367-40020
6	2327.90	I	7125-50069	6	4685.84	I	16367-37702
9	2379.14	I	7125-49144	0.6	8789.87	I	37702-49076
85	2417.37	I	7125-48480				

# GOLD

Au,  $Z=79$ ,  $M=197.0$ , Ratio  $\frac{\text{Au}}{\text{Cu}}=3.10$

Au I Normal state of valence electrons  $5d^{10} 6s^1 {}^2S_{0\frac{1}{2}}=0$ . I.P.=74410 K  
 Au II Normal state of valence electrons  $5d^{10} {}^1S_0=0$ . I.P.=165000 K

## References

Wavelengths:

G. R. Harrison, Massachusetts Institute of Technology Wavelength Tables (John Wiley & Sons, New York, 1939).

Classification:

Au I and Au II, J. R. Platt and R. A. Sawyer, Phys. Rev. **60**, 866 (1941).

## Relative intensity of gold lines observed in an arc of copper containing 0.1 atomic percent of gold

*Strong lines of gold*

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
340	2675.95	I	0-37359	$5d^{10}6s^1 {}^2S_{0\frac{1}{2}}-5d^{10}6p^1 {}^2P_{0\frac{1}{2}}$
200	2427.95	I	0-41174	$5d^{10}6s^1 {}^2S_{0\frac{1}{2}}-5d^{10}6p^1 {}^2P_{1\frac{1}{2}}$

## Gold — All Observed Lines

Intensity and Character	Wave- length in A	Spec- trum	Energy Levels in K	Intensity and Character	Wave- length in A	Spec- trum	Energy Levels in K
8	2012.00	I	9161-58845	32	3029.20	I	9161-42164
2.0	2021.38	I	9161-58616	160	3122.78	I	9161-41174
6	2352.65	I	9161-51654	4	3897.89	I	42164-67812
6	2387.75	I	9161-51029	4	4040.94	I	21435-46174
200	2427.95	I	0-41174	7	4065.08	I	37359-61952
1.6	2544.19	I	21435-60729	2.0	4315.09	I	45537-68705
3.0	2590.04	I	21435-60033	1.2	4437.27	I	46174-68705
26	2641.49	I	9161-47007	2.5	4488.25	I	45537-67812
340	2675.95	I	0-37359	9	4607.34	I	47007-68705
3.0	2688.71	I	21435-58616	5	4792.60	I	41174-62034
8	2700.89	I	9161-46174	2.5	5837.40	I	37359-54485
110	2748.26	I	9161-45537	6	6278.18	I	21435-37359
1.6	2883.45	I	21435-56106	6	7510.75	I	41174-54485
1.6	2932.19						

# HAFNIUM

Hf,  $Z=72$ ,  $M=178.50$ , Ratio  $\frac{\text{Hf}}{\text{Cu}}=2.809$

Hf I Normal state of valence electrons  $5d^2 6s^2 {}^3F_2 = 0$ . I.P. = 55000 K  
 Hf II Normal state of valence electrons  $5d^1 6s^2 {}^2D_{1/2} = 0$ . I.P. = 120000 K

## References

Wavelengths:

G. R. Harrison, Massachusetts Institute of Technology Wavelength Tables (John Wiley & Sons, New York, 1939).

C. H. Corliss and W. F. Meggers, J. Research NBS **61**, 269 (1958).

Classification:

Hf I, W. F. Meggers, unpublished material.

Hf II, W. F. Meggers and B. F. Scribner, J. Research NBS **13**, 625 (1934).

Molecular Spectra:

HfO, W. F. Meggers, unpublished material.

## Relative intensity of hafnium lines observed in an arc of copper containing 0.1 atomic percent of hafnium

*Strong lines of hafnium*

Intensity	Wavelength Å	Spectrum	Energy levels K	Term combination
260	3399.80	II	0-29405	$5d^1 6s^2 a {}^2D_{1/2} - 5d^1 6s^1 6p^1 z {}^4F_{3/2}$
240	2866.37	I	0-34877	$5d^2 6s^2 a {}^3F_2 - 5d^2 6s^1 6p^1 y {}^1F_3$
240	3072.88	I	0-32533	$5d^2 6s^2 a {}^3F_2 - 5d^2 6s^1 6p^1 y {}^3G_3$
220	2916.48	I	4568-38845	$5d^2 6s^2 a {}^3F_4 - 5d^2 6s^1 6p^1 x {}^3G_5$
220	2940.77	I	0-33995	$5d^2 6s^2 a {}^3F_2 - 5d^2 6s^1 6p^1 w {}^3F_2$
220	3682.24	I	0-27150	$5d^2 6s^2 a {}^3F_2 - 5d^2 6s^1 6p^1 y {}^3F_2$
200	2898.26	I	2357-36850	$5d^2 6s^2 a {}^3F_3 - 5d^2 6s^1 6p^1 w {}^3F_4$
160	2964.88	I	2357-36075	$5d^2 6s^2 a {}^3F_3 - 5d^2 6s^1 6p^1 x {}^3F_4$
150	3561.66	II	0-28069	$5d^1 6s^2 a {}^2D_{1/2} - 5d^1 6s^1 6p^1 z {}^4F_{1/2}$
140	2820.22	II	3051-38499	$5d^1 6s^2 a {}^2D_{3/2} - 5d^1 6p^1 z {}^4G_{3/2}$
140	2904.41	I	4568-38988	$5d^2 6s^2 a {}^3F_4 - 5d^2 6s^1 6p^1 v {}^3F_4$
140	2950.68	I	2357-36237	$5d^2 6s^2 a {}^3F_3 - 5d^2 6s^1 6p^1 x {}^1F_3$
140	3505.23	II	8362-36882	$5d^2 6s^1 a {}^4F_{4/2} - 5d^1 6s^1 6p^1 z {}^4D_{3/2}$
140	3777.64	I	0-26464	$5d^2 6s^2 a {}^3F_2 - 5d^1 6s^2 6p^1 z {}^1P_1$
140	3785.46	I	4568-30977	$5d^2 6s^2 a {}^3F_4 - 5d^2 6s^1 6p^1 z {}^3G_5$
130	3020.53	I	2357-35454	$5d^2 6s^2 a {}^3F_3 - 5d^2 6s^1 6p^1 w {}^3F_3$
130	3820.73	I	4568-30733	$5d^2 6s^2 a {}^3F_4 - 5d^2 6s^1 6p^1 y {}^3F_4$
120	2638.71	II	0-37886	$5d^1 6s^2 a {}^2D_{1/2} - 5d^1 6s^1 6p^1 y {}^2D_{1/2}$
120	2641.41	II	8362-46209	$5d^2 6s^1 a {}^4F_{4/2} - 5d^2 6p^1 z {}^4G_{5/2}$
120	2954.20	I	4568-38408	$5d^2 6s^2 a {}^3F_4 - 5d^2 6s^1 6p^1 w {}^3D_3$
120	2980.81	I	0-33538	$5d^2 6s^2 a {}^3F_2 - 5d^2 6s^1 6p^1 x {}^3F_2$
120	3012.90	II	0-33181	$5d^1 6s^2 a {}^2D_{1/2} - 5d^1 6s^1 6p^1 z {}^2D_{3/2}$
120	3016.94	II	0-33136	$5d^1 6s^2 a {}^2D_{1/2} - 5d^1 6s^1 6p^1 z {}^2P_{3/2}$
120	3057.02	I	4568-37270	$5d^2 6s^2 a {}^3F_4 - 5d^2 6s^1 6p^1 x {}^3G_4$
120	3569.04	II	6344-34355	$5d^2 6s^1 a {}^4F_{3/2} - 5d^1 6s^1 6p^1 z {}^4D_{3/2}$

Hafnium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
5	2012.78	II	3051-52717	11	2473.92	II	12921-53331
8	2028.18	II	13486-62775	6	2481.44	II	17830-58117
2.5	2096.18	II	15084-62775	6	2482.65	I	0-40267
4	2210.82	II	36883-82101	6	2487.16	I	0-40194
4	2254.01	II	3645-47996	32	2496.99	II	3645-43681
2.0	2255.15	II	3645-47973	8	2500.74	II	15084-55060
3.5	2266.83	II	4905-49006	8	2502.66	I	2357-42302
10	2277.16	II	0-43901	65	2512.69	II	4905-44691
6	2321.14	II	4905-47973	65	2513.03	II	6344-46125
16	2322.47	II	0-43044	15	2515.48	II	13486-53227
8	2323.25	II	3645-46675	100	2516.88	II	3051-42771
3.0	2324.50	II	12071-55077	8	2517.86	I	0-39704
8	2324.89	II	4905-47904	8	2521.49	II	17830-57478
6	2332.97	II	3645-46495	38	2531.19	II	4905-44400
6	2337.33	II	0-42771	9	2532.97	II	3051-42518
8	2343.32	II	6344-49006	22	2537.33	II	3645-43044
11	2347.44	II	6344-48931	12	2548.20	II	13486-52717
20	2351.22	II	0-42518	36	2551.40	II	17389-56572
4	2353.02	I	0-42485	3.0	2551.85	II	12921-52097
4	2365.98	II	4905-47158	7	2559.02	I	2357-41422
13	2380.30	II	3645-45643	14	2559.19	II	12071-51134
5	2381.00	II	14360-56346	28	2563.61	II	4905-43901
10	2393.18	II	12921-54693	6	2570.71	II	15084-53973
26	2393.36	II	4905-46675	100	2571.67	II	3645-42518
40	2393.83	II	0-41761	36	2573.90	II	12071-50910
9	2400.78	II	3051-44691	7	2574.89	I	
5	2404.56	II	13486-55060	36	2576.82	II	8362-47158
36	2405.42	II	6344-47904	34	2578.14	II	4905-43681
9	2406.44	II	11952-53494	36	2582.54	II	3051-41761
26	2410.14	II	8362-49841	14	2591.33	II	0-38579
7	2413.33	II	12071-53494	3.5	2594.12	I	4568-43105
4	2415.96	II	11952-53331	6	2599.22	II	15084-53546
26	2417.69	II	3051-44400	6	2602.67	I	2357-40768
10	2425.98	II	13486-54693	3.0	2602.87	I	0-38408
3.5	2428.75	I	2357-43518	44	2606.37	II	3051-41407
10	2428.99	II	12071-53227	50	2607.03	II	6344-44691
12	2433.57	II	17369-58448	6	2607.24	II	14360-52703
4	2434.74	II	17389-58448	13	2608.45	I	0-38325
4	2444.99	I	4568-45455	4	2609.96	I	4568-42871
42	2447.25	II	3051-43901	2.5	2612.59	I	5522-43786
16	2449.44	II	6344-47158	26	2613.60	II	17389-55639
4	2452.30	II	11952-52717	8	2614.29	II	15254-53494
12	2453.34	II	17369-58117	10	2616.61	I	5639-43845
50	2460.49	II	3051-43681	50	2622.74	II	3645-41761
8	2463.97	II	12921-53494	4	2623.32	I	8984-47092
48	2464.19	II	8362-48931	8	2626.95	II	6344-44400
10	2465.06	II	15084-55639	3.0	2635.57	I	6573-44504
4	2465.67	I	4568-45112	7	2635.79	II	17711-55639
16	2467.97	II	0-40507	18	2637.00	I	2357-40267
24	2469.18	II	13486-53973	120	2638.71	II	0-37886

## Hafnium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
120	2641.41	II	8362-46209	5	2772.32	II	14360-50420
8	2642.08	I	2357-40194	19	2773.02	I	2357-38408
18	2642.75	I	4568-42396	110	2773.36	II	6344-42391
75	2647.29	II	8362-46125	20	2774.02	II	8362-44400
5	2649.15	II	14360-52097	6	2775.27	II	11952-47973
11	2651.16	II	17369-55077	44	2779.37	I	2357-38325
3.5	2652.86	II	41407-79090	8	2783.69	I	6572-42485
7	2657.50	II	15084-52703	5	2786.30	II	15254-51134
18	2657.84	II	4905-42518	11	2789.50	II	17389-53227
24	2661.88	II	6344-43901	16	2789.73	II	17711-53546
					2789.80	II	12071-47904
10	2665.97	II	12921-50420	26	2808.00	II	4905-40507
10	2668.28	I	5639-43105	3.0	2812.32	I	10509-46056
9	2669.00	II	3051-40507	26	2813.86	II	3051-38579
5	2671.25	II	13486-50910	19	2814.48	II	13486-49006
2.5	2676.63	II	17711-55060				
2.0	2677.58	II	6344-43681	10	2814.76	II	17711-53227
2.0	2678.43	II	17369-54693	5	2815.82	I	6573-42076
4	2682.19	I	6573-43845	5	2816.07	II	17830-53330
32	2683.35	II	15084-52340	26	2817.68	I	8984-44464
6	2685.22	II	17830-55060	16	2818.94	I	6572-42036
2.0	2686.36	I	6572-43786	22	2819.74	I	0-35454
2.0	2688.35	I	8984-46170	140	2820.22	II	3051-38499
8	2696.18	I	2357-39435	6	2820.42	II	13486-48931
7	2699.63	I		55	2822.68	II	6344-41761
75	2705.61	I	0-36949	9	2829.32	II	17369-52703
12	2706.73	II	13486-50420	20	2833.28	I	0-35284
8	2711.83	I	8984-45848	12	2834.13	I	8984-44258
5	2711.99	II	17830-54693	8	2841.49	I	5522-40704
2.5	2712.14	II	12071-48931	46	2845.83	I	5639-40768
24	2712.42	II	4905-41761	30	2849.21	II	12071-47158
16	2713.84	I	2357-39194	8	2850.15	II	12921-47996
7	2718.51	II	14360-51134	30	2850.96	I	5639-40704
28	2718.59	I	0-36773	20	2851.21	II	6344-41407
9	2726.70	I	5639-42302	6	2857.65	II	12921-47904
8	2729.10	I	2357-38988	6	2860.31	II	17389-52340
10	2730.71	I	0-36610	20	2860.56	I	0-34948
13	2730.85	I	4568-41175	85	2861.01	II	0-34942
4	2732.68	II	17389-53973	85	2861.70	II	3645-38579
8	2737.83	I	5522-42036	240	2866.37	I	0-34877
80	2738.76	II	4905-41407	6	2867.70	I	8984-43845
22	2743.64	I	5639-42076	15	2869.82	II	3051-37886
4	2746.62	I	5639-42036	3.0	2873.65	I	
40	2751.81	II	8362-44691	17	2876.33	II	15084-49841
7	2756.91	II	17711-53973	5	2877.16	I	10509-45255
3.5	2758.31	I	10533-46776	6	2879.11	II	11952-46675
10	2758.78	I	0-36237	6	2885.47	II	14360-49006
50	2761.63	I	4568-40768	24	2887.14	I	4568-39194
7	2762.69	I	5639-41825	11	2887.54	I	6572-41194
18	2766.96	I	5639-41769	90	2889.62	I	0-34596
6	2770.46	II	12921-49006	7	2892.56	I	



## Hafnium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
2.0	2894.84	I	8984-43518	80	3050.76	I	5639-38408
200	2898.26	I	2357-36850	9	3054.52	II	3645-36373
15	2898.71	II	13486-47973	5	3055.44	II	15254-47973
140	2904.41	I	4568-38988	120	3057.02	I	4568-37270
100	2904.75	I	2357-36773	14	3063.78	I	5522-38152
16	2909.91	II	0-34355	14	3064.68	II	12071-44691
220	2916.48	I	4568-38845	95	3067.41	I	2357-34948
3.5	2917.49	II	17830-52097	10	3069.18	I	10532-43105
65	2918.58	I	2357-36610	240	3072.88	I	0-32533
36	2919.59	II	3645-37886	19	3074.10	I	2357-34877
20	2924.62	I	5522-39704	28	3074.79	I	5639-38152
7	2929.01	I	6572-40704	3.0	3075.30	I	10509-43016
55	2929.63	II	0-34124	17	3080.66	II	17389-49841
50	2929.90	I	8984-43105	48	3080.84	I	2357-34806
80	2937.80	II	8362-42391	10	3092.24	II	12071-44400
220	2940.77	I	0-33995	22	3096.76	I	4568-36850
18	2944.71	I	0-33949	38	3101.40	II	6344-38579
6	2947.13	II	15084-49006	80	3109.12	II	6344-38499
140	2950.68	I	2357-36237	14	3110.87	II	14360-46495
3.0	2951.90	I	10509-44375	8	3116.95	II	15084-47158
120	2954.20	I	4568-38408	14	3119.98	I	4568-36610
60	2958.02	I	5639-39435	5	3126.29	II	4905-36883
7	2960.82	II	17369-51134	10	3128.76	I	0-31952
13	2961.80	II	12921-46675	8	3129.58	I	0-31944
160	2964.88	I	2357-36075	80	3131.81	I	10533-42454
70	2966.93	I	6572-40267	5	3133.50	II	41761-73665
16	2967.23	II	11952-45643	95	3134.72	II	3051-34942
80	2968.81	II	4905-38579	14	3137.51	I	10533-42396
12	2973.37	I	6572-40194	19	3139.65	II	6344-38186
100	2975.88	II	4905-38499	13	3140.76	II	12071-43901
8	2977.60	II	12921-46495	25	3145.32	II	0-31784
17	2979.28	I	5639-39194	25	3148.41	I	6572-38325
120	2980.81	I	0-33538	13	3151.63	I	8984-40704
24	2982.72	I	10533-44049	4	3152.96	I	14092-45799
6	2984.05	I	8984-42485	50	3156.63	I	4568-36237
19	3000.10	II	3051-36373	30	3159.82	I	2357-33995
90	3005.56	I	10533-43795	80	3162.61	II	12071-43681
9	3011.24	II	17711-50910	5	3163.39	I	10509-42112
120	3012.90	II	0-33181	10	3165.73	I	6573-38152
60	3016.78	I	0-33138	50	3168.39	I	10509-42062
120	3016.94	II	0-33136	100	3172.94	I	4568-36075
3.0	3017.37	I	6572-39704	50	3176.86	II	4905-36373
110	3018.31	I	0-33122	5	3178.43	I	14542-45995
130	3020.53	I	2357-35454	4	3179.61	I	
9	3024.60	I	8984-42036	25	3181.01	I	5522-36949
9	3024.76	II	17369-50420	13	3181.15	I	4568-35994
16	3025.29	II	8362-41407	15	3189.62	I	0-31342
46	3031.16	II	4905-37886	40	3193.53	II	3051-34355
12	3046.08	II	15084-47904	75	3194.19	II	3645-34942
9	3049.29	I	8984-41769	7	3195.61	II	14360-45643

## Hafnium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
22	3196.93	I		26	3394.59	II	4905-34355
15	3199.99	II	15254-46495	16	3394.98	II	17711-47158
5	3203.67	II	13486-44691	26	3397.26	I	4568-33995
35	3206.11	I	2357-33538	26	3397.60	I	8984-38408
20	3210.98	I	5639-36773	260	3399.80	II	0-29405
10	3213.72	I	14542-45649	19	3400.21	I	0-29402
20	3217.30	II	3051-34124	20	3402.51	I	4568-33949
20	3220.61	II	15084-46125	10	3407.14	I	8984-38325
15	3230.06	I		16	3407.76	II	12071-41407
15	3239.44	I		26	3410.17	II	15084-44400
15	3243.35	I	16767-47590	7	3412.34	I	14542-43838
40	3247.66	I	2357-33139	10	3413.74	II	13486-42771
25	3249.53	I	2357-33121	26	3417.34	I	2357-31611
100	3253.70	II	3051-33776	46	3419.18	I	5639-34877
8	3254.86	I	14741-45455	5	3421.42	II	4905-34124
30	3255.28	II	3645-34355	16	3427.44	I	8984-38152
5	3261.90	I	14435-45083	22	3428.37	II	0-29160
13	3262.47	I	10533-41175	28	3438.24	II	18898-47973
10	3265.29	I	15673-46290	16	3438.43	I	5522-34596
8	3267.01	I		11	3441.84	I	14741-43786
8	3267.18	I	5639-36237	5	3448.29	I	
20	3273.66	II	6344-36883	11	3452.31	I	5639-34596
30	3279.98	II	3645-34124	16	3462.64	II	4905-33776
5	3283.38	II	12071-42518	16	3467.60	I	15673-44504
18	3291.05	I	6572-36949	80	3472.40	I	0-28790
24	3306.12	I	4568-34806	22	3478.99	II	17389-46125
13	3309.19	I	8984-39194	54	3479.28	II	3051-31784
38	3310.27	I	6573-36773	5	3487.57	II	17830-46495
5	3310.86	II	13486-43681	28	3495.75	II	6344-34942
75	3312.86	I	2357-32533	9	3495.93	II	15084-43681
8	3316.19	I	17901-48048	28	3497.16	I	
20	3317.99	II	3051-33181	110	3497.49	I	0-28584
5	3323.36	II	23146-53227	11	3498.98	I	4568-33139
15	3328.21	II	4905-34942	140	3505.23	II	8362-36882
5	3331.89	I	10509-40514	17	3513.28	I	10532-38988
100	3332.73	I	0-29997	15	3518.75	II	14360-42771
42	3352.06	II	8362-38186	6	3521.56	I	17901-46290
10	3356.09	II	17369-47158	110	3523.02	I	2357-30733
14	3356.78	I	15673-45455	11	3530.87	I	19293-47606
8	3358.30	II	17389-47158	11	3531.23	I	5639-33949
26	3358.91	I	14741-44504	110	3535.54	II	4905-33181
20	3360.06	I	0-29753	85	3536.62	I	0-28267
16	3366.68	I	14092-43786	20	3548.81	I	
4	3372.21	I	5639-35284	60	3552.70	II	3645-31784
20	3378.93	I	2357-31943	17	3554.00	I	14542-42671
16	3384.14	II	14360-43901	150	3561.66	II	0-28069
26	3384.70	II	3645-33181	17	3564.31	I	0-28048
19	3386.21	I	16767-46290	30	3567.36	I	6572-34596
90	3389.83	II	3645-33136	120	3569.04	II	6344-34355
26	3392.81	I	15673-45139	17	3579.90	I	14435-42361

## Hafnium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
12	3583.28	I	5639-33538	7	3782.78	II	12070-38499
24	3597.42	II	15254-43044	140	3785.46	I	4568-30977
	3597.51	I	8984-36773	3.5	3787.37	I	18381-44778
60	3599.87	I	16767-44537	65	3793.37	II	3051-29405
12	3615.04	I	0-27654	10	3798.66	I	10532-36850
90	3616.89	I	2357-29997	85	d 3800.38	I	0-26306
12	3617.68	I	14542-42176		3800.45	I	5639-31944
10	3620.04	I	5522-33138	7	3804.53	I	
12	3624.00	II	12921-40507	14	3806.07	II	21638-47904
36	3630.87	II	28105-55639	32	3811.78	I	2357-28584
11	3635.43	I	5639-33138	10	3817.20	II	17711-43901
6	3637.59	I	5639-33122	10	3819.38	I	14092-40267
90	3644.36	II	6344-33776	130	3820.73	I	4568-30733
36	3649.10	I	2357-29753	14	3829.67	I	16767-42871
10	3650.53	I	19293-46678	28	3830.02	I	14092-40194
22	3651.84	I	4568-31943	80	3849.18	I	5639-31611
14	3661.05	II	15084-42391	14	3849.52	II	17711-43681
8	3664.60	I	14018-41298	60	3858.31	I	2357-28267
22	3665.35	II	11952-39226	20	3860.91	I	8984-34877
10	3668.21	I	8984-36237	7	3867.34	II	17830-43681
20	3672.27	I		18	3872.55	II	12071-37886
48	3675.74	I	15673-42871	14	3877.10	II	23146-48931
220	3682.24	I	0-27150	34	3880.82	II	3645-29405
28	3696.51	I	2357-29402	18	3882.52	I	15673-41422
10	3698.40	II	17369-44400	13	3883.77	II	13486-39226
24	3699.72	II	13486-40507	18	3889.23	I	10532-36237
34	3701.15	II	17389-44400	18	3889.33	I	5639-31342
10	3704.92	I	18381-45365	6	3892.47	I	19791-45475
12	3705.40	II	17711-44691	55	3899.94	I	0-25634
100	3717.80	I	2357-29247	3.0	3900.65	II	30942-56572
65	3719.28	II	4905-31784	4	3906.89	I	14542-40130
14	3726.49	I	10509-37336	7	3909.18	I	19791-45365
16	3729.10	I	20960-47769	7	3917.45	II	21638-47158
46	3733.79	I	4568-31342	55	3918.09	II	3645-29160
16	3737.88	II	18898-45643	18	3923.90	II	12921-38399
12	3739.04	I	10533-37270	11	3926.42	I	10533-35994
6	3743.99	I	18381-45083	13	3927.57	I	14741-40194
10	3744.98	II	23146-49841	10	3929.54	II	28105-53546
40	3746.80	I	14741-41422	28	3931.38	I	4568-29997
8	3747.49	II	15084-41761	11	3935.65	II	17369-42771
14	3753.22	I	17901-44537	11	3939.04	I	6572-31952
6	3762.51	II	31878-58448	7	3950.80	I	
10	3765.05	I	18225-44778	36	3951.83	I	2357-27654
10	3765.56	I	6572-33122	7	3964.95	II	17830-43044
17	3766.92	II	20135-46675	14	3968.01	I	0-25194
20	3768.25	I	10509-37039	13	bl 3970.05	Hf O	
6	3771.36	II	12070-38579	18	3973.48	I	2356-27516
6	3773.12	I	14018-40514	7	3979.40	II	28105-53227
140	3777.64	I	0-26464	16	4032.27	I	2357-27150
3.5	3782.43	I	5522-31952	8	4044.39	I	16163-40882

## Hafnium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
9	4047.96	II	30942-55639	11	4417.35	II	15254-37886
6	4049.45	II	17830-42518	14	4417.91	I	5639-28267
6	4049.74	I		3.0	4418.25	I	8984-31611
20	4062.84	I	10509-35115	3.0	4422.23	I	10532-33139
12	4066.21	I	14542-39128	18	4438.04	I	5522-28048
16	4083.35	I	10509-34992	5	h 4443.07	I	18381-40882
3.0	4087.96	I	16163-40619	5	4453.00	I	0-22451
48	4093.16	II	3645-28069	12	4457.34	I	2357-24785
10	4104.23	I	5639-29997	12	4461.18	I	5639-28048
12	4106.58	I	10532-34877	4	4466.40	II	20135-42518
10	4113.53	II	12071-36373	5	4486.13	II	12071-34355
3.0	4115.90	I	18381-42671	5	4499.65	I	6572-28790
10	4118.60	I	10532-34806	4	4518.29	I	16163-38289
6	4118.91	I	14018-38289	12	4540.93	I	5639-27654
13	4127.80	II	14360-38579	7	4544.02	I	10532-32533
12	4145.76	I	5639-29753	22	4565.94	I	5639-27534
7	4158.88	II	17369-41407	2.0	4573.79	II	17369-39226
13	4162.36	II	17389-41407	4	h 4597.90	I	
10	4162.69	I	4568-28584	44	d 4598.80	I	0-21739
100	4174.34	I	2357-26306		4598.92	I	4568-26306
7	4187.66	II	18898-42771	2.0	4605.77	II	12071-33776
11	4190.95	I	14435-38289	8	4608.09	I	6573-28267
14	4206.58	II	20135-43901	20	4620.86	I	4568-26203
17	4209.70	I	14542-38289	6	4622.70	II	20135-41761
15	4228.08	I	0-23645	4	h 4630.61	I	19293-40882
15	4232.44	II	18898-42518	16	4655.19	I	6572-28048
7	4245.16	I	8984-32533	6	4664.12	II	12921-34355
3.5	4245.84	II	20135-43681	2.0	4669.24	I	10532-31943
11	bl 4252.08	HfO		9	4699.01	I	18011-39286
15	4260.98	I	10533-33994	3.0	4699.72	II	20135-41407
18	4263.39	I	0-23449	3.5	h 4708.84	I	22901-44132
15	4272.85	II	13486-36883	3.5	h 4719.10	II	11952-33136
28	4294.79	I	2357-25634	3.5	h 4731.37	II	17369-38499
7	4296.41	I	5522-28790	3.0	4738.58	I	14018-35115
11	4318.14	I	5639-28790	3.0	4757.58	I	8984-29997
7	4320.67	II	17369-40507	7	4766.51	I	14018-34992
14	4330.27	I	4568-27654	6	4773.72	I	5522-26464
3.5	4334.64	II	23146-46209	2.0	4774.89	I	22901-43838
16	4336.66	II	21638-44691	12	4782.74	I	18225-39128
3.0	h 4349.74	I	24785-47769	3.0	4790.72	II	17711-38578
13	4350.51	II	23146-46125	24	4800.50	I	5638-26464
3.5	h 4351.15	I		2.5	4817.21	II	21638-42391
7	4352.57	I	8984-31952	5	4818.87	I	18381-39128
6	4353.34	I	16163-39128	3.0	4834.19	I	14435-35115
22	4356.33	I	4568-27516	6	4837.23	I	5639-26306
5	4356.99	I	5639-28584	1.6	4850.61	I	10509-31119
6	4365.37	I	14435-37336	3.0	4858.41	I	6572-27150
10	4367.90	II	13486-36373	10	4859.24	I	14542-35115
16	4370.97	II	12071-34942	6	4863.27	I	14435-34992
5	b 4408.81	HfO		1.6	4872.94	I	20960-41476

## Hafnium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	
6	4877.58	I	19293-39789	3.0	5538.02	I	21739-39791	
1.4	4915.26	I	19791-40130	1.8	5538.26	I	10533-28584	
1.6	4934.45	II	12921-33181	15	5550.60	I	0-18011	
3.5	4948.94	I	10533-30733	15	5552.12	I	5639-23645	
1.6	4962.37	I	18143-38289	3.5	5575.86	I	26203-44132	
8	4975.25	I	2357-22450	0.9	5600.77	I	23449-41298	
1.0	4999.68	II	14360-34355	6	5613.27	I	5639-23449	
6	5018.20	I	20960-40882	1.6	5614.01	I	21739-39546	
1.0	5021.75	I	18381-38289	0.5	5628.27	I	23449-41211	
3.5	5040.82	II	11952-31784	1.2	5650.83	I	10509-28201	
6	5047.45	I	8984-28790	2.5	bl	HfO		
3.5	b	5074.74	HfO	1.6	5713.28	I	24785-42283	
2.0	5079.65	II	18898-38579	10	5719.18	I	8984-26464	
3.5	b	5093.88	HfO	1.6	bl	5720.16	HfO	
1.0	5112.13	I	5639-25194	0.8	5748.72	I	24785-42176	
1.2	5128.53	II	17389-36883	0.9	5767.18	II	12071-29405	
2.0	5157.96	I	22901-42283	0.8	5809.50	II	11952-29160	
3.5	5167.42	I	24785-44132	1.2	5817.47	I	14435-31620	
5	5170.18	I	19791-39128	1.6	5842.23	II	17830-34942	
15	5181.86	I	0-19293	1.6	5845.87	I	14018-31119	
2.0	5186.84	I	22901-42176	1.2	5847.77	I	22451-39546	
2.0	5187.75	II	15084-34355	1.4	5883.66	I	23645-40636	
7	5243.99	I	8984-28048	1.0	5926.47	I	23645-40514	
3.5	5247.10	II	28105-47158	4	5933.69	I	18143-34992	
1.6	5260.44	II	17369-36373	5	5974.28	I	18381-35115	
2.0	5264.95	II	18898-37886	1.6	5974.72	I	19791-36524	
3.5	5275.04	I	16163-35115	4	5978.66	I	18270-34992	
1.4	5286.09	I	23449-42361	1.6	5992.96	I		
8	5294.87	I	4568-23449	3.0	c	6016.79	I	27516-44132
3.0	5298.06	II	15254-34124	1.8	b	6021.12	HfO	
2.0	5307.82	I	23449-42283	1.6	b	6043.19	HfO	
3.0	5309.68	I	16163-34992	1.6	6054.17	I	14542-31055	
3.5	5311.60	II	14360-33181	6	6098.67	I	4568-20960	
0.8	5324.26	II	14360-33136	6	6185.13	I	0-16163	
0.6	5346.30	II	28458-47158	3.5	6210.70	I	24785-40882	
7	5354.73	I	25462-44132	1.8	6216.82	I	26203-42283	
7	5373.86	I	2357-20960	3.0	6238.58	I	2357-18381	
2.5	5389.34	I	8984-27534	4	6248.95	II	12071-28069	
1.2	5391.36	II	17830-36373	1.4	h	6299.54	I	26306-42176
1.2	5404.47	I	19791-38289	1.6	h	6311.85	I	22451-38289
1.8	5424.02	I	22451-40882	1.2	6318.33	I	19293-35115	
0.8	5435.78	I		2.0	6338.10	I	10532-26306	
2.5	5438.74	I	0-18381	1.2	h	6380.19	I	15673-31342
0.9	5444.07	II	20135-38499	4	6386.23	I	2357-18011	
5	5452.92	I	4568-22901	1.2	h	6409.52	I	21739-37336
2.0	5463.38	II	13486-31784	1.0	h	6556.50	I	25634-40882
1.0	5497.30	I	29753-47938	1.8	6587.23	I	16766-31943	
1.0	5510.12	I	0-18143	3.0	6644.60	II	14360-29405	
1.0	5510.45	I	18381-36524	1.2	6647.06	II	23146-38186	
1.2	5524.35	II	15084-33181	1.0	6659.40	I	14741-29753	

## Hafnium — All Observed Lines

Intensity and Character	Wave-length in A	Spectrum	Energy Levels in K	Intensity and Character	Wave-length in A	Spectrum	Energy Levels in K
3.0	6713.48	I	16163-31055	1.8	7556.37	I	16766-29997
0.6	6716.00	I	22451-37336	9	7562.93	I	6572-19791
1.6	6754.61	II	14360-29160	1.8	7564.22	I	34806-48022
1.0	6769.95	I	27516-42283	1.4	7576.95	I	18381-31576
8	6789.27	I	4568-19293	1.4	7592.96	I	23253-36419
15	6818.94	I	8984-23645	1.6	7608.59	I	31943-45083
1.4	6826.56	I	23645-38289	44	7624.40	I	10533-23645
1.2	6850.07	I	25194-39789	2.5	7645.64	I	17901-30977
3.5	6858.70	I	16766-31342	14	7740.17	I	10532-23449
4	6911.40	I	8984-23449	1.0	7743.57	I	15673-28584
0.9	6926.19	I	14092-28526	0.6	7757.89	II	18898-31784
1.8	6979.59	I	15673-29997	5	7790.90	I	17901-30733
2.0	6980.91	II	15084-29405	0.9	7796.81	I	23253-36075
0.8	7019.25	I	29247-43489	4	7814.55	I	14741-27534
0.8	7030.33	II	20135-34355	38	7845.35	I	5639-18381
0.9	7035.13	I	16767-30977	0.9	7846.56	I	23253-35994
1.4	7061.90	I	25634-39791	16	7920.71	I	5522-18143
1.8	7062.87	I	25634-39789	3.5	7938.06	I	15673-28267
20	7063.83	I	5639-19791	30	7994.73	I	5639-18143
1.4 h	7094.40	I	25194-39286	0.8	8010.58	I	16766-29247
1.8	7100.54	I	15673-29753	3.0	8056.52	I	14741-27150
7	7119.52	I	17901-31943	3.0	8080.32	I	5639-18011
70	7131.81	I	0-14018	2.0	8173.89	I	20908-33139
80	7237.10	I	4568-18381	16	8204.58	I	2357-14542
50	7240.87	I	2357-16163	0.8	8248.81	I	36237-48357
0.7	7262.62	I	14435-28201	7	8276.95	I	2357-14435
9	7320.05	I	4568-18225	1.6	8305.91	II	17369-29405
2.0	7321.76	I	5639-19293	3.0	8344.25	I	15673-27654
0.7	7356.10	I	23449-37039	0.6	8380.06	I	28584-40514
0.7	7365.28	I	15673-29247	0.6	8382.98	I	22880-34806
2.5	7390.70	I	14741-28267	4	8460.01	I	16767-28584
0.7	7423.69	I	8984-22450	18	8546.48	I	6572-18270
3.0	7437.56	I	14092-27534	20	8640.06	I	6572-18143
1.6	7463.86	I	23645-37039	5	8711.24	I	15673-27150
0.8	7484.56	I	22880-36237	8	9004.73	I	14092-25194

# HOLMIUM

Ho,  $Z=67$ ,  $M=164.94$ , Ratio  $\frac{Ho}{Cu}=2.596$

## References

### Wavelengths:

Below 7000 Å

A. Gatterer and J. Junkes, *Spektren der Seltenen Erden* (Specola Vaticana, Vatican, 1945).  
About 50 wavelengths were measured on our plates, including all lines above 7000 Å.

### Classification:

W. R. Bozman and C. H. Corliss, unpublished (1961).

### Spectrum Assignments:

From 3837 Å to 4661 Å: A. S. King, *Astrophys. J.* **72**, 221 (1930).

The rest of the assignments are from our plates.

### Molecular Spectra:

HoO, A. Gatterer, *Ricerche Spettroscop.* **1**, 139 (1942).

## Relative intensity of holmium lines observed in an arc of copper containing 0.1 atomic percent of holmium

### *Strong lines of holmium*

Intensity	Wavelength Å	Spectrum	Energy levels K	Term combination
1800 c	3456.00	II		
1500 c	3891.02	II		
1000 c	3796.75	I		
1000 c	3810.73	I		
1000	4103.84	I	0-24361	
900 c	3398.98	II		
900	4053.93	I	0-24660	
900	4163.03	I		
700	3484.84	II		
600	3416.46	II		
600 c	3474.26	II		
600 c	4045.44	II		
480	4127.16	I		
460 c	3515.59	II		
360	3453.14	II		
360 cw	3748.17	II		
340 c	3888.96	II		
320	4108.62	I		
300 c	3861.68	II		
300	4040.81	I	0-24740	
280 c	3494.76	II		
280	4173.23	I		
220 c	3425.34	II		
220 c	3428.13	II		
220	4227.04	I		
200 c	3854.07	II		

Holmium — All Observed Lines

Intensity and Character	Wave-length in A	Spectrum	Energy Levels in K	Intensity and Character	Wave-length in A	Spectrum	Energy Levels in K
11	2502.91	II		6	2814.91	II	
5	2508.53	II		4	2819.68	II	
7	2513.55	II		8	2819.80	II	
6	2518.73	II		7	2823.36	II	
11	2533.80	I		6	2823.73	II	
8	2536.86	II		26	2824.20	II	
5	2556.84	I		12	2826.64	II	
5	2567.73	II		5	2830.92	II	
5	2586.52	I		24	c 2831.69	II	
4	2591.05	II		5	2833.79	II	
6	2592.99	I		18	2834.99	II	
12	2605.86	II		10	2835.85	II	
7	2610.51	II		5	2836.70	II	
6	2613.99	II		6	2843.39	II	
4	2625.20	II		10	2844.18	II	
5	2640.09	II		9	2844.68	II	
5	2640.30	II		24	2849.10	II	
4	2649.68	II		4	2852.89	II	
7	2666.24	II		3.5	2860.87	II	
6	2689.03	II		9	2861.23	II	
4	2704.18	II		22	2861.49	II	
4	2709.30	II		13	2862.72	II	
18	2713.65	II		8	2866.79	II	
4	c 2721.77	II		18	2871.99	II	
4	2728.32	II		8	2872.44	II	
20	2733.95	II		6	2873.88	II	
4	2738.79	I		20	2874.06	II	
24	2750.35	II		14	2874.43	II	
4	2757.77	II		32	2880.26	II	
10	c 2759.35	II		40	2880.98	II	
10	2766.85	II		5	2882.04	II	
24	2769.89	II		3.0	2883.47	II	
6	2772.60	II		7	2884.64	II	
10	2772.83	II		6	2891.29	II	
6	2773.84	II		30	2894.99	II	
12	2777.10	II		14	2895.62	II	
5	2778.87	II		15	2900.84	II	
5	2787.20	II		5	2902.19	II	
5	2791.08	II		50	c 2909.41	II	
5	2793.90	II		5	2910.40	II	
12	2794.41	II		6	2914.09	II	
9	2799.99	II		4	2915.12	II	
9	2806.72	II		15	2915.82	II	
6	2807.31	II		26	2919.62	II	
7	2809.09	II		5	2921.85	II	
14	c 2809.99	II		6	2922.60	II	
19	2811.36	II		10	2925.35	II	
16	2812.00	II		14	2926.09	II	
7	2814.44	II		8	2926.99	II	
17	2814.74	II		26	c 2928.30	II	



## Holmium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
5	2936.24	II		11	c	3054.87	II
8	2940.99	I		44	c	3057.45	II
19	2942.05	II		6		3060.24	II
5	2942.59	II		10	c	3062.53	II
26	2944.49	II		7		3063.14	II
3.0	2945.04	II		16		3064.19	II
5	2945.83	II		20		3074.30	II
6	2952.36	II		9		3075.53	II
5	2952.73	II		7	c	3078.41	II
22	c	2953.11	II	44	c	3082.34	II
6	2954.28	II		80		3084.36	II
6	c	2954.94	II	38	c	3086.54	II
3.0	2955.27	II		20		3102.69	II
6	2957.41	II		17		3105.18	II
6	c	2964.40	II	22		3108.31	II
5	2972.43	II		17		3108.65	II
34	2973.00	II		22	c	3109.91	II
5	2975.24	II		7		3111.85	II
36	c	2979.63	II	7		3114.36	II
5	2980.64	II		85		3118.50	II
16	2981.46	II		7		3129.21	II
7	2984.07	II		8		3130.77	II
12	2985.48	II		34	c	3130.99	II
36	2987.64	II		22	c	3134.39	II
22	2990.27	II		34	c	3144.36	II
8	c	2992.71	II	8		3146.13	II
10	2995.86	II		17	c	3148.85	II
8	2998.29	II		13		3149.94	II
6	3000.69	II		7	c	3153.04	II
4	3005.29	II		14		3153.82	I
4	3007.08	II		22		3156.18	II
28	c	3008.10	II	30		3156.97	II
14	3009.48	II		13		3157.35	I
5	3012.07	II		13		3158.40	II
19	3014.60	II		22	c	3159.67	II
10	3016.21	II		7		3160.47	II
4	3017.73	II		7		3164.06	II
6	3018.16	II		13		3165.69	II
14	3023.14	II		65	c	3166.62	II
11	c	3024.38	II	18		3167.89	II
6	c	3026.13	II	44	dl	3171.72	II
10	3028.18	II		9		3172.37	II
11	3033.44	II		90		3173.78	II
15	3035.65	II		44		3174.84	II
24	3038.69	II		30	c	3176.97	II
8	3044.40	II		90	c	3181.50	II
6	3046.44	II		44		3183.84	II
42	c	3049.38	II	30	cw	3184.48	II
14	3050.73	II		22		3186.37	I
36	c	3054.00	II	16		3187.39	II

## Holmium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
18	3191.02	II		13	c	3329.02	II
8	3195.09	II		22		3331.93	II
16	c	3196.07	II	18		3333.16	II
7		3196.52	II	70	c	3337.23	II
44	c	3197.83	II	44	c	3338.86	II
12		3201.00	I	18		3340.44	II
44		3201.76	II	9		3342.70	II
18		3204.28	II	110	c	3343.58	II
11		3206.17	I	22		3344.47	II
22		3206.86	II	7		3344.79	II
30	c	3210.41	II	12		3348.61	II
13		3211.85	II	40		3350.49	II
9		3213.28	II	36		3352.10	II
16		3215.36	II	36	cw	3353.55	II
22	c	3221.42	II	36		3354.58	II
9		3224.27	II	9		3356.98	II
7		3230.04	II	36		3357.91	II
9	c	3231.67	II	16		3360.87	II
36		3233.34	II	13		3363.41	II
9		3233.87	II	36		3364.27	II
22		3236.90	II	9	c	3368.36	II
22		3237.40	II	11		3369.89	II
7		3240.42	II	32		3370.87	II
9		3243.00	II	11		3372.43	II
9		3247.22	II	26		3374.16	II
9		3256.28	II	8		3374.36	II
22	c	3257.45	II	9		3380.49	II
13	c	3258.45	II	9		3386.41	I
9		3262.20	II	18	c	3389.56	II
8		3263.66	II	32	c	3390.75	II
9		3266.34	II	18	c	3392.05	II
10		3267.36	II	9		3392.47	II
9		3277.16	II	36	c	3394.60	II
44	c	3278.15	II	12		3397.33	II
30		3279.25	II	900	c	3398.98	II
13		3281.18	II	12		3400.60	II
110	c	3281.97	II	22		3401.59	II
16		3283.08	II	14		3402.18	II
44		3288.46	II	13		3406.27	II
30	c	3290.96	II	22		3408.21	II
13	c	3297.06	II	22	c	3409.06	II
10		3298.12	II	90	c	3410.26	II
14		3301.34	I	44	c	3410.65	II
22	c	3305.16	II	32		3411.55	II
14		3312.39	II	17		3412.87	II
16		3315.66	II	22	c	3414.25	II
22		3319.87	II	160	c	3414.90	II
26		3320.25	II	600		3416.46	II
9		3321.11	II	9	c	3418.19	II
12		3323.74	II	13		3418.47	I

## Holmium — All Observed Lines

Intensity and Character	Wave-length in A	Spectrum	Energy Levels in K	Intensity and Character	Wave-length in A	Spectrum	Energy Levels in K
130	3421.63	II		460	c	3515.59	II
32	3424.11	I		46	c	3519.94	II
220	c	3425.34	II	24	c	3520.16	II
26	3426.76	II		17		3532.76	I
220	c	3428.13	II	24		3538.89	II
70	c	3429.18	II	14	c	3539.35	
36	c	3432.10	II	70		3540.76	II
16		3434.76	II	22		3541.41	I
16		3435.61	II	180		3546.05	II
18		3436.31	II	18		3548.53	
32		3437.04	I	9	c	3550.60	
14	c	3437.91	II	120	c	3556.78	II
7	c	3438.35	II	9	c	3558.15	
18		3445.66		8		3559.03	
14	c	3449.01	II	46		3560.15	II
44		3449.35	I	18	c	3563.45	
16		3451.23	I	12		3567.32	
360		3453.14	II	18		3568.79	
12	c	3453.85	II	32		3570.44	
90	c	3455.70	II	46	c	3573.24	II
1800	c	3456.00	II	4		3574.20	
16		3461.36	II	70	c	3574.80	II
180		3461.97	II	90		3579.12	I
40	c	3467.07	II	46		3580.75	II
9		3468.13	I	46		3581.83	II
16		3469.40	II	9	c	3582.80	
14	c	3470.76	II	28	cw	3589.77	
26	c	3472.31	II	17		3591.23	II
90	c	3473.91	II	70	c	3592.23	II
600	c	3474.26	II	19	c	3593.07	II
22		3477.75	II	120	cw	3598.77	II
22	c	3478.06	II	38		3599.48	I
9		3483.89	II	60	c	3600.95	II
700		3484.84	II	14	c	3602.65	II
22	c	3485.87	II	14		3605.77	I
18	c	3486.34	II	38		3613.31	II
55		3489.58	II	12	c	3616.93	II
32	c	3490.95	II	8		3618.08	II
7		3492.11	I	46		3618.43	I
65	c	3493.09	II	22		3619.41	II
9		3493.60	I	22		3623.59	I
280	c	3494.76	II	19	c	3625.46	II
9		3497.65	II	48	c	3626.69	II
90	c	3498.88	II	55		3627.25	II
8		3505.43	II	22		3630.91	I
46	c	3506.95	II	48	c	3631.76	II
36		3509.37	II	12		3632.95	II
14		3507.99	I	14	c	3634.67	II
90		3510.73	I	9	c	3635.35	II
18		3511.76	II	48	c	3638.30	II

Holmium — All Observed Lines

Intensity and Character	Wave-length in A	Spectrum	Energy Levels in K	Intensity and Character	Wave-length in A	Spectrum	Energy Levels in K
14	c	3640.17	II	24		I	
24		3641.25	I	20			
9	c	3642.36	II	90		I	
10	c	3649.60	II	20		II	
24		3654.45	II	22		I	
22	c	3658.48	I	360	cw	3748.17	II
180	c	3662.29	I	12	c	3748.78	II
48		3662.99	I	10		3750.19	II
80		3666.65	I	11	c	3752.07	II
14		3667.05	II	15	c	3753.01	II
160		3667.97	I	36	c	3753.73	II
36		3669.05	II	18		3754.45	I
50		3669.52	I	30	c	3757.26	II
10		3670.28	II	10		3760.48	I
8		3672.69	I	38		3769.09	I
16	c	3674.36	II	28		3772.40	I
50	c	3674.77	II	12		3773.83	I
20	cw	3677.64	II	24		3774.58	I
24		3678.59	II	20		3774.90	I
80		3679.19	I	15		3775.37	I
75		3679.70	I	28		3776.15	I
18	c	3680.00	II	15	hc	3778.00	I
80		3682.65	I	32		3780.37	II
48		3685.16	II	12	c	3780.99	II
16	c	3686.65	II	12		3782.65	II
65		3690.65	I	20		3785.23	II
26	c	3691.32	II	36		3788.08	II
38		3691.95	I	12		3788.44	II
15		3694.66		30		3791.00	II
12		3695.69	I	24		3791.55	
46		3700.04	I	12		3791.97	
14		3701.27	I	32		3792.95	
15		3701.78	II	20		3794.69	I
55	c	3702.35	II	1000	c	3796.75	I
9		3704.54	II	22		3797.26	I
11		3706.90	II	24		3798.25	II
28		3709.27		32	c	3801.28	II
36		3709.76	I	28		3804.15	
18	c	3710.74	II	12		3807.90	
18		3711.31	II	15		3809.49	II
48		3712.88	I	12	c	3809.93	II
30		3718.62	I	1000	c	3810.73	I
50		3720.72		55		3811.86	I
20	c	3721.32	II	100	c	3813.25	II
18	c	3721.80	II	20		3818.69	II
30		3724.45		34		3821.73	II
8		3725.05	I	24		3825.64	
20	c	3725.98	II	44		3829.27	I
120		3731.40	I	36	cw	3831.9	II
40		3732.09	I	46	c	3835.35	II

## Holmium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
140	cw			13			
24				26	c		
46	c			55			
120				13			
55	c			13			
34				11			
26	h			10			
36		II		12			
200	c			24			
44	cw			44	c		
80				19			
28				15			
300	c			24	cw		
60		I		18			
12				24			
40				9			
36	c	II		15			
70		II		42			
28				9	c		
60				18	cw		
340	c	II		24			
55		I		12			
1500	c	II		36			
32	c	II		18	c		
11		II		18	c		
60		II		18	c		
30	c	II		12			
14		II		36			
14		I		30			
32		II		20	c		
36		I		24			
140	cw	II		24	c		
11		I		300			
13		I		600	c		
36		I		24	c		
12		II		900			
36		I		60			
11	c	II		30			
11		II		24			
11		II		190			
14	ch	II		19			
36	c	II		80			
24		I		30			
36	cw	II		30			
20		I		32			
11		I		13	c		
24		I		26			
10		I		16			
10	c	II		19			
65		I		22			

## Holmium — All Observed Lines

Intensity and Character	Wave-length in A	Spectrum	Energy Levels in K	Intensity and Character	Wave-length in A	Spectrum	Energy Levels in K
16	4091.64	I		10	4315.03	II	
13	4094.78	I		28	4330.64	II	
26	4100.22	I		9	c 4332.55	II	
10	4101.09	I		34	4337.13	II	
1000	4103.84	I		11	cw 4346.84	II	
13	4105.04			140	4350.73	I	
30	4106.50	I		32	4356.73	II	
11	4107.36	I		16	4363.93	II	
320	4108.62	I		8	4371.43	II	
34	4112.00	I		8	4373.33	I	
11	4112.72	I		9	4376.58	II	
30	4116.73	I		19	4379.14	II	
10	4118.94	I		10	4379.83	II	
170	4120.20	I		20	c 4384.83	II	
140	4125.65	I		8	c 4388.69	II	
480	4127.16	I		8	h 4394.98	I	
34	4134.54	I		17	4400.55	II	
10	4135.08	I		13	4401.24	II	
170	4136.22	I		20	4403.27	I	
14	4139.34	I		22	4420.56	II	
26	4142.19	I		6	4426.20	II	
32	4148.97	I		9	4429.81	II	
110	cw 4152.61	II		8	4434.96	I	
900	4163.03	I		14	4444.63	I	
18	4172.23	I		8	4445.07	II	
280	4173.23	I		9	4447.23	II	
60	4194.35	I		7	4463.40	II	
11	4198.08	I		8	4467.28	I	
14	4203.21	I		8	4470.23	I	
7	4203.39	II		11	4473.59	II	
11	4211.30	II		34	4477.64	II	
10	4219.10	I		13	4484.57	II	
32	4222.29	I		16	4510.82	I	
32	4223.47	I		10	4512.55	II	
220	4227.04	I		11	c 4526.14	II	
44	4229.52	II		19	4530.08	II	
14	h 4231.24	I		19	c 4531.28	I	
32	4243.78	I		15	c 4531.65		
10	4245.40	II		19	4534.58	I	
140	cw 4254.43	I		7	4543.80	I	
14	c 4258.61	II		10	4548.94	II	
55	4264.05	I		5	4558.41	II	
34	4266.04	I		22	4562.52	I	
11	4273.63	II		7	c 4567.82	II	
9	4284.58	II		6	4572.42	II	
10	4290.18	II		10	c 4578.07	I	
10	c 4298.47	II		8	4589.70		
10	4299.15	I		10	c 4608.00	I	
10	4301.09	II		5	4608.67	II	
22	4311.04	I					

Holmium — All Observed Lines

Intensity and Character	Wave-length in A	Spectrum	Energy Levels in K	Intensity and Character	Wave-length in A	Spectrum	Energy Levels in K
13	cw			6	c		
		II		32		I	
		II				I	
15		I		3.0	c	I	
5		II		5		II	
11		I		7	c	II	
11	c	I		4		II	
32		II		6	cw	II	
6	h	I		28	c	II	
5	c	II		24		I	
		II		4	c	I	
8		II		10		I	
22	c	II		4	c	I	
5				6		II	
4		II		7		I	
15	c	II		3.5		I	
16	c			6			
6		I		7	c	I	
6		II		14		I	
5		II		4		I	
8		II		3.5		II	
9		II		3.5		II	
14		II		4	c	I	
7		I		7		I	
15	c	I		9		I	
4	c	II		16		I	
4		II		6		II	
32		II		15			
4	c	II		12			
4		I		18			
11	c	I		10	c	I	
4		II		14	c	I	
4		II		6		I	
6		II		10			
3.5		I		2.0		I	
8	c	I		5			
7		I		4	c	I	
6	c	I		7		I	
4		II		6		I	
4		II		10		I	
5	h	I		4		I	
3.0		II		4		I	
6		II		9		I	
3.5		I		10			
3.5		II		6		I	
5		I		3.5		I	
3.0	c	II		3.5		I	
3.5		I		2.0	h	I	
4		II		8		I	
6		II		11		I	
5		I		1.6		II	

## Holmium — All Observed Lines

Intensity and Character	Wave-length in A	Spectrum	Energy Levels in K	Intensity and Character	Wave-length in A	Spectrum	Energy Levels in K
1.8	5434.39	II		8	5921.76	I	
2.0	5435.87	I		3.5	c 5933.71	I	
3.5	5445.39	I		8	cw 5948.03	I	
2.0	5449.8	II		5	5955.98	I	
3.5	h 5451.9	I		8	5972.76	I	
1.6	5454.0			10	5973.52	I	
3.5	c 5498.57	I		2.5	5981.43	I	
3.5	5504.51	I		26	c 5982.90	I	
3.0	5515.56	II		6	6002.04	I	
2.0	5516.45	II		3.0	6005.33	I	
3.5	5534.33	I		4	6021.43	I	
3.0	5553.14	I		1.8	6038.97	I	
4	c 5560.94	I		3.0	6050.71	I	
4	b 5563.6	HoO		5	6060.31	I	
8	5566.52	I		13	6081.79	I	
2.0	5573.96	II		8	cw 6133.60	I	
4	bl 5584.7	HoO		4	6156.38	I	
6	b 5591.1	HoO		3.0	6156.58	I	
6	bl 5592.3	HoO		6	6191.68	I	
3.5	b 5607.1	HoO		8	6208.65	I	
3.0	5613.64	I		2.0	6234.17	I	
5	b 5626.4	HoO		5	c 6255.75	I	
7	5627.60	I		8	c 6305.36	I	
3.5	5628.24	II		2.5	6306.68		
6	5640.62			3.5	6321.94		
8	bs 5655.9	HoO		3.5	c 6354.35	I	
7	b 5658.9	HoO		3.5	c 6372.59	I	
16	5659.58	I		1.6	h 6373.86	I	
8	c 5671.84			2.5	h 6413.41	I	
7	5674.70	I		3.0	c 6471.77	I	
16	c 5691.47	I		1.4	6479.17	I	
8	bs 5696.3	HoO		1.2	6515.30	I	
16	c 5696.57	I		1.2	h 6538.99	I	
3.0	5734.02	I		8	6550.97	I	
5	5736.4	HoO		1.6	6560.08	I	
6	5739.24	I		3.5	d 6600.58	I	
2.5	5749.58	I		28	6604.94	I	
3.5	5766.64			6	6607.47	I	
3.0	b 5803.8	HoO		1.4	6628.35	I	
5	b 5819.2	HoO		13	6628.99	I	
3.0	h 5821.90	I		1.6	6632.24	I	
2.5	5839.47	I		1.0	h 6652.98	I	
5	b 5849.4	HoO		1.6	6662.52	I	
16	c 5860.28	I		2.0	c 6680.46	I	
3.0	h 5864.42	I		2.5	c 6681.62	I	
5	5870.85	I		1.6	h 6682.02		
3.0	b 5879.6	HoO		6	cw 6694.32	I	
8	c 5882.99	I		1.6	cw 6722.34	I	
4	c 5892.56	I		4	6745.05	I	
2.5	5904.29	I		1.4	6766.74	I	



Holmium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
3.0 c	6774.68	I		1.8	7589.20	I	
6 c	6785.43	I		2.5	7591.87	I	
1.4	6793.7	I		0.9 h	7593.64	I	
1.4 cw	6811.04	I		0.7 h	7594.35	I	
1.6 cw	6820.38	I		1.2	7602.31	II	
2.5	6821.64	I		1.6	7605.35	I	
1.8 c	6825.72	I		1.2	7617.05	I	
0.8 h	6826.62			1.4	7627.98	I	
0.8 h	6852.97			4 c	7628.42	I	
1.8 cw	6865.85	I		0.9 c	7641.14	I	
1.0	6883.36	I		0.4	7648.16	I	
1.4	6888.50	I		1.4 c	7653.80	I	
1.6 c	6892.96	I		1.2 c	7667.30	I	
1.8	6897.95	I		2.0	7690.43	I	
1.6 h	6903.80	I		5 c	7693.15	I	
1.6 cw	6913.47	I		4 cw	7715.06	I	
1.0	6916.70	I		1.6	7719.05	I	
4 cw	6939.49	I		1.6 h	7738.98	I	
5 cw	6950.39	I		0.8 c	7752.01	I	
1.4 hl	6955.3	I		6 cw	7815.48	I	
2.0	6976.7	II		4 cw	7823.63	I	
1.0	6985.11			0.8 h	7879.22	I	
0.9	6994.38			6	7894.64	I	
1.4 h	7000.71			1.0 h	8464.66	I	
1.0	7079.07			1.0 h	8482.67	I	
1.2	7098.58			5	8512.94		
0.9	7242.08	I		2.0	8545.61	II	
0.9	7250.60	I		1.8	8601.84	II	
1.4	7308.55			4	8670.19		
2.5	7341.43			0.8 h	8697.32		
1.8	7389.40			1.6 h	8805.48	II	
0.5 h	7496.20			2.0 c	8834.49	I	
1.0 h	7510.74	I		9	8915.98	II	
14	7555.09	I					

# INDIUM

In,  $Z=49$ ,  $M=114.82$ , Ratio  $\frac{\text{In}}{\text{Cu}}=1.807$

In I Normal state of valence electrons  $5s^2 5p^1 \ ^2P_{0\frac{1}{2}}^{\circ}=0$ . I.P.= 46670 K  
 In II Normal state of valence electrons  $5s^2 \ ^1S_0=0$ . I.P.=152195 K

## References

### Wavelengths and Classification:

In I, F. Paschen, Ann. der Physik **32**, 148 (1938).  
 In II, F. Paschen and J. S. Campbell, Ann. der Physik **31**, 29 (1938).

### Intensities:

Y. I. Ostrovskii and N. P. Penkin, Optika i Spektroskopiya **4**, 719 (1958).  
 S. Ch'en and A. Smith, Physica **25**, 1289 (1959).

## Relative intensity of indium lines observed in an arc of copper containing 0.1 atomic percent of indium

### *Strong lines of indium*

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
1800	4511.31	I	2213-24373	$5s^2 5p^1 \ ^2P_{1\frac{1}{2}}^{\circ} - 5s^2 6s^1 \ ^2S_{0\frac{1}{2}}$
1700	4101.76	I	0-24373	$5s^2 5p^1 \ ^2P_{0\frac{1}{2}}^{\circ} - 5s^2 6s^1 \ ^2S_{0\frac{1}{2}}$
1300	3256.09	I	2213-32916	$5s^2 5p^1 \ ^2P_{1\frac{1}{2}}^{\circ} - 5s^2 5d^1 \ ^2D_{2\frac{1}{2}}$
800	3039.36	I	0-32892	$5s^2 5p^1 \ ^2P_{0\frac{1}{2}}^{\circ} - 5s^2 5d^1 \ ^2D_{1\frac{1}{2}}$

## Indium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
3.5	2306.06	II	0-43349	18	c	I	2213-37452
2.0	2389.54	I	0-41836	3.0	c	I	0-34978
6	2460.08	I	0-40637	110		I	2213-36302
3.0	2468.02	I	2213-42718	2.0	c	I	2213-36020
10	2521.37	I	2213-41862	800		I	0-32892
110	2560.15	I	0-39048	1300		I	2213-32916
20	2601.76	I	2213-40637	300		I	2213-32892
160	2710.26	I	2213-39098	1700		I	0-24373
30	2713.94	I	2213-39048	1800		I	2213-24373
70	2753.88	I	0-36302	0.8	h	I	24373-38972
4	2775.37	I	0-36020	0.4	h	I	24373-38861

# IRIDIUM

$$\text{Ir, } Z=77, M=192.2, \text{ Ratio } \frac{\text{Ir}}{\text{Cu}}=3.025$$

Ir I Normal state of valence electrons  $5d^76s^2\ ^4F_{4\frac{1}{2}}=0$ . I.P.=75000 K

## References

Wavelengths:

G. R. Harrison, Massachusetts Institute of Technology Wavelength Tables (John Wiley & Sons, New York, 1939).

Classification:

Ir I, W. Albertson, Phys. Rev. **54**, 183 (1938); T. A. M. van Kleef, Physica **23**, 843 (1957).

Ir II, (spectrum assignment only) T. A. M. van Kleef, unpublished material (1959).

## Relative intensity of iridium lines observed in an arc of copper containing 0.1 atomic percent of iridium

### *Strong lines of iridium*

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
500	3220. 78	I	2835-33874	$5d^86s^1\ b\ ^4F_{4\frac{1}{2}}-5d^76s^16p^1\ z\ ^6F_{3\frac{1}{2}}$
380	2543. 97	I	2835-42132	$5d^86s^1\ b\ ^4F_{4\frac{1}{2}}-5d^8\ 6p^1\ ^4G_{5\frac{1}{2}}$
340	3133. 32	I	6324-38230	$5d^76s^2\ a\ ^4F_{3\frac{1}{2}}-5d^76s^16p^1\ ^4F_{4\frac{1}{2}}$
320	2924. 79	I	0-34180	$5d^76s^2\ a\ ^4F_{4\frac{1}{2}}-5d^76s^16p^1\ z\ ^6G_{5\frac{1}{2}}$
320	3513. 64	I	0-28452	$5d^76s^2\ a\ ^4F_{4\frac{1}{2}}-5d^76s^16p^1\ z\ ^6F_{5\frac{1}{2}}$
320	3800. 12	I	0-26308	$5d^76s^2\ a\ ^4F_{4\frac{1}{2}}-5d^76s^16p^1\ z\ ^6D_{4\frac{1}{2}}$
280	2849. 72	I	0-35081	$5d^76s^2\ a\ ^4F_{4\frac{1}{2}}-5d^76s^16p^1\ z\ ^6G_{4\frac{1}{2}}$
220	2694. 23	I	2835-39940	$5d^86s^1\ b\ ^4F_{4\frac{1}{2}}-5d^66s^26p^1\ ^6F_{5\frac{1}{2}}$
200	2502. 98	I	0-39940	$5d^76s^2\ a\ ^4F_{4\frac{1}{2}}-5d^66s^26p^1\ ^6F_{5\frac{1}{2}}$
200	2664. 79	I	0-37515	$5d^76s^2\ a\ ^4F_{4\frac{1}{2}}-5d^76s^16p^1\ z\ ^4D_{3\frac{1}{2}}$
200	2943. 15	I	6324-40291	$5d^76s^1\ a\ ^4F_{3\frac{1}{2}}-5d^76s^16p^1\ ^4F_{3\frac{1}{2}}$
170	2639. 71	I	0-37872	$5d^76s^2\ a\ ^4F_{4\frac{1}{2}}-5d^76s^16p^1\ z\ ^4F_{4\frac{1}{2}}$
160	2475. 12	I	0-40390	$5d^76s^2\ a\ ^4F_{4\frac{1}{2}}-5d^66s^26p^1\ ^6F_{4\frac{1}{2}}$
160	3068. 89	I	2835-35411	$5d^86s^1\ b\ ^4F_{4\frac{1}{2}}-5d^76s^16p^1\ z\ ^6G_{3\frac{1}{2}}$
130	2661. 98	I	2835-40390	$5d^86s^1\ b\ ^4F_{4\frac{1}{2}}-5d^66s^26p^1\ ^6F_{4\frac{1}{2}}$
120	2797. 70	I	2835-38568	$5d^86s^1\ b\ ^4F_{4\frac{1}{2}}-5d^76s^16p^1\ ^4D_{3\frac{1}{2}}$
120	3573. 72	I	7107-35081	$5d^86s^1\ b\ ^4F_{3\frac{1}{2}}-5d^76s^16p^1\ z\ ^6G_{4\frac{1}{2}}$
100	2481. 18	I	0-40291	$5d^76s^2\ a\ ^4F_{4\frac{1}{2}}-5d^76s^16p^1\ ^4F_{3\frac{1}{2}}$

## Iridium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
3.5	2010.65	I	0-49719	26	2304.22	I	2835-46220
3.5	2022.35	I	2835-52266	4	2305.47	I	5785-49146
7	2033.57	I	0-49159	2.0	2307.27	I	7107-50434
3.5	2052.22	I	6324-55036	9	2308.93	I	6324-49621
3.0	2060.64	I	7107-55619	5	2315.38	I	0-43176
3.0	2083.22	I	5785-53772	5	2321.45	I	7107-50170
2.5	2085.74	I	7107-55036	5	2321.58	I	2835-45896
13	2088.82	I	0-47858	2.5	2327.98	I	12218-55161
13	2092.63	I	2835-50606	7	2333.30	I	5785-48629
3.0	2112.68	I	6324-53642	10	2333.84	I	6324-49159
2.0	2119.54	I	0-47165	8	2334.50	I	6324-49146
2.5	2125.44	I	7107-54141	24	2343.18	I	5785-48449
6	2126.81	II		11	2343.61	I	5785-48441
2.5	2127.52	I	2835-49824	1.8	2352.62	I	12218-54711
6	2127.94	I	0-46979	10	2355.00	I	9878-52327
6	2148.22	I	7107-53642	4	2357.53	II	
4	2150.54	I	4079-50564	7	2358.16	I	4079-46472
6	2152.68	II		9	2360.73	I	9878-52224
5	2155.81	I	0-46372	48	2363.04	I	6324-48629
15	2158.05	I	2835-49159	7	2368.04	II	
4	2162.88	I	0-46220	70	2372.77	I	0-42132
12	2169.42	II		6	2375.09	II	
10	2175.24	I	0-45957	5	2377.28	I	7107-49159
6	2178.17	I	0-45896	5	2377.98	I	7107-49146
4	2187.43	II		11	2379.38	I	4079-46094
3.0	2190.38	II		12	2381.62	I	6324-48299
2.0	2191.64	I	2835-48449	5	2383.17	I	13088-55036
3.0	2208.09	II		2.0	2383.79	I	9878-51815
5	2220.37	I	2835-47858	3.0	2386.58	II	
3	2221.07	II		30	2386.89	I	6324-48207
12	2242.68	II		60	2390.62	I	2835-44652
3	2245.76	II		70	2391.18	I	2835-44643
11	2253.38	I	7107-51471	2.5	2401.77	I	13088-54711
	2253.49	I	4079-48441	7	2407.59	I	7107-48629
11	2255.10	I	2835-47165	9	2409.37	I	4079-45571
8	2255.81	I	5785-50101	9	2410.17	I	13088-54566
2.0	2258.51	I	9878-54141	9	2410.73	I	12218-53687
8	2258.86	I	6324-50580	17	2413.31	I	4079-45503
5	2264.61	I	2835-46979	12	2415.86	I	5785-47165
7	2266.33	I	6324-50434	22	2418.11	I	7107-48449
7	2268.90	I	10579-54639	5	2424.32	I	10579-51815
5	2280.00	I	6324-50170	5	2424.66	I	9878-51108
7	2281.02	II		8	2424.89	I	5785-47011
5	2281.91	I	9878-53687	14	2424.99	I	6324-47549
2.5	2284.60	I	13940-57698	11	2425.66	I	6324-47537
3.0	2295.08	I	5785-49342	6	2426.53	II	
7	2298.05	I	11831-55333	2.0	2426.78	I	5785-46979
	2298.16	I	6324-49824	20	2427.61	I	4079-45259
4	2299.53	I	7107-50580	22	2431.24	I	0-41119
8	2300.50	I	6324-49779	55	2431.94	I	4079-45186

Iridium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
7	2432.36	I	7107-48207	28	2537.22	I	5785-45186
4	2432.58	I	13940-55036	8	2537.68	I	16103-55497
11	2435.14	I	13088-54141	2.0	2538.88	I	12952-52327
3.5	2436.42	I	13088-54119	2.0	2540.40	I	12952-52304
11	2445.34	I	6324-47206	5	2541.48	I	11831-51166
2.0	2447.49	I	17779-58625	28	2542.02	I	5785-45112
11	2447.76	I	6324-47165	2.0	2542.80	II	
9	2448.23	I	5785-46618	380	2543.97	I	2835-42132
2.0	2449.02	I	12952-53772	7	2545.54	I	12952-52224
44	2452.81	I	2835-43592	38	2546.03	I	7107-46372
4	2454.12	I	12952-53687	6	2547.20	I	6324-45571
65	2455.61	I	0-40711	6	2547.69	I	13088-52327
11	2455.87	I	4079-44785	10	2551.40	I	12952-52134
10	2457.03	I	5785-46472	9	2554.40	I	13088-52224
10	2457.23	I	13088-53772	10	2555.35	I	4079-43202
4	2462.36	I	13088-53687	8	2555.88	I	7107-46220
4	2463.03	I	12218-52807	7	2563.28	I	5785-44785
4	2464.90	I	11831-52388	44	2564.18	I	7107-46094
6	2465.09	I	13088-53642	10	2569.88	I	12952-51852
42	2467.30	I	4079-44597	5	2570.62	I	12218-51108
160	2475.12	I	0-40390	3.5	2572.07	I	10579-49446
10	2478.11	I	2835-43176	3.5	2572.37	I	12952-51815
2.0	2479.16	I	13940-54264	11	2572.70	I	5785-44643
100	2481.18	I	0-40291	36	2577.26	I	7107-45896
5	2485.38	I	9878-50101	5	2578.71	I	16565-55333
2.0	2486.37	I	18547-58754	3.5	2578.91	I	13088-51852
2.0	2486.75	I	13940-54141	1.8	2579.49	II	
2.0	2489.20	I	16103-56265	1.8	2583.18	I	18547-57248
30	2493.08	I	7107-47206	36	2592.06	I	0-38568
10	2496.27	I	6324-46372	36	2599.04	I	7107-45571
4	2500.27	I	11831-51815	7	2602.04	I	16565-54985
12	2502.63	I	9878-49824	9	2604.55	I	13088-51471
200	2502.98	I	0-39940	9	2607.52	I	13088-51427
8	2504.37	I	17779-57697	34	2608.25	I	6324-44652
6	2505.74	I	6324-46220	85	2611.30	I	2835-41119
4	2506.60	I	12506-52388	3.5	2612.04	I	6324-44597
6	2507.63	I	10579-50445	10	2614.98	I	0-38230
4	2508.35	I	12952-52807	3.5	2615.88	I	16103-54320
8	2509.71	I	12218-52052		2616.00	I	12952-51166
8	2511.94	I	12506-52304	16	2617.78	I	4079-42268
8	2512.58	II		10	2619.88	I	0-38158
10	2513.71	I	6324-46094	3.5	2623.64	II	
6	2515.36	I	9878-49621	12	2625.32	I	7107-45186
2.0	2524.88	II		2.0	2625.67	I	16565-54639
8	2525.05	I	10579-50170	5	2626.76	I	12506-50564
2.0	2526.77	I	19061-58625	2.5	2628.20	I	16103-54141
2.5	2532.20	I	18547-58027	2.0	2629.41	I	13088-51108
6	2532.52	I	5785-45259	34	2634.17	I	12218-50170
48	2533.13	I	9878-49342	8	2635.27	I	4079-42014
55	2534.46	I	2835-42279	1.6	2638.97	I	12218-50101

## Iridium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
12	2639.42	I	2835-40711	6	d 2777.43	I	11831-47825
170	2639.71	I	0-37872		2777.53	I	17779-53772
2.5	2640.38	I	10579-48441	38	2781.29	I	6324-42268
10	2644.19	I	5785-43592	24	2785.22	I	10579-46472
8	2653.76	I	9878-47549	6	2796.46	I	16103-51852
3.5	2653.95	I	16103-53772	40	2797.35	I	5785-41522
5	2656.81	I	10579-48207	120	2797.70	I	2835-38568
1.6	2657.71	I	11831-49446	28	2798.18	I	4079-39806
130	2661.98	I	2835-40390	3.0	2799.74	I	16681-52388
26	2662.63	I	7107-44652	30	2800.82	I	9878-45571
6	2663.31	I	7107-44643	3.0	2812.80	I	13088-48629
200	2664.79	I	0-37515	50	2823.18	I	0-35411
10	2668.99	I	2835-40291	90	2824.45	I	2835-38230
4	2669.46	I	16103-53553	5	2830.17	I	2835-38158
38	2669.91	I	4079-41522	4	2830.51	I	12218-47538
38	2671.84	I	5785-43201	3.0	2831.36	I	9878-45186
24	2673.61	I	5785-43176	8	2833.24	II	
9	2676.83	I	13088-50434	8	2835.66	I	12952-48206
7	2679.06	I	11831-49146	60	2836.40	I	4079-39324
4	2681.10	I	5785-43072	12	2837.33	I	9878-45112
2.0	2682.46	I	6324-43592	80	2839.16	I	13088-48299
8	2684.04	I	10579-47825		2839.24	I	4079-39289
4	2691.06	I	12952-50101	60	2840.22	I	6324-41522
20	2692.34	I	4079-41210	12	2842.28	I	7107-42279
2.0	2692.88	I	12218-49342	280	2849.72	I	0-35081
2.0	2693.49	I	17779-54895	3.0	d 2855.82	I	18547-53553
220	2694.23	I	2835-39940		2855.93	I	16103-51108
8	2704.03	I	2835-39806	3.0	2860.66	I	12218-47165
3.0	2704.93	I	10579-47537	8	2863.84	I	9878-44786
2.0	2706.88	I	17779-54711	4	2866.69	I	12952-47825
12	2712.74	I	6324-43176	2.5	2867.63	I	16565-51427
5	2720.45	I	6324-43072	6	2869.70	I	10579-45415
2.5	2723.76	I	16103-52807	28	2875.60	I	9878-44643
3.0	2729.56	I	10579-47204	28	2875.98	I	12218-46979
4	2730.71	I	11831-48441	20	2877.68	I	5785-40525
5	2732.67	I	12218-48802	10	2879.41	I	9878-44597
2.5	2739.32	I	13940-50434	4	2881.16	I	12506-47204
2.5	2740.00	I	7107-43592	60	2882.64	I	2835-37515
2.5	2740.18	I	5785-42268	48	2897.15	I	5785-40291
10	2744.00	I	10579-47011	6	2899.63	I	16103-50580
2.0	2747.51	I	19593-55979	2.5	2900.39	I	19593-54061
2.0	2749.32	I	17779-54141	19	2901.95	I	13088-47538
6	2758.23	I	5785-42029	19	2904.80	I	7107-41522
5	2759.32	I	12218-48449	3.0	2905.64	I	4079-38485
4	2759.91	I	12218-48441	15	2907.24	I	6324-40711
2.0	2767.65	I	16103-52224	5	2909.56	I	13940-48299
6	2771.61	I	7107-43176	32	2916.36	I	4079-38358
24	2772.46	I	13088-49146	17	2918.57	I	12218-46472
2.0	2774.58	I	16103-52134	320	2924.79	I	0-34180
18	2775.55	I	9878-45896	6	2930.63	I	12506-46618

Iridium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
90	2934.64	I	6324-40390	32	3083.22	I	12218-44643
65	2936.68	I	4079-38121	24	3086.44	I	9878-42268
18	2938.47	I	5785-39806	38	3088.04	I	5785-38158
14	2939.27	I	7107-41119	7	3094.01	I	4079-36390
10	2940.54	I	16103-50101	50	3100.29	I	2835-35081
3.0	2941.08	I	10579-44570	50	3100.45	I	6324-38568
200	2943.15	I	6324-40291	6	3114.05	I	16103-48206
17	2946.97	I	13088-47011	9	3114.55	I	13088-45186
15	2949.76	I	13088-46979	34	3120.76	I	6324-38358
85	2951.22	I	0-33874	20	3121.78	I	13088-45112
11	2962.99	I	11831-45571	9	3122.38	I	13940-45957
3.5	2965.20	I	9878-43592	7	3128.39	I	13940-45896
2.5	2968.49	I	12218-45896	7	3133.09	I	5785-37693
2.0	2974.10	I	4079-37693	340	3133.32	I	6324-38230
15	2974.95	I	16565-50170	7	3140.41	I	12952-44786
32	2980.65	I	5785-39324	7	3145.07	I	28452-60239
11	2985.80	I	6324-39806	19	3150.61	I	5785-37515
14	2990.62	I	11831-45259	7	3154.55	I	12952-44643
22	2996.08	I	4079-37446	19	3154.74	I	10579-42268
5	2997.19	I	11831-45186	19	3159.15	I	12952-44597
13	2997.41	I	12218-45571	14	3168.18	I	13088-44643
16	3002.25	I	9878-43176	48	3168.88	I	6324-37872
44	3003.63	I	7107-40390	36	3177.58	I	7107-38568
6	3005.21	I	13940-47206	17	3180.35	I	16103-47538
3.0	3009.90	I	16565-49779	36	3198.92	I	7107-38358
12	3011.69	I	9878-43072	60	3212.12	I	7107-38230
9	3016.43	I	12952-46094	7	3213.55	I	19061-50170
20	3017.31	I	13088-46221	7	3218.46	I	16103-47165
10	3019.23	I	26307-59419	36	3219.51	I	7107-38158
6	3020.01	I	26307-59410	500	3220.78	I	2835-33874
6	3022.41	I	26307-59384	10	3221.28	I	28452-59487
8	3025.82	I	13940-46979	30	3229.28	I	12218-43176
28	3029.36	I	6324-39324	10	3230.76	I	10579-41522
5	3032.41	I	12218-45186	6	3232.00	I	28452-59384
3.0	3033.62	I	11831-44786	46	3241.52	I	4079-34920
7	3037.75	I	12506-45415	8	3254.40	I	19061-49779
24	3039.26	I	12218-45112	20	3262.01	I	9878-40525
4	3040.47	I	18547-51427	38	3266.44	I	5785-36390
2.5	3042.65	II		16	3277.28	I	13088-43592
22	3047.16	I	13088-45896	6	3287.06	I	9878-40291
22	3049.44	I	5785-38568	10	3287.59	I	7107-37515
3.0	3052.16	I	19061-51815	16	3310.52	I	11831-42029
6	3053.60	I	11831-44570	8	3312.13	I	11831-42014
22	3057.28	I	7107-39806	20	3322.60	I	13088-43176
5	3061.41	I	17779-50434	8	3322.87	I	19060-49147
4	3064.51	I	10579-43201	13	3334.16	I	13088-43072
160	3068.89	I	2835-35411	6	3338.37	I	10579-40525
19	3069.09	I	5785-38358	55	3368.48	I	2835-32513
19	3069.71	I	12218-44785	6	3419.42	I	13940-43176
17	3076.69	I	10579-43072	65	3437.02	I	6324-35411

Iridium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
10	3437.50	I	16103-45186	14	4040.08	I	5785-30530
40	3448.97	I	4079-33065	40	4069.92	I	12952-37515
8	3476.46	I	6324-35081	16	4070.68	I	11831-36390
6	3477.77	I	10579-39325	11	4092.61	I	13088-37515
8	3484.48	I	9878-38568	15	4115.78	I	13940-38230
320	3513.64	I	0-28452	2.5	4127.92	I	13940-38158
22	3515.95	I	7107-35540	3.0	4155.70	I	28452-52509
40	3522.03	I	4079-32464	1.6	4166.04	I	9878-33874
16	3557.17	I	16681-44785	10	4172.56	I	16565-40525
32	3558.99	I	5785-33874	4	4182.47	I	32513-56416
6	3568.00	I	12506-40525	1.6 h	4183.21	I	38230-62128
120	3573.72	I	7107-35081	2.0	4185.66	I	12506-36390
32	3594.39	I	7107-34920	2.5	4197.54	I	11831-35648
22	3609.77	I	2835-30530	3.0	4217.76	I	16103-39806
19	3617.21	I	9878-37515	1.4	4220.80	I	26365-50050
8	3625.71	I	12952-40525	8	4259.11	I	2835-26308
16	3626.29	I	9878-37446	3.0	4265.30	I	12952-36390
65	3628.67	I	6324-33874	28	4268.10	I	7107-30530
22	3636.20	I	11831-39324	2.5	4286.62	I	12218-35540
30	3661.71	I	13088-40390	8	4301.60	I	16565-39806
30	3664.62	I	5785-33065	6	4310.59	I	12218-35411
32	3674.98	I	13088-40291	24	4311.50	I	9878-33065
20	3687.08	I	10579-37693	2.0	4351.30	I	18547-41522
8	3698.10	I	19060-46094	2.0	4352.56	I	19061-42029
14	3725.38	I	19060-45896	2.0	4392.59	I	16565-39325
20	3731.36	II		18	4399.47	I	16565-39289
14	3738.53	I	6324-33065	7	4403.78	I	12218-34920
55	3747.20	I	5785-32464	12	4426.27	I	9878-32464
4	3750.40	I	32831-59487	1.6	4450.18	I	16103-38568
4	3753.32	I	16565-43201	6	4478.48	I	13088-35411
7	3768.68	I	11831-38358	1.8	4495.35	I	33065-55304
5	3770.73	I	9878-36390	1.2 h	4496.03	I	34180-56416
12	3793.79	I	13940-40291	6	4545.68	I	13088-35081
3.5	3794.06	I	12218-38568	3.5	4548.48	I	30530-52509
320	3800.12	I	0-26308	1.4	4550.78	I	12952-34920
24	3817.24	I	6324-32513	4	4568.09	I	10579-32464
18	3865.64	I	11831-37693	2.0	4570.02	I	23310-45186
50	3902.51	I	2835-28452	2.0	4604.48	I	35081-56793
10	3902.66	I	12952-38568	7	4616.39	I	12218-33874
50	3915.38	I	9878-35411	2.5	4656.18	I	13940-35411
44	3934.84	I	7107-32513	1.6 h	4668.99	I	16103-37515
13	3946.27	I	16681-42014	2.0	4708.88	I	19060-40291
7	3951.95	I	12218-37515	5	4728.86	I	13940-35081
3.5	3952.62	I	17779-43072	2.0	4731.86	I	16565-37693
3.5	3962.78	I	12218-37446	2.5	4756.46	I	33874-54893
4	3966.09	I	12952-38158	1.2	4757.96	I	16681-37693
65	3976.31	I	13088-38230	6	4778.16	I	12952-33874
50	3992.12	I	9878-34920	3.0	4795.67	I	12218-33065
20	4020.03	I	26307-51176	1.0	4807.14	I	19593-40390
38	4033.76	I	13088-37872	2.0	4809.47	I	13088-33874



Iridium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
1.0	4840.77	I	9878-30530	0.8	5620.04	I	37515-55304
1.6	4845.38	I	11831-32464	3.5	5625.55	I	16103-33874
5	4938.09	I	12218-32464	0.8	5828.55	I	38230-55382
2.5	4970.48	I	12952-33065	0.8	5882.30	I	34180-51176
2.0	4999.74	I	32513-52509	0.6	5887.36	I	23310-40291
2.0	5002.74	I	6324-26308	3.0	5894.06	I	16103-33065
1.4	5009.17	I	12506-32464	0.6	6026.10	I	13940-30530
2.5	5014.98	I	13940-33874	1.0	6067.83	I	39940-56416
1.4	5046.06	I	35081-54893	1.6	6110.67	I	16103-32464
2.5	5123.66	I	12952-32464	1.0	6288.28	I	16565-32464
1.6	5177.95	I	16103-35411	0.6	6334.44	I	16681-32464
1.8	5238.92	I	16565-35648	0.4	6624.73	I	40291-55382
1.0	5340.74	I	23310-42029	1.2	6686.08	I	39940-54893
3.0	5364.32	I	19593-38230	0.6	6830.01	I	37872-52509
6.0	5449.50	I	32831-51176	0.8	6929.88	I	16103-30530
2.5	5454.50	I	34180-52509	0.7	7183.71	I	18547-32464
0.6	5469.40	I	19593-37872	1.0	7834.32	I	42132-54893

# IRON

Fe,  $Z=26$ ,  $M=55.85$ , Ratio  $\frac{\text{Fe}}{\text{Cu}}=0.879$

Fe I Normal state of valence electrons  $3d^64s^2\ ^5D_4=0$ . I.P.= 63700 K  
 Fe II Normal state of valence electrons  $3d^64s^1\ ^6D_{4\frac{1}{2}}=0$ . I.P.=130524 K

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## Relative intensity of iron lines observed in an arc of copper containing 0.1 atomic percent of iron

### Strong lines of iron

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
700	3734. 87	I	6928-33695	$3d^74s^1 a\ ^5F_5 - 3d^74p^1\ y\ ^5F_5^o$
600	3581. 20	I	6928-34844	$3d^74s^1 a\ ^5F_5 - 3d^74p^1\ z\ ^5G_6^o$
600	3719. 94	I	0-26875	$3d^64s^2 a\ ^5D_4 - 3d^64s^14p^1\ z\ ^5F_5^o$
500	3820. 43	I	6928-33096	$3d^74s^1 a\ ^5F_5 - 3d^74p^1\ y\ ^5D_5^o$
420	3859. 91	I	0-25900	$3d^64s^2 a\ ^5D_4 - 3d^64s^14p^1\ z\ ^5D_4^o$
400	3440. 61	I	0-29056	$3d^64s^2 a\ ^5D_4 - 3d^64s^14p^1\ z\ ^5P_3^o$
400	3570. 10	I	7377-35379	$3d^74s^1 a\ ^5F_4 - 3d^74p^1\ z\ ^3G_3^o$
400	3749. 49	I	7377-34040	$3d^74s^1 a\ ^5F_4 - 3d^74p^1\ y\ ^5F_4^o$
340	3737. 13	I	416-27167	$3d^64s^2 a\ ^5D_3 - 3d^64s^14p^1\ z\ ^5F_4^o$
320	3825. 88	I	7377-33507	$3d^74s^1 a\ ^5F_4 - 3d^74p^1\ y\ ^5D_3^o$
300	3758. 24	I	7728-34329	$3d^74s^1 a\ ^5F_3 - 3d^74p^1\ y\ ^5F_3^o$
300	4045. 82	I	11976-36686	$3d^74s^1 a\ ^3F_4 - 3d^74p^1\ y\ ^3F_4^o$
280	2483. 27	I	0-40257	$3d^64s^2 a\ ^5D_4 - 3d^64s^14p^1\ x\ ^5F_5^o$
280	2522. 85	I	0-39626	$3d^64s^2 a\ ^5D_4 - 3d^64s^14p^1\ x\ ^5D_4^o$
280	3020. 64	I	0-33096	$3d^64s^2 a\ ^5D_4 - 3d^74p^1\ y\ ^5D_4^o$
260	2488. 15	I	416-40594	$3d^64s^2 a\ ^5D_3 - 3d^64s^14p^1\ x\ ^5F_4^o$
260	2719. 02	I	0-36767	$3d^64s^2 a\ ^5D_4 - 3d^64s^14p^1\ y\ ^5P_3^o$
240	3745. 56	I	704-27395	$3d^64s^2 a\ ^5D_2 - 3d^64s^14p^1\ z\ ^5F_3^o$
200	2599. 40	II	0-38459	$3d^64s^1 a\ ^6D_{4\frac{1}{2}} - 3d^64p^1\ z\ ^6D_{4\frac{1}{2}}^o$
200	3608. 86	I	8155-35856	$3d^74s^1 a\ ^5F_1 - 3d^74p^1\ z\ ^5G_2^o$
200	3618. 77	I	7986-35612	$3d^74s^1 a\ ^5F_2 - 3d^74p^1\ z\ ^5G_3^o$
200	3631. 46	I	7728-35257	$3d^74s^1 a\ ^5F_3 - 3d^74p^1\ z\ ^5G_4^o$

Iron — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
5	2084.12	I	0-47967	14	2472.34	I	6928-47363
15	2166.77	I	0-46137	90	2472.88	I	704-41131
7	2178.09	I	416-46314		2472.91	I	416-40842
3.5	2191.84	I	704-46314	22	2474.81	I	7728-48123
3.5	2196.04	I	888-46410	7	2479.48	I	7986-48305
4	2297.79	I	416-43923	100	2479.78	I	704-41018
7	2332.80	II	385-43239	280	2483.27	I	0-40257
4	2338.00	II	863-43621	90	2484.19	I	888-41131
11	2343.49	II	0-42658	9	2486.37	I	0-40207
4	2348.10	II	1873-44447	7	2486.69	I	7728-47930
4	2348.30	II	668-43239	9	2487.06	I	8155-48351
4	2359.10	II	863-43239	3.5	2487.37	I	704-40895
4	2360.00	II	1873-44233	260	2488.15	I	416-40594
3.5	2360.29	II	2430-44785	180	2489.75	I	978-41131
8	2364.83	II	385-42658	180	2490.64	I	704-40842
4	2368.60	II	2838-45044	140	2491.16	I	888-41018
11	2373.73	II	0-42115	18	2493.18	II	21430-61528
3.0	2375.19	II	3118-45207		2493.26	II	21252-61347
7	2379.28	II	2430-44447	14	2496.53	I	7377-47420
7	2380.76	II	668-42658	10	2498.89	I	416-40422
60	2382.04	II	0-41968			II	21582-61587
4	2383.24	II	2838-44785	90	2501.13	I	0-39970
3.0	2384.39	II	3118-45044	3.5	2501.70	I	6928-46889
16	2388.63	II	385-42237	10	2507.90	I	7728-47590
60	2395.62	II	385-42115	90	2510.83	I	416-40231
20	2399.24	II	668-42335	7	2511.76	II	21712-61513
4	2404.43	II	863-42440	7	2512.36	I	416-40207
60	2404.88	II	668-42237	9	2517.66	I	7986-47693
19	2406.66	II	863-42401	70	2518.10	I	704-40405
19	2410.52	II	863-42335	6	2519.63	I	8155-47831
14	2411.07	II	977-42440	280	2522.85	I	0-39626
15	2413.31	II	977-42401	14	2523.66	I	
4	2424.14	II	22637-63876	50	2524.29	I	888-40491
3.0	2430.07	II	22810-63949	6	2525.02	I	
7	2439.74	I	19390-60366	7	2525.39	II	21252-60838
5	2440.11	I	19788-60758	5	2526.30	II	20831-60402
10	2442.57	I	19621-60549	140	2527.43	I	416-39970
5	2443.87	I	6928-47835	50	2529.13	I	704-40231
4	2444.51	II	20831-61726	6	2529.55	II	22637-62158
3.0	2445.56	II	21812-62690	16	2529.83	I	888-40405
7	2447.71	I	0-40842	7	2530.69	I	704-40207
6	2453.47	I	7377-48123	7	2533.63	II	21430-60888
18	2457.60	I	6928-47606	6	2533.80	I	
7	2458.78	II	25805-66464	6	2534.42	II	21712-61157
11	2462.18	I	416-41018	70	2535.60	I	978-40405
70	2462.64	I	0-40594	12	2536.82	II	21582-60990
3.5	2463.73	I	7728-48305	12	2537.17		
14	2465.15	I	7377-47930	7	2538.81	II	21430-60807
3.5	2467.73	I	7728-48239	7	2539.00	II	21252-60625
14	2468.88	I	6928-47420	80	2540.98	I	888-40231

Iron — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
16	2542.10	I	21039-60365	5	2666.64	II	27620-65110
3.5	2543.38	II	21582-60888	10	2666.82	I	6928-44415
16	2543.92	I	20875-60172	18	2679.06	I	6928-44244
7	2544.71	I	20641-59927	12	2689.21	I	7377-44551
80	2545.98	I	704-39970	8	2699.11	I	7377-44415
65	2549.61	I	416-39626	4	2703.99	II	27315-64286
2.5	2550.02	II	26353-65556	6	2706.02	I	19390-56334
6	2551.09	I		18	2706.58	I	7728-44664
20	2562.53	II	7955-46967	7	2708.57	I	20641-57550
13	2563.47	II	8392-47390	2.0	2710.55	I	12969-49851
6	2566.91	II	8680-47626	8	2711.65	I	7377-44244
6	2570.52	II		19	2714.41	II	7955-44785
4	2574.37	II	20831-59663	10	2718.44	I	7986-44761
6	2575.74	I		260	2719.02	I	0-36767
10	2576.69	I	6928-45726	120	2720.90	I	416-37158
9	2577.92	II	8847-47626	70	2723.58	I	704-37410
5	2582.30	I		8	2724.96	I	7728-44415
9	2582.58	II	8680-47390	8	2726.05	I	8155-44827
26	2584.54	I	6928-45608	18	2727.54	II	8392-45044
65	2585.88	II	0-38660	6	2728.02	I	7377-44023
9	2588.00	I		5	2728.82	I	19788-56423
9	2591.54	II	8392-46967	9	2730.74	II	8680-45290
3.0	2592.78	II		70	2733.58	I	6928-43500
9	2593.73	II	8847-47390	3.0	2734.00	I	7986-44551
65	2598.37	II	385-38859	3.0	2734.27	I	17550-54112
200	2599.40	II	0-38459	28	2735.48	I	7377-43923
30	2599.57	I	7377-45833	10	2736.97	II	8680-45207
8	2605.65	I	6928-45295	70	2737.31	I	888-37410
16	2606.82	I	7377-45726	75	2739.55	II	7955-44447
65	2607.09	II	668-39013	8	2742.26	I	7728-44184
80	2611.87	II	385-38660	55	2742.41	I	704-37158
32	2613.82	II	863-39109	28	2743.20	II	8847-45290
32	2617.62	II	668-38859	5	2743.56	I	7728-44166
12	2618.02	I	7728-45914	30	2744.07	I	978-37410
9	2620.41	II	863-39013	6	2744.53	I	7986-44411
17	2621.67	II	977-39109	42	2746.48	II	8680-45080
15	2623.53	I	7728-45833	38	2746.98	I	6928-43321
44	2625.67	II	385-38459			II	8392-44785
32	2628.29	II	977-39013	12	2749.18	II	8680-45044
4	2629.59	I	978-38996	60	2749.32	II	8392-44754
55	2631.05	II	22810-60807	70	2750.14	I	416-36767
55	2631.32	II	668-38660	3.0	2750.88	I	17550-53892
8	2632.24	I	7986-45965	8	2753.29	II	26353-62662
16	2635.81	I	7986-45914	4	2753.69	I	8155-44459
6	2641.65	I	7377-45221	4	2754.04	I	7986-44285
12	2644.00	I	8155-45965	75	2755.74	II	7955-44233
3.0	2647.56	I	416-38175	24	2756.26	I	416-36686
4	2656.15	I	19390-57028		2756.33	I	888-37158
3.0	2662.06	I	7728-45282	8	2757.32	I	8155-44411
7	2664.66	II	27315-64832	2.0	2759.82	I	8155-44378

Iron — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
15	2761.78	I	7986-44184	20	2912.16	I	0-34329
	2761.81	II	8847-45044	8	2918.03	I	26106-60366
16	2762.03	I	7728-43923	5	2920.69	I	12969-47197
5	2763.11	I	7986-44166	8	2923.29	I	26351-60549
2.0	2764.33	I	17727-53892	5	2923.85	I	21716-55907
2.0	2766.91	I	8155-44285	6	2926.59	II	7955-42115
18	2767.50	II	26170-62293	20	2929.01	I	416-34547
	2767.52	I	7377-43500	80	2936.90	I	0-34040
18	2772.08	I	6928-42992	13	2941.34	I	704-34692
3.0	2773.24	I		3.5	2944.40	II	13673-47626
3.0	2774.73	I	8155-44184	80	2947.88	I	416-34329
15	2778.22	I	6928-42912	3.5	2948.43	I	21999-55906
3.0	2778.84	I		60	2953.94	I	704-34547
3.5	2781.84	I	7986-43923	32	2957.36	I	888-34692
70	2788.10	I	6928-42784	8	2959.99	I	21716-55490
2.0	2789.80	I	21716-57550	18	2965.26	I	978-34692
2.5	2791.79	I	19621-55430	170	2966.90	I	0-33695
2.0	2795.01	I	0-35768	4	2969.36	I	888-34556
8	2797.78	I	7377-43109	8	2969.48	I	6928-40594
15	2804.52	I	7377-43023	34	2970.10	I	888-34547
16	2806.98	I	7377-42992	60	2973.13	I	704-34329
42	2813.29	I	7377-42912	120	2973.24	I	416-34040
2.0	2817.51	I	7728-43210	1.0	2976.13	I	18378-51969
50	2823.28	I	7728-43138	1.0	2980.54	I	22249-55791
15	2825.56	I	7728-43109	28	2981.45	I	416-33947
3	2825.69	I	0-35379	1.2	2981.85	I	17550-51077
2.5	2828.81	I	7986-43326	140	2983.57	I	0-33507
32	2832.44	I	7728-43023	12	2984.78	I	6928-40422
2.5	2835.46	I	0-35257		2984.83	II	13474-46967
10	2838.12	I	7986-43210	1.2	2986.46	I	888-34363
2.5	2840.42	I	416-35612	12	2987.29	I	7377-40842
9	2843.63	I	7377-42533	5	2990.39	I	21999-55430
26	2843.98	I	7986-43138	120	2994.43	I	416-33802
7	2845.60	I	7728-42860	1.0	2996.39	I	19552-52916
1.6	2848.72	I	7986-43079	36	2999.51	I	6928-40257
38	2851.80	I	8155-43210	5	3000.45	I	11976-45295
5	2863.44	I	11976-46889	110	3000.95	I	704-34017
4	2863.86	I	704-35612	10	3003.03	I	7728-41018
2.5	2866.63	I	7986-42860	3.5	3007.14	I	11976-45221
8	2869.31	I	416-35257	10	3007.28	I	704-33947
5	2872.34	I	7728-42533	90	3008.14	I	888-34122
10	2874.17	I	0-34782	28	3009.57	I	7377-40594
2.5	2875.30	I	11976-46745	5	3011.48	I	22249-55446
5	2877.30	I	11976-46721	8	3016.18	I	7986-41131
1.0	2887.81	I	21716-56334	20	3017.63	I	888-34017
8	2894.50	I	18378-52916	18	3018.98	I	7728-40842
4	2895.04	I	12561-47093	60	3020.49	I	704-33802
4	2899.42	I	18378-52858	280	3020.64	I	0-33096
2.0	2901.92	I	19350-53800	160	3021.07	I	416-33507
2.5	2907.52	I	21999-56383	26	3024.03	I	888-33947

Iron — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
18	3025.64	I	19390-52431	30	3239.44	I	19562-50423
38	3025.84	I	978-34017	22	3244.19	I	19562-50378
18	3026.46	I	7986-41018	13	3265.62	I	17550-48163
19	3030.15	I	19621-52613	15	3271.00	I	17727-48290
19	3031.22	I	19788-52769	28	3286.76	I	17550-47967
19	3031.64	I	8155-41131	28	3305.97	I	17727-47967
95	3037.39	I	888-33802	28	3306.35	I	17927-48163
17	3040.43	I	7377-40257	6	3355.23	I	26627-56423
7	3041.64	I	12561-45428	8	3369.55	I	21999-51668
12	3041.74	I	7728-40594	12	3370.79	I	21716-51374
6	3042.02	I	8155-41018	8	3383.98	I	17550-47093
19	3042.66	I	7986-40842	7	3392.31	I	17727-47197
130	3047.60	I	704-33507	15	3392.66	I	17550-47017
6	3055.26	I	12561-45282	22	3399.34	I	17727-47136
65	3057.45	I	6928-39626	15	3404.36	I	17727-47093
100	3059.09	I	416-33096	30	3407.46	I	17550-46889
40	3067.24	I	7377-39970	23	3413.14	I	17727-47017
34	3075.72	I	7728-40231	15	3417.84	I	17927-47177
24	3083.74	I	7986-40405	15	3418.51	I	17927-47172
20	3091.58	I	8155-40491	8	3422.66	I	17927-47136
55	d 3099.90	I	8155-40405	16	3424.29	I	17550-46745
	3099.97	I	7377-39626	7	3426.39	I	17550-46727
26	3100.30	I	7986-40231	7	3426.64	I	17727-46902
26	3100.67	I	7728-39970	32	3427.12	I	17550-46721
6	3116.63	I	8155-40231	8	3428.20	I	17727-46889
11	3125.65	I	7986-39970	400	3440.61	I	0-29056
7	3175.45	I	19351-50833	80	3440.99	I	416-29469
14	3180.23	I	19757-51192	40	3443.88	I	704-29733
6	3184.90	I	416-31805	16	3445.15	I	17727-46745
7	3191.66	I	0-31323	5	3447.28	I	17727-46727
7	3192.80	I	20020-51331	8	3450.33	I	17927-46902
11	3193.23	I	0-31307	8	3451.92	I	17927-46889
24	3196.93	I	19562-50833	8	3452.28	I	7728-36686
14	3199.52	I	19562-50808	60	3465.86	I	888-29733
15	3200.48	I	19913-51149	80	3475.45	I	704-29469
11	3205.40	I	20020-51208	32	3476.70	I	978-29733
7	3210.83	I	19913-51048	6	3485.34	I	17727-46410
15	3211.99	I	19351-50475	80	3490.58	I	416-29056
30	3214.04	I	19757-50862	6	3495.29	I	20641-49243
6	3214.40	I	704-31805	8	3497.11	I	17550-46137
7	3215.94	I	19913-50999	24	3497.84	I	888-29469
5	3217.38	I	19351-50423	6	3506.50	I	18378-46889
12	3219.58	I	19757-50808	40	3513.82	I	6928-35379
7	3219.81	I	19562-50611	36	3521.26	I	7377-35768
34	3222.07	I	19351-50378	18	3526.04	I	704-29056
50	3225.79	I	19351-50342	13	3526.17	I	7728-36079
19	3227.75	II	13474-44447	8	3533.20	I	23245-51540
	3227.80	I	19562-50534	20	3536.56	I	23193-51461
7	3230.97	I	19757-50699	24	3541.09	I	22997-51229
7	3233.97	I	19562-50475	22	3542.08	I	23111-51335

Iron — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
6	3553.74	I	28820-56951	6	3716.45	I	23711-50611
28	3554.93	I	22846-50968	600	3719.94	I	0-26875
65	3558.52	I	7986-36079	80	3722.56	I	704-27560
160	3565.38	I	7728-35768	8	3724.38	I	18378-45221
400	3570.10	I	7377-35379	3.0	3726.92	I	24507-51331
600	3581.20	I	6928-34844	75	3727.62	I	7728-34547
13	3584.66	I	21716-49604	12	3732.40	I	17727-44512
36	3585.32	I	7728-35612	70	3733.32	I	888-27666
30	3585.71	I	7377-35257	700	3734.87	I	6928-33695
13	3586.11	I	26106-53983	340	3737.13	I	416-27167
40	3586.99	I	7986-35856	7	3738.31	I	26351-53094
7	3589.11	I	6928-34782	60	3743.36	I	7986-34692
8	3594.64	I	22997-50808	240	3745.56	I	704-27395
16	3603.21	I	21716-49461	60	3745.90	I	978-27666
24	3605.46	I	21999-49727	140	3748.26	I	888-27560
32	3606.68	I	21716-49434	400	3749.49	I	7377-34040
200	3608.86	I	8155-35856	7	3753.61	I	17550-44184
20	3610.16	I	22650-50342	300	3758.24	I	7728-34329
13	3617.79	I	24336-51969	6	3760.05	I	19390-45978
200	3618.77	I	7986-35612	1.6	3760.53	I	17927-44512
24	3621.46	I	21999-49604	170	3763.79	I	7986-34547
16	3622.00	I	22249-49851	14	3765.54	I	26106-52655
8	3623.19	I	19390-46982	120	3767.19	I	8155-34692
5	3625.15	I	22846-50423	1.0	3774.83	I	17927-44411
200	3631.46	I	7728-35257	1.0	3776.46	I	17550-44023
8	3632.04	I	24772-52297	3.0	3785.95	I	19621-46027
13	3638.30	I	22249-49727	3.0	3786.68	I	8155-34556
22	3640.39	I	21999-49461	46	3787.88	I	8155-34547
6	3645.82	I	25091-52512	6	3790.10	I	7986-34363
160	3647.84	I	7377-34782	3.0	3794.34	I	19788-46136
16	3649.51	I	21716-49109	65	3795.00	I	7986-34329
30	3651.47	I	22249-49628	6	3797.52	I	26106-52431
8	3659.52	I	19788-47107	32	3798.51	I	7377-33695
16	3669.52	I	21999-49243	48	3799.55	I	7728-34040
20	3677.63	I	22249-49433	12	3805.34	I	26628-52899
65	3679.92	I	0-27167	6	3806.70	I	26351-52613
16	3682.21	I	28605-55754	3.0	3807.54	I	17927-44184
11	3683.06	I	416-27560	32	3812.96	I	7728-33947
11	3684.11	I	21999-49135	160	3815.84	I	11976-38175
13	3686.00	I	23711-50833	500	3820.43	I	6928-33096
80	3687.46	I	6928-34040	7	3821.18	I	26351-52514
13	3689.46	I	23711-50808	80	3824.44	I	0-26140
24	3694.01	I	24507-51570	320	3825.88	I	7377-33507
8	3695.05	I	20875-47930	130	3827.82	I	12561-38678
30	3701.09	I	24181-51192	3.0	3833.31	I	20641-46721
8	3704.46	I	21716-48703	130	3834.22	I	7728-33802
80	3705.57	I	416-27395	3.5	3839.26	I	24575-50614
28	d 3707.82	I	704-27666	80	3840.44	I	7986-34017
	3707.92	I	17550-44512	80	3841.05	I	12969-38996
85	3709.25	I	7377-34329	6	3843.26	I	24575-50587

Iron — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
6	3846.80	I	26225-52213	3.0	3998.06	I	21716-46721
50	3849.97	I	8155-34122	40	4005.25	I	12561-37521
7	3850.82	I	7986-33947	3.5	4009.72	I	17927-42860
2.0	3852.58	I	17550-43500	4	4014.53	I	28820-53722
85	3856.37	I	416-26340	4	4021.87	I	22249-47107
6	3859.22	I	19390-45295	300	4045.82	I	11976-36686
420	3859.91	I	0-25900	3.0	4062.44	I	22947-47556
34	3865.53	I	8155-34017	120	4063.60	I	12561-37163
2.0	3867.22	I	24336-50187	100	4071.74	I	12969-37521
34	3872.50	I	7986-33802	4	4107.49	I	22838-47177
3.5	3873.76	I	19621-45428	3.0	4109.81	I	22947-47272
50	3878.02	I	7728-33507	8	4118.55	I	28820-53094
85	3878.58	I	704-26479	2.0	4127.61	I	23052-47272
2.5	3885.51	I	19552-45282	32	4132.06	I	12969-37163
180	3886.28	I	416-26140	4	4134.68	I	22838-47017
35	3887.05	I	7377-33096	8	4143.42	I	24575-48703
35	3888.52	I	12969-38678	40	4143.87	I	12561-36686
3.5	3893.39	I	23784-49461	2.0	4147.67	I	11976-36079
35	3895.66	I	888-26550	4	4154.50	I	22838-46902
3.5	3897.90	I	21716-47363	4	4156.80	I	22838-46889
3.5	3898.01	I	8155-33802	3.5	4175.64	I	22947-46889
55	3899.71	I	704-26340	8	4181.76	I	22838-46745
55	3902.95	I	12561-38175	3.0	4184.90	I	22838-46727
1.8	3903.90	I	24119-49727	13	4187.04	I	19757-43634
14	3906.48	I	888-26479	13	4187.80	I	19562-43435
2.0	3916.73	I	26106-51630	8	4191.44	I	19913-43764
4	3917.18	I	7986-33507	11	4198.31	I	19351-43163
3.0	3918.65	I	24339-49851	13	4199.10	I	24575-48383
36	3920.26	I	978-26479	34	4202.03	I	11976-35768
55	3922.91	I	416-25900	1.4	4203.99	I	22947-46727
70	3927.92	I	888-26340	4	4210.35	I	20020-43764
75	3930.30	I	704-26140	1.6	4216.19	I	0-23711
2.0	3935.82	I	22838-48239	7	4219.36	I	28820-52514
1.6	3940.88	I	7728-33096	4	4222.22	I	19757-43435
1.4	3942.44	I	22947-48305	13	4227.43	I	26875-50523
3.5	3948.78	I	26351-51668	11	4233.61	I	20020-43634
3.5	3949.96	I	17550-42860	17	4235.94	I	19562-43163
3.0	3951.17	I	26406-51708	3.0	4238.82	I	27395-50980
2.0	3952.61	I	21716-47008	3.0	4247.43	I	27167-50704
3.5	3956.46	I	26106-51374	12	4250.13	I	19913-43435
7	3956.68	I	21716-46982	24	4250.79	I	12561-36079
4	3966.07	I	12969-38175	36	4260.48	I	19351-42816
3.0	3966.63	I	25900-51103	12	4271.16	I	19757-43163
3.0	3967.42	I	26628-51826	100	4271.76	I	11976-35379
55	3969.26	I	11976-37163	8	4282.41	I	17550-40895
2.5	3971.33	I	21716-46889	14	4294.13	I	11976-35257
6	3977.74	I	17727-42860	12	4299.24	I	19562-42816
2.0	3981.77	I	21999-47107	100	4307.91	I	12561-35768
4	3983.96	I	21999-47093	6	4315.09	I	17727-40895
8	3997.40	I	21999-47008	95	4325.76	I	12969-36079



Iron — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
4	4337.05	I	12561-35612	6	5192.36	I	24181-43435
4	4352.74	I	17927-40895	3.0	5194.95	I	12561-31805
1.4	4369.77	I	24575-47453	2.5	5202.34	I	17550-36767
6	4375.93	I	0-22846	2.5	5216.28	I	12969-32134
170	4383.55	I	11976-34782	3.0	5226.88	I	24507-43634
85	4404.75	I	12561-35257	12	5227.19	I	12561-31686
48	4415.12	I	12969-35612	11	5232.94	I	23711-42816
6	4427.31	I	416-22997	5	5266.58	I	24181-43163
5	4442.34	I	17727-40231	22	5269.54	I	6928-25900
2.0	4443.20	I	23052-45552	8	5270.36	I	12969-31937
5	4447.72	I	17927-40405	2.0	5281.80	I	24507-43435
5	4459.12	I	17550-39970	4	5283.63	I	26140-45061
3.0	4461.65	I	704-23111	2.5	5302.31	I	26479-45334
6	4466.55	I	22838-45221	7	5324.18	I	25900-44677
6	4476.02	I	22947-45282	18	5328.05	I	7377-26140
3.0	d 4482.17	I	888-23193	2.5	5328.53	I	12561-31323
	4482.26	I	17927-40231	1.4	5339.94	I	26340-45061
6	4494.57	I	17727-39970	1.8	5341.03	I	12969-31686
10	4528.62	I	17550-39626	1.2	5364.88	I	35856-54491
2.0	4531.15	I	11976-34040	1.4	h 5367.46	I	35612-54237
2.5	4602.94	I	11976-33695	2.0	5369.96	I	35257-53874
1.6	4736.78	I	25900-47006	12	5371.49	I	7728-26340
2.0	4859.75	I	23193-43764	3.0	5383.37	I	34782-53353
6	4871.32	I	23111-43634	2.0	5393.18	I	26140-44677
3.5	4872.15	I	23245-43764	7	5397.13	I	7377-25900
1.2	4878.22	I	23270-43764	3.5	h 5404.15	I	35768-54267
3.5	4890.77	I	23193-43634	7	5405.78	I	7986-26479
8	4891.50	I	22997-43435	1.8	5410.91	I	36079-54555
1.0	4903.32	I	23245-43634	3.0	h 5415.21	I	35379-53841
5	4919.00	I	23111-43435	3.5	h 5424.08	I	34844-53275
12	4920.50	I	22846-43163	8	5429.70	I	7728-26140
4	4957.31	I	22997-43163	5	5434.53	I	8155-26550
13	4957.61	I	22650-42816	1.0	h 5445.04	I	35379-54379
1.2	5001.87	I	31307-51294	6	5446.92	I	7986-26340
1.0	5005.72	I	31323-51294	4	5455.61	I	8155-26479
2.5	5006.13	I	22846-42816	1.6	5497.52	I	8155-26340
1.2	5012.07	I	6928-26875	1.0	5501.47	I	7728-25900
1.0	5041.76	I	11976-31805	2.0	5506.78	I	7986-26140
2.0	5049.82	I	18378-38175	2.0	5569.62	I	27560-45509
1.0	5051.64	I	7377-27167	3.0	5572.85	I	27395-45334
1.0	5068.79	I	23711-43435	0.7	5576.11	I	27666-45595
0.8	5083.34	I	7728-27395	4	5586.76	I	27167-45061
1.0	5098.71	I	17550-37158	0.8	5602.96	I	27666-45509
2.0	5110.41	I	0-19562	5	5615.65	I	26875-44677
2.5	5133.68	I	33695-53169	1.0	5624.55	I	27560-45334
2.5	5139.26	I	24181-43634	1.2	5658.83	I	27395-45061
3.5	5139.48	I	23711-43163	0.7	5763.01	I	33947-51294
13	5167.49	I	11976-31323	0.8	6024.06	I	36686-53282
6	5171.60	I	11976-31307	1.2	6065.49	I	21039-37521
4	5191.47	I	24507-43764	3.0	6136.62	I	19788-36079

Iron — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
2.0	6137.70	I	20875-37163	0.3	7620.54	I	38175-51294
2.0	6191.56	I	19621-35768	0.2	7661.22	I	34329-47378
2.0	6230.73	I	20641-36686	0.6	7664.30	I	24119-37163
0.7	6246.34	I	29056-45061	1.0	7748.28	I	23784-36686
1.2	6252.56	I	19390-35379	1.0	7780.59	I	36079-48928
0.5	6265.14	I	17550-33507	1.4	7832.22	I	35768-48532
0.6	6301.52	I	29469-45334	1.4	7937.17	I	34782-47378
0.5	6318.02	I	19788-35612	1.4	7945.88	I	35379-47961
1.0	6393.60	I	19621-35257	1.4	7998.97	I	35257-47756
1.6	6400.02	I	29056-44677	0.3	8028.34	I	36079-48532
1.0	6411.66	I	29469-45061	1.2	8046.07	I	35612-48037
0.8	6421.36	I	18378-33947	1.0	8085.20	I	35856-48221
1.0	6430.85	I	17550-33096	0.3	8198.95	I	35768-47961
3.0	6494.98	I	19390-34782	3.0	8220.41	I	34844-47006
0.6	6546.24	I	22249-37521	0.3	8232.35	I	35612-47756
0.9	6592.92	I	21999-37163	4	8327.06	I	17727-29733
1.8	6677.99	I	21716-36686	0.9	8331.94	I	35379-47378
0.4	6945.21	I	19552-33947	0.4	8339.43	I	35768-47756
0.3	6978.86	I	20038-34363	3.5	8387.78	I	17550-29469
0.6	7130.94	I	34017-48037	1.2	8468.41	I	17927-29733
0.8	7164.47	I	33802-47756	0.9	8514.08	I	17727-29469
2.0	7187.34	I	33096-47006	0.3	8515.11	I	24339-36079
1.2	7207.41	I	33507-47378	0.6	8611.81	I	22947-34556
0.6	7389.42	I	34692-48221	3.5	8661.91	I	17927-29469
0.7	7411.18	I	34547-48037	0.9	8674.75	I	22838-34363
1.4	7445.78	I	34329-47756	7	8688.63	I	17550-29056
1.8	7495.09	I	34040-47378	0.8	8757.19	I	22947-34363
3.0	7511.04	I	33695-47006	0.8	8764.00	I	37521-48928
0.5	7531.17	I	35257-48532	0.6	8793.38	I	37163-48532
0.3	7568.92	I	34547-47756	4	8824.23	I	17727-29056
0.4	7583.80	I	24339-37521	1.0	8866.96	I	36686-47961
1.0	7586.04	I	34782-47961	2.5	8999.56	I	22838-33947

## LANTHANUM

La,  $Z=57$ ,  $M=138.92$ , Ratio  $\frac{\text{La}}{\text{Cu}}=2.186$

La I Normal state of valence electrons  $5d^1 6s^2 {}^2D_{1/2}=0$ . I.P.=45293 K  
 La II Normal state of valence electrons  $5d^2 {}^3F_2=0$ . I.P.=92240 K

### References

#### Wavelengths:

- A. Gatterer and J. Junkes, *Spektren der Seltenen Erden* (Specola Vaticana, Vatican, 1945), below 7550 Å.  
 G. R. Harrison, *Massachusetts Institute of Technology Wavelength Tables* (John Wiley & Sons, New York, 1939), above 7550 Å.

#### Classification:

La I, La II and La III, H. N. Russell and W. F. Meggers, *J. Research NBS* **9**, 625 (1932).

#### Molecular Spectra:

LaO, W. F. Meggers and J. A. Wheeler, *J. Research NBS* **6**, 239 (1931).

### Relative intensity of lanthanum lines observed in an arc of copper containing 0.1 atomic percent of lanthanum

#### *Strong lines of lanthanum*

Intensity	Wavelength Å	Spectrum	Energy levels K	Term combination
900	3949.10	II	3250-28565	$6s^1 a {}^3D_3-6p^1 x {}^3F_4$
550	4086.72	II	0-24463	$5d^2 a {}^3F_2-6p^1 y {}^1D_2$
460	3794.78	II	1971-28315	$5d^2 a {}^3F_4-6p^1 y {}^3D_3$
460	4333.74	II	1394-24463	$6s^1 a {}^1D_2-6p^1 y {}^1D_2$
440	3790.83	II	1016-27388	$5d^2 a {}^3F_3-6p^1 y {}^3D_2$
440	3988.52	II	3250-28315	$6s^1 a {}^3D_3-6p^1 y {}^3D_3$
440	4123.23	II	2592-26838	$6s^1 a {}^3D_2-6p^1 x {}^3F_3$
360	3995.75	II	1394-26414	$6s^1 a {}^1D_2-6p^1 x {}^3F_2$
340	3871.64	II	1016-26838	$5d^2 a {}^3F_3-6p^1 x {}^3F_3$
300	4042.91	II	7473-32201	$5d^2 a {}^1G_4-6p^1 x {}^1F_3$
280	3759.08	II	1971-28565	$5d^2 a {}^3F_4-6p^1 x {}^3F_4$
280	4031.69	II	2592-27388	$6s^1 a {}^3D_2-6p^1 y {}^3D_2$
280	4077.35	II	1895-26414	$6s^1 a {}^3D_1-6p^1 x {}^3F_2$
220	3929.22	II	1394-26838	$6s^1 a {}^1D_2-6p^1 x {}^3F_3$
200	3337.49	II	3250-33204	$6s^1 a {}^3D_3-6p^1 x {}^3P_2$
200	3380.91	II	2592-32161	$6s^1 a {}^3D_2-6p^1 x {}^3P_1$
200	4429.90	II	1895-24463	$6s^1 a {}^3D_1-6p^1 y {}^1D_2$

Lanthanum — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
1.2	2187.87	II	0-45692	10	3510.00	II	1016-29498
8	2256.76	II	1394-45692	10	3512.93	II	1895-30353
18	2297.78	III	1603-45111	6	3514.07	I	1053-29502
1.8	2317.82	II	18895-62026	10	3517.14	III	13591-42015
4	2319.44	II	2592-45692	6	3550.82	II	0-28155
1.8	2328.75	II	16599-59528	9	3557.26	II	1394-29498
40	2379.38	III	0-42015	28	3574.43	I	0-27969
1.6	2438.01	II	18895-59900	9	3601.06	II	2592-30353
6	2471.90	II	5250-45692	6	3610.25	II	
3.0	2472.44	II	17826-58259	9	3612.34	II	24463-52138
3.0	2479.85	II	19215-59528	9	3613.08	I	0-27669
6	2487.59	II	17212-57400	38	3628.83	II	1016-28565
4	2533.14	II	6227-45692	4	3636.67	I	1053-28543
4	2560.37	II	19215-58259	14	3637.15	II	5718-33204
1.6	2580.82	II	15699-54435	20	d 3641.53	I	1053-28506
2.0	2582.56	II	14148-52858		3641.66	II	27388-54840
4	2596.09	II	16599-55107	120	3645.42	II	0-27424
46	2610.34	II	7395-45692	11	3649.53	I	0-27393
6	2672.91	II	18580-55982	46	3650.18	II	0-27388
7	2695.47	II	19750-56838	20	3662.08	II	1016-28315
6	2725.58	I	1053-37732	2.0	3672.02	I	0-27225
6	2791.51	II	22106-57919	4	3701.81	II	28315-55321
6	2798.56	II	22537-58259	14	3704.54	I	1053-28040
48	2808.39	II	10095-45692	38	3705.82	II	6227-33204
1.2	2838.45	II	19215-54435	65	3713.54	II	1394-28315
1.8	2840.51	II	29498-64693	16	3714.87	II	5250-32161
5	2855.90	II	24523-59528	32	3715.53	II	2592-29498
3.0	2862.98	II	20403-55321	11	3725.05	II	0-26838
10	2880.65	II	20403-55107	4	3735.85	II	1394-28155
15	2885.14	II	21332-55982	280	3759.08	II	1971-28565
18	2893.07	II	22283-56838	9	3773.12	II	26838-53333
12	2950.50	II	28526-62408	14	3780.67	II	5718-32161
24	3104.59	II	0-32201	8	3784.81	II	0-26414
8	3108.46	II	0-32161	440	3790.83	II	1016-27388
18	3142.76	II	1394-33204	460	3794.78	II	1971-28315
20	3171.68	III	13591-45110	8	3808.79	II	3250-29498
10	3193.02	II	1895-33204	19	3835.08	II	5718-31786
5	3215.81	I	1053-32141	60	3840.72	II	1394-27424
70	3245.13	II	1394-32201	12	3846.00	II	1394-27388
36	3249.35	II	1394-32161	160	3849.02	II	0-25973
75	3265.67	II	2592-33204	13	3854.91	II	6227-32161
110	3303.11	II	1895-32161	8	3864.49	II	28565-54435
200	3337.49	II	3250-33204	340	3871.64	II	1016-26838
13	3342.23	I	1053-30965	170	3886.37	II	2592-28315
120	3344.56	II	1895-31786	5	3898.60	I	0-25643
28	3376.33	II	2592-32201	3.5	3902.58	I	0-25617
200	3380.91	II	2592-32161	4	3910.81	II	2592-28155
18	3452.18	II	1394-30353	130	3916.05	II	1895-27424
24	3453.17	II	3250-32201	110	3921.54	II	1895-27388
9	3461.18	I	1053-29937	16	3927.56	I	0-25454

## Lanthanum — All Observed Lines

Intensity and Character	Wave-length in A	Spectrum	Energy Levels in K	Intensity and Character	Wave-length in A	Spectrum	Energy Levels in K
220	3929.22	II	1394-26838	60	4296.05	II	6227-29498
18	3936.22	II	1016-26414	12	4300.44	II	0-23247
900	3949.10	II	3250-28565	5	4315.90	II	3250-26414
4	3953.68	I	1053-26339	44	4322.51	II	1394-24523
440	3988.52	II	3250-28315	460	4333.74	II	1394-24463
360	3995.75	II	1394-26414	2.0	4334.96	II	14148-37210
18	4015.39	I	1053-25950	4	4340.73	I	8446-31477
9	4023.59	II	14376-39222	55	4354.40	II	7395-30353
25	4025.88	II	2592-27424	6	4354.80	I	9184-32141
280	4031.69	II	2592-27388	11	4364.67	II	5250-28155
4	4036.59	II	7395-32161	11	bl 4371.97	LaO	
14	4037.21	I	0-24763	11	bl 4375.84	LaO	
300	4042.91	II	7473-32201	11	4378.10	II	14375-37210
32	4050.08	II	15774-40458	6	bl 4379.72	LaO	
22	4060.33	I	4122-28743	28	4383.44	II	14148-36955
16	4064.79	I	3495-28089	10	4385.20	II	14375-37173
6	4065.58	I	1053-25643	6	4389.87	I	9719-32493
85	4067.39	II	1394-25973	5	4402.65	I	9044-31752
11	4076.71	II	0-24523	5	4411.21	II	28565-51229
280	4077.35	II	1895-26414	22	bl 4418.24	LaO	
12	4079.18	I	0-24508	8	4419.16	II	16599-39222
550	4086.72	II	0-24463	16	bl 4423.17	LaO	
18	4089.61	I	3010-27455	16	4423.90	I	9920-32518
28	4099.54	II	14148-38534	26	4427.55	II	14375-36955
11	4104.87	I	2668-27023	10	bl 4428.10	LaO	
5	4109.80	I	1053-25378	200	4429.90	II	1895-24463
5	4117.68	I		16	bl 4432.98	LaO	
440	4123.23	II	2592-26838	5	4435.85	II	0-22537
11	4137.04	I	1053-25218	10	bl 4438.01	LaO	
55	4141.74	II	3250-27388	5	bl 4443.00	LaO	
110	4151.97	II	1895-25973	10	4452.15	I	9961-32411
22	4152.78	II	14148-38221	10	4455.80	II	5718-28155
4	4157.52	I	0-24046	4	4468.97	I	3010-25380
10	4160.26	I	1053-25083	4	4486.06	I	7490-29776
5	4172.32	I	3495-27455	4	4493.11	I	1053-23303
7	4177.48	I	1053-24984	4	4494.71	I	2668-24910
28	4187.32	I	0-23875	9	4500.22	I	7680-29895
28	4192.36	II	14375-38221	85	4522.37	II	10095-32201
150	4196.55	II	2592-26414	17	4525.31	II	15699-37791
24	4204.04	II	5718-29498	42	4526.12	II	6227-28315
30	4217.56	II	15699-39403	3.0	4541.79	I	7490-29502
20	4230.95	II	15774-39403	8	4549.50	I	3010-24984
160	4238.38	II	3250-26838	40	4558.46	II	2592-24523
14	4249.99	II	15699-39222	11	4559.29	II	6227-28155
5	4262.34	I	1053-24508	16	4567.91	I	3495-25380
32	4263.59	II	15774-39222	20	4570.02	I	4122-25997
48	4269.50	II	14375-37791	40	4574.88	II	1394-23247
24	4275.64	II	2592-25973	20	4580.06	II	5718-27546
30	4280.27	I	1053-24410	3.0	4602.05	I	8052-29776
60	4286.97	II	15699-39019	14	4605.78	II	5718-27424

## Lanthanum — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
36	4613.39	II	5718-27388	5	4878.86	I	8052-28543
2.0	4615.07	I	7231-28893	2.0	4887.61	I	8052-28506
36	4619.88	II	14148-35788	65	4899.92	II	0-20403
3.5	4636.43	II	18895-40458	5	4901.87	I	1053-21448
10	4645.28	II	1016-22537	2.0	4905.13	I	7012-27393
4	4646.34	I	9961-31477	80	4920.98	II	1016-21332
6	4647.51	II	15699-37210	80	4921.79	II	1971-22283
7	4648.65	I	2668-24174	11	4934.83	II	10095-30353
3.0	4650.33	I	3010-24508	2.0	4935.62	II	5718-25973
4	4652.08	I	3495-24984	2.0	4945.85	I	7012-27225
48	4655.50	II	15699-37173	8	4946.47	II	1895-22106
3.0	4660.70	I	8052-29502	28	4949.77	I	0-20197
32	4662.51	II	0-21442	5	4952.07	II	19215-39403
20	4663.76	II	15774-37210	26	4970.39	II	2592-22705
18	4668.91	II	14375-35788	2.5	4977.95	I	0-20083
14	4671.83	II	15774-37173	28	4986.83	II	1394-21442
8	4691.18	II	1394-22705	11	4991.28	II	7395-27424
20	4692.50	II	14148-35453	5	4993.88	I	0-20019
8	4699.63	II	3250-24523	2.5	4996.82	II	19215-39222
3.0	4700.26	I		55	4999.47	II	3250-23247
3.0	4702.64	I	4122-25380	4	5001.79	I	8052-28040
12	4703.28	II	15699-36955	2.5	5002.13	II	18236-38221
3.0	4708.19	I	9184-30417	2.5	h 5019.51	I	
6	4712.93	II	3250-24463	11	5046.88	I	3495-23303
15	4716.44	II	6227-27424	2.0	5048.04	II	19215-39019
3.0	4717.59	II	16599-37791	16	5050.57	I	3010-22804
12	4719.94	II	15774-36955	13	5056.46	I	2668-22439
3.0	4724.43	II	6227-27388	3.5	5062.92	II	6227-25973
20	4728.42	II	1394-22537	3.5	5067.90	I	3495-23221
44	4740.28	II	1016-22106	1.8	5078.92	I	
34	4743.09	II	14375-35453	2.5	h 5079.38	I	
28	4748.73	II	7473-28526	2.5	h 5080.21	II	15774-35453
4	4750.41	I	9920-30965	1.8	5103.13	I	
14	4766.89	I	0-20972	15	5106.23	I	2668-22247
3.0	4770.43	I	7012-27969	36	5114.56	II	1895-21442
2.5	4796.69	II	7473-28315	3.5	5120.88	I	8446-27969
2.5	4800.00	I	9961-30788	36	5122.99	II	2592-22106
2.0	4800.25	I	7680-28506	1.6	5135.44	I	
14	4804.04	II	1895-22705	1.8	5139.16	I	
14	4809.01	II	1895-22684	34	5145.42	I	3010-22439
2.5	h 4817.17	I	9184-29937	14	5156.74	II	1016-20403
18	4824.06	II	5250-25973	14	5157.43	II	17826-37210
2.0	4826.88	II	1394-22106	22	5158.69	I	0-19379
6	4839.52	I	7012-27669	9	5163.62	II	1971-21332
4	4840.01	II	2592-23247	6	5167.79	I	4122-23467
4	4850.58	II	6227-26838	2.0	5172.91	II	18895-38221
6	4850.82	I	1053-21663	6	5173.84	II	32201-51524
2.0	4854.95	I	9184-29776	44	5177.31	I	3495-22804
28	4860.91	II	1971-22537	1.8	5179.12	I	8446-27749
2.5	4870.56	I	8446-28972	65	5183.42	II	3250-22537

Lanthanum — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
7	5183.92	I	1053-20338	1.4	5529.87	I	9961-28040
20	5188.22	II	19750-39019	1.0	5532.06	I	
13	5204.15	II	18580-37791	7	5535.67	II	10095-28155
55	5211.86	I	4122-23303	5	5541.26	I	9184-27225
2.5	5226.21	II	17826-36955	1.8	5544.91	I	9719-27749
40	5234.27	I	4122-23221	4	5565.44	I	7680-25643
2.5	5239.55	I	8052-27133	3.0	5565.72	I	3010-20972
2.0	5240.83	I		1.8	5566.94	II	19215-37173
26	5253.46	I	1053-20083	6	5568.46	I	3495-21448
2.5	5257.85	I		1.2	5570.38	I	0-17947
8	5259.39	II	1394-20403	6	5588.34	I	3495-21384
28	5271.19	I	1053-20019	6 bl	5600.02	LaO	
4	5276.42	I	8446-27393	8 bl	5602.50	LaO	
2.0	5279.13	II	18236-37173	2.5 bl	5626.03	LaO	
11	5290.84	II	0-18895	3.5 bl	5628.60	LaO	
28	5301.98	II	3250-22106	12	5631.22	I	3010-20763
11	5302.62	II	16599-35453	5	5632.03	I	7012-24763
14	5303.55	II	2592-21442	3.0	5639.31	I	7490-25218
3.5	5304.02	I	7490-26339	18	5648.25	I	9920-27620
1.8	5307.53	I		2.5 b	5654.82	LaO	
1.2	5320.16	I	3495-22286			I	7231-24910
2.5	5323.57	I	8446-27225	1.2	5656.54	I	9719-27393
8	5340.67	II	18236-36955	10	5657.72	I	2668-20338
8	5357.86	I	7680-26339	4	5671.55	II	17826-35453
1.6	5365.89	I	7012-25643	7	5696.19	I	1053-18604
10	5377.09	II	18580-37173	1.0	5699.39	I	4122-21663
1.6	5380.01	I	9961-28543	3.5	5703.33	II	5718-23247
11	5380.99	II	7395-25973	0.8	5710.85	I	9719-27225
6	5381.92	II	17212-35788	5	5712.40	II	1394-18895
1.6 bl	5405.66	LaO		3.0	5714.02	I	7012-24508
1.8 bl	5407.69	LaO		1.0	5714.55	I	9961-27455
2.0	5415.68	I	7490-25950	3.5	5720.02	I	3495-20972
3.0	5429.86	I	7231-25643	2.0	5727.29	II	5250-22705
1.6	5437.54	I	7231-25617	3.0	5734.95	I	9961-27393
38	5455.15	I	1053-19379	14	5740.66	I	2668-20083
2.5	5458.69	II	18895-37210	1.4	5742.94	I	7231-24639
3.5	5464.38	II	6227-24523	12	5744.41	I	7680-25083
1.0	5466.92	I	8052-26339	12	5761.84	I	2668-20019
3.0	5475.17	I		12	5769.07	II	10095-27424
2.0	5480.73	II	17212-35453	28	5769.34	I	3010-20338
5	5482.27	II	0-18236	6	5769.99	I	8052-25378
2.0	5491.07	I	7012-25218	24	5789.24	I	3495-20763
3.0	5493.45	II	1016-19215	34	5791.34	I	4122-21384
36	5501.34	I	0-18172	17	5797.58	II	1971-19215
2.0	5502.25	I	9920-28089	12	5805.78	II	1016-18236
1.4	5502.67	I	3495-21663	0.8	5808.06		
7	5503.81	I	4122-22286	4	5808.32	II	0-17212
4	5506.00	I	0-18157	11	5821.99	I	9961-27132
3.0	5515.28	I	7490-25617	4	5823.83	I	8052-25218
5	5517.34	I	9920-28040	1.8	5827.56	I	9184-26339

## Lanthanum — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
6	5829.72	I	7490-24639	1.2	6107.27	I	3010-19379
1.2	5839.79	I	1053-18172	6	6108.48	I	7680-24046
1.8	5845.03	I	1053-18157	3.5	6111.72	I	8052-24410
5	5848.38	I	13260-30354	6	6126.09	II	10095-26414
1.0	5848.95	II	21442-38534	2.0	6127.05	I	8446-24763
2.5 h	5852.27	I	7680-24763	6	6129.56	II	6227-22537
6	5855.58	I	3010-20083	4	6134.39	I	7231-23528
6	5863.71	II	7473-24523	1.8 h	6142.98	I	
1.2 bl	5866.42	LaO		1.0	6145.30	I	15020-31288
1.2 bl	5869.50	LaO		1.4	6146.53	II	1971-18236
1.2	5869.95	I	8052-25083	6	6165.70	I	7490-23705
1.6	5874.00	II	6227-23247	2.5	6172.73	II	1016-17212
3.5	5874.73	I	7490-24508	2.0	6188.09	II	23247-39403
1.6	5877.63	I	3010-20019	1.2	6203.51	II	22106-38221
1.2	5877.99	I		1.0	6218.20	I	9920-25997
5	5880.64	II	1895-18895	2.5	6233.51	I	7490-23528
1.2 bh	5893.57	LaO		2.5 h	6234.86	I	9184-25218
5	5894.85	I	7680-24639	1.4 h	6236.17	I	
1.2 bh	5896.67	LaO		1.0 h	6236.74	I	7231-23261
0.8	5900.75	I	7231-24174	1.4 h	6238.59	I	7680-23705
1.2	5901.96	II	22283-39222	55	6249.93	I	4122-20117
1.2	5904.30	I	8052-24984	20 d	6262.30	II	3250-19215
3.5	5917.63	I	1053-17947	7	6266.02	I	9920-25875
1.2 bh	5920.84	LaO		1.0	6273.76	II	24523-40458
1.2 bh	5923.97	LaO		1.4	6287.74	I	9184-25083
1.2	5927.71	II	22537-39403	1.2	6288.56	I	9719-25617
1.6	5928.49	I	7012-23875	5	6293.57	I	3495-19379
24	5930.62	I	1053-17910	14	6296.09	II	10095-25973
	5930.68	I	0-16857	1.6	6305.46	II	1971-17826
5	5935.24	I	3495-20338	1.2	6310.14	I	
4	5936.22	II	1394-18236	2.5	6310.92	II	21332-37173
1.0	5940.83	I	7680-24508	1.2	6318.26	I	8052-23875
1.4 h	5948.30	II	20403-37210	12	6320.39	II	1394-17212
2.0	5960.59	I	8446-25218	8	6325.91	I	1053-16857
1.2	5962.60	I	9184-25950	2.5	6358.13	II	5718-21442
1.2	5965.30	I		2.5	6360.22	I	9044-24763
1.0	5971.09	II	10095-26838	13	6390.48	II	2592-18236
3.5	5973.53	II	22283-39019	34	6394.23	I	3495-19129
1.4 h	5975.75	I	7680-24410	4	6399.05	II	21332-36955
2.0	5982.35	I	2668-19379	16	6410.99	I	3010-18604
1.2	5992.36	I	7490-24174	2.5	6446.61	II	22283-37791
5	6007.36	I	4122-20763	1.6	6448.11	I	2668-18172
1.2	6017.16	I	13260-29875	1.0	6450.34	I	9719-25218
4	6038.59	I	7490-24046	7 c	6454.52	I	2668-18157
1.0	6041.55	I		19	6455.99	I	1053-16538
1.0	6067.14	II	6227-22705	1.0 h	6468.44	I	9184-24639
3.5	6068.68	I	7231-23705	1.8 h	6485.55	I	8052-23467
1.0	6072.05	I	8446-24910	3.0	6498.19	II	20403-35788
1.2 h	6084.89	I	16857-33287	0.8	6506.23	I	14096-29461
3.0	6100.38	II	5718-22106	1.6 h	6520.74	I	



Lanthanum — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
8	6526.99	II	1895-17212	1.2 b	7054.80	LaO	
0.8 h	6529.73	II	7395-22705	15	7066.23	II	0-14148
10	6543.16	I	2668-17947	6	7068.37	I	1053-15197
2.0	6565.44	I	1053-16280	2.0 bl	7070.79	LaO	
0.6	6570.96	II	6227-21442	1.2	7076.38	I	
11	6578.51	I	0-15197	2.0 bl	7085.40	LaO	
0.8	6582.19	I	16099-31288	2.5 bl	7101.02	LaO	
3.5	6593.46	I	3010-18172	1.0 h	7116.8	II	7395-21442
2.5	6600.17	I	3010-18157	1.8 bl	7131.58	LaO	
3.5	6608.26	I	9961-25090	1.0	7149.77	I	7680-21663
4	6616.59	I	3495-18604	4 h	7158.08	I	1053-15020
0.8	6631.21	I		5	7161.25	I	7012-20972
0.8	6636.53	II	7473-22537	1.0	7162.60	LaO	
2.0	6642.79	II	20403-35453	2.0	7219.91	I	3010-16857
2.5	6644.41	I	1053-16099	1.0 b	7257.16	LaO	
1.4	6645.16	I	16243-31288	2.5	7270.09	I	7012-20763
6	6650.81	I	0-15032	1.0	7270.30	I	1053-14804
7	6661.40	I	4122-19129	10 cw	7282.34	II	1971-15699
3.0 c	6671.40	II	3250-18236	1.0	7320.91	I	1053-14709
3.5	6692.87	I	3010-17947	10 cw	7334.18	I	0-13631
0.7	6699.25	I		6	7345.34	I	8052-21663
0.8	6699.85	I		5 bl	7379.71	LaO	
15	6709.50	I	3010-17910	8 bl	7380.08	LaO	
1.6	6714.09	II	22283-37173	3.5	7382.73	I	9719-23261
0.6	6718.68	II	24523-39403	10 bl	7403.52	LaO	
0.6	6732.78	II	22106-36955	20 bl	7403.75	LaO	
3.0	6748.13	I	8446-23261	5 b	7411.34	LaO	
5	6753.04	I	0-14804	6 bl	7434.28	LaO	
10	6774.26	II	1016-15774	10 bl	7434.36	LaO	
0.6	6796.73	I	0-14709	3.0 b	7442.92	LaO	
2.5 h	6808.86	II	1016-15699	5 h	7463.08	I	8052-21448
1.2	6813.66	II	22537-37210	5 bl	7465.25	LaO	
4	6823.78	I	7012-21663	9 bl	7465.48	LaO	
3.0	6834.05	II	1971-16599	7 cw	7483.50	II	1016-14375
2.0	6837.90	II	2592-17212	4 bl	7496.50	LaO	
0.7 h	6859.03	II	3250-17826	9 bl	7496.78	LaO	
1.8	6917.24	I	3495-17947	5	7498.83	I	8052-21384
1.0	6918.30	I	1053-15504	3.0 b	7506.79	LaO	
6	6925.24	I	7012-21448	1.8 bl	7528.21	LaO	
4	6935.01	I	3495-17910	5 bl	7528.39	LaO	
0.7 h	6952.51	II	1394-15774	3.0	7533.59	I	3010-16280
1.8 h	6954.52	II	0-14375	8	7539.23	I	0-13260
3.0	6958.10	II	10095-24463	3.5 bl	7560.09	LaO	
1.0	6976.86	I		3.5 bl	7592.26	LaO	
1.2 b	6996.89	LaO		1.8 h	7612.94	II	1016-14148
1.2 b	7011.22	LaO		1.8 b	7624.99	LaO	
7	7023.67	I	8052-22286	2.0	7664.34	I	3495-16538
2.5	7032.05	I	9044-23261	1.4 h	7841.80	I	3495-16243
2.5 b	7040.84	LaO		2.0 b	7876.87	LaO	
10	7045.96	I	2668-16857	7 bl	7877.22	LaO	

## Lanthanum — All Observed Lines

Intensity and Character	Wave- length in Å	Spec- trum	Energy Levels in K	Intensity and Character	Wave- length in Å	Spec- trum	Energy Levels in K
7	bl	7910.19	LaO	0.8	b	8453.55	LaO
14	bl	7910.54	LaO	0.8	h	8467.62	I 20117-31924
5	b	7944.61	LaO	2.5		8476.48	I 3010-14804
10	bl	7944.95	LaO	1.2	h	8507.37	I 8446-20197
4		7964.83	I 2668-15220	1.2	h	8513.57	I 9920-21663
3.5	b	7979.34	LaO	0.8	h	8514.65	II 7473-19215
7	bl	7979.70	LaO	1.6	b	8526.59	LaO
3.5	h	8001.89	I 3010-15504	1.6	c	8543.46	I 9961-21663
2.0	b	8014.43	LaO	6		8545.44	I 3010-14709
6	bl	8014.79	LaO	1.4	b	8563.54	LaO
3.0	b	8019.48	LaO	0.9	h	8590.94	I 8446-20083
3.5	hc	8051.39	I 4122-16538	0.9	b	8600.81	LaO
7		8086.05	I 2668-15031	0.7	h	8624.22	I 7012-18604
1.4	b	8122.20	LaO	1.4		8638.47	I 8446-20019
1.4	b	8159.02	LaO	1.8	hw	8672.11	I 9920-21448
0.7	h	8203.38	I 3010-15197	4		8674.43	I 3495-15020
5		8247.44	I 4122-16243	1.2	h	8720.41	I 9920-21384
1.2	h	8316.04	I 3010-15031	3.5		8748.38	I 2668-14096
8		8324.69	I 3495-15504	1.8		8818.93	I
9		8346.53	I 4122-16099	3.5		8825.82	I 8052-19379
0.8	h	8379.80	I 19129-31060	2.0		8839.63	I 3495-14804

**LEAD**

Pb,  $Z=82$ ,  $M=207.21$ , Ratio  $\frac{\text{Pb}}{\text{Cu}}=3.261$

Pb I Normal state of valence electrons  $6s^26p^2\ ^3P_0=0$ . I.P.= 59821 K  
 Pb II Normal state of valence electrons  $6s^26p^1\ ^2P_{0\frac{1}{2}}=0$ . I.P.=121243 K

References

Wavelengths:

G. R. Harrison, Massachusetts Institute of Technology Wavelength Tables (John Wiley & Sons, New York, 1939).  
 W. F. Meggers, unpublished material (1955).

Classification:

Pb I, W. F. Meggers, unpublished material (1955).  
 Pb II, L. T. Earls and R. A. Sawyer, Phys. Rev. **47**, 115 (1935).

Intensities:

H. Engler, Z. Physik **144**, 343 (1956).

**Relative intensity of lead lines observed in an arc of copper containing 0.1 atomic percent of lead**

*Strong lines of lead*

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
3400	4057.83	I	10650-35287	$6s^26p^2\ ^3P_2-6s^26p^17s^1\ ^3P_1^{\circ}$
1400	3683.48	I	7819-34960	$6s^26p^2\ ^3P_1-6s^26p^17s^1\ ^3P_0^{\circ}$
1000	2801.99	I	10650-46329	$6s^26p^2\ ^3P_2-6s^26p^16d^1\ ^3F_3^{\circ}$
950	2833.06	I	0-35287	$6s^26p^2\ ^3P_0-6s^26p^17s^1\ ^3P_1^{\circ}$

**Lead — All Observed Lines**

Intensity and Character	Wave- length in A	Spec- trum	Energy Levels in K	Intensity and Character	Wave- length in A	Spec- trum	Energy Levels in K
5	2022.02	I	0-49440	300	2663.16	I	10650-48189
8	2053.27	I	0-48687	1000	2801.99	I	10650-46329
22	2169.99	I	0-46069	410	2823.20	I	10650-46061
9	2203.53	II	14081-59448	950	2833.06	I	0-35287
2.0	2246.88	I	7819-52312	280	2873.32	I	10650-45443
2.0	2332.44	I	10650-53511	3.0	3220.57	I	21458-52500
1.8	2388.80	I	10650-52500	110	3572.74	I	21458-49440
90	2393.79	I	10650-52412	550	3639.58	I	7819-35287
1.8	2399.60	I	10650-52312	34	3671.51	I	21458-48687
36	2401.95	I	7819-49440	1400	3683.48	I	7819-34960
8	2411.73	I	10650-52102	280	3739.95	I	21458-48189
1.6	2428.63	I	21458-62621	40	4019.64	I	21458-46329
36	2443.84	I	7819-48726	3400	4057.83	I	10650-35287
65	2446.19	I	7819-48687	55	4062.14	I	21458-46069
130	2476.38	I	7819-48189	13	4168.03	I	21458-45443
110	2577.27	I	10650-49440	9	5005.44	I	29467-49440
50	2613.65	I	7819-46069	3.5	5201.47	I	29467-48687
700	2614.18	I	7819-46061	0.8	6001.93	I	35287-51944
24	2628.28	I	10650-48687	14	7229.00	I	21458-35287
1.6	2657.09	I	7819-45443				

# LITHIUM

$$\text{Li, } Z=3, M=6.940, \text{ Ratio } \frac{\text{Li}}{\text{Cu}}=0.1092$$

Li I Normal state of valence electrons  $1s^2 2s^1 \ ^2S_{0\frac{1}{2}}=0$ . I.P.= 43487 K  
 Li II Normal state of valence electrons  $1s^2 \ ^1S_0=0$ . I.P.=610079 K

## References

### Wavelengths:

G. R. Harrison, Massachusetts Institute of Technology Wavelength Tables (John Wiley & Sons, New York, 1939).  
 R. W. France, Proc. Roy. Soc. (London) [A] **129**, 340 (1930).

### Classification:

Li I, A. Fowler,, Report on Series in Line Spectra (Fleetway Press, London, 1922).

### Intensities:

A. Filippov, Z. Physik **69**, 526 (1931).  
 G. Stephenson, Nature **167**, 156 (1951).

## Relative intensity of lithium lines observed in an arc of copper containing 0.1 atomic percent of lithium

### *Strong line of lithium*

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
3600	6707.84	I	0-14904	$1s^2 2s^1 \ ^2S_{0\frac{1}{2}} - 1s^2 2p^1 \ ^2P_{0\frac{1}{2}, 1\frac{1}{2}}$

## Lithium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
5	2741.20	I	0-36470	320	6103.64	I	14904-31283
17	3232.61	I	0-30925	3600	6707.84	I	0-14904
13 hl	4602.86	I	14904-36623	48	8126.52	I	14904-27206
8 h	4971.99	I	14904-35012				

# LUTETIUM

Lu,  $Z=71$ ,  $M=174.99$ , Ratio  $\frac{\text{Lu}}{\text{Cu}}=2.754$

Lu I Normal state of valence electrons  $5d^1 6s^2 \ ^2D_{1/2}=0$ . I.P.= 49600 K  
 Lu II Normal state of valence electrons  $6s^2 \ ^1S_0=0$ . I.P.=118000 K  
 Lu III Normal state of valence electrons  $6s^1 \ ^2S_1=0$ .

## References

Wavelengths, Spectrum Assignments and Molecular Spectra (LuO):  
 W. F. Meggers and B. F. Scribner, J. Research NBS **19**, 31 (1937).

### Classification:

Lu I, P. F. A. Klinkenberg, Physica **21**, 53 (1954).  
 Lu II, L. F. H. Bovey and R. W. B. Pearse, Atomic Energy Research Establishment C/R  
 1976 (Harwell, 1956).  
 Lu III, W. F. Meggers and B. F. Scribner, J. Research NBS **5**, 73 (1930).

## Relative intensity of lutetium lines observed in an arc of copper containing 0.1 atomic percent of lutetium

### *Strong lines of lutetium*

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
1200	2615.42	II	0-38223	$6s^2 a \ ^1S_0 - 6s6p \ z \ ^1P_1$
600	2911.39	II	14199-48537	$5d6s a \ ^3D_3 - 6s6p \ z \ ^3F_4$
500	3077.60	II	12435-44919	$5d6s a \ ^3D_2 - 6s6p \ z \ ^3F_3$
480c	3507.39	II	0-28503	$6s^2 a \ ^1S_0 - 6s6p \ z \ ^3P_1$
440	3281.74	I	1994-32457	$5d6s^2 \ ^2D_{3/2} - 32457_{1/2, 2/2}$
440	3359.56	I	1994-31751	$5d6s^2 \ ^2D_{3/2} - 5d6s6p \ ^2F_{3/2}$
420	2894.84	II	14199-48733	$5d6s a \ ^3D_3 - 6s6p \ z \ ^3D_3$
360	3312.11	I	0-30184	$5d6s^2 \ ^2D_{1/2} - 5d6s6p \ ^2D_{1/2}$
360	3376.50	I	0-29608	$5d6s^2 \ ^2D_{1/2} - 5d6s6p \ ^2F_{3/2}$
340h	3081.47	I	1994-34436	$5d6s^2 \ ^2D_{3/2} - 6s^2 7p \ ^2P_{1/2}$
340	4518.57	I	0-22125	$5d6s^2 \ ^2D_{1/2} - 5d6s6p \ ^2D_{1/2}$

Lutetium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
7	h	2195.54	II	0-45532	120		0-33443
4		2236.17	III	0-44705	200		12435-45532
1.0		2276.94	II	27264-71169	8		12435-45458
2.5		2297.41	II	28503-72017	140		14199-46904
55		2392.19	II	17332-59122	9		6304-38997
5		2399.14	II	32453-74122	500		12435-44919
4		2419.21	II	38223-79547	26		0-32457
3.5		2430.26	II	32453-73588	340	h	1994-34436
10		2459.64	II	12435-53079	200		0-31523
6		2469.27	II	28503-68989	140		
16	h	2481.72	II	32453-72736	6		17332-48733
28		2536.95	II	11796-51202	15		32453-63774
3.0		2546.87	II	32453-71705	80		14199-45458
3.0	d	2549.52	I		280		14199-44919
2.5		2561.80	II	12435-51458	220		0-30489
70		2571.23	II	14199-53079	440		1994-32457
130		2578.79	II	12435-51202	360		0-30184
6	h	2582.13	II	32453-71169	440		1994-31751
38	c	2603.33	III	6304-44705	360		0-29608
120		2613.40	II	11796-50049	55		1994-31523
1200		2615.42	II	0-38223	9	h	3391.55
120		2619.26	II	11796-49963	80		3396.82
6		2657.05			240		3397.07
180		2657.80	II	12435-50049	280		3472.48
6	h	2677.25	I		480	c	3507.39
38	h	2685.08	I	4136-41368	95		3508.42
6	h	2685.54	I		280		3554.43
280		2701.71	II	14199-51202	280		3567.84
6	h	2715.91	I		20		3596.34
12	d	2719.09	I		65		3623.99
32	h	2728.95	I	0-36633	55		3636.25
5	c	2738.17	II	27264-63774	210		3647.77
240		2754.17	II	12435-48733	5		3684.32
50	h	2765.74	I	4136-40282	5		3710.95
26		2772.58	III	8648-44705	9		3756.70
180		2796.63	II	17332-53079	9		3756.79
2.5		2821.23	III		2.5	h	3786.18
18	c	2834.35	II	28503-63774	12		3800.67
22	h	2845.13	I	1994-37131	6	h	3829.07
200		2847.51	II	11796-46904	220		3841.18
38	h	2885.14	I		8		3843.61
420		2894.84	II	14199-48733	10		3853.29
300		2900.30	II	12435-46904	4		3874.61
20		2903.05	I	0-34436	55		3876.65
600		2911.39	II	14199-48537	3.0		3911.77
18	h	2949.73	I	7476-41368	5		3918.86
80		2951.69	II	17332-51202	3.5	h	3926.62
4		2955.78	II		50		3968.46
280		2963.32	II	11796-45532	5		3991.38
160		2969.82	II	11796-45458	70		4054.45

## Lutetium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
8	bl			70			
3.5	h			5	h		
10	h		0-24308	12			
32				240			
320			7476-31714	11	bl		LuO
16	c			15			
48			7476-31542	8			
2.5				3.5			
170		II	17332-41225	7			
16		I		44			0-18505
26				12	c		1994-20433
34	d		7476-30748	9			
			7476-30747	3			4136-22468
16			1994-25192	180		II	14199-32453
8				0.8		II	30889-48537
3.0		II	36098-59122	1.2		II	29407-46904
7	h		21462-44076	48		I	0-17427
20	c			5		I	20433-37743
3.5				7		I	
20			7476-29938	3.5	h		22222-39279
5	h			0.8		I	7476-24518
6	h		0-22222	60	cw	II	11796-28503
340			0-22125	12		I	22609-39279
2.5	b			120		I	7476-24125
2.5	b			3.0	h		21195-37743
8	c		18851-40559	38		I	1994-18505
9	h			1.0		I	21462-37743
10	h			13		II	32504-48733
9	h			14		II	29407-45532
6	b			180		II	12435-28503
100			0-21462	3.0		II	29407-45458
8	h			7		II	32504-48537
60	bl			14		II	30889-46904
30	bl			1.4	h		21195-37194
40	bl			6	h		23524-39279
26	bl			1.6	h		21462-37194
18	bl			0.8		I	21195-36900
3.0			0-21195	1.4			
6	b			1.9		I	22222-37743
6	h			1.0		II	29407-44919
10	bl			95		II	11796-27264
7	bl			2.5		I	1994-17427
4	bl			5	c		
14		II	17332-38223	3.0	cw	II	17332-32453
8		I	0-20762				6611.58
5	c		11796-32453				6611.80
1.6		II	38575-59122				6611.95
40		I	4136-24518				6612.04
16		I	1994-22222	1.0		II	36098-51202
70		II	12435-32453	3.0	c		22222-37194

Lutetium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
1.2 h	6735.76	I	20433-35275	0.8	7409.70	II	36557-50049
4 c	6793.77	I	4136-18851	2.0 c	7441.52	I	24308-37743
1.4	6826.59	II	36557-51202	1.4	7456.96	II	36557-49963
8	6917.31	I		1.2 ch	7640.08	I	24109-37194
1.4	6943.96	II	35652-50049	1.2 cw	7758.30	I	24308-37194
4	7031.24	I	23524-37743	1.2 h	7815.9	I	24109-36900
2.5 c	7096.34	I	25192-39279	1.6 c	8178.16	I	
8	7125.84	II	30889-44919	3.0	8382.08	I	7476-19403
1.6	7142.79	I		6	8459.19	II	29407-41225
1.2	7143.10	I		1.8 d	8478.50	I	
1.4	7165.94	II	36098-50049	5 c	8508.08	I	23524-35275
2.5 ch	7237.98	I	21462-35275	6 c	8610.98	I	22222-33832



# MAGNESIUM

Mg,  $Z=12$ ,  $M=24.32$ , Ratio  $\frac{Mg}{Cu}=0.383$

Mg I Normal state of valence electrons  $2p^63s^2^1S_0=0$ . I.P.= 61669 K  
 Mg II Normal state of valence electrons  $2p^63s^1^2S_{0\frac{1}{2}}=0$ . I.P.=121267 K

## References

### Wavelengths:

G. R. Harrison, Massachusetts Institute of Technology Wavelength Tables (John Wiley & Sons, New York, 1939).

### Classification:

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 Mg II, A. Fowler, Report on Series in Line Spectra p. 118 (Fleetway Press, London, 1922).

### Intensities:

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## Relative intensity of magnesium lines observed in an arc of copper containing 0.1 atomic percent of magnesium

### *Strong lines of magnesium*

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
6000	2852.13	I	0-35051	$3s^2^1S_0 - 3s^13p^1^1P_1$
1000	2795.53	II	0-35761	$3s^1^2S_{0\frac{1}{2}} - 3p^1^2P_{1\frac{1}{2}}$
600	2802.70	II	0-35669	$3s^1^2S_{0\frac{1}{2}} - 3p^1^2P_{0\frac{1}{2}}$

## Magnesium — All Observed Lines

Intensity and Character	Wave- length in A	Spec- trum	Energy Levels in K	Intensity and Character	Wave- length in A	Spec- trum	Energy Levels in K
38	2776.69	I	21870-57874	2.0 h	2942.11	I	21911-55892
32	2778.29	I	21850-57833	14 hl	3096.90	I	21911-54192
90	2779.83	I	21911-57874	6	3332.15	I	21870-51872
		I	21870-57833	9	3336.68	I	21911-51872
32	2781.42	I	21870-57813	140	3829.35	I	21850-47957
36	2782.97	I	21911-57833	300	3832.31	I	21870-47957
13	2790.79	II	35669-71491	500	3838.26	I	21911-47957
1000	2795.53	II	0-35761	7	4703.02	I	35051-56308
16	2798.06	II	35761-71490	75	5167.34	I	21850-41197
600	2802.70	II	0-35669	220	5172.70	I	21870-41197
6000	2852.13	I	0-35051	400	5183.62	I	21911-41197
1.6	2928.75	II	35669-69805	6 h	5528.46	I	35051-53135
3.0	2936.54	II	35761-69805	14	8806.79	I	35051-46403

MANGANESE

$$\text{Mn, } Z=25, M=54.94, \text{ Ratio } \frac{\text{Mn}}{\text{Cu}}=0.865$$

Mn I Normal state of valence electrons  $3d^5 4s^2 {}^6S_{2\frac{1}{2}}=0$ . I.P.= 59960 K  
 Mn II Normal state of valence electrons  $3d^5 4s^1 {}^7S_3=0$ . I.P.=126147 K

References

Wavelengths:

G. R. Harrison, Massachusetts Institute of Technology Wavelength Tables (John Wiley & Sons, New York, 1939).

Classification:

Mn I, O. G. Riquelme, Anales Soc. Esp. Fis. y Quim. **45A**, 435 and 547 (1949). M. A. Catalán, W. F. Meggers, O. G. Riquelme, and R. Velasco (monograph in preparation).  
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Relative intensity of manganese lines observed in an arc of copper containing 0.1 atomic percent of manganese

*Strong lines of manganese*

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
2000	4030. 76	I	0-24802	$3d^5 4s^2$ $a {}^6S_{2\frac{1}{2}}-3d^5 4s^1 4p^1 z {}^6P_{3\frac{1}{2}}$
1400	4033. 07	I	0-24788	$3d^5 4s^2$ $a {}^6S_{2\frac{1}{2}}-3d^5 4s^1 4p^1 z {}^6P_{2\frac{1}{2}}$
1200	2576. 10	II	0-38807	$3d^5 4s^1$ $a {}^7S_3-3d^5 4p^1 z {}^7P_{4\frac{1}{2}}$
800	2593. 73	II	0-38543	$3d^5 4s^1$ $a {}^7S_3-3d^5 4p^1 z {}^7P_{3\frac{1}{2}}$
800	2794. 82	I	0-35770	$3d^5 4s^2$ $a {}^6S_{2\frac{1}{2}}-3d^5 4s^1 4p^1 y {}^6P_{3\frac{1}{2}}$
800	4034. 49	I	0-24779	$3d^5 4s^2$ $a {}^6S_{2\frac{1}{2}}-3d^5 4s^1 4p^1 z {}^6P_{1\frac{1}{2}}$
650	2798. 27	I	0-35726	$3d^5 4s^2$ $a {}^6S_{2\frac{1}{2}}-3d^5 4s^1 4p^1 y {}^6P_{2\frac{1}{2}}$
550	2605. 69	II	0-38366	$3d^5 4s^1$ $a {}^7S_3-3d^5 4p^1 z {}^7P_{2\frac{1}{2}}$
480	2801. 06	I	0-35690	$3d^5 4s^2$ $a {}^6S_{2\frac{1}{2}}-3d^5 4s^1 4p^1 y {}^6P_{1\frac{1}{2}}$
420	4041. 36	I	17052-41790	$3d^6 4s^1$ $a {}^6D_{4\frac{1}{2}}-3d^6 4p^1 z {}^6D_{4\frac{1}{2}}$
360	3806. 72	I	17052-43314	$3d^6 4s^1$ $a {}^6D_{4\frac{1}{2}}-3d^6 4p^1 z {}^6F_{5\frac{1}{2}}$
340	3569. 49	I	18705-46713	$3d^5 4s^1 4p^1 z {}^8P_{4\frac{1}{2}}-3d^5 4s^1 4d^1 e {}^8D_{5\frac{1}{2}}$
240	2949. 20	II	9473-43370	$3d^5 4s^1$ $a {}^5S_2-3d^5 4p^1 z {}^5P_{3\frac{1}{2}}$
240	3823. 51	I	17282-43429	$3d^6 4s^1$ $a {}^6D_{3\frac{1}{2}}-3d^6 4p^1 z {}^6F_{4\frac{1}{2}}$

Manganese — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
6	1995.40	I	0-50099	14	2688.25	II	
9	1998.86	I	0-50013	11	2692.66	I	25266-62393
12	2003.82	I	0-49888	3.5	2693.19	II	29889-67009
3.0	2092.13	I	0-47782	7	2695.36	II	29919-67009
4	2109.58			3.5	2698.97	II	29889-66929
2.0	2208.81	I	0-45259	11	2701.00	II	29889-66901
4	2213.85	I	0-45156	20	2701.70	II	27547-64550
6	2221.83	I	0-44994	16	2705.74	II	27571-64519
8	2533.06	I	25266-64732	10	2707.53	II	27571-64494
5	2543.45	II	27589-66894	14	2708.45	II	27583-64494
8	2556.57	II	27583-66686	6	2709.96	II	27583-64473
10	2558.59	II	27571-66643	10	2710.33	II	27588-64473
15	2563.65	II	27547-66542	14	2711.58	II	27588-64456
60	2572.76	I	18532-57389	7	2728.61	II	
50	2575.51	I	18402-57218	4	2738.86	I	30354-66855
1200	2576.10	II	0-38807	6	h 2760.93	I	17052-53261
70	2584.31	I	18705-57389	4	2771.44	I	17052-53124
6	2589.71	II	32788-71390	4	h 2776.23	I	17282-53291
32	2592.94	I	18532-57086	4	2780.00	I	23297-59257
800	2593.73	II	0-38543	7	2789.20	I	17282-53124
32	2595.76	I	18705-57218	8	2790.36	I	17282-53109
12	2598.90	II	29951-68417	8	2791.08	I	17052-52870
		II	32857-71323	800	2794.82	I	0-35770
5	2602.14	I		650	2798.27	I	0-35726
6	2603.72	II	29889-68284	28	2799.84	I	17052-52758
550	2605.69	II	0-38366	480	2801.06	I	0-35690
24	2610.20	II	27547-65847	9	2804.10	I	17452-53103
18	2622.90	I	25281-63395	8	2806.14	I	25266-60891
19	2624.04	I	25266-63363	7	2808.02	I	17282-52884
5	2624.80	II	27571-65658	14	2809.11	I	17282-52870
26	2625.58	II	27583-65658	8	2812.84	I	17568-53109
12	2626.64	I	18402-56462	9	2813.47	I	17568-53101
4	2630.26	I	25281-63289	8	2815.02	II	35004-70518
8	2630.57	I	25285-63289	11	2817.97	I	17282-52758
24	2632.35	II	27588-65566	5	2818.77	I	17637-53103
16	2638.17	II	27589-65483	7	2821.45	I	17452-52884
10	2639.84	II	32788-70657	7	2822.55	I	17452-52870
3.5	2650.99	II	32788-70497	10	2830.79	I	17568-52884
8	2655.91	II	32857-70497	3.5	2836.31	I	17637-52884
6	2667.00	I	18705-56190	8	2870.08	II	
14	2672.59	II	29889-67295	10	2879.49	II	33147-67866
7	2673.37	II	32836-70231	5	2882.90	I	17452-52129
7	2674.43	II	33147-70527	9	2886.68	II	33278-67910
4	2676.33	I	23549-60903	20	2889.58	II	33248-67846
6	2680.34	II	33248-70546	7	2892.39	II	33248-67812
5	2681.72	I		10	2900.16	II	36274-70745
6	2683.02	I		5	2907.22	I	25266-59653
3.0	2683.75	I		18	h 2914.60	I	18402-52702
7	2684.55	II	33278-70518	24	h 2925.57	I	18532-52703
7	2685.94	II	30523-67744	3.5	2928.68	I	25281-59416

Manganese — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
140	2933.06	II	9473-43557	10	3320.69	I	17282-47388
3.5	2934.02	I	25288-59361	11	3330.67	I	17452-47467
190	2939.30	II	9473-43485	110	3441.99	II	14326-43370
32	2940.39	I	18705-52705	55	3460.33	II	14594-43485
	2940.48	I	18705-52703	55	h 3474.04	II	14594-43370
					3474.13	II	14781-43557
8	2941.04	I	25266-59257				
240	2949.20	II	9473-43370	44	3482.91	II	14781-43485
5	3007.66	I	25281-58520	28	3488.68	II	14901-43557
5	3011.16	I	25286-58486	22	3495.84	II	14960-43557
5	3011.38	I	25288-58486	8	3496.81	II	14781-43370
5	3014.67	I	25266-58427	16	3497.54	II	14901-43485
8	3016.45	I	25286-58427	55	3531.85	I	18402-46708
9	3022.75	I	25266-58339		3532.00	I	18402-46707
7	3031.06	II	34762-67744	170	3532.12	I	18402-46706
12	3040.60	I	25281-58160	200	3547.80	I	18532-46710
3.5	3042.73	I	25281-58137	170	3548.03	I	18532-46708
11	3043.36	I	25288-58137	60	3548.20	I	18532-46707
42	3044.57	I	17052-49888	340	3569.49	I	18705-46713
15	3045.59	I	25286-58110	110	3569.80	I	18705-46710
26	3047.04	I	25266-58075		3570.04	I	18705-46708
5	3048.86	I	25286-58075	220	3577.88	I	17052-44994
32	3054.36	I	17282-50012	110	3586.54	I	17282-45156
18	3062.12	I	17452-50099	44	3595.12	I	17452-45259
22	3066.02	I	17282-49888	65	3607.54	I	17282-44994
22	3070.27	I	17452-50012	65	3608.49	I	17452-45156
20	3073.13	I	17569-50099	55	3610.30	I	17569-45259
14	3079.63	I	17637-50099	44	3619.28	I	17637-45259
8	3081.33	I	17569-50012	34	3623.79	I	17569-45156
3.5	3082.05	I	17452-49888	22	3629.74	I	17452-44994
6	3097.06	I	27248-59527	16	3660.40	I	37420-64732
6	3110.68	I	27201-59339	11	3670.52	I	17052-44289
9	h 3148.18	I	18403-50158	11	3676.96	I	37631-64820
14	h 3161.04	I	18532-50158	8	3682.09	I	37737-64888
22	h 3178.50	I	18705-50158	32	3693.67	I	34139-61205
34	3212.88	I	17052-48168	20	3696.57	I	23297-50341
10	3216.95	I	0-31076	8	3701.73	I	17282-44289
160	3228.09	I	17052-48021	24	3706.08	I	34251-61226
46	3230.72	I	17282-48226	15	3718.93	I	34344-61226
130	3236.78	I	17282-48168	6	3728.89	I	23549-50359
50	3243.78	I	17452-48271	15	3731.93	I	41404-68192
100	3248.52	I	17452-48226	30	3790.22	I	17052-43429
16	3251.14	I	17569-48318	6	3799.26	I	17282-43596
48	3252.95	I	17569-48301	12	3800.55	I	31001-57306
10	3254.04	I	17052-47774	6	3801.91	I	25266-51561
48	3256.14	I	17569-48271	360	3806.72	I	17052-43314
34	3258.41	I	17637-48318	80	3809.59	I	17282-43524
28	3260.23	I	17637-48301	6	3810.69	I	25281-51516
28	3264.71	I	17282-47904	10	3816.75	I	17452-43644
10	3296.88	I	17452-47774	240	3823.51	I	17282-43429
10	3298.22	I	27201-57512	44	3823.89	I	17452-43596

Manganese — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
15	3829.68	I	17568-43673	6	4148.80	I	34423-58520
36	3833.86	I	17568-43644	11	4176.60	I	34139-58075
100	3834.36	I	17452-43524	9	4189.99	I	34251-58110
26	3839.78	I	17637-43673	5	4201.76	I	34344-58136
50	3841.08	I	17568-43596	5	4211.75	I	34423-58160
26	3843.98	I	17637-43644	28	4235.14	I	23549-47155
5	3918.32	I	34139-59653	38	4235.29	I	23297-46901
9	3926.47	I	31001-56462	14	4239.72	I	23720-47299
5	3952.84	I	33825-59117	22	4257.66	I	23819-47299
4	3975.89	I	34845-59990	22	4265.92	I	23720-47155
5	3977.08	I	34463-59600	20	4281.10	I	23549-46901
10	3982.58	I	25281-50383	5	4284.08	I	23819-47155
11	3985.24	I	25288-50373	5	4312.55	I	23720-46901
14	3986.83	I	25266-50341	3.5	4374.95	I	27248-50099
11	3987.10	I	25286-50359	3.5	4381.70	I	38670-61485
110	4018.10	I	17052-41933	4	4411.88	I	38009-60668
11	4026.44	I	25266-50095	26	4414.88	I	23297-45941
2000	4030.76	I	0-24802	4	4419.78	I	38120-60739
1400	4033.07	I	0-24788	16	4436.35	I	23549-46084
800	4034.49	I	0-24779	60	4451.59	I	23297-45754
110	4035.73	I	17282-42054	12	4453.00	I	23720-46170
4	4038.73	I	30354-55108	10	4455.01	I	24779-47220
420	4041.36	I	17052-41790	12	4455.32	I	24779-47218
16	d 4045.13	I	34939-59653	8	4455.82	I	24779-47216
	4045.21	I	34139-58853	4	4457.04	I	24788-47218
80	4048.76	I	17452-42144	16	4457.55	I	24788-47216
6	4049.00	I	35041-59732	20	4458.26	I	24788-47212
4	4051.73	I		4	4460.38	I	24802-47216
5	4052.47	I	35115-59784	11	4461.08	I	24802-47212
11	4055.21	I	35165-59818	38	4462.02	I	24802-47207
140	4055.54	I	17282-41933	22	4464.68	I	23549-45941
16	4057.95	I	24779-49415	15	4470.14	I	23720-46084
80	4058.93	I	17569-42199	10	4472.79	I	23819-46170
11	4059.39	I	24788-49415	3.0	4479.40	I	
55	4061.74	I	24802-49415	13	4490.08	I	23819-46084
55	4063.53	I	17452-42054	18	4498.90	I	23720-45941
6	4065.08	I	34251-58843	18	4502.22	I	23549-45754
6	4068.00	I	17569-42144	6	4605.36	I	38120-59828
22	4070.28	I	17637-42199	6	4626.54	I	38009-59617
55	4079.24	I	17282-41790	2.5	4671.69	I	23297-44696
55	4079.42	I	17637-42144	4	4701.16	I	23549-44815
80	4082.94	I	17569-42054	13	4709.72	I	23297-44524
80	4083.63	I	17452-41933	14	4727.48	I	23549-44696
5	4089.94	I	34423-58867	10	4739.11	I	23720-44815
4	4105.36	I	34939-59290	80	4754.04	I	18403-39431
15	4110.90	I	34939-59257	14	4761.53	I	23819-44815
11	4131.12	I	34139-58339	60	4762.38	I	23297-44289
9	4135.04	I	34251-58427	24	4765.86	I	23720-44696
6	4141.06	I	34344-58486	40	4766.43	I	23549-44524
4	4147.53	I	27202-51306	75	4783.42	I	18532-39431

Manganese — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
80	4823.52	I	18705-39431	0.7	5573.68	I	35165-53101
2.0	4844.32	I	31001-51638	0.6	5738.29	I	34139-51561
3.0	4965.88	I	23297-43429	0.6	5780.19	I	34251-51546
1.6	5004.91	I	23549-43524	0.6	5816.84	I	34344-51531
2.5	5074.79	I	27202-46901	12	6013.50	I	24779-41404
5	5117.94	I	25281-44815	17	6016.64	I	24788-41404
4	5150.89	I	25288-44696	24	6021.80	I	24802-41404
4	5196.59	I	25286-44524	0.6	6384.67	I	30426-46084
7	5255.32	I	25266-44289	1.4	6440.97	I	30420-45941
13	5341.06	I	17052-35770	2.0	6491.71	I	30354-45754
1.6	5349.88	I	43314-62001	1.2 h	6942.52	I	41789-56190
8	5377.63	I	31001-49591	1.0	6989.96	I	42054-56356
8	5394.67	I	0-18532	1.2	7069.84	I	37420-51561
4	5399.49	I	31076-49591	1.0	7184.25	I	37631-51546
8	5407.42	I	17282-35770	0.8	7247.82	I	37737-51531
3.0	5413.69	I	31125-49591	2.0 h	7283.82	I	35690-49415
7	5420.36	I	17282-35726	3.0 h	7302.89	I	35726-49415
3.0	5432.55	I	0-18402	4.0	7326.51	I	35770-49415
1.0	5457.47	I	17452-35770	1.0	7680.20	I	44289-57306
5	5470.64	I	17452-35726	0.8	7712.42	I	44524-57486
3.5	5481.40	I	17452-35690	0.8 h	7764.72	I	43314-56190
2.5	5505.87	I	17568-35726	0.8 h	8670.92	I	35690-47220
4	5516.77	I	17568-35690	1.0 h	8672.06	I	35690-47218
3.5	5537.76	I	17637-35690	0.8 h	8673.97	I	35690-47216
1.8	5551.98	I	44289-62295	1.0 h	8701.05	I	35726-47216
0.7	5567.76	I	44523-62479	1.4 h	8703.76	I	35726-47212
0.6	5573.01	I	35165-53103	2.5 h	8740.93	I	35770-47207

# MERCURY

Hg,  $Z=80$ ,  $M=200.61$ , Ratio  $\frac{\text{Hg}}{\text{Cu}}=3.157$

Hg I Normal state of valence electrons  $5d^{10}6s^2\ ^1S_0=0$ . I.P.= 84184K  
 Hg II Normal state of valence electrons  $5d^{10}6s^1\ ^2S_{0\frac{1}{2}}=0$ . I.P.=151280K

## References

### Wavelengths:

G. R. Harrison, Massachusetts Institute of Technology Wavelength Tables (John Wiley & Sons, New York, 1939).

### Classification:

Hg I, K. Burns, K. B. Adams, and J. Longwell, J. Opt. Soc. Am. **40**, 339 (1950).

### Intensities:

R. Ladenburg and G. Wolfsohn, Z. Physik **65**, 207 (1930).

J. W. Schouten and J. A. Smit, Physica **10**, 661 (1943).

## Relative intensity of mercury lines observed in an arc of copper containing 0.1 atomic percent of mercury

### *Strong lines of mercury*

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
1500	2536. 52	I	0-39412	$5d^{10}6s^2\ ^1S_0-5d^{10}6s^16p^1\ ^3P_1$
400	4358. 35	I	39412-62350	$5d^{10}6s^16p^1\ ^3P_1-5d^{10}6s^17s^1\ ^3S_1$

## Mercury — All Observed Lines

Intensity and Character	Wave- length in A	Spec- trum	Energy Levels in K	Intensity and Character	Wave- length in A	Spec- trum	Energy Levels in K
1500	2536. 52	I	0-39412	30	3654. 83	I	44043-71396
6	2752. 78	I	37645-73961	8	3662. 88	I	44043-71336
10	2893. 60	I	39412-73961	24	3663. 28	I	44043-71333
120	2967. 28	I	37645-71336	180	4046. 56	I	37645-62350
20	3021. 50	I	44043-77129	12	4077. 81	I	39412-63928
40	3125. 66	I	39412-71396	400	4358. 35	I	39412-62350
32	3131. 55	I	39412-71336	320	5460. 74	I	44043-62350
32	3131. 83	I	39412-71333	24	hs 5769. 59	I	54069-71396
6	3341. 48	I	44043-73961	28	h 5790. 65	I	54069-71333
280	3650. 15	I	44043-71431				

# MOLYBDENUM

Mo,  $Z=42$ ,  $M=95.95$ , Ratio  $\frac{\text{Mo}}{\text{Cu}}=1.510$

Mo I Normal state of valence electrons  $4d^5 5s^1 {}^7S_3 = 0$ . I.P. = 57260 K

Mo II Normal state of valence electrons  $4d^5 {}^6S_{2\frac{1}{2}} = 0$ . I.P. = 130300 K

## References

Wavelengths:

G. R. Harrison, Massachusetts Institute of Technology Wavelength Tables (John Wiley Sons, New York, 1939).

Supplemented by Kiess, cited below.

Classification:

Mo I, C. C. Kiess, unpublished material.

Mo II, C. C. Kiess, J. Research NBS **60**, 375 (1958).

Intensities:

E. I. Nikonova and V. K. Prokofiev, Optika i Spektroskopiya **1**, 290 (1956).

## Relative intensity of molybdenum lines observed in an arc of copper containing 0.1 atomic percent of molybdenum

*Strong lines of molybdenum*

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
3200	3798.25	I	0-26320	$4d^5 5s^1 a {}^7S_3 - 4d^5 5p^1 z {}^7P_{\frac{1}{2}}$
2800	3864.11	I	0-25872	$4d^5 5s^1 a {}^7S_3 - 4d^5 5p^1 z {}^7P_{\frac{3}{2}}$
1800	3132.59	I	0-31913	$4d^5 5s^1 a {}^7S_3 - 4d^5 5s^1 5p^1 y {}^7P_{\frac{1}{2}}$
1800	3902.96	I	0-25614	$4d^5 5s^1 a {}^7S_3 - 4d^5 5p^1 z {}^7P_{\frac{3}{2}}$
1100	3170.35	I	0-31533	$4d^5 5s^1 a {}^7S_3 - 4d^5 5s^1 5p^1 y {}^7P_{\frac{3}{2}}$
950	3193.97	I	0-31300	$4d^5 5s^1 a {}^7S_3 - 4d^5 5s^1 5p^1 y {}^7P_{\frac{3}{2}}$
750	3158.16	I	0-31655	$4d^5 5s^1 a {}^7S_3 - 4d^5 5s^1 5p^1 z {}^7D_{\frac{3}{2}}$
480	5506.49	I	10768-28924	$4d^5 5s^1 a {}^5S_2 - 4d^5 5p^1 z {}^5P_{\frac{3}{2}}$
400	3447.12	I	12346-41348	$4d^4 5s^2 a {}^5D_4 - 4d^5 5p^1 y {}^5F_{\frac{3}{2}}$
380	3208.83	I	0-31155	$4d^5 5s^1 a {}^7S_3 - 4d^5 5s^1 5p^1 z {}^7D_{\frac{3}{2}}$
320	5533.05	I	10768-28837	$4d^5 5s^1 a {}^5S_2 - 4d^5 5p^1 z {}^5P_{\frac{3}{2}}$
280	4143.55	I		
240	3384.62	I	11859-41396	$4d^4 5s^2 a {}^5D_3 - 4d^5 5p^1 y {}^5F_{\frac{1}{2}}$
240	4188.32	I		
240	4411.57	I	16784-39445	$4d^5 5s^1 a {}^5G_6 - 4d^5 5p^1 z {}^5G_{\frac{5}{2}}$
240	4411.70	I	16785-39445	$4d^5 5s^1 a {}^5G_5 - 4d^5 5p^1 z {}^5G_{\frac{3}{2}}$
220	2775.40	II	13461-49481	$4d^4 5s^1 a {}^6D_{\frac{1}{2}} - 4d^4 5p^1 z {}^6P_{\frac{3}{2}}$
220	2816.15	II	13461-48960	$4d^4 5s^1 a {}^6D_{\frac{3}{2}} - 4d^4 5p^1 z {}^6F_{\frac{3}{2}}$
220	2848.23	II	12900-47999	$4d^4 5s^1 a {}^6D_{\frac{3}{2}} - 4d^4 5p^1 z {}^6F_{\frac{1}{2}}$
220	2871.51	II	12417-47232	$4d^4 5s^1 a {}^6D_{\frac{5}{2}} - 4d^4 5p^1 z {}^6F_{\frac{3}{2}}$
220	4069.88	I	16784-41348	$4d^5 5s^1 a {}^5G_6 - 4d^5 5p^1 y {}^5F_{\frac{3}{2}}$
200	3358.12	I	11454-41224	$4d^4 5s^2 a {}^5D_2 - 4d^5 5p^1 y {}^5F_{\frac{3}{2}}$
180	4381.64	I	16784-39600	$4d^5 5s^1 a {}^5G_6 - 4d^5 5p^1 z {}^5H_{\frac{7}{2}}$
170	3112.12	I	0-32123	$4d^5 5s^1 a {}^7S_3 - 4d^5 5s^1 5p^1 z {}^7D_{\frac{1}{2}}$
170	3581.89	I	16785-44695	$4d^5 5s^1 a {}^5G_5 - 4d^5 5s^1 5p^1 y {}^5H_{\frac{7}{2}}$
170	3624.46	I	16748-44330	$4d^5 5s^1 a {}^5G_5 - 4d^5 5s^1 5p^1 z {}^5I_{\frac{3}{2}}$
160	2890.99	II	12034-46614	$4d^4 5s^1 a {}^6D_{\frac{1}{2}} - 4d^4 5p^1 z {}^6F_{\frac{3}{2}}$
160	2923.39	II	12417-46614	$4d^4 5s^1 a {}^6D_{\frac{3}{2}} - 4d^4 5p^1 z {}^6F_{\frac{1}{2}}$
160	3344.75	I	11143-41032	$4d^4 5s^2 a {}^5D_1 - 4d^5 5p^1 y {}^5F_{\frac{1}{2}}$
160	3405.94	I		
160	3694.94	I	16641-43698	$4d^5 5s^1 a {}^5G_2 - 4d^5 5s^1 5p^1 y {}^5H_{\frac{3}{2}}$
160	3833.75	I	12346-38423	$4d^4 5s^2 a {}^5D_4 - 4d^5 5s^1 5p^1 z {}^5D_{\frac{1}{2}}$
150	5570.45	I	10768-28715	$5d^5 5s^1 a {}^5S_2 - 4d^5 5p^1 z {}^5P_{\frac{1}{2}}$
140	2911.92	II	12900-47232	$4d^4 5s^1 a {}^6D_{\frac{3}{2}} - 4d^4 5p^1 z {}^6F_{\frac{3}{2}}$
140	2930.50	II	12034-46148	$4d^4 5s^1 a {}^6D_{\frac{1}{2}} - 4d^4 5p^1 z {}^6F_{\frac{1}{2}}$
140	3233.14	I	16784-47705	$4d^5 5s^1 a {}^5G_6 - 4d^5 5s^1 5p^1 y {}^5G_{\frac{5}{2}}$
140	3289.02	I	11454-41850	$4d^4 5s^2 a {}^5D_2 - 4d^5 5p^1 y {}^3F_{\frac{3}{2}}$
140	3680.60	I	16784-43946	$4d^5 5s^1 a {}^5G_6 - 4d^5 5p^1 z {}^3G_{\frac{5}{2}}$
140	3680.68	I	16785-43946	$4d^5 5s^1 a {}^5G_5 - 4d^5 5p^1 z {}^3G_{\frac{3}{2}}$
140	4232.59	I	16748-40367	$4d^5 5s^1 a {}^5G_4 - 4d^5 5p^1 z {}^5H_{\frac{3}{2}}$



## Molybdenum — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
18	2015.11	II	0-49609	8	2482.57	II	23934-64203
40	2020.30	II	0-49481	5	2484.75	II	23934-64168
24	2038.44	II	0-49041	5	2485.31	I	
24	2045.98	II	0-48861	3.0	2496.24	II	22444-62492
9	2081.68	II	0-48022	11	2498.28	II	15691-55706
5	2089.52	II	15199-63041	5	2500.44	II	22444-62425
5	2092.50	II	15331-63105	8	2502.84	II	12900-52843
9	2093.11	II	15447-63207	6	2508.67	I	
7	2100.84	II	15428-63012	6	2509.56	I	12346-52182
4	2104.29	II	15447-62954	6	2511.80	II	12417-52217
3.5	2108.02	II	23248-70670	4	2513.33	I	
7	2269.69	II	15447-59492	8	2515.08	II	22980-62728
4	2304.25	II	27627-71011	3	2515.66	I	12346-52085
4	2306.97	II	15427-58761	6	2517.46	I	11454-51165
4	2325.94	I	12346-55328	3.0	2517.83	I	
8	2330.46	I		12	2524.81	I	11454-51049
4	2332.12	II	15330-58197	9	2527.14	II	24836-64395
7	2340.47	I		6	2530.34	II	24659-64168
7	2341.59	II	15199-57892	9	2532.31	II	22864-62342
3.5	2352.61	I	12346-54839	9	2536.85	I	12346-51753
3.5	2355.22	I	11143-53589	55	2538.46	II	13461-52843
3.5	2355.42	II	15699-58141	6	2539.44	II	24509-63877
3.5	2364.37	I	11454-53736	14	2540.45	I	11859-51210
2.5	2366.09	II	15890-58141	42	2542.67	II	12900-52217
7	2372.27	I	11454-53595	8	2543.35	I	11859-51165
6	2380.41	I	11859-53855	5	2543.61	II	22444-61746
9	2383.52	I	11859-53800	42	2548.22	I	10768-49999
7	2389.20	II	23853-65695	14	2550.85	I	11859-51049
10	2403.61	II	23833-65425	8	2555.42	II	23833-62954
6	2404.66	II	24509-66082	5	2556.75	II	23853-62954
10	2405.86	I		10	2558.88	II	24836-63904
3.0	2408.39	I	12346-53855		2558.94	I	11858-50926
3.5	2412.84	II	22444-63877	8	2562.08	II	27725-66744
10	2413.01	II	15890-57320	11	2564.34	II	25342-64326
6	2415.33	I	12346-53736	5	2566.26	II	12417-51373
7	2417.96	II	16796-58141	32	2567.05	I	10768-49712
6	2419.01	II	23934-65261	2.5	2571.45	II	26406-65282
7	2420.18	II	24138-65444	40	2572.34	I	12346-51210
7	2424.00	II	23833-65075	6	2574.42	II	12900-51732
7	2430.43	I	12346-53479	5	2575.77	I	11858-50670
7	2435.96	II	22864-63904	5	2576.56	II	24138-62937
7	2440.28	II	17174-58141	5	2578.36	II	26488-65261
5	2461.81	II	24836-65444	12	2578.77	I	11858-50625
6	2466.68	II	22864-63392	32	2582.16	I	10768-49484
6	2466.97	II	16796-57320	4	2585.95	II	23833-62492
6	2468.78	II	23833-64326	8	2588.78	II	23934-62551
4	2470.04	II	23853-64326	5	2591.77	II	23853-62425
19	h 2471.97	I	10768-51210	9	2591.98	I	11143-49712
9	2477.57	II	26041-66391	32	2593.70	II	12034-50577
9	h 2481.81	I	10768-51049	13	2595.40	I	10966-49484

Molybdenum — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
5	2596.77	I	21343-59841	2.5	2673.84	I	
4	2597.22	I	10768-49259	4	2678.67	I	11454-48775
5	2597.38	II	23853-62342	130	2679.85	I	12346-49651
6	2599.64	I	12346-50802	12	2681.36	II	23833-61116
10	2601.69	I		4	2682.62	I	11143-48409
32	2602.80	II	11783-50192	80	2683.23	II	11783-49041
3.5	2603.32	I	10768-49169	110	2684.14	II	13461-50706
5	2605.08	II	26739-65115	70	2687.99	II	12417-49609
5	2605.93	II	17344-55706	6	2688.64	I	21343-58526
32	2607.37	I	11143-49484	4	2692.61	II	27725-64852
4	2608.86	I	20930-59250	3.5	2693.04	I	12346-49468
24	2611.20	I	20951-59236	2.5	2693.53	I	
36	2613.08	I	11454-49712	7	2695.22	II	23833-60925
16	2615.39	I	10966-49190	8	2696.07	I	10768-47848
50	2616.78	I	11143-49346	4	2696.83	II	33601-70671
9	2619.34	II	11783-49949	11	2697.81	I	10966-48022
18	2621.07	I	11859-49999	7	2699.41	II	22444-59478
40	2627.55	I	11143-49190	8	2700.21	I	12346-49370
20	2628.74	I	11454-49484	17	2701.03	I	11858-48870
10	2628.97	I	11143-49169	60	2701.42	II	12034-49041
55	2629.85	I	11454-49468	4	2701.87	II	26041-63041
8	2631.50	I	10966-48956	4	2704.93	II	33045-70004
9	2635.57	I	11859-49790	6	2705.24	I	11454-48409
42	2636.67	II	12034-49949	12	2706.12	I	11143-48085
32	2638.30	I	11454-49346	6	2709.25	I	
90	2638.76	II	12417-50302	5	2710.19	II	15330-52217
4	2639.49	I		8	2710.74	I	11143-48022
4	2639.68	I		4	2711.49	II	23833-60702
10	2640.28	I		6	2712.35	II	33146-70004
52	2640.99	I	11859-49712	24	2713.51	II	13461-50302
5	2643.81	I	11143-48956	6	2715.17	I	10768-47588
75	2644.35	II	12900-50706	10	2717.16	I	
4	2645.79	I		36	2717.35	II	15428-52217
46	2646.49	II	12417-50192	10	2720.17	I	11454-48206
4	2647.25	I	10768-48532	14	2724.41	I	16784-53479
4	2649.25	I	11454-49190	22	2725.15	I	11143-47827
80	2649.46	I	11859-49591	6	2725.95	I	11859-48532
5	2650.68	I	11454-49169	3.5	2726.65	I	21154-57818
60	2653.35	II	12900-50577	11	2726.97	II	26069-62728
70	h 2655.03	I	12346-49999	2.0	2728.34	I	
5	2655.93	I	10768-48409	11	2728.70	I	11143-47779
5	2656.49	I	11143-48775	7	2729.13	I	11454-48085
36	2658.11	I	11859-49468	17	2729.68	II	12417-49041
80	2660.58	II	12034-49609	10	2730.20	II	26488-63105
14	2665.10	I	11859-49370	42	2732.88	II	12900-49481
6	2666.75	I	11859-49346	32	2733.39	I	11454-48028
8	2670.32	I	10768-48206	3.5	2735.65	I	16784-53327
7	2671.83	II	15427-52843	3.0	2735.88	I	11858-48399
90	2672.84	II	12900-50302	3.5	2736.42	I	18356-54889
32	2673.27	II	15447-52843	20	2736.96	II	15691-52217

Molybdenum — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
10	h 2737.88	II	35406-71920	50	2807.76	II	12417-48022
6	2738.60	II	27627-64130	9	2808.37	I	11454-47052
5	2741.32	II	26739-63207	4	2809.96	I	11143-46720
7	2741.62	II	24509-60973	3.0	2810.43	I	18229-53800
30	2743.07	I	11143-47588	4	2811.50	I	
12	2743.71	I	10966-47402	3.5	2812.58	II	23934-59478
10	2745.09	I	10768-47186	3.0	2814.67	II	28877-64395
5	2745.38	I	16784-53198	4	2815.54	I	18229-53736
36	2746.30	II	15330-51732	9	2815.91	I	11454-46956
7	2748.49	I	11454-47827	220	2816.15	II	13461-48960
40	2751.47	I	11859-48192	28	2817.44	II	15890-51373
4	2754.29	I	10768-47064		2817.50	I	23516-58999
4	2755.37	I	10966-47248	5	2818.30	I	11454-46926
14	2756.07	II		6	2822.03	II	11783-47208
8	d 2758.63	II	11783-48022	4	2822.43	I	11454-46874
3.5	2759.58	I	11859-48085	3.0	2822.86	I	18229-53644
2.5	2760.53	II	26739-62954	6	2825.67	I	18356-53736
24	2761.53	I	12346-48547	30	2826.54	I	24823-60191
8	2762.70	I	12346-48532	6	2826.75	I	18229-53595
8	2763.03	I	11143-47324	10	2827.74	II	27627-62980
28	2763.62	II	15199-51373	5	2828.79	I	24096-59437
5	2763.93	I	11859-48028	5	2829.79	I	11858-47186
14	2766.26	I	11143-47282	9	2829.94	I	11858-47184
5	2766.72	I	11454-47588	5	2831.44	II	33601-68909
4	2767.22	I	10768-46895	4	2832.07	II	24836-60135
5	2768.09	I		10	2834.39	II	16947-52217
30	2769.76	II	27114-63207	10	2835.33	II	15447-50706
3.5	2771.36	I	10966-47039	2.5	2835.91	I	11858-47110
20	2773.78	II	15691-51732	1.2	2836.03	I	16641-51891
24	2774.39	II	15699-51732	5	h 2837.32	I	
220	2775.40	II	13461-49481	6	2837.90	I	21154-56381
16	2777.74	I	11858-47848	7	2839.58	I	11858-47064
8	2777.86	II	12034-48022	20	2842.15	II	12034-47208
9	2779.48	I	11143-47110	8	2842.37	I	
110	2780.04	II	12900-48861	3.0	2843.73	II	33895-69050
50	2784.99	II	16947-52843	28	2844.39	I	24466-59612
4	2786.11	I		220	2848.23	II	12900-47999
22	2787.83	I	12346-48206	20	2849.38	I	
9	2788.94	I	12346-48192	8	d 2850.79	I	11859-46926
3.0	2790.01	I	16748-52579		2850.90	I	10768-45835
12	2790.31	I	11454-47282	4	2851.18	I	12346-47409
	2790.41	II	23853-59680	46	2853.23	II	27114-62152
5	2791.54	II	30019-65831	5	2853.58	I	16641-51675
10	2792.96	I	11454-47248	5	d 2854.87	I	24823-59841
4	2796.78	I	24096-59841	6	2856.00	II	27724-62728
30	d 2797.93	I	11454-47184	6	2859.57	I	20948-55908
	2798.01	I	11859-47588	4	2862.84	I	
28	2801.47	I	10768-46453	3.0	2863.20	II	24138-59053
	2801.55	I		46	2863.81	II	26739-61648
4	2807.36	I	11454-47064	20	2864.31	I	24096-58998

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Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
18	2864.66	I	11859-46756	6	2930.06	II	28883-63002
5	2865.62	II	15691-50577	140	2930.50	II	12034-46148
28	2866.69	II	17344-52217	7	2930.77	II	30019-64130
5	2868.11	II	26069-60924	6	2931.08	I	12346-46453
5	2868.32	II	26604-61457	100	2934.30	II	11783-45853
9	2869.56	I	12346-47184	8	2934.84	I	25549-59612
3.5	2870.18	I	12346-47177	8	2935.20	II	15890-49949
3.5	2870.90	I	21154-55976	10	2936.50	I	21343-55387
220	2871.51	II	12417-47232	15	2937.66	I	
3.5	2871.89	I		5	2938.30	II	28989-63012
11	2872.88	II	27628-62425	12	2940.10	II	27114-61116
5	2873.64	I	24823-59612	6	2940.98	I	20350-54343
6	2876.54	I	21154-55908	14	2941.22	II	30213-64203
5	2878.38	I	11858-46590	7	2942.85	I	11454-45425
28	2879.05	II	30391-65115	18	2944.21	I	0-33955
5	2882.54	I	20158-54839	19	2944.82	II	35099-69047
8	2885.74	I	25549-60192	10	2945.43	I	20948-54889
11	2886.61	I	21343-55976	18	2945.66	I	11143-45080
3.5	2887.62	I	10768-45389		2945.95	II	30391-64326
8	2888.15	II	33146-67760	24	2946.01	I	11454-45389
5	2889.84	I	11858-46453	18	2946.42	I	
160	2890.99	II	12034-46614	18	2946.69	II	30213-64140
12	2891.28	II	16796-51373	12	2947.28	II	29034-62954
24	2892.81	II	17174-51732	6	2953.56	I	16784-50631
8	2893.23	I	25639-60192	12	2955.84	II	26406-60227
120	2894.45	II	13461-47999	30	2956.06	II	12034-45853
3.5	2896.44	I	12346-46861	9	2956.90	II	35099-68909
3.5	2896.97	I		11	h 2957.75	I	
17	2897.63	II	15691-50192	10	2959.48	I	20158-53938
10	2898.65	I	20350-54839	10	2959.80	I	11859-45635
9	2900.80	II	29034-63498	12	2960.24	II	13461-47232
36	2903.07	II	26488-60924	18	2962.89	I	
20	2905.27	I	12346-46756	32	2963.79	II	12417-46148
8	2906.06	I	20130-54531	6	2964.96	II	28877-62595
10	2907.12	II	17344-51732	26	2965.27	II	12900-46614
3.5	2907.78	I	11454-45835	9	2971.91	II	26041-59680
3.0	2908.16	I	21154-55530	32	2972.61	II	16947-50577
75	2909.12	II	11783-46148	10	2972.96	I	11454-45081
140	2911.92	II	12900-47232	10	2975.40	II	29699-63298
9	2913.52	I	10768-45081	6	2977.27	I	20158-53736
7	2913.81	II	28989-63298	22	2978.28	I	11859-45425
6	2915.26	I	25549-59841	15	2981.52	I	11858-45389
7	2915.38	I	20281-54572	6	2983.04	I	19970-53483
6	2916.10	I	11143-45425	8	2983.81	I	20350-53855
15	2918.83	II	15699-49949	6	2985.16	I	12346-45836
3.0	2919.20	I	11143-45389	6	2985.84	I	25517-58999
7	2919.38	I	12346-46590	14	2987.92	I	20130-53588
160	2923.39	II	12417-46614	10	2988.23	I	20281-53736
17	2924.32	II	26041-60227	20	2988.68	I	20350-53800
8	2927.54	II	30019-64168	24	2989.80	I	20158-53595

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Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
12	2992.84	II	17174-50577	28	3147.35	I	16784-48547
6	2993.52	II	16796-50192	28	3152.82	II	26488-58197
6	3000.23	I	20158-53479	7	3155.64	II	29022-60702
24	3002.21	I	0-33299	7	3156.51	I	11858-43530
5	3004.46	II	26406-59680	750	3158.16	I	0-31655
6	3010.26	I	12346-45556	12	3163.90	I	16641-48238
16	3013.39	I	18229-51405	15	3164.53	I	11454-43046
18	h 3013.76	I		1100	3170.35	I	0-31533
10	3016.78	I	21154-54292	7	3171.38	I	
32	3025.00	I	18356-51405	12	3172.03	II	17344-48860
12	3027.77	II	17174-50192	5	3172.37	I	16693-48206
6	3035.33	I	18229-51165	20	3172.74	II	15699-47208
13	3036.31	I	18480-51405	12	3177.90	I	16748-48206
6	3039.82	I	25639-58526	12	3179.77	I	
38	3041.70	I	16784-49650	46	3183.03	I	16785-48192
19	3046.80	I	16784-49596	15	3184.57	I	16693-48085
26	3047.31	I	16785-49591	46	3185.10	I	11858-43246
26	3055.32	I	16748-49468	22	3185.71	I	16641-48022
13	3060.78	II	16947-49609	15	d 3187.59	II	23853-55216
20	3061.59	I	16693-49346		3187.68	I	18229-49591
100	3064.28	I	16784-49408	8	3188.09	I	23668-55026
32	3065.04	II	38054-70670	8	3188.40	I	23534-54889
13	3068.00	I	16785-49370	12	3191.52	I	21343-52667
32	3070.90	I	16748-49302	12	3192.80	I	21154-52465
11	3071.44	I	16641-49190	950	3193.97	I	0-31300
100	3074.37	I	16784-49302	8	3194.87	I	24096-55387
11	3077.66	II	35406-67889	36	3195.96	I	16748-48028
19	3079.88	I	23515-55975	15	3198.85	I	12346-43598
26	3080.41	I	16693-49147	8	3200.21	I	18229-49468
5	3081.16	I	18480-50926	8	3200.89	I	18480-49712
100	3085.62	I	16748-49147	5	3201.50	II	16796-48022
34	3087.62	II	27114-59492	42	3205.22	I	10966-42156
13	3089.12	I	16784-49147	15	3205.54	I	11858-43046
13	3089.71	I	16641-48997	110	3205.88	I	12346-43530
24	3092.07	II	15691-48022	380	3208.83	I	0-31155
70	3094.66	I	16693-48997	30	3210.97	I	16693-47827
14	3099.93	I	16748-48999	15	3212.59	I	
14	3100.88	I	23668-55908	8	3213.32	I	11858-42970
70	3101.34	I		15	3214.44	I	16748-47848
7	3106.34	I		70	3215.07	I	11143-42237
170	3112.12	I	0-32123	8	3220.86	I	10768-41807
7	3117.54	I	24823-56891	44	3221.74	I	18229-49259
36	3122.00	II	26740-58761	8	3223.49	I	11143-42156
1800	3132.59	I	0-31913	110	3228.22	I	11454-42422
5	3135.60	I		75	3229.79	I	12346-43299
7	3135.89	I	24096-55976	140	3233.14	I	16784-47705
12	3136.46	I	16748-48622	24	3235.38	I	12346-43246
6	3136.75	I	23516-55387	120	3237.08	I	20281-51165
14	3138.72	II	26041-57892	14	3237.98	I	16784-47659
7	3144.34	I		24	3240.49	I	12346-43197

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Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
8	3240.71	II	17174-48022	120	3363.78	I	10768-40488
6	3244.47	I	18356-49169	8	3369.25	I	18356-48028
8	3245.92	I	27727-58526	8	3375.22	I	18229-47848
8	3249.92	I	16641-47402	8	3375.65	I	21619-51234
120	3256.21	I	11454-42156	16	3378.20	I	11143-40736
14	3259.16	I	24466-55140	16	3378.46	I	25549-55140
8	3260.48	I	16748-47409	120	3379.97	I	11454-41032
38	3262.63	I	16641-47282	8	3382.29	I	11454-41012
14	3263.83	I	10768-41398	40	3382.48	I	11143-40699
60	3264.40	I	16785-47409	240	3384.62	I	11859-41396
16	3265.14	I		8	3385.88	I	26636-56162
100	3270.90	I	11859-42422	12	3387.75	I	11454-40964
8	3279.44	I	16692-47177	20	3389.80	I	18356-47848
3.0	3285.02	I	10966-41398	12	3392.17	I	21154-50625
4	3285.36	I	16748-47177	20	3393.65	I	21343-50802
8	3287.38	I	16641-47052	16	3395.36	II	36289-65732
140	3289.02	I	11454-41850	20	3397.69	I	11143-40566
24	3289.84	I	16784-47172	16	3402.81	I	27766-57144
120	3290.82	I	11858-42237	8	3403.35	I	11454-40829
24	3292.31	II	25342-55706	80	3404.34	I	11859-41224
16	3294.85	I	11143-41484	8	3405.20	I	18229-47588
13	3296.40	I	11858-42186	160	3405.94	I	
13	3303.34	I	16693-46956	30	3418.52	I	11454-40698
22	3304.22	I	11143-41398	6	3418.96	I	20350-49591
40	3305.56	I	10768-41012	32	3420.04	I	18356-47588
16	3305.90	I	21619-51859	24	3421.25	I	10768-39989
40	3307.12	I	11859-42088	32	3422.31	I	20158-49370
20	3310.77	I	10768-40964	24	3424.60	I	10768-39960
12	3312.33	I	16693-46874	12	3424.76	I	16748-45939
13	3313.62	II	28884-59053	12	3425.19	I	20281-49468
16	3319.59	I	16693-46808	16	3425.48	I	16784-45969
16	3319.79	I	16641-46755	16	3426.00	I	18229-47409
24	3320.90	II	25112-55216	20	3426.79	I	11859-41032
80	3323.95	I	12346-42422	10	3427.90	I	27727-56891
45	3325.67	I	10768-40829	12	3432.87	I	16748-45870
45	3327.30	I	10966-41012	12	3434.04	I	11454-40566
8	3329.04	I		48	3434.79	I	11859-40964
8	3331.40	I	16748-46756	40	3435.45	I	25639-54739
16	3336.51	I	18229-48192	80	3437.22	I	16785-45870
30	3340.17	I	10768-40698	32	3438.87	I	10966-40037
12	3343.72	I		32	3441.44	I	12346-41396
160	3344.75	I	11143-41032	8	3442.66	I	20130-49169
12	3346.40	II	25342-55216	32	3443.26	I	11454-40488
40	3347.02	I	11143-41012	12	3445.04	I	20350-49370
8	3349.19	I	18356-48206	24	3445.26	I	16693-45710
16	3350.30	I	12346-42186	16	3446.08	II	23833-52843
16	3354.99	I	10768-40566	400	3447.12	I	12346-41348
200	3358.12	I	11454-41224	80	3449.07	I	11859-40844
32	3361.37	I	12346-42088	12	3449.85	I	20281-49259
16	3362.37	I	10966-40698	38	3451.75	I	

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Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
32	3452.60	I	18229-47184	8	3586.86	I	25456-52327
13	3454.22	I	16693-45635	13	3588.95	I	20350-48206
24	3456.15	I	18356-47282	25	3590.74	I	20350-48192
120	3456.39	I	0-28924	8	3592.02	I	16693-44525
8	3458.15	I	20281-49190	13	3595.55	I	20281-48085
20	3459.92	I	11143-40037	8	3595.71	I	20608-48411
16	3460.23	I	18356-47248	26	3598.88	I	25549-53327
8	3460.78	I	16748-45635	12	3600.28	I	16693-44461
40	3466.83	I	0-28836	34	3602.94	I	20281-48028
8	3466.97	I	18229-47064	8	3604.07	I	25997-53736
32	3467.85	I	18356-47184	26	3608.37	I	11454-39160
40	3469.22	I	16641-45458	17	3612.00	I	20350-48028
8	3469.63	I	24823-53637	13	3612.45	I	20948-48622
24	3470.92	I	18480-47282	17	3613.37	I	11454-39122
8	3473.22	I	16641-45425	13	3613.64	I	21154-48819
24	3475.03	I	18480-47248	8	3615.15	I	26639-54292
22	3479.43	I	16693-45425	8	3615.74	I	20130-47779
13	3480.09	I	18229-46956	9	3616.84	I	18229-45870
13	3481.79	I	20158-48870	25	3623.23	I	
24	3482.40	I	11859-40566	170	3624.46	I	16748-44330
12	3483.67	I	18229-46926	42	3626.18	I	12346-39916
24	3483.84	I	18356-47052	8	3628.35	I	20158-47711
30	3485.93	I	11143-39821	13	3628.66	I	16641-44192
16	d 3491.77	I	18480-47110	3.0	3629.31	I	25639-53184
	3491.87	I	11858-40488	3.5	3635.14	II	25342-52843
16	3493.34	I	12346-40964	130	3635.43	I	16693-44192
100	3504.41	I	18229-46756	8	3637.52	I	11143-38626
30	3505.32	I	20350-48870	20	3638.20	I	18356-45835
70	3508.12	I	12346-40844	17	3640.62	I	20951-48411
13	3510.78	I	28241-56717	12	3640.99	I	20130-47588
13	3513.70	I	18356-46808	9	3642.20	I	20951-48399
16	3517.56	I	25517-53938	9	3648.61	I	16641-44041
16	3518.22	I	18480-46895	17	3651.35	I	11143-38522
60	3521.41	I	20158-48547	50	3657.35	I	16641-43975
8	3522.37	I		9	3660.92	I	26336-53644
13	3524.23	I	11454-39821	22	3661.78	I	11858-39160
24	3524.65	I	25821-54184	17	3662.99	I	25906-53198
30	3524.98	I	18229-46590	17	3663.30	I	20948-48238
80	3537.28	I		9	3664.30	I	16693-43975
40	3542.17	I	18229-46452	60	3664.81	I	18356-45635
12	3554.20	I	20281-48409	32	3666.72	I	16748-44012
8	3555.43	I	20281-48399	12	3666.94	I	11858-39122
65	3558.10	I	18356-46453	7	3668.00	I	20951-48206
50	3563.14	I	11859-39916	8	3668.49	I	20158-47409
8	3563.76	I	19970-48022	24	3669.34	I	21154-48399
38	3566.05	I	20158-48192	4	3670.42	I	20350-47588
30	3570.65	I	25639-53637	65	3672.82	I	26636-53855
40	3573.88	I	18480-46452	10	3675.36	I	25997-53198
14	3580.54	I	28241-56162	2.5	3675.98	I	18229-45425
170	3581.89	I	16785-44695	10	3676.24	I	20130-47324

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Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
10	3677.70	I		9	3735.62	I	25906-52667
140	3680.60	I	16784-43946	10	3735.91	I	20350-47110
	3680.68	I	16785-43946	3.0	3736.17	I	20281-47039
10	d 3681.55	I	20930-48085	20	3737.91	I	16784-43530
	3681.72	I	20158-47311	3.0	3740.76	I	18356-45081
5	3684.22	II	36741-63877	26	3742.28	I	20350-47064
	3684.33	I	20951-48085	6	3743.81	I	20158-46861
4	3686.11	I	20281-47402	3.0	3744.10	I	20350-47052
7	3688.31	II	25112-52217	9	3744.37	II	
8	3688.97	I	25906-53006	3.0	3744.94	I	
26	3690.59	I	20951-48039	10	3745.48	I	18229-44921
2.5	3692.08	I	18480-45556	12	3747.19	I	
20	3692.64	II	24659-51732	16	3748.49	I	26636-53306
18	3693.38	I	11454-38522	14	3751.20	I	20158-46808
160	3694.94	I	16641-43698	15	3755.10	I	25821-52444
10	3696.04	I	29982-57030	3.5	3755.54	I	21619-48238
6	3698.53	I	20281-47311	3.5	3755.84	I	23516-50134
8	3700.01	I	20158-47177	20	3758.52	I	20158-46756
24	3702.03	I	16693-43698	3.5	3759.60	I	26636-53227
20	3702.55	I	20281-47282	10	3760.88	I	25997-52579
		II	24372-51373	10	3761.76	I	20350-46926
6	3705.41	I	20130-47110	6	3762.09	I	21619-48192
9	3707.17	I	20281-47248	16	3763.35	I	11859-38423
9	3708.56	I	23668-50625	6	3764.44	I	21154-47711
6	3710.14	I	18480-45425	10	3765.22	I	16748-43299
3.0	3711.51	I	10966-37902	6	3765.74	I	
9	3712.95	I	19970-46895	3.5	3767.73	I	21343-47877
9	3713.47	I	20130-47052	7	3768.62	I	20281-46808
8	3714.55	I	21619-48532	7	3768.74	I	27766-54292
24	3715.65	I	16693-43598	7	3770.00	I	27774-54292
15	3716.07	I		40	3770.45	I	16784-43299
9	3716.87	I	20281-47177		3770.52	I	11454-37968
6	3718.48	I	26759-53644	20	3771.95	I	16693-43197
13	3719.55	I		16	3772.82	I	16748-43246
	3719.74	I	20951-47827	3.5	3775.65	I	19970-46448
8	3720.25	I	25707-52579	3.5	3776.10	I	25707-52182
8	3723.51	I		3.5	3776.55	I	20930-47402
4	3723.81	I		7	3777.72	I	28241-54704
20	3725.56	I	20350-47184	6	3777.96	I	
15	3726.22	I	20281-47110	24	3779.77	I	16748-43197
	3726.32	I	20951-47779	40	3781.59	I	11143-37579
55	3727.69	I		7	3782.19	I	20158-46590
18	3728.30	I	23668-50482	6	3783.53	I	
16	3728.50	I		10	3785.03	I	16785-43197
3.0	3730.56	I	20158-46956	6	3785.51	I	26336-52747
36	d 3732.71	I		10	3788.26	I	26189-52579
	3732.80	I	16748-43530	12	3793.62	I	16693-43046
13	3733.03	I	21619-48399	10	3794.43	I	23516-49864
9	3733.40	I	21343-48121	6	3796.04	I	24466-50802
9	3734.37	I	20281-47052	28	3797.30	I	10966-37293



Molybdenum — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
3200	3798.25	I	0-26321	7	3922.32	I	19970-45458
32	3801.84	I	20158-46453	11	3923.75	I	23668-49147
10	3804.52	I	16693-42970	6	3928.79	I	21619-47064
10	3805.93	I	25821-52088	3	3931.40	I	20281-45710
	3805.99	I	23534-49801	3.5	3935.02	I	23516-48922
6	3807.65	I	21154-47409	6	3941.48	II	25342-50706
10	3811.39	I	21619-47848	22	3943.04	I	20281-45635
10	3812.47	I	16748-42970	3.5	3943.51	I	20951-46302
7	3818.66	I	20930-47110	7	3945.25	I	16748-42088
13	3819.87	I	20281-46452	3.5	3947.17	I	20130-45458
18	3822.98	I	11143-37293	7	3950.99	I	16784-42088
7	3825.32	I	23516-49651	11	3953.93	I	20350-45635
50	3826.70	I	11454-37579	6	3955.49	I	30113-55387
9	3827.16	I	23668-49790	3.5	3958.60	I	24096-49351
90	3828.87	I	11859-37968	3	3963.53	I	26636-51859
7	3830.82	I	25795-51891	3	3963.99	I	26639-51859
3.5	3831.07	I	27384-53479	3.5	3965.76	I	16641-41850
3.5	3831.76	I	16693-42783	7	3968.75	I	21619-46808
14	3832.11	I	25997-52085	14	3973.77	I	29982-55140
160	3833.75	I	12346-38423	11	3973.93	I	16693-41850
4	3834.97	I	25517-51585	6	3975.96	I	20281-45425
7	3835.31	I	21343-47409	6	3977.90	I	
6	3843.90	I	20948-46956	3.5	3979.22	I	27342-52465
11	3845.95	I	16748-42742	7	3980.20	I	26759-51876
36	3847.25	I	11143-37128	7	3982.05	I	23516-48622
18	3848.30	I	24823-50802	3.5	3982.60	I	16748-41850
7	3851.99	I	25906-51859	13	3986.20	I	25517-50596
2800	3864.11	I	0-25872	3.5	3991.39	I	25549-50596
3.5	3866.69	I	25821-51675	3.5	3991.85	I	20930-45974
55	3869.08	I	11454-37293	3.5	3993.93	I	23516-48547
55	3886.82	I	11859-37579	3.5	3998.29	I	22244-47248
7	3888.18	I	20158-45870	6	4000.39	I	20948-45938
7	3888.88	I	21154-46861	11	4000.50	I	26415-51405
3.5	3890.71	I	26189-51884	7	4006.05	I	26321-51276
3.5	3893.32	I	20158-45836	3.0	4008.05	I	24466-49408
3.5	3896.38	I	20281-45938	11	4009.37	I	24466-49400
3.5	3896.85	I	21154-46808	6	4011.97	I	25872-50791
36	3901.77	I	12346-37968	4	4017.38	I	24466-49351
1800	3902.96	I	0-25614	12	4021.02	I	29842-54704
7	3906.92	I		16	4024.09	I	16641-41484
	3906.98	I	25997-51585				
13	3908.25	I	20130-45710	6	4028.65	I	21154-45969
7	3909.55	I		4	4032.50	I	16693-41484
7	3911.09	I	16784-42345	4	4033.63	I	21154-45938
3.5	3911.94	I	26336-51891	4	4037.30	I	20948-45710
7	3913.36	I	26636-52182	8	4037.78	I	20951-45710
10	3915.44	I	22876-48409	12	4038.08	I	16641-41398
7	3916.92	I	22876-48399	3.0	4041.12	I	27727-52465
14	3917.54	I	20350-45870	12	4042.87	I	25549-50277
7	3917.78	I	20930-46448	3	4050.09	I	20951-45635
				26	4056.01	I	16748-41396

Molybdenum — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
7	4056.32	I	26759-51405	24	4194.56	I	25517-49351
4	4057.58	I	25639-50277	5	4200.57	I	18356-42156
18	4059.61	I	21343-45969	5	4201.32	I	16693-40488
130	4062.08	I	16785-41396	9	4205.81	I	25639-49408
8	4066.37	I	24823-49408	5	4211.02	I	16748-40488
220	4069.88	I	16784-41348	4	4219.40	I	18480-42173
18	4075.25	I	16693-41224	3.5	4222.41	I	18480-42156
5	4075.54	I		140	4232.59	I	16748-40367
18	4076.19	I	24096-48622	4	4233.49	I	24096-47711
120	4081.44	I		3.5	4235.03	I	21154-44760
90	4084.38	I	16748-41224	8	4237.16	I	20930-44525
14	4086.02	I	20948-45415	9	d 4239.07	I	16784-40367
17	4096.81	I	21154-45556		4239.19	I	16785-40367
5	4098.18	I	20130-44525	13	4240.08	I	18229-41807
14	4098.74	I	16641-41032	13	4240.28	I	24823-48400
24	4102.15	I	16641-41012	18	4240.83	I	20951-44525
14	4105.08	I	24466-48819	3.5	4242.80	I	24096-47659
5	4105.53	I	21619-45969	18	4246.02	I	25517-49062
70	4107.47	I	16693-41032	16	4251.87	I	28241-51753
8	4114.93	I		13	4254.96	I	26639-50134
9	4118.96	I	16693-40964	9	4260.36	I	26336-49801
60	4120.10	I		4	4260.66	I	25906-49370
13	4123.65	I	20281-44525	3.0	4261.44	I	
13	4124.54	I	24823-49062	9	4266.18	I	20608-44041
5	4126.53	I		7	4268.08	I	25639-49062
14	4128.28	I	16748-40964	26	4269.28	I	21343-44760
7	4128.83	I	21343-45556	3.0	4272.06	I	26189-49591
17	4131.92	I	25456-49651	12	4273.07	I	16641-40037
7	4132.23	I	18229-42422	85	4276.91	I	16693-40068
4	4135.38	I		110	4277.24	I	12346-35719
280	4143.55	I		4	4281.83	I	
22	4148.94	I	16748-40844	8	h 4284.60	I	
7	4151.88	I	25517-49596	11	4287.08	I	16641-39960
24	4155.28	I	16785-40844	130	4288.64	I	11859-35169
17	4155.58	I	16641-40698	13	4289.42	I	21154-44461
4	4156.79	I	22876-46926	4	h 4290.18	I	25517-48819
19	4157.40	I	25549-49596	4	4291.20	I	26415-49712
17	4162.68	I	25549-49565	65	4292.13	I	11143-34435
4	4164.08	I	18229-42237	85	4293.21	I	11454-34740
4	4166.28	I	24823-48819	34	4293.88	I	10966-34248
8	4169.82	I	23516-47492	4	4296.16	I	25549-48819
8	4171.07	I		3.0	4296.62	I	16693-39960
14	4177.26	I	22876-46808	3.0	4298.90	I	18229-41484
19	4178.27	I	25639-49565	3.0	4301.26	I	
8	4181.05	I	20130-44041	4	4304.92	I	16693-39916
4	4184.39	I	25517-49408	8	4310.39	I	24466-47659
46	4185.82	I	25517-49400	4	4312.80	I	16641-39821
5	4186.28	I	18356-42237	4	4312.97	I	20350-43530
240	4188.32	I		16	4317.93	I	
9	4190.00	I	25549-49408	7	4321.97	I	16785-39916

Molybdenum — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
80	4326.14	I	16641-39750	10	4443.07	I	11454-33955
24	4326.74	I	11143-34248	8	4446.43	I	29982-52465
3.0	4329.63	I	20951-44041	2.0	4447.23	I	27384-49864
4	4332.51	I	27727-50802	32	4449.74	I	16693-39160
11	4334.81	I	26284-49346	3.0	4452.56	I	23516-45969
4	4338.71	I	18356-41398	2.0	4455.30	I	27363-49801
4	4339.82	I	27767-50802	46	4457.36	I	16693-39122
8	4340.75	I	26759-49790	3	4458.65	I	23516-45938
12	4341.42	I	20948-43975	6	4460.62	I	16748-39160
3.0	4344.66	I	26336-49346	6	4464.77	I	20350-42742
22	4350.34	I	11454-34435	18	4468.28	I	16748-39122
3.0	4351.55	I		5	4471.66	I	21619-43975
7	4353.31	I	20281-43246	5	4472.04	I	28241-50596
4	4357.34	I	24466-47409	12	4473.18	I	18480-40829
3.0	4359.62	I	26415-49346	60	4474.56	I	16641-38983
4	4362.02	I	18480-41398		4474.65	I	18356-40698
4	4362.71	I	11858-34774	9	4475.62	I	18229-40566
8	4364.47	I	26284-49190	14	4484.97	I	16693-38983
7	4366.54	I	20350-43246	8	4487.05	I	22244-44525
22	4369.04	I	11859-34740	3.0	4489.00	I	23668-45938
3.5	4373.32	I	24096-46956	6	4490.19	I	20158-42422
4	4374.89	I	25549-48400	22	4491.28	I	18229-40488
7	4375.01	I	27774-50625	3.0	4491.66	I	33904-56162
14	4380.29	I	12346-35169	5	4499.44	I	18480-40698
3.5	4380.59	I	16641-39463	5	4501.29	I	18356-40566
180	4381.64	I	16784-39600	11	4504.90	I	25997-48189
7	4382.41	I	20158-42970	5	4506.67	I	26636-48819
2.5	4385.89	I	11454-34248	13	4512.15	I	11143-33299
7	4391.54	I	24096-46861	8	4515.18	I	20281-42422
7	4392.12	I	25639-48400	22	4517.13	I	18356-40488
5	4394.32	I	27384-50134	5	4517.41	I	10768-32899
5	4394.47	I	20948-43697	2.0	4518.44	I	20158-42282
13	4396.66	I	16784-39522	5	4522.19	I	20130-42237
14	4397.29	I	18229-40964	22	4524.34	I	11859-33955
3.5	4402.49	I	27774-50482	8	4526.37	I	18480-40566
7	4402.90	I	24466-47172	3	h 4528.62	I	27093-49169
3.0	4404.55	I	16748-39445	11	4529.40	I	20350-42422
3.5	4406.87	I	29982-52667	4	4535.38	I	20130-42173
3.5	4409.44	I		38	4536.80	I	28241-50277
7	4409.95	I	24823-47493	4	4541.56	I	
240	4411.57	I	16784-39445	5	4553.32	I	21343-43299
	4411.70	I	16785-39445	2.5	4553.80	I	25456-47409
10	4412.77	I	18356-41012	10	4558.11	I	10966-32899
3.5	4422.06	I	18356-40964	2.5	4558.74	I	20158-42088
20	4423.62	I	18229-40829	8	4560.13	I	23534-45458
16	4426.67	I	20158-42742	8	4567.68	I	20350-42237
95	4434.95	I	16748-39290	2.0	4569.02	I	23668-45548
10	4436.89	I	18480-41012	5	4570.13	I	20281-42156
6	4438.96	I	27342-49864	4	4574.48	I	25639-47493
19	4442.20	I	16784-39290		4574.61	I	21343-43197

Molybdenum — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
20	4576.50	I	11454-33299	8	4750.39	I	20350-41396
2.5	4577.78	I	18229-40068	3.5	4758.50	I	29781-50790
2.5	4582.35	I	31510-53327	60	4760.19	I	21343-42345
2.5	4582.50	I	21154-42970	6	4764.42	I	18480-39463
2.5	4586.06	I	25906-47705	6	4773.44	I	20281-41224
2.5	4586.57	I	22244-44041	3.0	4774.22	I	21343-42283
2.0	4586.79	I		5	4775.66	I	21154-42088
2.5	h 4590.38	I		12	4776.34	I	18229-39160
4	4592.21	I	26639-48409	4	4782.94	I	20130-41032
13	4595.16	I	11143-32899			I	20948-41850
2.5	4597.88	I	30113-51856	7	4785.12	I	18229-39122
2.0	4598.25	I	27867-49608	3.0	4786.46	I	10768-31655
4	4599.16	I	20350-42088	1.6	4788.18	I	18480-39358
2.5	4608.71	I	20158-41850	5	4792.74	I	20948-41807
28	4609.88	I	18229-39916	5	4793.41	I	20951-41807
4	4611.15	I	18356-40037	1.6	4793.82	I	27384-48238
2.5	4616.62	I	25517-47172	8	4796.52	I	21343-42186
2.5	4617.95	I	22876-44525	1.4	4804.91	I	20158-40964
8	4621.38	I	18356-39989	2.5	4805.58	I	18356-39160
2.5	4623.46	I	25549-47172	2.5	4808.09	I	23668-44461
2.5	4624.24	I	29171-50790	7	4811.06	I	30496-51276
36	4626.47	I	12346-33955	1.4	4814.47	I	10768-31533
8	4627.48	I	18356-39960	2.0	4817.70	I	20281-41032
4	4630.02	I	18229-39821	32	4819.25	I	21343-42088
3.5	4633.10	I	28274-49852	1.4	4822.42	I	20281-41012
2.5	4642.70	I	25639-47172	2.0	4828.47	I	
6	4647.81	I	18480-39989	32	4830.51	I	21154-41850
2.5	4649.12	I	25906-47409	3.0	4832.92	I	20158-40844
5	4651.05	I	29781-51276	2.0	4833.96	I	20350-41032
6	4661.93	I	11454-32899	1.2	4838.11	I	24096-44760
17	4662.76	I	11859-33299	1.4	4839.59	I	
10	4671.90	I	21343-42742	1.6	4845.17	I	27766-48399
2.5	4683.83	I	25517-46861	3.5	4858.22	I	28241-48819
2.5	4685.81	I	27727-49062	2.0	4860.05	I	
2.0	4686.10	I	28274-49608	28	4868.00	I	20948-41484
10	4688.22	I	28241-49565	4	4869.20	I	10768-31300
3.0	4690.86	I	25549-46861	1.8	4878.37	I	20350-40844
3.0	4693.93	I		2.0	4886.47	I	23516-43975
2.5	4696.51	I	20951-42237	1.6	4889.22	I	20951-41398
4	4700.49	I	28837-50105	1.6	4897.26	I	25456-45870
6	4706.06	I	23516-44760	5	4903.81	I	10768-31155
50	4707.26	I	20158-41396	2.0	4907.43	I	31485-51856
12	4708.22	I	18229-39463	1.6	4909.19	I	24096-44461
2.5	4714.51	I	20951-42156	1.4	4924.78	I	30502-50802
17	4717.92	I	20158-41348	2.5	4926.19	I	24466-44760
3.0	4718.88	I	28667-49852	2.5	4926.43	I	18229-38522
2.0	4723.06	I	32688-53855	5	4933.10	I	12346-32612
1.6	4725.34	I	27766-48922	5	4941.66	I	25906-46136
8	4729.14	I	20948-42088	7	4950.62	I	18229-38423
55	4731.44	I	21154-42283	9	4957.54	I	18356-38522

## Molybdenum — All Observed Lines

Intensity and Character	Wave-length in A	Spectrum	Energy Levels in K	Intensity and Character	Wave-length in A	Spectrum	Energy Levels in K	
1.6	4964.19	I	25997-46136	1.6	5232.36	I	20930-40037	
2.5	4964.41	I	20350-40488	6	5234.26	I	18480-37579	
1.4	4973.36	I	20930-41032	28	h	5238.20	I	25872-44957
13	4979.12	I	10768-30847	14	h	5240.88	I	25872-44947
1.6	4985.56	I	21343-41395	7	h	5242.81	I	25872-44941
1.4	4995.32	I	23516-43530	6	5245.51	I	20930-39989	
7	4999.91	I	24466-44461	9	5259.04	I	20951-39961	
1.2	5010.81	I	26639-46590	1.0	5260.17	I	30847-49852	
11	5014.60	I	24823-44760	4	5261.14	I	20158-39160	
1.6	5016.78	I	27384-47311	1.2	5268.95	I		
1.2	5019.85	I	25795-45710	2.0	5271.80	I	20158-39122	
5	5029.00	I	24096-43975	2.0	5276.28	I	21619-40566	
4	5030.78	I	25997-45870	4	5279.65	I	16784-35719	
1.4	5038.91	I	25795-45635	13	5280.86	I	22876-41807	
1.6	5046.52	I	21154-40964	1.2	5283.84	I	26636-45556	
6	5047.71	I	20930-40736	3.5	5292.08	I	16828-35719	
3.0	5055.00	I	12346-32123	2.0	5293.46	I	18480-37366	
2.0	5058.01	I	27727-47492	3.5	5295.47	I	20281-39160	
12	5059.88	I	20157-39916	1.0	5302.35	I	25906-44760	
2.0	5062.52	I	20951-40699	1.2	5306.26	I	20281-39122	
1.8	5064.64	I	18229-37968	3.5	5313.89	I	18480-37293	
2.0	5079.87	I	26189-45870	2.0	5315.04	I	20350-39160	
6	5080.02	I	20281-39960	1.2	5319.89	I	31485-50277	
2.0	5081.26	I	11859-31533	1.2	5324.47	I	26639-45415	
2.5	5090.97	I	25997-45635	2.0	5327.06	I	23516-42283	
2.0	5091.34	I	20930-40566	1.0	5334.79	I	23668-42408	
2.0	5092.16	I		1.0	5337.20	I	24466-43197	
2.5	5095.89	I	20948-40566	1.0	5349.79	I		
6	5096.65	I	20951-40566	1.2	5352.35	I	27774-46453	
8	5097.52	I	18356-37968	5	5354.88	I	23516-42186	
2	5098.03	I	20350-39960	2.0	5355.51	I	32123-50790	
8	5109.71	I	20350-39916	4	5356.48	I	32612-51276	
5	5114.97	I	18356-37902	34	hl	5360.56	I	26321-44970
2.0	5116.97	I	20951-40488	7	hl	5364.28	I	26321-44957
1.8	5123.83	I	27415-46926	2.0	hl	5367.11	I	26321-44947
9	5145.38	I	20608-40037	2.0	5372.40	I	22876-41484	
7	5147.39	I	18480-37902	1.6	5388.69	I	31300-49852	
5	5163.19	I	31913-51276	4	5394.52	I	20930-39463	
6	5167.76	I	21619-40964	2.0	5397.38	I	22876-41398	
10	d	5171.08	I	25614-44947	3.0	5400.47	I	20951-39463
		5171.25	I	20130-39463	2.0	5405.79	I	27342-45836
14	h	5172.94	I	25614-44941	2.0	5406.39	I	22244-40736
10	h	5174.18	I	25614-44936	1.0	5414.67	I	
2.5		5191.44	I	31533-50790	2.5	5417.38	I	22244-40699
7		5200.17	I	21619-40844	1.4	5426.89	I	16748-35169
3.0		5200.74	I	18356-37579	0.7	5427.55	I	23668-42088
1.6		5210.44	I	12346-31533	1.0	5431.02	I	20951-39359
3.0		5211.86	I	20281-39463	3.5	5435.68	I	20130-38522
5		5219.40	I	22244-41398	4	5437.75	I	16785-35169
4		5231.06	I	27342-46453	0.9	5439.71	I	

Molybdenum — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
2.5	5450.51	I	21619-39961	3.0	5634.86	I	16693-34435
0.9	5453.03	I	23516-41850	14	5650.13	I	11143-28837
2.0	5456.46	I	22244-40566	0.7	5651.87	I	30160-47848
1.6	5460.53	I	31300-49608	0.7	5664.34	I	29842-47492
1.4	5465.57	I			5664.38	I	27766-45415
0.8	5473.37	I	20157-38423	0.8	5667.30	I	27774-45415
2.0	5475.90	I		0.6	5672.07	I	35042-52667
0.8	5488.67	I	27342-45556	1.4	5673.63	I	20281-37902
2.0	5490.28	I	20951-39160	3.5	5674.47	I	20350-37968
1.2	5492.17	I	21619-39821	2.5	5677.89	I	16641-34248
1.6	h 5493.80	I	31655-49852	2.0	5682.89	I	20930-38522
0.8	h 5496.94	I	24096-42283	0.6	5687.64	I	22244-39821
1.6	5498.49	I	23668-41850	28	5689.14	I	11143-28715
3.0	5501.54	I	20350-38522	0.6	5694.39	I	23668-41224
1.4	5501.87	I	20951-39122	0.8	5696.03	I	30160-47711
1.6	h 5503.54	I		0.7	5698.27	I	29642-47186
480	5506.49	I	10768-28924	1.4	5699.28	I	21619-39160
0.7	5511.49	I	23668-41807	0.7	5702.11	I	25997-43530
1.4	5520.04	I	31485-49596	5	5705.72	I	24823-42345
1.6	5520.64	I	27727-45836	1.4	5711.80	I	21619-39122
0.8	5521.17	I		13	5722.74	I	11454-28924
2.5	5526.52	I	24096-42186	0.7	5723.11	I	29642-47110
2.5	5526.97	I	22876-40964	1.4	5728.77	I	25795-43246
320	5533.05	I	10768-28837	1.6	d 5729.45	I	20130-37579
2.5	5539.41	I	16692-34740		5729.59	I	
0.8	5541.65	I	25906-43946	0.9	5729.87	I	23516-40964
3.0	5543.12	I	20948-38983	1.0	5734.06	I	12346-29781
2.5	5544.49	I	27384-45415	0.7	5739.66	I	27342-44760
0.6	5552.19	I	21154-39160	0.9	5741.71	I	31510-48922
3.5	5556.28	I	16748-34740	1.0	5747.67	I	25906-43299
1.6	5556.72	I	24096-42088	38	5751.40	I	11454-28837
0.7	5562.49	I		0.6	5769.75	I	23517-40844
1.2	5564.05	I	21154-39121	0.6	5771.05	I	19970-37293
2.5	5568.62	I	22876-40829	1.4	5774.55	I	11858-29171
1.6	5569.48	I	23534-41484	0.6	5778.19	I	25997-43299
150	5570.45	I	10768-28715	2.5	5779.36	I	20281-37579
2.0	5575.19	I	19970-37902	0.6	5780.11	I	23668-40964
1.2	5591.58	I	24466-42345	1.4	h 5783.33	I	25456-42742
0.6	5596.32	I	23534-41398	0.6	5785.69	I	
0.5	5598.47	I	34810-52667	32	5791.85	I	11454-28715
0.9	5601.05	I	33904-51753	1.4	h 5795.77	I	34740-51990
2.5	5602.76	I	25456-43299	1.6	5800.46	I	20130-37366
1.4	5608.62	I	26636-44461	2.0	5802.67	I	20350-37579
1.4	5609.23	I	26189-44012	0.5	5803.98	I	25821-43046
6	5610.93	I	24466-42283	0.6	5806.19	I	22244-39463
1.4	5613.07	I	20158-37968	1.0	5806.69	I	26759-43975
1.2	5618.45	I	16641-34435	0.6	5808.23	I	11454-28667
0.6	5618.77	I	22244-40037	0.5	5809.03	I	34435-51644
1.4	5619.38	I	27766-45556	0.6	5813.86	I	39521-56717
20	5632.47	I	10966-28715	1.0	5815.52	I	

Molybdenum — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
0.6	5815.74	I	29982-47172	0.7	6323.54	I	30160-45969
0.6	5820.69	I	23668-40844	2.5	6357.22	I	18229-33955
1.4	5825.20	I	20130-37293	1.0	6389.11	I	26636-42283
1.4	5835.59	I	11143-28274	0.7	6391.12	I	
1.2	5839.99	I	27342-44461	2.0	6401.07	I	
1.2	h 5848.86	I	28715-45806	1.6	6409.11	I	18356-33955
3.5	h 5849.73	I	28715-45805	0.6	6412.39	I	
3.0	h 5851.52	I	28715-45800	6	6424.37	I	20158-35719
32	5858.27	I	11859-28924	1.2	6446.34	I	25456-40964
1.2	5861.38	I	26189-43246	1.2	6471.20	I	23534-38983
0.8	5868.76	I	25707-42742	1.2	6473.99	I	25906-41348
3.0	5869.33	I	27727-44760	0.6	6493.13	I	30160-45556
1.6	5876.59	I	20281-37293	1.4	6519.84	I	30502-45836
0.6	5881.53	I	20130-37128	0.4	6590.90	I	26639-41807
0.6	5882.72	I	27766-44760	0.9	h 6611.20	I	25707-40829
50	5888.33	I	11859-28837	14	6619.13	I	10768-25872
0.7	h 5891.56	I	28837-45806	0.6	6624.57	I	26759-41850
1.4	5892.29	I	25456-42422	0.3	6637.16	I	26336-41398
3.0	h 5893.38	I	28837-45800	4	6650.38	I	25456-40488
1.2	5898.78	I		1.0	6659.68	I	20158-35169
	5898.82	I	27093-44041	0.3	h 6678.89	I	25872-40840
2.5	5901.47	I	18229-35169	0.4	6687.87	I	26450-41398
0.5	5912.12	I	26336-43246	1.4	6690.47	I	18356-33299
0.6	h 5923.79	I	28924-45800	0.3	6691.08	I	27342-42283
2.5	h 5926.36	I	28924-45793	0.7	6728.04	I	25707-40566
10	h 5928.88	I	28924-45786	8	6733.98	I	10768-25614
1.0	5937.91	I	25906-42742	1.6	6746.08	I	18480-33299
0.6	5965.57	I		4	6746.27	I	20350-35169
0.5	5968.48	I	27774-44525	2.5	6753.97	I	27384-42186
0.9	5974.26	I	27727-44461	1.0	6763.50	I	25707-40488
1.0	5982.93	I	26336-43046	0.3	6764.92	I	29982-44760
2.5	5988.17	I	27767-44461	0.6	6787.98	I	26284-41012
1.0	5989.47	I	33904-50596	0.6	6788.94	I	26759-41484
0.6	5990.01	I		0.8	h 6799.88	I	26759-41398
0.6	5991.35	I	27774-44461	0.8	6802.62	I	26336-41032
2.0	6025.49	I	27384-43976	0.8	6812.03	I	26336-41012
1.0	6027.27	I	22876-39463	1.0	6825.63	I	30113-44760
80	6030.66	I	12346-28924	1.4	d 6828.87	I	26759-41398
1.2	6047.83	I	25707-42237		6829.05	I	26189-40829
1.2	6054.81	I	18229-34740	3.0	6838.88	I	27727-42345
1.2	6079.58	I	23516-39960	1.2	6848.92	I	26415-41012
0.6	6081.27	I	25906-42345	1.6	6886.28	I	27766-42283
2.5	6101.87	I	18356-34740	1.2	6892.36	I	25456-39960
0.6	6130.63	I		0.8	6898.01	I	31300-45793
0.6	6197.66	I	32688-48819	0.8	6898.98	I	25997-40488
1.2	6217.89	I	18356-34435	1.0	6908.20	I	11143-25614
0.6	6264.27	I	33904-49864	2.5	6914.01	I	20281-28924
1.0	6265.88	I	18480-34435	0.7	6931.40	I	20350-34774
0.9	6290.74	I	18356-34248	1.0	6934.10	I	11454-25872
0.8	6301.75	I	24096-39961	0.4	6946.75	I	27093-41484

Molybdenum — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
0.8	6947.39	I	20350-34740	1.2	7447.34	I	31533-44957
0.6	6953.78	I	26189-40566	1.2 h	7452.85	I	25707-39122
0.8	6960.64	I	26336-40698	0.6	7475.43	I	27363-40736
0.6	6961.48	I	25707-40068	13	7485.74	I	26320-39675
1.2	6978.71	I	26639-40964	0.5	7501.62	I	25795-39122
0.6	6980.37	I	27766-42088	1.2	7504.47	I	26639-39960
0.5	6984.67	I	27774-42087	0.6	7571.53	I	27363-40566
2.0	6988.94	I	20130-34435	1.0	7572.64	I	26759-39960
0.7	6991.69	I	26189-40488	0.6	7579.58	I	27774-40964
0.9	6999.13	I	26415-40699	0.6	7591.66	I	20130-33299
0.6	6999.88	I	25707-39989	1.0 h	7595.16	I	25997-39160
1.2	7001.60	I	19970-34284	1.0	7601.84	I	27415-40566
0.8	7016.44	I	26450-40698	0.6	7649.52	I	27774-40844
0.6	7018.43	I		0.5	7653.26	I	26759-39821
0.6	7025.32	I	26336-40566	1.6 h	7656.76	I	31913-44970
2.0	7037.98	I	26639-40844	1.2	7679.49	I	20281-33299
0.8 h	7045.29	I	26639-40829	0.8	7709.54	I	25456-38423
2.0	7060.21	I	11454-25614	2.5	7720.77	I	20350-33299
1.2	7063.34	I	20281-34435	0.8	7723.63	I	27093-40037
1.2	7081.22	I	20130-34248	0.8	7732.49	I	19970-32899
0.8	7102.65	I	27774-41850	0.4	7752.34	I	27093-39989
10	7109.87	I	25614-39675	1.6	7829.65	I	20130-32899
0.7	7122.65	I	27363-41398	1.4	7854.45	I	27093-39821
2.5	7134.08	I	11858-25872	0.7	7887.74	I	27363-40037
0.7	7240.46	I	26759-40566	0.5	7917.62	I	27363-39989
14	7242.50	I	25872-39675	1.0	7923.15	I	20281-32899
3.5	7245.85	I	20158-33950	0.8	7968.85	I	27415-39960
2.0	7267.62	I	11858-25614	0.4	7984.35	I	26639-39160
0.6	7281.53	I	25906-39635	1.4	7986.60	I	25906-38423
1.6	7300.19	I		0.6	8027.32	I	20158-32612
0.7	7322.25	I	26336-39989	0.4	8058.22	I	45786-58193
0.7	7322.79	I		0.5	8104.67	I	39521-51856
0.7	7333.71	I	26189-39821	0.8	8153.45	I	25707-37968
1.2	7348.49	I	20350-33955	0.4 h	8192.60	I	23516-35719
0.5	7360.38	I	25707-39290	2.0 h	8245.06	I	28715-40840
1.2	7361.65	I	27384-40964	3.5 h	8328.44	I	28836-40840
0.9 h	7364.41	I		0.8	8351.15	I	25997-37968
0.7	7365.25	I		4 h	8389.32	I	28924-40840
3.5	7391.36	I	12346-25872	4 h	8483.39	I	25795-37579
0.9	7434.10	I	25997-39445				



# NEODYMIUM

Nd,  $Z=60$ ,  $M=144.27$ , Ratio  $\frac{\text{Nd}}{\text{Cu}}=2.270$

Nd I Normal state of valence electrons  $4f^4 6s^2 {}^5I_4 = 0$ . I.P.  $\approx 44000\text{K}$

Nd II Normal state of valence electrons  $4f^4 6s^1 {}^6I_{3/2} = 0$ .

## References

### Wavelengths:

Below 5000 Å:

A. S. King, *Astrophys. J.* **78**, 9 (1933).

Supplemented by A. Gatterer and J. Junkes, *Spektren der Seltenen Erden* (Specola Vaticana, Vatican, 1945).

F. Exner and E. Haschek, *Spektren der Elemente bei Normalen Druck* (Franz Deuticke, Leipzig and Vienna, 1911).

From 5000 to 6900 Å:

A. Gatterer and J. Junkes, *Spektren der Seltenen Erden* (Specola Vaticana, Vatican, 1945).

Supplemented by C. C. Kiess, *Sci. Papers BS* **18**, 201 (1922).

Above 6900 Å:

C. C. Kiess, *Sci. Papers BS* **18**, 201 (1922).

Supplemented by G. R. Harrison, *Massachusetts Institute of Technology Wavelength Tables* (John Wiley & Sons, New York, 1939).

W. Albertson, G. R. Harrison, and J. R. McNally, *Phys. Rev.* **61**, 167 (1942).

### Classification:

Nd I, F. W. Paul, *Phys. Rev.* **49**, 156 (1936) (Spectrum assignment only).

P. F. A. Klinkenberg, Thesis, Univ. of Amsterdam (1955).

Nd I and Nd II, A. S. King, *Astrophys. J.* **78**, 9 (1933) (Spectrum assignment only).

Nd II, W. E. Albertson, G. R. Harrison, and J. R. McNally, *Phys. Rev.* **61**, 167 (1942).

## Relative intensity of neodymium lines observed in an arc of copper containing 0.1 atomic percent of neodymium

### *Strong lines of neodymium*

Intensity	Wavelength Å	Spectrum	Energy levels K	Term combination
320	4303.58	II	0-23230	$4f^4 6s a {}^6I_{3/2} - 4f^4 6p z {}^6K_{3/2}$
280	4061.09	II	3802-28419	$4f^4 6s a {}^6I_{7/2} - 4f^4 6p z {}^6K_{3/2}$
220 d	3863.33	II	0-25877	$4f^4 6s a {}^6I_{3/2} - 17I_{3/2}$
220	3863.40	II	0-25876	$4f^4 6s a {}^6I_{3/2} - 4f^4 6p y {}^6H_{3/2}$
220	4012.25	II	5086-30002	$4f^4 6s a {}^6I_{8/2} - 4f^4 6p z {}^6K_{3/2}$
180	4040.80	II	1470-26211	$4f^4 6s a {}^6I_{5/2} - 18I_{3/2}$
180	4156.08	II	1470-25524	$4f^4 6s a {}^6I_{5/2} - 4f^4 6p z {}^6K_{3/2}$
150	3805.36	II		
150	4109.46	II	2585-26913	$4f^4 6s a {}^6I_{6/2} - 4f^4 6p z {}^6K_{7/2}$
140	3784.25	II		
140 d	3851.66	II		
140	3851.74	II	1470-27425	$4f^4 6s a {}^6I_{5/2} - 23I_{3/2}$
140	4177.32	II	513-24445	$4f^4 6s a {}^6I_{4/2} - 4f^4 6p z {}^6K_{3/2}$
120	3900.21	II		
120	3911.16	II		
120	3941.51	II	513-25877	$4f^4 6s a {}^6I_{4/2} - 17I_{3/2}$
120	3951.16	II	1470-26772	$4f^4 6s a {}^6I_{5/2} - 21I_{3/2}$
120	4247.38	II	0-23537	$4f^4 6s a {}^6I_{3/2} - 4f^4 6p z {}^6I_{1/2}$
100	3838.98	II	0-26041	$4f^4 6s a {}^6I_{3/2} - 26041I_{3/2}$
100 d	3848.24	II	1470-27449	$4f^4 6s a {}^6I_{5/2} - 4f^4 6p y {}^6I_{3/2}$
100	3848.31	II		
100	3905.89	II		
90	3848.52	II		
85	3990.10	II	3802-28857	$4f^4 6s a {}^6I_{7/2} - 4f^4 6p y {}^6I_{7/2}$
80	3775.50	II		
80	3963.12	II	3802-29027	$4f^4 6s a {}^6I_{7/2} - 29027I_{3/2}$
80	4109.08	II	513-24843	$4f^4 6s a {}^6I_{4/2} - 12I_{3/2}$
80	4451.57	II	3067-25524	$4f^4 6s a {}^6I_{5/2} - 4f^4 6p z {}^6K_{3/2}$
80	5249.59	II	7869-26913	$4f^4 5d a {}^6L_{8/2} - 4f^4 6p z {}^6K_{7/2}$
75	3889.93	II		
75	3890.58	II		
75	3890.94	II		
75	3901.84	II		
75	4232.38	II	513-24134	$4f^4 6s a {}^6I_{4/2} - 4f^4 6p z {}^6I_{3/2}$
75	5130.60	II	10517-30002	$4f^4 5d a {}^6L_{10/2} - 4f^4 6p z {}^6K_{3/2}$
75	5293.17	II	6637-25524	$4f^4 5d a {}^6L_{7/2} - 4f^4 6p z {}^6K_{3/2}$

Neodymium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
5	2702.46			3.0	3188.73	II	
5	2704.54			3.0	3200.62	II	
5	2764.98	I		9	3203.47	II	
4	2785.79	I		5	3211.00	II	
3.0	2863.95			6	3217.12	II	
3.0	2921.26			3.0	3222.62	I	
3.5	2962.88	II		3.0	3228.04	II	
4	2963.58	II		3.5	3234.62		
5	2993.20	II		2.5	3237.91	II	
2.5	2994.73			6	3254.08	II	
6	3007.97	II		3.0	3256.91	II	
6	3014.19	II		13	3259.24	II	
6	3018.35	II		6	3260.66	II	
5	3026.47			13	3265.12	II	
3.0	3038.98	II		3.0	3265.38	II	
3.0	3043.29			10	3267.25	II	
3.0	3051.11	II		6	3273.18	II	
5	3052.15	II		19	3275.22	II	
9	3056.71	II		3.0	3281.49		
8	3069.73	II		3.0	3282.78	II	0-30453
4	d 3071.43	II		17	3285.10	II	
	3071.50	II		6	3286.62	II	
10	3075.38	II		3.0	3289.52		
6	3079.38	II		6	3290.65	II	
6	3080.94	II		4	3293.84	II	
6	3092.73			4	3294.68	II	
15	3092.92	II		4	3298.61		
9	3098.48	II		18	3300.16	II	
3.5	3099.52	II		8	3300.91	II	
8	3105.43	II		4	3304.66	II	
6	3106.18	II		5	3305.33		
4	3108.01	II		6	3310.38	II	
16	3115.18	II		8	3310.91	II	
12	3116.15	II		12	3312.75	II	
3.0	3119.75	II		6	3313.16	II	
10	3123.06	II		6	3316.02	II	
12	3124.58	II		12	3325.90	II	
17	3133.60	II		4	h 3326.26		
13	3134.90	II		3	3327.69		
6	3137.24	II		24	3328.28	II	0-30037
10	3141.46	II		15	3331.57	II	
10	3142.44	II		17	3334.48	II	1470-31451
6	3144.55	II		17	3339.07	II	513-30453
6	3144.82	II		5	3345.71		
6	3148.51	II		5	3347.56	II	
6	3149.29	II		6	3347.89		
6	3149.51	II		10	3348.17	II	
6	3162.62	II		19	3353.59	II	
6	3175.99	II		5	3354.60	II	1650-31451
3.0	3181.54	II		12	3355.93	II	

Neodymium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
5	3356.55			7	3607.72		
10	3359.76	II		19	3609.79	II	
16	3364.96	II		5	3612.75		
5	3375.23	II		22	3615.82	II	1650-29298
4	3386.29			18	3618.96	II	
6	3386.52	II		11	3624.65	II	
6	3388.03	II		7	3626.18		
4	3389.33			7	3627.41		
4	3392.31			5	3629.59		
17	3393.63	II		10	3629.94	II	
9	3410.25	II		18	3631.02	II	
4	3412.39			4	3633.47		
3	3415.55			20	3634.30	II	
11	3425.22	II		10	3634.87	II	
10	3428.93	II		4	3635.11		
6	3432.99			14	3637.00	II	
3	3435.43			14	3637.23	II	
6	3443.32	II		11	3637.79	II	
3	3454.38	II		4	3638.70		
3	3461.83			14	3640.24	II	
7	3468.42	II		11	3641.50	II	
7	3470.86	II	1650-30453	4	3642.46		
9	3481.44	II		11	3643.63	II	
7	h 3484.88	I		4	3645.63		
7	3510.70	II		14	3645.78	II	
7	3522.05	II	3067-31451	7	3647.93		
12	3527.53	II		20	3648.20	II	
5	h 3531.71	II		14	3649.46		
10	3533.59	II		14	3650.42	II	
11	3541.60	II		3	3650.69		
17	3543.35	II		11	3651.59		
4	3553.99			7	3652.45		
12	3555.77	II		24	3653.15	II	
24	3560.75	II		14	3654.16		
4	3561.61	II		7	3655.03	II	
20	3568.87	II		7	3659.94	II	
4	3576.16			7	3660.97		
11	3582.63			28	3662.26	II	
6	3582.88			5	3663.03		
5	3586.82			32	3665.18	II	
28	3587.51	II		9	3668.79		
7	3588.23			11	3669.45		
5	3592.09	II		5	3669.75		
18	3592.59	II		9	3670.92	I	
7	3595.41			7	3671.66		
7	3595.91			32	3672.36	II	
20	3598.02	II		34	3673.54	II	
4	3600.12			6	3674.65		
18	3600.91	II		5	3677.60		
4	3606.30			14	3678.18	II	

Neodymium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
6	3678.88			15	3754.83		
5	3684.29			22	3755.60	II	
70	3685.80	II		6	3756.83		
7	3686.07			30	3757.82	II	
26	3687.30	II		55	3758.95	II	
24	3689.69	II		18	3759.79	II	
18	3694.81	II		8	3761.58		
7	3697.17			5	3762.09		
24	3697.56	II		55	3763.47	II	
6	3701.75			7	3765.34	II	
14	3702.84			7	3765.92		
7	3703.88			18	3766.59		
14	3704.95			6	3768.71		
12	3712.81			30	3769.65	II	1650-28170
28	3713.70	II		8	3772.40	I	
22	3714.20	II		8	3772.93		
38	3714.73	II	513-27425	11	3773.18		
	3714.81	II		6	3774.93		
15	3715.04	II		80	3775.50	II	
12	3715.39	II		15	3776.34		
28	3715.68	II		8	3777.00		
5	3716.58			42	3779.47	II	
24	3718.54			34	3780.40	II	3802-30247
5	3719.21			30	3781.32	II	
8	3720.54			18	3783.78		
24	3721.35	II		140	3784.25	II	
13	3722.42			16	3784.73		
46	3723.50	II		11	3784.85	II	
24	3724.87	II		9	3785.11	II	
15	3726.90			7	3785.40		
42	3728.13	II		7	3788.97		
28	3730.58	II		20	3791.50	II	
10	3731.22	II		9	3792.81		
5	3731.63			20	3795.45	II	
6	3732.02			7	3796.49		
16	3732.78	II		10	3799.24		
60	3735.54	II		14	3799.55		
	3735.60	II		22	3801.12		
26	3737.10			12	3801.38	II	
60	3738.06	II		20	3802.30		
16	3741.42	II		70	3803.47	II	
7	3742.59			12	3804.10		
8	3744.24			150	3805.36	II	
9	3749.10			20	3805.55	II	
12	3749.85	II		28	3807.23	II	513-26772
19	3750.31			8	3808.25		
6	3750.74			32	3808.77	II	
7	3752.29	I		26	3809.06	II	
34	3752.49	II		34	3810.49	II	
22	3752.67	II	0-26640	14	3811.06	II	3067-29298

## Neodymium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
16	3811.77	II	0-26227	32	3887.87	II	513-26227
12	3812.53			22	h 3889.66	II	
42	3814.73	II		75	3889.93	II	
11	3817.38	II		10	3890.22	II	
6	3818.84			75	3890.58	II	
14	3819.70			75	3890.94	II	
24	3822.47	II		34	3891.51	II	
5	3823.26			28	3892.06	II	
70	3826.42	II	513-26640	48	3894.63	II	513-26182
14	3828.00	II		8	3895.37	II	
32	3828.85	II		5	3895.91		
26	3829.16	II		16	3896.13	II	
30	3830.47	II		26	3897.63	II	
6	3832.76			120	3900.21	II	
44	3836.54	II		75	3901.84	II	
20	3837.91	II		8	3902.51	I	
100	3838.98	II	0-26041	7	3903.51		
20	3839.51	II		6	3905.56		
24	h 3841.95			100	3905.89	II	
6	3844.18			8	3906.09	II	
6	3845.74			6	3907.50		
11	3846.71			12	3907.64		
6	3846.97			30	3907.84	II	
100	d 3848.24	II	1470-27449	120	3911.16	II	
	3848.31	II		50	3912.23	II	
90	3848.52	II		20	3913.69	II	
28	3850.22	II		26	3915.13	II	
140	d 3851.66	II	1470-27425	36	3915.95	II	
	3851.74	II		20	3917.65		
20	3858.55			5	3918.90		
7	3859.42			13	3919.92	II	
16	3860.94			65	3920.96	II	
18	3862.52	II		8	3924.49	II	
220	d 3863.33	II	0-25877	5	3924.98		
	3863.40	II	0-25876	5	3925.63		
10	3865.98	II		4	3926.62	II	
14	3866.52	II		30	3927.10	II	
13	3866.81	II		12	3929.26	II	
50	3869.07	II	1470-27309	9	3934.09	II	
14	3875.74	II		36	3934.82	II	
28	3875.87	II		24	3936.11	II	
65	3878.58	II		8	3937.00	I	
60	3879.55	II		4	3937.57	II	0-25389
46	3880.38	II		30	3938.86	II	
70	3880.78	II	513-26274	8	3939.52	II	
12	3881.59			120	3941.51	II	513-25877
6	3883.76			5	3942.12	II	
6	3884.08			9	3942.62	II	
6	3884.74			4	3946.81		
5	h 3886.09	I		6	3947.61	I	

## Neodymium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
9	3948.32	II		32	4004.02	II	
4	3950.42			6	4004.26		
120	3951.16	II	1470-26772	24	4007.43	II	
48	3952.20	II	0-25295	5	4008.75		
19	3952.87	II		6	4010.45	II	
5	3953.40	II		9	4011.09	II	
19	3953.52	II		220	4012.25	II	5086-30002
6	3954.41			32	4012.70	II	
3.5	3955.09			8	h 4013.25	II	
7	3955.95	II		4	4015.56		
14	3957.45	II		22	4018.81	II	513-25389
35	3958.00	II	513-25772	7	4019.79	II	
30	3962.21	II		5	4020.05	II	
80	3963.12	II	3802-29027	60	4020.87	II	2585-27449
16	3963.90	II		60	4021.34	II	2585-27446
7	3967.06	II		60	4021.78	II	
9	3967.75	II		70	4023.03	II	
10	3968.88			20	4024.78	II	513-25352
7	3969.67			24	4030.47	II	1470-26274
65	3973.30	II	5086-30247	70	4031.82	II	
44	3973.69	II	2585-27744	7	4033.50		
9	3975.20			6	4033.90		
7	3976.09	I		4	4034.01	II	513-25295
44	3976.85	II	0-25138	16	4038.12	II	1470-26227
6	3977.33			180	4040.80	II	1470-26211
3.5	3977.99			12	4041.06	II	
4	3979.03			5	4042.51		
44	3979.49	II	1650-26772	5	4043.05		
3.5	3980.98			24	4043.59	II	2585-27309
8	3981.24	II		5	4044.35	II	
19	3982.36	II	3067-28170	24	4048.81	II	
5	3983.41	II		50	4051.15	II	3067-27744
4	3983.58			5	4054.86	II	
28	3986.25	II		5	4056.83	II	
3.5	3987.25			50	4059.96	II	1650-26274
3.0	3987.81	II		280	4061.09	II	3802-28419
4	3988.82	II		5	4067.73	I	
85	3990.10	II	3802-28857	65	4069.28	II	513-25081
60	3991.74	II	0-25045	6	4071.46	II	
5	3992.16			8	4074.42	II	
5	3992.28			42	4075.12	II	1650-26182
10	3992.60	II		28	4075.28	II	513-25045
65	3994.72	II		14	4077.62		
8	3995.26	II		28	4080.23	II	513-25014
4	3997.44	II		8	4082.55	II	
4	3997.78			14	4085.82	II	0-24468
10	3997.93			4	4086.82		
5	3998.16			5	4088.56	II	
10	3998.69			4	4089.12	II	
24	4000.50	II	1650-26640	7	4089.68	II	

Neodymium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
5	4091.00	II		3.5	4174.46		
8	4094.62	II		48	4175.61	II	5086-29027
5	4095.43	II		140	4177.32	II	513-24445
16	4096.13	II		10	d 4178.44	II	
6	4096.71	II			4178.53	II	
13	4098.18	II		12	4178.64	II	
6	4098.91	II		38	4179.59	II	1470-25389
11	4100.24	II	3067-27449	5	4182.52	II	
5	4101.45	II		4	4183.13	I	
5	4102.53	II		15	4184.98	II	
9	4104.23	II		5	4185.77		
3.0	4104.54	II		8	4186.04	II	1470-25352
12	4106.59	II	4512-28857	4	4187.11		
7	4107.44	II		4	4188.26		
7	4107.96	II		2	4195.03	II	
80	4109.08	II	513-24843	5	4198.17	II	
150	4109.46	II	2585-26913	7	4199.11	II	513-24321
30	4110.48	II	0-24321	4	4200.04	II	
18	h 4113.83	II	1470-25772	4	h 4203.43	II	
4	4116.34			7	4205.25	II	
2.0	4116.77	II		28	4205.60	II	5086-28857
5	4120.66	II	5986-30247	28	4211.29	II	1650-25389
5	4121.94	II		4	4212.75	II	
24	4123.88	II	3067-27309	5	4213.07	II	
3.0	4125.05	II		5	4213.22	II	
5	4128.70	II		6	4214.22	II	
3.0	4129.87	I		6	4214.60	II	
3.0	4130.72	II		7	4217.28	II	3067-26772
5	4132.56	II		4	4218.55	II	
28	4133.36	II	2585-26772	4	4219.56	II	
5	4134.72	II		17	4220.25	II	2585-26274
30	4135.33	II		10	h 4221.14	I	
6	4136.76	II		7	4223.21	II	
10	4144.56	II	1650-25772	8	4224.84	II	
8	4146.13	II		4	4226.99	II	
10	4151.68	II		26	4227.73	II	3802-27449
6	4153.73	II		11	4228.03	II	1650-25295
180	4156.08	II	1470-25524	11	4228.20	II	3802-27446
30	4156.26	II		6	4229.50	II	
4	4157.58	II		75	4232.38	II	513-24134
8	4159.57	II		6	4233.15		
20	4160.57	II		15	4234.19	II	1470-25081
3.5	4164.41			17	h 4235.24	II	
3.5	4164.85	I		17	4239.84	II	
9	4165.04	II		8	4241.21	II	
24	4168.00			5	4244.56		
4	4168.76	II		5	4244.96	II	
6	4170.46	II		7	4246.88	II	513-24053
6	4170.76	II		120	4247.38	II	0-23537
6	4173.38	II	513-24468	5	4248.15		

## Neodymium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
50	4252.44	II		4	4359.25	II	4512-27446
7	4252.88	h		4	4360.87	II	
6	4253.87	II		3	4361.40	h	
17	4254.29			7	4364.14	II	
4	4256.24	II	1650-25138	14	4366.38	II	
6	4256.47	I		20	4368.64	II	513-23397
6	4256.82	II		3.5	4372.14	II	
10	4257.79	II		3.5	4372.28	II	
4	4259.62	II		3.5	4372.73	h	
24	4261.84	II		28	4374.93	d	1470-24321
9	4262.24	II			4375.04	II	0-22851
9	4263.44	II		3.0	4376.45	II	
9	4263.91	h		3.5	4377.40	II	
	4264.00			7	4382.74	II	3067-25877
20	4266.71	II	1650-25081	42	4385.66	II	1650-24445
14	4270.56	II	0-23410	15	4390.66	II	
20	4272.79	II	0-23397	4	4391.10	II	2585-25352
20	4275.09	II		2.5	4392.12		
8	4277.29	II	1470-24843	2.5	4394.18	II	
4	4280.17			2.5	4395.50		
28	4282.44	II		2.5	4395.89		
14	4282.57	II	513-23857	3.0	4398.03		
42	4284.52	II	5086-28419	2.5	4399.58		
7	4290.96	II		32	4400.83	II	513-23230
5	4294.19	h		7	4407.08	II	
4	4297.36	II		30	4411.06	II	1470-24134
16	4297.80	II		8	4412.27	II	513-23171
5	4299.71	II		4	4414.44	II	513-23160
4	4301.22	I	2367-25609	8	4416.89	II	
320	4303.58	II	0-23230	3.0	4420.11	d	I
20	4304.45	II		2.5	4420.52		
4	4305.48	II		2.0	4426.83	II	1470-24053
7	4306.75	II		3.5	4432.30	II	
12	4307.78	II	3067-26274	5	4439.00	II	
6	4310.51	II	1650-24843	2.0	4444.29	II	
5	4311.25	I		3.5	4444.99	I	0-22491
5	4313.36	II		34	4446.39	II	1650-24134
10	4314.38	II		80	4451.57	II	3067-25524
28	4314.52	II	0-23171	12	4451.99	II	0-22456
65	4325.76	II	3802-26913	18	4456.40	II	5986-28419
30	4327.93	II		10	4462.42	II	1650-24053
32	4338.70	II	5986-29027	44	4462.99	II	4512-26913
8	4342.07	II	513-23537	6	4465.07	II	0-22390
4	4343.50	I	0-23016	7	4465.60	II	1470-23857
5	4349.10			5	4467.85	II	
4	4350.21	II		8	4469.26	II	
40	4351.29	II	1470-24445	5	4470.97	II	5086-27446
9	4356.02	II		5	4471.41	II	
50	4358.17	II	2585-25524	2.5	4475.57	II	513-22851
5	4358.70	II	4512-27449	1.8	4475.84	I	2367-24703



## Neodymium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
3.0	4477.46	II		3.5	4631.29	I	
8	4477.88	I		3.0	4632.64	II	1650-23230
8	4480.97	I	1128-23438	30	4634.24	I	0-21572
4	4481.90	I	1128-23434	3.5	4637.20	I	0-21559
2.5	4485.95	II	3067-25352	5	4638.72	II	
5	4493.42	II		5	4639.14	I	1128-22678
2.5	4497.27	II		20	4641.10	I	
2.5	4497.40	I		15	4645.77	II	
5	4497.93	II		12	4646.40	I	
24	4501.82	II	1650-23857	18	4649.67	I	
12	4506.59	II	513-22697	3.5	4652.39	I	
10	4513.34	II		12	4654.73	I	1128-22606
15	4516.36	II		4	h 4664.45	II	
4	4522.84	II		11	4670.56	II	
2.5	4523.58	II		4	4671.10	I	1128-22530
7	4527.25	I	5049-27131	2.0	4673.97	I	2367-23756
4	4529.94	I		5	4675.52	I	3682-25064
20	4541.27	II	3067-25081	14	4680.74	II	513-21871
5	4542.06	I	0-22010	26	4683.45	I	0-21346
20	4542.61	II		9	4684.04	I	1128-22471
2.5	4544.26	II		1.2	4688.55	I	
2.0	4545.33	II		9	4690.35	I	0-21314
5	4548.24	I	3682-25662	16	4696.44	I	3682-24968
2.5	4549.02	II		11	4703.57	II	3067-24321
2.0	4554.97	II	3067-25014	40	4706.54	II	0-21241
3	4555.14	II		12	4706.96	I	1128-22367
6	4556.14	II	513-22456	16	4709.71	II	1470-22697
5	4556.74	II	1470-23410	16	4715.59	II	1650-22851
10	4559.67	I	2367-24292	5	4717.08	II	
3.5	4560.42	I		20	4719.02	I	
3.5	4561.18	II		16	4724.35	II	
4	4561.86	I		2.5	4726.55	I	
20	4563.22	II		12	4731.77	I	1128-22256
5	4567.61	II	1650-23537	3.0	4734.90	I	
12	4578.89	II		1.6	4736.20	II	
12	4579.32	II		2.5	4749.03		
2.5	4584.04	II		2.5	4749.56	II	
6	4586.62	I		6	4749.75	I	3682-24730
3.5	4586.96	I		4	4755.85	I	3682-24703
5	4594.45	II	1650-23410	2.0	4759.10	I	
12	4597.02	II	1650-23397	1.8	4760.45	I	1128-22129
6	4603.82	I	5049-26764	4	4763.62	II	3067-24053
2.5	4607.38	II	4512-26211	7	4763.87	II	1470-22456
6	4609.87	I	1128-22815	6	4770.20	I	
2.0	4612.47	II	513-22188	2.0	4771.73		
18	4621.94	I	2367-23996	1.6	4772.26	I	
5	4624.21	I		3.5	4772.88	II	
5	4626.50	I	1128-22737	3.5	4777.72	II	
6	4627.98	I	2367-23968	1.2	4778.40	I	
3.5	4629.91	II		10	4779.46	I	

## Neodymium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
6	4783.80	II		5	4910.05	I	0-20361
3.5	4786.06	II		16	4913.41	I	
1.8	4787.40	I	1128-22010	14	4914.37	II	3067-23410
14	4789.41	II		28	4920.68	II	513-20830
10	4797.15	II	4512-25352	3.0	4921.14	I	3682-23996
5	4799.42	II	0-20830	3.0	4922.45	I	
3.5	4806.62	I	1128-21927	40	4924.53	I	0-20301
20	4811.34	II	513-21292	3.0	4930.72	II	6637-26913
3.0	4817.17	II		3.0	4942.95	II	5986-26211
2.0	4818.96	II		5	4943.90	II	1650-21871
1.2	4819.64	II		22	4944.83	I	
12	4820.34	II	1650-22390	7	4947.02	II	
1.2	4824.18	II	4512-25235	4	4949.03		
30	4825.48	II	1470-22188	4	4950.29	I	
2.0	d 4827.57	I		3.0	4950.67	I	
	4827.74	I					
4	4828.58	II		6	4952.46	I	1128-21314
11	4832.28	II		32	4954.78	I	0-20177
2.5	4835.66	I	2367-23040	6	4958.10	II	3067-23230
6	4835.98	II	0-20673	32	4959.13	II	513-20673
5	4836.62	I		16	4961.39	II	5086-25235
9	4849.06	II		9	4963.33	I	
7	4853.33	I	1128-21727	4	4969.75	I	
3.0	4855.31	I	1128-21718	4	4970.93	II	2585-22697
24	4859.02	II	2585-23160	4	4972.82		
				2.5	4973.40	I	
2.5	4859.58	I		10	4975.50	I	
2.0	4861.77	I		3.0	4980.88	I	
4	4864.78			8	4981.28	II	
16	4866.74	I	0-20542	4	4982.89	I	
4	4867.84	II	1650-22188	10	4987.17	II	
4	4869.27	I	3682-24213	4	4989.46		
3.0	4871.44	I		28	4989.94	II	
3.0	4874.37	I		10	4998.55	II	
5	d 4875.73	I		8	5000.44	II	
	4875.84	II		6	5011.67	II	
2.0	4876.12	II	4512-25014	7	5014.55	I	
4	4879.79	I		2.0	5015.40		
2.5	4882.88	II		2.0	5022.67	I	
30	4883.81	I		10	5027.15	I	
4	4885.01	I		7	5027.85	II	4438-24321
12	4889.10	II		10	5029.45	I	1128-21005
19	4890.70	II		16	5033.52	II	9166-29027
20	4891.07	I		3.0	5039.92	I	
4	4893.23	I	1128-21559	6	5040.20	I	1128-20963
24	4896.93	I	1128-21543	5	5051.06	I	
10	4901.53	I		10	5056.89	I	0-19770
18	4901.84	I		3.0	5060.04	I	
9	4902.03	II	513-20907	12	5063.73	II	
2.5	4907.26	I	2367-22739	4	5066.85		
2.5	4907.78	I	2367-22737	7	5071.87	I	1128-20839

## Neodymium — All Observed Lines

Intensity and Character	Wave-length in A	Spectrum	Energy Levels in K	Intensity and Character	Wave-length in A	Spectrum	Energy Levels in K
4	5073.87	I	3682-23385	40	5255.51	II	1650-20673
4	5074.52	I		2.5	5257.35		
40	5076.59	II		4	5264.22	I	
8	5077.16	II		3.0	h 5265.74		
6	5079.09	I		2.5	h 5266.64	I	
3.5	5081.89			13	5269.48		
16	h 5089.84	II	1650-21292	10	5269.78	II	
40	5092.80	II	3067-22697	6	5270.09	I	
7	5096.52	II	4438-24053	6	5270.69		
20	5102.39	II	5488-25081	3.0	5272.00		
8	5103.11	I		65	5273.43	II	5488-24445
16	d 5105.21	II		16	5276.88	II	6932-25877
	5105.35	I		6	5286.68	I	
40	5107.59	II	6637-26211	4	5287.13		
3.0	5114.53	I		12	5291.67	I	
4.0	5119.61	II	5488-25014	75	5293.17	II	6637-25524
4.0	5121.30			2.5	5298.88	I	
38	5123.79	II		3.0	5300.58	I	1128-19989
75	5130.60	II	10517-30002	18	5302.28	II	11392-30247
19	5132.33	II		3.0	5302.61	I	
2.5	5134.23			7	5303.21	II	
5	5136.83			12	5306.47	II	6932-25772
9	5143.33	II	1470-20907	3.0	5308.28	I	
5	5156.01			3.0	5308.42	II	10195-29027
8	5161.71	II		5	5310.01		
19	5165.14	II	5488-24843	24	5311.46	II	7950-26772
10	5167.92	II	4512-23857	4	5314.55		
2.5	5170.91			6	5316.60	II	
9	5176.79	II		5	5319.11		
2.0	5178.75	I	1128-20432	55	5319.82	II	4438-23230
3.5	5179.78	II		3.0	5320.79	I	
14	5181.17	II	6932-26227	4	5324.59	I	
13	5182.60	II	6005-25295	3.0	5329.11		
2.0	5187.05	I		2.0	5329.88	I	
55	5191.45	II	1650-20907	3.0	5332.43	I	
70	5192.62	II	9166-28419	3.0	5334.33	I	0-18741
6	5195.60	I	2367-21608	10	5336.55	II	4438-23171
6	5198.07	I	1128-20361	5	5338.01		
36	5200.12	II		1.8	5343.65	I	
7	5204.38	I	0-19209	9	5345.71	II	9043-27744
34	5212.37	II	1650-20830	2.5	5349.26	I	
17	5213.23	I	2367-21543	4	5349.58	I	1128-19816
10	5215.65	II		20	5356.98	II	10195-28857
7	5221.57	II		5	5361.17	II	4512-23160
14	5225.05	II	6005-25138	32	5361.47	II	5488-24134
14	5228.43	II	3067-22188	4	5365.12	II	
50	5234.20	II	4438-23537	1.6	5370.16		
28	5239.79	II		17	5371.94	II	11392-30002
80	5249.59	II	7869-26913	4	5377.79	I	
22	5250.82	II	6005-25045	2.5	5378.23	I	

## Neodymium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
3.5	5383.85	II		10	5533.82	I	2367-20432
12	5385.90	II		6	5535.27	II	
2.5	5388.23			2.5	5537.77	II	
2.0	5396.72			3.0	5539.26	II	6005-24053
2.5	5399.12	II	7525-26041	6	5543.24	I	
3.5	5400.20	I		5	5545.91	II	
3.0	5402.90	I		6	5548.47	II	4438-22456
5	5406.17	II		3.0	5548.68		
2.0	5411.93	I	2367-20839	3.0	5550.09	II	
3.5	5414.74	I		4	5557.62	II	
2.0	5415.31	I		6	5561.17	I	0-17977
8	5416.38	II	6932-25389	4	5569.96	II	
2.0	5420.66	I		3.0	5575.50	I	
9	5421.56	II	6005-24445	3.0	5576.70	I	3682-21608
2.0	5424.07	I		3.0	5577.70	I	
2.0	5429.30	I		2.5	5578.66		
8	5430.79	I		3.5	5581.60	II	6932-24843
18	5431.53	II	9043-27449	3.0	5587.61	I	
4	5432.36	II	9043-27446	2.0	5587.96	II	
4	5441.26			3.5	5588.91		
10	5442.27	II	5488-23857	2.0	5592.67	I	
3.0	5447.28	I		26	5594.43	II	9043-26913
4	5447.56	II	8420-26772	2.0	5595.81		
6	5449.24	I		6	5601.43	I	
12	5451.12	II		5	5601.92	I	
8	5455.82	II	7950-26274	4	5602.68	II	
3.5	5456.56			3.0	5603.65	II	3067-20907
2.0	5458.60			4	5614.30	II	8420-26227
4	5473.08	II	9043-27309	2.0	5615.35	I	
5	5474.73	II	7950-26211	4	5617.71	II	
3.0	5478.61	I		3.0	5619.00		
2.0	5483.12	II	7950-26182	24	5620.54	I	0-17787
5	5485.10	II		1.2	5623.62	I	
19	5485.70	II	10195-28419	4	5625.72	II	7525-25295
2.5	5487.03	II	8420-26640	7	5635.76	I	
4	5492.30	I		5	5639.54	I	
1.6	5493.34	I		2.0	5647.98	I	
7	5494.01	II		4	5653.57	I	
2.0	5496.42	I		4	5659.78	II	
1.4	5498.86	I		2.0	5662.46	I	
4	5501.47	I	0-18172	1.2	5665.26	I	
2.0	5507.66			8	5668.87	II	11392-29027
4	5508.40	II	6932-25081	7	5669.77	I	
2.0	5516.29	I		15	5675.97	I	1128-18741
3.0	5520.60	d		6	5676.33	I	
1.4	5522.17	I		1.2	5681.16	I	
2.0	5523.94	I		24	5688.53	II	7950-25524
5	5525.72	I		2.5	5689.51	I	
4	5528.33	II		1.2	5695.23	I	
2.0	5529.07	I	1128-19209	5	5698.93	II	12460-30002

## Neodymium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
3.5	5701.57	I		2.5	5845.95	I	
14	5702.24	II	6005-23537	1.8	5846.36	II	
9	5706.21	II	7525-25045	1.4	5847.59	I	
18	5708.28	II	6932-24445	3.5	5857.52	II	
9	5718.12	II	11373-28857	6	5858.91	I	
3.5	5719.09	I		4	5865.06	II	11373-28419
7	5726.83	II	8420-25877	4	5867.08	I	
11	5729.29	I		3.5	5868.90	I	
1.8	5731.05	I		3.0	5871.04	I	
2.5	5734.55			3.0	5877.83	II	
5	5739.96	II		3.0	5882.78	II	
8	5740.86	II	9358-26772	3.5	5883.29	I	
3.0	5741.28			2.5	5886.24	I	
5	5742.08	II		3.5	5887.91	I	
3.0	5742.76			4	5891.53	II	8420-25389
3.5	5743.20	II	10337-27744	2.0	5899.49	I	
1.2	5744.14	II	6005-23410	2.5	5900.43	II	7525-24468
5	5744.77	II	7950-25352	3.0	5906.65	II	6932-23857
3.5	5748.15	II	6005-23397	4	5909.87	II	
3.0	5749.06			1.0	5914.40	I	
6	5749.19	I		3.0	5921.22	I	
3.0	5749.66	I		1.0	5922.79	I	
3.0	5753.53	II		3.0	5934.75	II	6005-22851
2.0	5760.00			3.5	5943.22	II	
3.5	5761.70	II	8420-25772	1.6	5949.64	I	
1.6	5762.08	I		3.0	5955.87	I	
1.2	5764.23	I	3682-21025	1.6	5961.16	I	
2.5	5767.33	I		3.5	5989.34	II	6005-22697
4	5769.87	II		3.5	5994.76	I	
5	5770.50	II	8717-26041	3.0	5996.47	I	
5	5776.12	I		5	6007.67	I	
5	5784.96	I	2367-19648	1.6	6009.30	II	
5	5788.22	I		1.0	6025.54	I	
3.0	5795.17	II		4	6031.27	II	10337-26913
5	5800.09	I		3.0	6033.29	I	
18	5804.02	II	6005-23230	5	6034.24	II	12460-29027
5	5809.25	I		6	6066.03	I	
9	5811.57	II	6931-24134	3.0	6071.70	I	
5	5813.89	I		3.5	6073.97	I	
1.8	5815.44	I		1.6	6101.75	I	
3.0	5820.37	I	1128-18304	1.6	6108.41	II	9674-26041
5	d 5823.37	II		2.5	d 6133.47	I	
3.0	d 5823.72	I		3.0	6149.28	I	0-16258
	5824.00	I		3.0	6155.06	I	
8	5825.87	II	8717-25877	1.6	6156.16	I	
3.5	5826.74	I	3682-20839	4	6157.83	II	
1.8	5830.72	I		2.5	6166.67	II	
9	5842.39	II	10337-27449	4	6170.49	II	9674-25877
1.8	5843.23			5	6178.59	I	
3.5	5844.66	I		3.0	6183.91	II	9358-25524

Neodymium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
2.0	6201.74	II		4	6485.69	I	0-15414
1.4	6208.01			1.8	6492.35	II	
3.0	6208.24	I		0.8	6495.59	II	
1.0	6210.68	II		1.8	6500.16	I	
1.4	6216.69	I		0.9	6504.46	II	9675-25045
5	6223.39	I		1.8	6514.96	II	
3.0	6226.50	I	2367-18423	1.4	6519.86	II	
2.5	6238.50	II	8420-24445	0.8	6523.15	II	7525-22851
4	6244.08	I		1.4	6539.94	II	6005-21292
1.4	6248.28	II		1.6	6549.54	II	
1.0	6250.43	II		1.6	6550.19	II	
2.5	6257.49	I		1.4	6553.07	II	6932-22188
3.0	6258.73	II		1.4	6558.97	II	
2.0	6263.23	II		0.8	6568.47		
2.0	6269.42	I		1.4	6572.65	II	
1.4	6270.27	I		2.0	h 6580.94	II	
2.5	6277.29	II		2.0	6585.71	II	
2.0	6282.00	I		1.8	6588.03	II	
3.0	6285.79	I		1.2	6591.43	II	
2.5	6292.84	II		1.8	6601.76	I	
2.5	6297.07	I		2.0	6611.99	I	
1.8	h 6298.42	II	7525-23397	1.2	6615.88	I	
2.0	6301.97	I		1.8	c 6618.53	I	
1.2	6308.26	I		2.0	6619.35	I	
6	6310.49	I	2367-18209	5	6630.14	I	0-15078
2.0	6319.69	II		1.0	6636.15		
1.2	6321.22	I		2.0	6637.19	II	
2.0	6330.17	II		4	6637.96	II	
3.0	6341.51	II		7	6650.57	II	
1.0	6355.95	I		5	6655.67	I	
2.0	6361.43	II		1.6	6669.65	II	8420-23410
2.0	6362.09	II	8420-24134	1.6	6670.37	I	2367-17354
2.0	6365.55	II	7525-23230	1.8	6678.52	II	
1.2	6375.97	I		3.0	6680.14	II	
2.5	6382.07	II		1.0	6698.65	II	
7	6385.20	I	1128-16785	1.6	6712.27	I	
2.0	6390.00	II		1.0	6714.15		
1.4	6403.20	I		3.0	6727.74	II	
2.0	6425.79	II		4	6737.79	II	
2.0	6428.65	II		6	6740.11	II	
0.7	6429.84	I		4	6742.54	I	
1.8	6432.65	I		1.6	6763.01	I	
1.0	6445.79	II		1.4	6763.78	I	
1.6	6451.23	I		1.4	6764.61		
0.8	6454.80	I		5	6790.41	II	
1.4	6457.13	I		1.8	6801.34	I	
1.6	6463.58	I		2.5	6803.06	I	
1.2	6465.24	II		5	6804.00	II	
1.4	6480.21	II		2.0	h 6812.30	II	
0.6	6482.28	II		2.0	6816.02	II	6005-20673

## Neodymium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
1.4	6825.35	I		5	7189.42	I	
2.5	6842.66	II		4	7192.01	I	
4	6846.72	II		2.0	7198.83	I	
1.7	6846.93			1.6 h	7227.01		
1.7	6852.23	I		3.0	7236.52		
1.5	6857.00	I		1.4 h	7261.64	II	8420-22188
1.5	6873.07			1.8	7285.29	II	9675-23397
2.2	6874.62	II		1.8	7288.56	II	7525-21241
1.2	6876.00	II		1.2	7291.38		
1.5	6886.86	I		1.4	7298.77		
2.2	6896.68	I		2.5	7316.80		
2.0	6897.29			1.4 h	7321.43		
6	6900.43	II		1.4	7323.10		
1.7	6901.33			1.2	7334.56	I	
2.0	6906.07	I		1.2	7357.16		
3.5	6923.86	I		1.2	7374.04		
2.5	6926.87	II		1.4	7381.81		
1.4	6932.16	I		1.8	7401.31	I	
1.8	6936.44			2.0	7406.62		
2.5	6938.67			1.2	7411.20		
3.5	6940.14			2.0	7418.18		
5	6941.39	II		1.8	7427.41		
2.5 d	6964.64	I		1.8	7448.76		
1.8	6982.65			1.0	7481.37	I	
1.4 h	6985.25	I		2.5	7511.16		
1.8 h	6995.27	I		3.5	7513.77	II	7525-20830
3.5 h	7010.80			1.4 h	7514.44		
1.6	7018.85			1.4	7516.01		
3.5	7020.92			1.8	7526.49		
3.5	7024.58			2.5	7529.01		
2.0	7033.21			2.0	7538.27		
7	7037.30			1.0	7540.98		
1.4	7052.16			1.4	7547.00	I	
1.4	7054.72			1.0	7577.54		
1.4	7061.48			1.4	7587.66	II	9675-22851
8	7066.89			1.2	7590.49		
1.6	7082.92			1.2	7603.75	II	7525-20673
2.5 h	7089.84			1.0	7605.94		
2.5 h	7092.09			1.0	7614.69		
2.5 h	7092.74			1.8	7639.79		
2.5 h	7092.94			1.6	7645.98		
3.5 h	7093.98	I		1.2	7663.48		
4 h	7095.42			2.5	7696.61		
6	7129.35			1.2	7718.15		
2.5 h	7142.04			0.9	7743.87		
2.0	7143.72			0.9	7749.02		
1.6	7151.03			2.0	7750.97		
1.2	7153.09			1.2	7773.03		
1.2 h	7185.01			1.4	7792.24	II	9358-22188
2.0	7189.02			1.2	7796.42	II	10337-23160

Neodymium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
1.6	7797.32			1.6	8172.49		
1.0	7798.40			1.8	8179.83		
2.0	7808.50			1.8	8182.41		
1.4	7818.86			0.8	8185.63		
1.0	7825.20	II	12460-25235	1.4 h	8205.36		
2.5	7862.84			2.0	8231.47		
1.0 h	7872.03			0.8	8248.77		
1.4	7886.60			1.0 h	8249.70		
0.8 h	7896.50			0.9 h	8262.80		
1.8	7900.38			1.4 h	8266.71		
1.0 h	7906.03			0.9	8272.75		
2.5	7917.01			0.9 h	8302.74		
2.0	7925.03			2.0	8307.72		
1.0	7947.95			1.2	8324.51		
2.0	7949.65			0.9	8332.01		
1.0 h	7955.38			2.5	8346.35		
2.5	7958.93			1.6 h	8375.23		
2.5	7965.69			0.9	8394.72		
3.0	7982.09	II	8717-21241	1.4	8400.79		
2.5	7982.67			1.0 h	8456.80		
2.5	8000.75			0.9	8530.44		
1.8	8007.72	I		1.0	8582.03		
0.8 h	8020.08			1.0	8591.43		
1.6	8026.41			1.4	8594.84		
2.0	8043.33	I	1128-13557	1.6 c	8643.48	II	9675-21241
1.6	8051.30			1.0	8667.00		
1.0	8064.00			1.0	8677.48		
2.0	8099.09			1.2	8691.30		
2.0	8120.85			1.2	8695.07		
2.5	8122.08			1.2	8712.84		
2.5	8141.72			1.2	8715.01		
2.5	8143.29			3.5	8838.96		
1.4 h	8164.97	I					



# NICKEL

Ni,  $Z=28$ ,  $M=58.71$ , Ratio  $\frac{\text{Ni}}{\text{Cu}}=0.924$

Ni I Normal state of valence electrons  $3d^8 4s^2 {}^3F_4 = 0$ . I.P. = 61579 K  
 Ni II Normal state of valence electrons  $3d^9 {}^2D_{3/2} = 0$ . I.P. = 146408 K

## References

### Wavelengths:

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### Classification:

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## Relative intensity of nickel lines observed in an arc of copper containing 0.1 atomic percent of nickel

*Strong lines of nickel*

Intensity	Wavelength Å	Spectrum	Energy levels K	Term combination
750	3414.76	I	205-29481	$3d^9 4s^1 a {}^3D_3 - 3d^9 4p^1 z {}^3F_4$
750	3524.54	I	205-28569	$3d^9 4s^1 a {}^3D_3 - 3d^9 4p^1 z {}^3P_2$
600	3515.05	I	880-29321	$3d^9 4s^1 a {}^3D_2 - 3d^9 4p^1 z {}^3F_3$
600	3619.39	I	3410-31031	$3d^9 4s^1 a {}^1D_2 - 3d^9 4p^1 z {}^1F_3$
500	3492.96	I	880-29501	$3d^9 4s^1 a {}^3D_2 - 3d^9 4p^1 z {}^3P_1$
460	3458.47	I	1713-30619	$3d^9 4s^1 a {}^3D_1 - 3d^9 4p^1 z {}^3F_2$
460	3461.65	I	205-29084	$3d^9 4s^1 a {}^3D_3 - 3d^8 4s^1 4p^1 z {}^5F_4$
460	3566.37	I	3410-31442	$3d^9 4s^1 a {}^1D_2 - 3d^9 4p^1 z {}^1D_2$
440	3446.26	I	880-29888	$3d^9 4s^1 a {}^3D_2 - 3d^9 4p^1 z {}^3D_2$
320	3002.49	I	205-33501	$3d^9 4s^1 a {}^3D_3 - 3d^8 4s^1 4p^1 y {}^3D_3$
300	3012.00	I	3410-36601	$3d^9 4s^1 a {}^1D_2 - 3d^8 4s^1 4p^1 y {}^1D_2$
300	3380.57	I	3410-32982	$3d^9 4s^1 a {}^1D_2 - 3d^9 4p^1 z {}^1P_1$
300	3392.99	I	205-29669	$3d^9 4s^1 a {}^3D_3 - 3d^9 4p^1 z {}^3D_3$
280	3050.82	I	205-32973	$3d^9 4s^1 a {}^3D_3 - 3d^8 4s^1 4p^1 y {}^3F_4$

Nickel — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
18	2289.98	I	0-43655	280	3050.82	I	205-32973
8	2300.78	I	205-43655	120	3054.32	I	880-33611
30	2310.96	I	0-43259	150	3057.64	I	1713-34409
26	2312.34	I	1332-44565	40	3064.62	I	880-33501
22	2313.66	I		38	3080.76	I	1713-34163
22	2313.98	I	2217-45419	24	3097.12	I	1332-33611
7	2316.04	II	8394-51558	19	3099.12	I	1332-33590
22	2317.16	I	1332-44475	240	3101.55	I	880-33112
44	2320.03	I	0-43090	120	3101.88	I	3410-35639
30	2321.38	I	2217-45281	20	3105.47	I	2217-34409
4	2322.68	I		25	3114.12	I	880-32982
26	2325.79	I	1332-44315	260	3134.11	I	1713-33611
17	2329.96	I	2217-45122	5	3145.72	I	1332-33112
9	2337.49	I	0-42768	5	3181.74	I	15610-47030
3.0	2337.82	I	1713-44475	9	3184.37	I	2217-33611
26	2345.54	I	0-42621	5	3195.57	I	2217-33501
4.0	2346.63	I	1332-43933	14	3197.11	I	1713-32982
9	2347.52	I	0-42585	5	3202.14	I	25754-56974
4	2360.63	I	2217-44565	16	3214.06	I	25754-56858
5	2362.06	I	1332-43655	16	3217.83	I	25754-56821
8	2386.58	I	880-42768	9	3221.27	I	30923-61958
12	2394.52	II	13550-55300	14	3221.65	I	0-31031
10	2416.14	II	14995-56371	19	3225.02	I	3410-34409
12	2419.31	I	1332-42654	100	3232.96	I	0-30923
4	2421.23	I	1332-42621	26	3234.65	I	880-31786
4	2423.33	I	1332-42585	55	3243.06	I	205-31031
4	2423.66	I	2217-43464	9	3248.46	I	205-30980
4	2424.03	I	1713-42954	11	3250.74	I	3410-34163
6	2437.89	II	13550-54557	9	3271.12	I	880-31442
6	2453.99	I	2217-42954	11	3282.70	I	1332-31786
11	2472.06	I	2217-42656	60	3315.66	I	880-31031
6	2476.87	I	0-40361	30	3320.26	I	1332-31442
3.0	2696.49	I	3410-40484	28	3322.31	I	3410-33501
12	2798.65	I	880-36601	30	3361.56	I	880-30619
20	2821.29	I	205-35639	30	3365.77	I	3410-33112
4	2865.50	I	1713-36601	30	3366.17	I	1332-31031
5	2907.46	I	2217-36601	6	3366.81	I	27261-56954
2.0	2914.01	I	1332-35639	6	3367.89	I	205-29888
40	2943.91	I	205-34163	260	3369.57	I	0-29669
46	2981.65	I	880-34409	36	3371.99	I	1332-30980
20	2984.13	I	0-33501	24	3374.22	I	205-29833
40	2992.60	I	205-33611	12	3374.64	I	27261-56885
80	2994.46	I	205-33590	300	3380.57	I	3410-32982
320	3002.49	I	205-33501	22	3380.85	I	2217-31786
180	3003.63	I	880-34163	120	3391.05	I	0-29481
300	3012.00	I	3410-36601	300	3392.99	I	205-29669
28	3019.14	I	0-33112	12	3409.58	I	0-29321
10	3031.87	I	0-32973	30	3413.48	I	1332-30619
140	3037.94	I	205-33112			I	28542-57829
12	3045.01	I	1332-34163	30	3413.94	I	880-30163

Nickel — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
750	3414.76	I	205-29481	12	3973.56	I	3410-28569
150	3423.71	I	1713-30913	12	4401.55	I	25754-48467
240	3433.56	I	205-29321	9	4459.04	I	26666-49086
90	3437.28	I	0-29084	2.0	4462.46	I	27944-50346
440	3446.26	I	880-29888	6	4470.48	I	27415-49778
120	3452.89	I	880-29833	4	4592.53	I	28578-50346
460	3458.47	I	1713-30619	2.0	4600.37	I	29013-50745
460	3461.65	I	205-29084	7	4605.00	I	28068-49778
18	3467.50	I	1332-30163	2.0	4606.23	I	29013-50717
22	3469.49	I	2217-31031	8	4648.66	I	27580-49086
150	3472.54	I	880-29669	2.5	4686.22	I	29013-50346
50	3483.77	I	2217-30913	10	4714.42	I	27261-48467
12	3485.89	I	1713-30392	2.0	4715.78	I	28578-49778
500	3492.96	I	880-29501	3.0	4756.52	I	28068-49086
60	3500.85	I	1332-29888	1.4	4763.95	I	29481-50466
6	3502.60	I	0-28542	4	4786.54	I	27580-48467
5	3507.69	I	1332-29833	2.0	4807.00	I	29669-50466
240	3510.34	I	1713-30192	2.0	h 4829.03	I	28569-49271
24	3513.93	I	1713-30163	1.8	4831.18	I	29084-49778
600	3515.05	I	880-29321	4	4855.41	I	28569-49159
60	3519.77	I	2217-30619	3.0	4866.27	I	28542-49086
750	3524.54	I	205-28569	1.6	4873.44	I	29833-50346
10	3527.98	I	1332-29669	3.5	4904.41	I	28569-48953
30	3548.18	I	2217-30392	2.0	4918.36	I	30980-51306
5	3551.53	I	1332-29481	1.2	4935.83	I	31786-52040
6	3561.75	I	0-28068	3.5	4980.16	I	29084-49158
460	3566.37	I	3410-31442	3.5	4984.13	I	30619-50678
90	3571.87	I	1332-29321	1.2	h 5000.34	I	29321-49314
12	3587.93	I	205-28068	1.4	5012.46	I	29833-49778
120	3597.70	I	1713-29501	4	5017.59	I	28542-48467
120	3610.46	I	880-28569	8	5035.37	I	29321-49175
48	3612.74	I	2217-29888	1.2	5048.85	I	31031-50832
600	3619.39	I	3410-31031	8	5080.52	I	29481-49158
12	3624.73	I	0-27580	5	5081.11	I	31031-50706
18	3664.10	I	2217-29501	2.0	h 5084.08	I	29669-49333
12	3669.24	I	1332-28578	1.4	5099.32	I	29481-49086
16	3670.43	I	1332-28569	2.0	h 5099.95	I	29669-49271
24	3674.15	I	205-27415	1.6	5115.40	I	30923-50466
16	3688.42	I	2217-29321	1.4	h 5129.38	I	29669-49159
8	3693.93	I	880-27944	1.8	5137.08	I	13521-32982
12	3722.48	I	1713-28569	1.8	h 5142.77	I	29888-49328
15	3736.81	I	3410-30163	3.0	h 5146.48	I	29888-49314
6	3739.23	I	1332-28068	3.0	h 5155.76	I	31442-50832
60	3775.57	I	3410-29888	1.2	5168.66	I	29833-49175
70	3783.53	I	3410-29833	1.0	5176.56	I	31442-50754
70	3807.14	I	3410-29669	0.6	5435.87	I	16017-34409
12	3831.69	I	3410-29501	14	5476.91	I	14729-32982
130	3858.30	I	3410-29321	0.5	5510.00	I	31031-49175
3.5	3889.67	I	1713-27415	0.5	5578.73	I	13521-31442
4	3972.17	I	3410-28578	0.7	5587.86	I	15610-33501

Nickel — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
1.0	5592.28	I	15734-33611	1.0	7182.00	I	30192-44112
0.7	5614.79	I	33501-51306	0.8	7197.02	I	15610-29501
0.4	h 5625.33	I	32982-50754	0.8	7261.93	I	15734-29501
0.3	5649.70	I	33611-51306	0.7	7291.45	I	15610-29321
0.4	5664.02	I	36601-54251	0.6	7385.24	I	22102-35639
0.9	5682.20	I	33112-50706	2.5	7393.60	I	29084-42606
0.6	5695.00	I	32982-50537	2.5	7409.35	I	30619-44112
1.8	5709.56	I	13521-31031	0.8	7414.51	I	16017-29501
0.8	5711.90	I	15610-33112	3.5	7422.28	I	29321-42790
0.8	5715.09	I	32973-50466	2.0	7522.76	I	29501-42790
1.2	5754.68	I	15610-32982	1.4	7525.12	I	29321-42606
0.6	5760.85	I	33112-50466	3.0	7555.60	I	31031-44263
0.8	5857.76	I	33611-50678	1.2	7574.05	I	30913-44112
0.8	5892.88	I	16017-32982	3.5	7617.00	I	29481-42606
0.8	6108.12	I	13521-29888	1.4	7619.21	I	29669-42790
0.8	6176.81	I	32973-49158	2.5	7714.32	I	15610-28569
0.8	6191.18	I	13521-29669	0.8	h 7715.58	I	29833-42790
1.0	6256.36	I	13521-29501	3.0	7727.61	I	29669-42606
0.8	6314.66	I	15610-31442	3.0	7748.89	I	29888-42790
1.8	6643.64	I	13521-28569	1.6	7788.94	I	15734-28569
2.5	6767.77	I	14729-29501	2.0	7797.59	I	31442-44263
1.0	6772.32	I	29501-44263	0.3	7917.44	I	30163-42790
1.2	6914.56	I	15734-30192	0.3	8809.42	I	31442-42790
0.8	7110.90	I	15610-29669	1.4	8862.55	I	32982-44263
4	7122.20	I	28569-42606				

# NIOBIUM

$$\text{Nb, } Z=41, M=92.91, \text{ Ratio } \frac{\text{Nb}}{\text{Cu}}=1.462$$

Nb I Normal state of valence electrons  $4d^4 5s^1 {}^6D_{0\frac{1}{2}}=0$ . I.P.= 54600 K  
 Nb II Normal state of valence electrons  $4d^4 {}^5D_0=0$ . I.P.= 113000 K

## References

### Wavelengths:

G. R. Harrison, Massachusetts Institute of Technology Wavelength Tables (John Wiley & Sons, New York, 1939).  
 Supplemented by Humphreys' and Meggers' paper cited below.

### Classification:

Nb I and Nb II, C. J. Humphreys and W. F. Meggers, J. Research NBS **34**, 477 (1945).

## Relative intensity of niobium lines observed in an arc of copper containing 0.1 atomic percent of niobium

### *Strong lines of niobium*

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
1700	4058.94	I	1050-25680	$5s a {}^6D_{4\frac{1}{2}}-5p y {}^6F_{5\frac{1}{2}}$
1200	4079.73	I	695-25200	$5s a {}^6D_{3\frac{1}{2}}-5p y {}^6F_{4\frac{1}{2}}$
700	4100.92	I	392-24770	$5s a {}^6D_{2\frac{1}{2}}-5p y {}^6F_{3\frac{1}{2}}$
600	3580.27	I	1050-28973	$5s a {}^6D_{4\frac{1}{2}}-5p y {}^6P_{3\frac{1}{2}}$
550	4123.81	I	154-24397	$5s a {}^6D_{1\frac{1}{2}}-5p y {}^6F_{2\frac{1}{2}}$
460	4152.58	I	695-24770	$5s a {}^6D_{3\frac{1}{2}}-5p y {}^6F_{3\frac{1}{2}}$
460	4163.66	I	154-24165	$5s a {}^6D_{1\frac{1}{2}}-5p y {}^6F_{1\frac{1}{2}}$
420	4164.66	I	392-24397	$5s a {}^6D_{2\frac{1}{2}}-5p y {}^6F_{3\frac{1}{2}}$
360	3791.21	I	1050-27420	$5s a {}^6D_{4\frac{1}{2}}-5p y {}^6D_{4\frac{1}{2}}$
360	4168.13	I	0-23985	$5s a {}^6D_{0\frac{1}{2}}-5p y {}^6F_{0\frac{1}{2}}$
340	3713.01	I	1050-27975	$5s a {}^6D_{4\frac{1}{2}}-5p y {}^6D_{4\frac{1}{2}}$
280	3726.24	I	154-26983	$5s a {}^6D_{1\frac{1}{2}}-5p x {}^6D_{3\frac{1}{2}}$
280	3739.80	I	695-27427	$5s a {}^6D_{3\frac{1}{2}}-5p x {}^6D_{3\frac{1}{2}}$
280	3798.12	I	392-26713	$5s a {}^6D_{2\frac{1}{2}}-5p x {}^6D_{1\frac{1}{2}}$
280	3802.92	I	695-26983	$5s a {}^6D_{3\frac{1}{2}}-5p x {}^6D_{3\frac{1}{2}}$
280	4139.71	I	1050-25200	$5s a {}^6D_{4\frac{1}{2}}-5p y {}^6F_{4\frac{1}{2}}$
240	3535.30	I	0-28278	$5s a {}^6D_{0\frac{1}{2}}-5p y {}^6P_{1\frac{1}{2}}$
240	4137.10	I	695-28973	$5s a {}^6D_{3\frac{1}{2}}-5p y {}^6P_{3\frac{1}{2}}$
220	3094.18	II	0-24165	$5s a {}^6D_{0\frac{1}{2}}-5p y {}^6F_{1\frac{1}{2}}$
200	3349.06	I	4146-36455	$5s a {}^5F_5-5p z {}^5G_8$
200	3358.42	I	2154-32005	$5s^2 a {}^4F_{3\frac{1}{2}}-5p x {}^4G_{4\frac{1}{2}}$
180	3130.79	II	2805-32573	$5s^2 a {}^4F_{4\frac{1}{2}}-5p x {}^4G_{5\frac{1}{2}}$
180	3575.85	I	3542-35474	$5s a {}^5F_4-5p z {}^5G_8$
180	3742.39	I	695-28653	$5s a {}^6D_{3\frac{1}{2}}-5p y {}^6P_{2\frac{1}{2}}$
180		I	0-26713	$5s a {}^6D_{0\frac{1}{2}}-5p x {}^6D_{1\frac{1}{2}}$
180	3787.06	I	154-26552	$5s a {}^6D_{1\frac{1}{2}}-5p x {}^6D_{0\frac{1}{2}}$
170	2927.81	II	4146-38291	$5s a {}^5F_5-5p z {}^5D_4$
170	2950.88	II	4146-38024	$5s a {}^5F_5-5p z {}^5F_5$
160	3697.85	I	392-27427	$5s a {}^6D_{2\frac{1}{2}}-5p x {}^6D_{3\frac{1}{2}}$
150	2697.06	II	1225-38291	$4d^4 a {}^5D_4-5p z {}^5D_4$
150	3341.97	I	1143-31057	$5s^2 a {}^4F_{1\frac{1}{2}}-5p x {}^4G_{2\frac{1}{2}}$
150	3343.71	I	1587-31485	$5s^2 a {}^4F_{2\frac{1}{2}}-5p x {}^4G_{3\frac{1}{2}}$
150	3537.48	I	392-28653	$5s a {}^6D_{2\frac{1}{2}}-5p y {}^6P_{2\frac{1}{2}}$
140	3163.40	II	3030-34632	$5s a {}^5F_3-5p z {}^5G_8$
140	3790.15	I	1050-27427	$5s a {}^6D_{4\frac{1}{2}}-5p x {}^6D_{3\frac{1}{2}}$

Niobium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
5	2029.32	II		14	2558.94	I	1143-40210
5	2032.99	II	3542-52715	24	2562.41	II	6192-45207
8	2109.42	II		24	2565.41	I	1587-40555
8	2125.21	II	3030-50069	13	2567.51	I	1143-40079
5	2126.54	II	3542-50552	18	2569.03	I	9329-48242
8	2131.18	II	2629-49537	5	2570.78	I	1587-40474
12	2295.68	II	1225-44771	5	2571.05	I	1587-40470
10	2302.08	II	801-44227	20	2571.33	II	1225-40104
13	2376.40	II	801-42869	13	2572.10	I	1143-40010
10	2387.09	II	10836-52715	8	2574.84	II	159-38984
13	2387.52	II	7901-49772	10	2576.60	I	2154-40953
4	2388.27	II	7901-49759	10	2578.20	I	1587-40362
16	2398.48	II	10247-51927	36	2578.74	I	2154-40921
6	2405.34	II	10653-52215	8	2580.28	II	9510-48253
6	2405.85	II	10836-52389	11	2583.11	I	8827-47528
17	2412.46	II	8320-49759	8	2583.22	I	2154-40854
19	2416.99	II	10919-52280	70	2583.99	II	9813-48501
18	2418.69	II	10604-51936	5	2589.27	I	
12	2433.80	II	9510-50585	70	2590.94	II	10186-48771
6	2435.95	II	9813-50852	48	2592.20	I	2805-41371
5	2436.33	I	2154-43187	8	2594.34	II	801-39335
7	2437.42	II	7506-48520	17	2594.74	II	7901-46429
6	2442.14	II	10247-51182	8	2597.14	I	1587-40079
5	2442.68	II	16219-57145	13	2601.29	II	10186-48617
12	2451.87	II	12263-53036	6	2601.84	I	1587-40010
12	2453.95	II	13690-54429	5	2602.01	I	
10	2458.09	II	14791-55461	4	2603.31	I	2154-40555
12	2462.89	I	2805-43396	5	h 2608.84	I	2154-40474
6	2466.73	I	2805-43333	5	2608.96	II	9813-48130
10	2469.08	I	2154-42643	13	2610.28	I	1587-39886
20	2477.38	II	6192-46545	11	2612.38	I	2154-40422
12	2478.29	II	10247-50585	2.0	2613.85	II	438-38685
12	2479.94	II	10186-50498	19	2616.48	I	2154-40362
6	2483.88	II	10604-50852	12	2620.45	II	7506-45656
5	2502.49	II	10604-50552	2.0	2622.00	I	8827-46954
20	2504.65	I	2805-42719	20	2623.51	I	1143-39248
20	2511.00	II	5562-45375	19	2627.44	I	2805-40854
7	2520.51	I		19	2628.49	I	1587-39620
20	2521.40	II	9510-49158	14	2632.52	II	8320-46296
5	2524.99	I	1143-40735	6	2634.71	I	1587-39530
16	2525.81	II	10919-50498	5	2637.98	II	10604-48501
10	2530.97	II	14626-54125	14	2640.92	I	2154-40009
5	2531.25	II	14678-54173	4	2641.06	II	10919-48771
16	2540.62	II	14661-54010	30	2642.24	II	9510-47345
16	2541.42	II	1225-40561	48	2646.26	II	438-38216
70	2544.80	II	7261-46545	50	2647.50	I	1143-38903
5	2548.63	II	13055-52280	36	2649.52	I	2154-39886
20	2551.38	II	6192-45375	13	2651.12	II	10919-48627
10	2555.63	II	9510-48627	5	2652.94	I	8827-46510
24	2556.94	II	7261-46359	14	2653.38	I	2805-40482

Niobium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
50	2654.45	I	1587-39248	70	2721.98	II	801-37528
6	2655.70	I	8827-46471	4	2722.31	I	1143-37865
46	2656.08	II	159-37797	5	2723.66	II	13055-49759
10	2656.98	I	9329-46954	9	2723.98	I	2154-38854
24	2657.62	I	2805-40422	8	2726.08	I	1143-37815
4	2658.88	II	8320-45919	4	2727.43	II	13119-49772
4	2660.04	II	10919-48501	5	2728.08	I	1587-38232
6	2661.86	I	2805-40362	4	2729.83	I	2805-39427
4	2663.56	II	9813-47345	8	2730.32	II	13119-49733
16	2665.25	II	10247-47756	46	2733.26	II	801-37377
17	2666.59	II	801-38291	12	2733.46	II	159-36732
6	2667.15	II	8320-45802	3.0	2734.35	II	7506-44067
17	2667.30	II	0-37480	16	2737.09	II	438-36963
13	2667.76	II	10604-48078	13	2740.18	II	9813-46296
19	2668.29	I	2154-39620	6	2741.15	I	8827-45297
60	2671.93	II	801-38216	4	2744.96	II	10653-47073
30	2673.57	II	15396-52788	9	2745.30	II	4146-40561
30	2675.94	II	438-37797	10	2745.73	II	9510-45919
4	2677.66	II	10919-48253	30	2746.91	I	1143-37537
10	2678.66	II	159-37480	30	2748.85	I	1587-37955
14	2679.01	I	1587-38903	28	2753.01	I	
7	2680.06	II	8320-45622	11	2753.14	II	15396-51707
4	2682.13	I	2154-39427	4	2754.07	I	
10	2686.39	II	18508-55722	10	2754.52	II	438-36732
19	2687.15	I	2805-40009	14	2755.29	I	8827-45110
24	2691.77	II	159-37298	12	2755.64	I	1587-37865
14	2695.04	I	2154-39248	9	2757.26	II	12263-48520
6	2696.05	I	2805-39886	42	2758.61	I	2154-38393
150	2697.06	II	1225-38291	4	2758.78	II	10836-47073
48	2698.86	II	438-37480	8	2761.00	I	
6	2700.15	II	7901-44925	12	2763.38	I	2805-38982
3.0	2700.56	II	3542-40561	8	2764.56	II	801-36963
48	2702.20	II	801-37797	10	2765.28	II	1225-37377
22	2702.52	II	1225-38216	5	2765.93	II	7506-43649
6	h 2704.26	II	13480-50447	2.5	2766.18	I	12102-48242
14	2706.40	II	438-37377	36	2768.13	II	438-36553
5	2707.83	II	9510-46429	2.5	2769.57	II	10247-46343
3.0	2714.20	I	2805-39638	10	2771.40	II	21073-57145
4	2715.34	II	16219-53036	3.0	2771.65	II	13690-49759
4	2715.50	I	2805-39620	46	2773.20	I	2805-38854
4	2715.69	I	1143-37955	8	2779.36	I	1143-37112
6	2715.88	II	13055-49864	10	2779.72	I	
10	2716.10	I	1587-38393	40	2780.24	II	4146-40104
9	2716.31	II	159-36963	20	2782.36	I	9329-45259
70	2716.62	II	1225-38024	4	2790.57	II	10604-46429
5	2717.33	II		12	2791.74	II	9813-45622
4	2717.63	II	9510-46296	17	2793.05	II	3542-39335
4	2720.02	I	5965-42719	4	2795.14	II	13480-49246
4	2720.26	II	3030-39780	3.0	2795.86	I	1587-37344
6	2721.63	II	0-36732	9	c 2797.69	II	11340-47073

Niobium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
7	2798.91	II	7901-43618	85	2883.18	II	3542-38216
5	2799.36	I	2154-37866	10	2884.97	I	12503-47155
6	2800.32	I	1587-37287	3.5	2887.69	II	14626-49246
3.0	2802.07	I	2154-37832	42	2888.83	II	2357-36963
9	2803.81	II	3030-38685	5	2889.90	I	1587-36180
6	2808.05	I	1587-37188	6	2894.42	II	10836-45375
4	2809.17	II	2629-38216	70	2897.81	II	3030-37528
11	2810.81	II	8320-43887	60	2899.24	II	3542-38024
6	2811.63	I	11525-47081	14	2903.65	I	1587-36016
4	2816.68	II	13666-49158	70	2908.24	II	2357-36732
8	2819.21	I		12	2908.88	II	14791-49158
6	2820.80	II	2357-37797	100	2910.59	II	3030-37377
3.0	2821.92	I	2805-38232	70	2911.74	II	2629-36963
11	2825.18	I	2154-37540	10	2917.05	II	10653-44925
3.5	2825.86	II	10919-46296	170	2927.81	II	4146-38291
10	2826.48	I	2154-37524	16	2931.47	II	2629-36732
28	2827.08	II	159-35521	5	h 2932.66	II	10836-44925
6	2829.75	II	1225-36553	4	2935.29	II	9510-43568
14	2835.12	II	3030-38291	5	2937.33	II	10604-44639
22	2836.24	I		14	2938.07	I	2154-36180
16	2840.94	I	2154-37344	130	2941.54	II	3542-37528
38	2841.15	II	3030-38216	16	h 2945.88	II	10836-44771
3.5	2842.02	I	5298-40474	17	2946.12	II	3030-36963
42	2842.65	II	2629-37797	16	2946.90	II	2629-36553
4	2843.64	II	10186-45342	170	2950.88	II	4146-38024
4	2844.44	II	14626-49772	3.0	2954.02	II	14678-48520
8	2845.80	II	9510-44639	6	2954.53	II	14791-48627
24	2846.28	II	2357-37480	5	2955.45	I	10238-44063
3.5	2847.24	II	14661-49772	6	2956.89	II	7901-41710
10	2848.30	II	14661-49759	3.0	2959.97	I	2154-35928
11	2849.56	II	438-35521	6	2963.68	I	4998-38730
16	2851.45	I	10238-45297	12	2965.48	I	4998-38710
13	2851.98	I	12102-47155	5	d 2970.40	II	12263-45919
10	2854.17	I	2805-37832		2970.47	II	13690-47345
7	2857.29	I	5965-40953	60	2972.57	II	11340-44971
6	2859.04	II	10836-45802	48	2974.10	II	10919-44532
14	2859.96	I	2805-37761	32	2977.68	II	10653-44227
36	2861.09	II	2357-37298	9	2978.94	II	17292-50852
15	2864.32	I		8	2979.88	II	21473-55021
15	2865.61	II	0-34886	14	2980.72	II	12263-45802
6	2866.67	I	1143-36016	10	2981.64	I	2805-36334
75	2868.52	II	2629-37480	30	2982.11	II	3030-36553
14	2874.57	I	1143-35920	6	2983.14	I	1143-34655
120	2875.39	II	3030-37797	8	2985.05	II	13055-46545
40	2876.95	II	3542-38291	13	2987.29	I	5298-38763
80	2877.03	II	2629-37377	10	d 2988.69	I	9439-42889
10	2878.74	II	159-34886		2988.79	I	4998-38447
7	2879.36	II	801-35521	50	2990.26	II	11340-44771
7	2879.49	I	2805-37524	12	2991.95	II	10653-44067
15	2880.72	II	10919-45622	70	2994.73	II	4146-37528



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Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
4	3000.12	I		8	3152.16	II	21073-52788
10	3002.21	II	11340-44639	140	3163.40	II	3030-34632
5	3005.14	I	1587-34854	5	3172.51	I	1143-32654
8	3005.77	II	17292-50552	9	3173.20	II	14791-46296
5	3010.38	II	15949-49158	18	3175.78	II	10653-42133
					3175.86	II	7506-38984
5	3010.69	II	17292-50498				
8	3020.67	I	5298-38393	46	3180.29	II	7901-39335
8	3022.74	II	17425-50498	8	3181.40	II	7261-38685
17	3024.74	II	10836-43887	9	3184.22	II	15949-47345
42	3028.44	II	3542-36553	9	3186.54	I	4998-36371
4	3029.74	II	12806-45802	24	3187.49	I	2805-34169
36	3032.77	II	10604-43568	9	3189.28	II	17425-48771
4	3039.41	II	2629-35521	36	3191.10	II	4146-35474
8	3039.68	I	5965-38854	18	3191.43	II	17292-48617
5	3039.82	II	11340-44227	120	3194.98	II	2629-33919
12	3044.76	II	13666-46500	8	3200.53	I	2154-33390
18	3048.10	I	5965-38763	14	3203.35	II	17292-48501
13	3053.09	I	5965-38710	36	3206.34	II	7506-38685
12	3055.52	II	16053-48771	9	3210.29	I	9329-40470
9	3056.62	I		46	3215.60	II	3542-34632
4	3061.11	I	9329-41987	11	3217.29	I	5298-36371
4	3061.24	I	5298-37955	8	3217.86	I	1587-32654
9	3063.79	II	13666-46296	9	3223.32	II	8320-39335
26	3064.53	II	10247-42869	95	3225.48	II	2357-33351
9	3065.26	II	10836-43450	17	3229.56	II	7261-38216
4	3066.10	II	13690-46296	48	3236.40	II	3030-33919
13	3069.68	II	13055-45622	5	3246.78	I	1143-31934
12	3070.90	II	14791-47345	24	3247.47	II	7901-38685
4	3071.18	II	15949-48501	14	3248.94	II	6192-36963
13	3071.56	II	11340-43887	19	3249.52	I	1143-31908
5	3072.41	I	4998-37537	9	3251.62	I	2154-32899
8	3072.51	II	13119-45656	38	3254.07	II	2629-33351
12	3073.24	II	2357-34886	9	3260.14	I	1143-31808
48	3076.87	II	3030-35521	28	3260.56	II	17470-48130
13	3080.35	II	10836-43290	19	3263.37	II	21073-51707
9	3087.86	II	12263-44639	19	3264.59	I	2805-33428
220	3094.18	II	4146-36455	9	3267.05	I	8827-39427
8	3096.50	I	1587-33872	14	3270.47	I	
17	3099.19	II	2629-34886	12	3270.76	I	1143-31708
18	3111.45	I	1587-33717	24	3272.07	I	1587-32140
9	3116.36	I	10238-42317	9	3272.22	II	14791-45342
8	3122.65	I	2154-34169	19	3277.67	I	1587-32088
32	3127.53	II	17425-49390	24	3283.46	II	16053-46500
4	3129.64	II	10653-42597	28	3285.66	I	1587-32013
180	3130.79	II	3542-35474	24	3287.59	I	1143-31551
9	3133.08	I	8827-40735	19	3287.92	I	5965-36371
9	3136.97	I	1143-33011	10	3291.06	II	3542-33919
9	3140.50	II	12806-44639	19	3292.02	II	15551-45919
46	3145.40	II	8320-40104	10	3294.36	II	15949-46296
17	3151.87	I	2154-33872	38	3296.01	I	2805-33136

## Niobium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
19	3299.61	I	2154-32452	10	3398.25	I	
14	3304.83	I	13146-43396	14	3399.40	I	2805-32214
14	3308.05	I	1587-31808	10	3399.71	II	14661-44067
14	3310.47	I	2805-33004	10	3403.02	I	
10	3311.34	I	12982-43173	28	3405.41	I	9498-38854
48	3312.60	I	2154-32333	16	3406.13	I	9043-38393
24	3315.22	I	8827-38982	32	3408.38	I	2154-31485
24	3318.98	I	1587-31708	28	3408.68	II	6192-35521
14	3319.26	I	2805-32924	22	3409.19	II	5562-34886
14	3319.58	II	7261-37377	9	3409.91	I	11044-40362
5	3320.81	II	15551-45656	28	3412.94	II	7261-36553
29	3326.62	I	9329-39381	11	3414.07	I	2805-32088
20	3329.36	I	8827-38854	22	3415.97	I	9498-38763
13	3332.16	I	2154-32156	11	3417.86	I	8705-37955
15	3341.60	II	10186-40104	11	3420.63	II	7506-36732
150	3341.97	I	1143-31057	22	3423.76	I	2805-32005
150	3343.71	I	1587-31485	28	3425.42	II	10919-40104
10	3343.96	II	8320-38216	16	3425.85	I	13012-42194
15	3346.93	I	4998-34868	28	3426.57	II	10604-39780
200	3349.06	I	2154-32005	28	3427.45	I	2805-31973
50	3349.52	I	11525-41371	5	3428.79	I	10923-40079
5	3352.59	I	2154-31973	16	3429.04	I	5965-35120
40	3354.74	I	2805-32605	5	3432.42	I	8411-37537
15	3357.04	I	2154-31934	22	3432.70	II	16219-45342
200	3358.42	I	2805-32573	9	3433.09	I	9329-38449
15	3365.58	II	8320-38024	11	3436.96	II	15551-44639
40	3366.96	I	9329-39021	11	3439.92	II	7901-36963
10	3367.38	I	8705-38393	22	3440.59	II	8320-37377
15	3369.16	II	15949-45622	8	3442.65	I	8827-37866
8	3369.83	I	9043-38710	4	3442.79	I	12102-41140
20	3371.33	I	2154-31808	11	3445.68	I	12358-41371
8	3372.09	I	2805-32452	11	3452.35	II	14661-43618
8	3372.56	II	10919-40561		3452.37	I	11525-40482
5	3374.25	II	7901-37528	9	3456.54	I	9329-38251
42	3374.92	I	8827-38449	11	3457.79	I	9043-37955
8	3376.34	I	12137-41746	9	3458.95	I	5965-34868
10	3376.73	I	11248-40854	11	3459.70	I	9498-38393
8	3380.05	I	2805-32382	6	3462.65	I	2154-31026
32	3380.41	I	1143-30716	20	3463.81	I	13012-41874
16	3380.86	I	5298-34868	22	3465.86	I	1143-29987
	3380.93	II	16053-45622	11	3467.47	I	8705-37537
10	3383.80	I	8411-37955	15	3469.44	I	9329-38144
10	3384.66	I	12018-41555	12	3471.19	I	16919-45719
20	3386.24	II	9813-39335	17	3473.02	I	13146-41931
10	3387.75	I	5298-34808	6	3475.58	I	12982-41746
10	3390.63	I	9498-38982	34	3478.69	I	5965-34704
5	3391.33	I	12137-41615		3478.78	II	10247-38984
42	3392.34	I	1587-31057	24	3479.56	II	10604-39335
5	3394.98	II	12263-41710	6	3481.05	I	4998-33717
20	3395.93	I	1587-31026	12	3484.05	II	6192-34886

Niobium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
6	3485.93	I	13515-42194	60	3593.97	I	392-28208
9	3489.09	II	7901-36553	6	3597.26	I	12288-40079
28	3491.03	I	1143-29779	6	3598.35	I	0-27783
6	3491.48	I	1143-29776	18	3599.28	I	13146-40921
9	3496.03	I	12358-40953	18	3599.63	I	1587-29360
24	3497.81	I	392-28973	60	3602.56	I	695-28445
60	3498.63	I	5298-33872	6	3604.08	I	695-28434
12	3503.20	I	9329-37866	18	3615.50	I	12358-40009
6	3505.81	I	9439-37955	11	3617.71	I	17476-45110
55	3507.96	I	154-28653	6	3618.44	I	154-27783
24	3510.26	II	16053-44532	11	3618.90	I	4998-32623
10	3511.19	I	10238-38710	36	3619.51	II	7901-35521
24	3515.42	II	10247-38685	6	3619.73	II	15949-43568
6	3516.20	I	9329-37761	24	3621.03	I	2154-29763
10	3516.86	I	9439-37865	17	3625.17	I	10238-37815
24	3517.67	II	16219-44639	17	3625.71	I	12982-40555
	3517.76	I	5298-33717	18	3630.62	I	12102-39638
24	3520.06	I	1587-29987	12	3633.00	I	12692-40210
10	3525.23	I	13012-41371	11	3633.31	II	16053-43568
12	3533.66	I	154-28445	18	3633.71	I	154-27666
6	3534.12	I	5965-34253	12	3634.44	I	8827-36334
240	3535.30	I	0-28278	12	3635.32	I	12503-40003
		I	695-28973	12	3636.96	I	12358-39846
150	3537.48	I	392-28653	12	3637.54	I	12137-39620
12	3539.65	I	9043-37287	18	3637.83	I	
30	3540.96	II	8320-36553	12	3638.79	I	2805-30279
12	3541.90	I	13146-41371	24	3639.33	I	13012-40482
6	3542.56	I	2805-31026	18	3640.64	I	154-27614
11	3542.98	I	1143-29360	10	3643.34	I	12982-40422
60	3544.02	I	0-28208	10	3643.72	I	15282-42719
30	3544.65	I	5965-34169	12	3644.94	I	9439-36867
12	3548.13	I	1587-29763	6	3647.31	I	13012-40422
6	3549.26	I	13405-41572	50	3649.85	I	392-27783
36	3550.45	I	392-28549	30	3650.81	I	1050-28434
30	3554.52	I	2154-30279	48	3651.19	II	7506-34886
120	3554.66	I	154-28278	12	3655.98	I	154-27499
6	3559.12	I	4998-33087	12	3657.11	I	13146-40482
75	3563.50	I	154-28208	24	3659.61	II	15551-42869
75	3563.62	I	392-28445	70	3660.37	I	2805-30117
6	3568.51	II	7506-35521	6	3661.68	I	10238-37540
12	3568.72	I	4998-33011	10	3662.05	I	1143-28442
22	3569.47	I	2154-30162	100	3664.70	I	695-27975
6	3575.13	I	12018-39981	6	3666.53	I	11248-38514
180	3575.85	I	695-28653	5	3667.00	I	12358-39620
24	3577.72	I	10238-38180	6	3667.66	I	10923-38180
					3667.76	I	
600	3580.27	I	1050-28973	14	3668.62	I	4998-32249
10	3582.36	I	5965-33872	24	3669.01	I	5298-32546
60	3584.97	I	392-28278	11	3669.74	I	12288-39530
90	3589.11	I	695-28549	4	3671.37	I	12018-39248
60	3589.36	I	2805-30658				

Niobium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
6 hc	3672.44	I	392-27614	180	3742.39	I	0-26713
3.0	3673.23	I	13146-40362	20	3744.00	I	10923-37625
30	3674.78	I	392-27597	14	3746.91	I	
3.0	3675.17	I		18	3748.55	I	8827-35496
10	3676.31	I	12692-39886	7	3750.63	I	1143-27797
10	3677.08	I	11044-38232	26	3753.18	I	695-27332
12	3677.78	I	9329-36511	4	3755.28	I	1587-28208
3.0	3678.72	I	15467-42643	22	3755.77	I	11248-37866
9	3686.56	I	2154-29272	14	3759.55	I	392-26983
3.0	3687.44	I	12137-39248	4	3760.64	I	11248-37832
12	3687.97	II	17425-44532	18	3761.13	I	11044-37625
9	3688.18	II	10919-38024	4	3762.45	I	
12	3688.70	I	695-27797	55	3763.49	I	154-26718
9	3689.04	I	11044-38144	16	3764.12	I	154-26713
16	3693.37	I	4998-32066	36	3765.08	I	0-26552
16	3694.67	I	11525-38583	26	3766.13	I	392-26937
10	3695.90	II	14661-41710	18	3769.15	I	1143-27666
13	3697.39	I	5965-33004	14	3769.98	I	12503-39021
160	3697.85	I	392-27427	8	3770.71	I	11248-37761
10	3699.93	I		14	3770.87	I	
13	3703.16	I	13012-40008	55	3771.85	I	392-26897
13	3703.91	I	13012-40003	11	3773.15	I	11044-37540
15	3704.14	I	11525-38514	7	3774.44	I	5965-32452
7	3707.80	I	1587-28549	14	3775.45	I	11044-37524
20	3709.25	II	11340-38291	4	3776.60	I	1143-27614
	3709.42	I	5298-32249	5	3777.28	I	2805-29272
7	3710.45	I	10923-37866	6	3777.67	I	15282-41746
34	3711.34	I	0-26937	90	3781.01	I	392-26832
5	3711.78	I	5965-32899	11	3781.38	II	13666-40104
340	3713.01	I	1050-27975	14	3783.84	I	10923-37344
20	3713.82	I	695-27614	14	3786.22	I	2805-29209
9	3716.21	I	695-27597	180	3787.06	I	154-26552
50	3716.99	I	11248-38144	7	3787.48	I	2154-28549
	3717.06	II	13666-40561	7	3789.50	I	2154-28535
14	3717.54	I	10923-37815	140	3790.15	I	1050-27427
9	3720.46	II	13690-40561	360	3791.21	I	1050-27420
7	3721.52	I	12982-39846	9	3794.47	I	12102-38449
10	3722.32	I	13146-40003	14	3795.54	I	
10	3722.95	I		11	3796.44	I	15282-41615
7	3725.22	I	9498-36334	11	3796.59	I	1587-27919
280	3726.24	I	154-26983	11	3796.85	I	13515-39846
14	3727.23	I	11044-37866	280	3798.12	I	392-26713
10	3732.03	I	11044-37832	18	3800.94	I	9329-35631
7	3733.32	I	18332-45110	28	3801.30	I	11044-37344
7	3733.62	I	1143-27919	280	3802.92	I	695-26983
28	3738.42	I	10238-36979	70	3803.88	I	1050-27332
280	3739.80	I	695-27427	55	3804.74	I	11248-37524
70	3740.73	II	13055-39780			II	17292-43568
	3740.84	I	695-27420	18	3806.20	I	10923-37188
28	3741.78	I	0-26718	6	3806.63	I	14211-40474

Niobium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
70	3810.49	I	11525-37761	5	3894.03	I	11044-36717
55	3811.03	I	154-26386	4	3894.70	I	392-26061
3.5	3813.47	I		18	3895.90	I	9439-35100
55	3815.51	I	695-26897	11	3898.28	II	13690-39335
7	3816.34	I	1587-27783	11	3898.56	I	2154-27797
22	3818.86	II	12806-38984	7	3899.25	I	15282-40921
22	3819.15	I	4998-31175	12	3904.18	I	12018-37625
3.5	3821.19	I	8705-34868	9	3906.91	I	8827-34416
70	3824.88	I	695-26832	4	3908.59	I	13405-38982
11	3827.01	I	13515-39638	22	3908.97	I	1143-26718
3.5	3828.24	II	13666-39780	7	3909.60	I	13012-38583
3.5	3830.00	I	8705-34808	13	3913.01	I	11318-36867
18	3831.84	II	13690-39780	70	3914.70	I	10923-36460
3.5	3833.26	I	12503-38583	7	3919.00	I	9329-34838
36	3835.18	I	0-26067	7	3919.16	I	12358-37866
26	3836.45	I	9439-35497	3.5	3919.72	II	13480-38984
7	3837.08	I	14899-40953	55	3920.20	I	13012-38514
18	3841.81	I	13405-39427	11	3922.35	I	12137-37625
14	3842.71	I	9329-35345	7	3924.49	I	12358-37832
3.5	3843.93	I	5965-31973	18	3925.00	I	695-26166
7	3844.08	I	11248-37254	7	3926.61	I	2154-27614
22	3845.90	I	392-26386	13	3929.29	I	2154-27597
11	3853.38	I	10923-36867	3.5	3931.46	I	9439-34868
3.5	3854.70	I	11044-36979	3.5	3934.14	I	10923-36334
7	3855.15	I	11044-36976	10	3934.41	I	1143-26552
7	3855.45	I	0-25930	9	3935.45	I	12137-37540
30	3858.95	I	154-26061	6	3936.45	I	1587-26983
3.5	3860.86	I	12358-38251	70	3937.44	I	1050-26440
14	d 3862.93	I	0-25880	10	3937.96	I	12137-37524
	3863.05	II	12806-38685	18	3941.27	I	695-26061
36	3863.38	I	5298-31175	54	3943.67	I	1587-26937
7	3865.02	II	13119-38984	10	3947.53	I	12018-37344
	3865.04	I	13515-39381	7	d 3949.33	I	9439-34753
28	3867.92	I	1050-26897		3949.46	II	14791-40104
7	3871.19	I	9043-34868	6	3949.94	I	1587-26897
3.5	3875.42	I	12018-37815	7	3952.37	II	13690-38984
18	3875.76	I	1143-26937	10	3953.08	I	11044-36334
14	3876.96	I	12358-38144	11	3955.68	I	2154-27427
55	3877.56	I	1050-26832	7	3959.36	I	12982-38232
90	3878.82	I	392-26166	3.5	3960.98	I	13012-38251
	3878.97	I	1587-27360	3.5	3964.66	I	9439-34655
7	3879.35	II	14791-40561	26	3965.69	I	5965-31175
70	3883.14	I	695-26440	95	d 3966.09	I	12137-37344
110	3885.44	I	11525-37254		3966.25	I	2154-27360
70	3885.68	I	11248-36976	7	3970.65	I	2154-27332
22	3886.07	I	154-25880	22	3971.85	I	12018-37188
4	3889.63	I			3971.93	I	2805-27975
3	3889.80	I	2154-27855	18	3972.52	I	12358-37524
60	3891.30	I	695-26386	11	3973.62	I	16829-41987
5	3893.73	I	392-26067	13	3976.67	I	15282-40422

Niobium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
11	3977.94	I	13012-38144	4	4061.26	I	10238-34854
11	3978.75	I	1587-26713	14	4061.54	I	2805-27420
7	3979.37	I	12692-37815	9	4064.81	I	12692-37287
4	3980.48	I	1050-26166	9	4066.12	I	11044-35631
3.5	3982.06	I	13146-38251	18	4067.16	I	12137-36717
3.0	3984.81	I	15467-40555	22	4068.26	I	10923-35496
6	3985.18	I	11248-36334	3.0	4070.04	I	
11	3988.16	I	16829-41896	14	4070.96	I	12982-37540
3.0	3990.67	I	12137-37188	4	4072.07	II	13666-38216
11	3991.68	I		9	4073.51	I	15439-39981
3.0	3994.43	I	11248-36276		4073.64	I	12982-37524
15	3999.18	I	13146-38144	6	4076.09	I	2805-27332
4	4000.60	II	14791-39780	8	4077.09	I	15461-39981
8	4001.13	I	12358-37344	5	4078.35	I	392-24905
3.0	4002.26	I		4	4078.60	I	13012-37524
4	d 4005.93	I		1200	4079.73	I	695-25200
14	4008.28	I	10238-35179	4	4083.78	I	1587-26067
14	4009.71	I	12692-37625	9	4084.18	I	5298-29776
7	4012.06	I	1143-26061	28	4084.86	I	1587-26061
20	4013.27	I	16919-41829	9	4086.63	I	9439-33902
3.0	4014.93	I	12288-37188	4	4087.05	I	13405-37865
4	4016.08	I		14	4090.16	I	12018-36460
12	4017.56	I	12982-37866	5	4095.56	I	13405-37815
3.0	4020.24	I		4	h 4097.64	I	17476-41874
3.0	4022.39	I	13012-37866	5	4098.22	I	13146-37540
16	4023.14	I	12982-37832	18	4099.07	I	154-24543
7	4027.31	I	12288-37112	46	4100.40	I	392-24773
7	4027.98	I	13012-37832	700	4100.92	I	392-24770
3.0	4029.22	I		8	4106.18	I	9043-33390
4	h 4030.35	I		3.5	4106.78	I	1587-25930
110	4032.52	I	2805-27597	4	4109.88	I	5298-29623
3.0	4033.20	I	1143-25930	14	4112.13	I	16829-41140
7	4035.10	I	13405-38180	5	4113.35	I	12982-37287
7	4035.93	I	15439-40210	18	4113.94	I	11044-35345
4	h 4038.18	I		32	4116.90	I	0-24283
9	4039.10	I	11525-36276	9	4119.28	II	21073-45342
26	4039.53	I	13012-37761	12	4122.81	I	11248-35496
7	h 4040.47	I	2154-26897	550	4123.81	I	154-24397
9	4042.57	I	12137-36867	8	4125.25	I	10923-35157
9	4043.16	I	15282-40009	5	4125.58	I	2154-26386
17	4044.10	I	13146-37866	5	4126.90	I	
13	4044.71	I	13515-38232	9	4127.45	I	16919-41140
18	4049.76	I	13146-37832	70	4129.43	I	695-24905
18	4051.52	I	9329-34004	80	4129.93	I	
3.5	4056.94	I	12982-37625	9	4131.53	I	12137-36334
3.0	4057.27	I	15439-40079	18	4134.59	I	11318-35497
1700	c 4058.94	I	1050-25680	8	4135.42	I	12692-36867
22	4059.51	I	10126-34753	240	4137.10	I	0-24165
12	4060.31	I	2805-27427	8	4137.59	I	12018-36180
36	4060.79	I	154-24773	5	4138.30	I	18036-42194

## Niobium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
46	4139.44	I	392-24543	36	4214.73	I	1050-24770
280	4139.71	I	1050-25200	44	4217.94	I	695-24397
5	4142.24	I	11044-35179	4	4222.68	I	9329-33004
36	4143.21	I	154-24283	8	4226.22	I	8411-32066
5	4146.00	I	11044-35157	4	4227.51	I	9438-33087
17	4147.19	I	11525-35631	44	4229.15	I	9498-33136
9	4148.74	I	8827-32924	18	4229.83	I	2805-26440
90	4150.12	I		13	4230.32	I	12288-35920
12	4152.04	I	695-24773	18	4231.95	I	392-24015
460	4152.58	I	695-24770	8	4237.81	I	11248-34838
3.5	4156.68	II	16053-40104	9	4241.45	I	9329-32899
18	4158.01	I	12137-36180	12	4242.63	I	18332-41896
5	4160.80	I	2805-26832	13	4246.30	I	8705-32249
8	4161.25	I	13515-37540	3.0	4248.66	I	154-23684
5	4162.81	I	10238-34253	13	4249.46	I	0-23526
90	4163.47	I	2154-26166	17	4252.97	I	9498-33004
460	4163.66	I	154-24165	15	4253.70	I	9043-32546
420	4164.66	I	392-24397	13	4254.69	I	8411-31908
9	4165.85	I	12018-36016	26	4255.44	I	10923-34416
360	4168.13	I	0-23985	4	4255.94	I	
18	4169.57	I	12358-36334	9	4258.91	I	9329-32802
12	4173.95	I	18036-41987	9	4261.71	I	9043-32501
9	4174.34	I	8705-32654	80	4262.05	I	1050-24507
5	4177.44	I	10238-34169	44	4266.02	I	8705-32140
9	4179.76	I	12358-36276	9	4268.67	I	154-23574
9	4181.34	I	11248-35157	30	4270.69	I	9043-32452
32	4184.44	I	392-24283	3.5	4272.97	I	10923-34319
8	4186.10	I	13405-37287	3.0	4273.36	I	12102-35496
6	4189.99	I	18036-41896	8	4274.69	I	8827-32214
9	4190.65	I	9043-32899	13	4277.50	I	154-23526
120	4190.88	I	1050-24905	8	4279.50	I	8705-32066
90	4192.07	I	695-24543	4	4279.71	I	12137-35496
6	4193.83	I	8411-32249	17	4280.60	I	5298-28653
90	4195.09	I	154-23985	8	4286.22	I	12692-36016
140	4195.66	I	8827-32654	42	4286.99	I	695-24015
5	4196.95	I	11525-35345	20	4289.44	I	5965-29272
5	4197.61	I	16919-40735	15	4291.19	I	8411-31708
32	4198.51	I	695-24507	8	4292.04	I	392-23684
8	4198.85	I	11044-34854	15	4292.48	I	9043-32333
3.5	4200.99	I	5965-29763	11	4295.62	I	12358-35631
36	4201.52	I	11044-34838	12	4296.16	I	
7	4203.41	I	13405-37188	60	4299.60	I	5298-28549
7	4204.32	I	8827-32605	60	4300.99	I	5965-29209
90	4205.31	I	392-24165	3.0	4303.88	I	8705-31934
9	4206.13	I	12692-36460	8	4306.28	I	9439-32654
16	4208.16	I	154-23911	4	4308.12	I	9043-32249
9	4212.04	I	12982-36717	8	4308.69	I	8705-31908
9	4212.53	I	10923-34655	12	4309.56	I	12982-36180
9	4213.26	I	12288-36016	40	4311.27	I	13146-36334
4	4213.46	I	16829-40555		4311.39	I	13146-36334

Niobium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
7	4311.70	I	1587-24773	2.5	4416.41	I	12018-34655
12	4312.45	I	392-23574	20	4419.44	I	5298-27919
4	4313.88	I	16829-40003	6	4419.83	I	2154-24773
4	4316.48	I	12018-35179	6	4420.45	I	2154-24770
4	4318.01	I	10238-33390	10	4420.64	I	392-23007
3.0	4323.47	I	9329-32452	3.0	4423.87	I	16829-39427
36	4326.33	I	9498-32605	10	4426.68	I	5965-28549
12	4327.38	I	8705-31808	10	4429.44	I	5965-28535
10	4328.43	I	9043-32140	24	c 4437.22	I	
8	4329.73	I	154-23244	2.5	4437.90	I	17476-40003
40	4331.37	I	4998-28079	2.0	4440.43	I	12982-35496
3.0	4337.56	I	9498-32546	6	4441.81	I	9498-32005
3.0	4338.70	I	12137-35179	6	4445.85	I	1050-23537
14	4342.82	I	12137-35157	8	4446.17	I	13146-35631
10	4345.32	I	0-23007	30	4447.18	I	5965-28445
4	4346.12	I	8705-31708	15	4456.80	I	1143-23574
4	4347.31	I	13515-36511	15	4457.42	I	1587-24015
14	4348.65	I	695-23684	6	4458.12	I	13405-35829
11	4349.03	I	12358-35345	5	4460.20	I	
4	4350.30	I	8827-31808	9	4460.42	I	13515-35928
30	4351.57	I	8827-31801	9	4464.15	I	2805-25200
6	4353.27	I	1050-24015	2.5	4465.92	I	10238-32623
3.0	4354.19	I	11044-34004	2.5	4466.42	I	1143-23526
3.0	4356.85	I	12982-35928	5	4469.32	I	5298-27666
7	c 4359.85	I	9043-31973	14	4469.71	I	12288-34655
3.5	4361.65	I	4998-27919	14	4471.29	I	9329-31688
4.0	4367.97	II	13666-36553	14	4472.53	I	2154-24507
22	4368.43	I	9329-32214	3.0	4475.28	I	
2.5	4369.62	I	695-23574	3.0	4481.44	I	10238-32546
6	4370.36	I	2805-25680	2.0	4492.96	II	21040-43290
4	4374.78	I	391-23244	5	4494.57	I	5965-28208
3.0	4375.25	I	10238-33087	2.0	4497.25	I	8827-31057
14	4377.96	I	12018-34854	8	4499.80	I	12102-34319
7	4379.52	I	9329-32156	16	4503.04	I	5298-27499
4	4381.13	I	13515-36334	2.5	4503.42	I	13146-35345
2.5	4382.49	I	12288-35100	5	4508.41	I	12982-35157
3.5	4382.84	I	1587-24397	8	4511.09	I	17476-39638
7	4384.86	I	12358-35157	2.0	4512.13	I	9329-31485
7	4387.74	I	4998-27783	55	4523.41	I	1143-23244
13	4388.36	I	5298-28079	8	4524.12	I	1587-23684
17	4392.69	I	9329-32088	2.5	4527.65	II	12806-34886
7	4397.04	I	12102-34838	2.5	4529.42	I	11318-33390
3.5	4400.35	I	16919-39638	4	4542.80	I	0-22007
6	4400.83	I	12137-34854	50	4546.82	I	1587-23574
3.5	4402.05	I		2.5	4547.85	I	9043-31026
3.5	4406.55	I	5965-28653	9	4553.84	I	5965-27919
34	4410.21	I	4998-27666	4	4556.84	I	4998-26937
10	4411.52	I	10238-32899	2.0	4559.42	I	
2.5	4412.18	I	8827-31485	38	4564.53	I	12102-34004
3.0	4414.88	I	9043-31688	2.5	4570.95	I	12982-34854



Niobium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
75	4573.08	I	2154-24015	5	4736.49	I	17476-38583
2.0	4574.33	I	11044-32899	5	4740.61	I	5298-26386
8	4574.84	I	154-22007	5	4743.84	I	8705-29779
4	4575.37	I	10238-32088	6	4744.62	I	12358-33428
2.5	4579.45	II	13690-35521	17	c 4749.70	I	11525-32573
50	4581.62	I	12503-34323	5	4751.42	I	16981-38021
8	4582.29	I	5965-27783	2	4755.32	I	13146-34169
2.5	4599.48	I	9439-31175	5	4766.81	I	17304-38277
10	4600.21	I	12503-34235	2.5	4771.85	I	9329-30279
2.0	4602.86	I	4998-26718	6	4773.25	I	9043-29987
120	4606.77	I	2805-24507	1.6	4777.62	I	12503-33428
2.5	4608.58	I	13146-34838	2.0	4785.70	I	12982-33872
2.0	4610.69	I	10923-32605	5	4789.96	II	19690-40561
3.0	4612.12	I	11248-32924	2.0	4802.45	I	695-21512
18	4616.17	I	1587-23244	3.0	4807.06	I	12102-32899
2.0	4627.48	I		4	4809.37	I	12137-32924
34	4630.11	I	11525-33116	6	c 4810.60	I	9498-30279
5	4638.10	I	11248-32802	8	4816.38	I	11248-32005
2.0	4643.31	I	2154-23684	4	4829.30	I	17937-38638
5	c 4643.68	I	11044-32573	5	4833.37	I	154-20838
4	4646.95	I	18332-39846	2.0	4837.62	I	18435-39101
34	4648.95	I	1143-22647	2.0	4837.99	I	9498-30162
8	4649.27	I		4	4842.15	I	12358-33004
2.5	4658.18	I	5965-27427	4	4845.17	I	12503-33136
34	4663.83	I	1587-23023	8	c 4848.37	I	9498-30117
2.0	4665.33	I	12288-33717	6	4868.99	I	18876-39409
26	4666.24	I	11248-32672	7	4890.75	I	11044-31485
18	4667.22	I	2154-23574	4	4892.50	I	12018-32452
2.5	4669.87	I	11044-32452	2.0	4895.58	I	5965-26386
44	4672.09	I	2805-24203	5	4900.79	I	12102-32501
2.5	4673.59	I	18036-39427	5	4904.53	I	0-20384
40	4675.37	I	2154-23537	6	4910.95	I	13515-33872
8	4678.48	I	8411-29779	2.5	4928.98	I	13146-33428
2.0	4682.66	I	16672-38021	1.4	4941.52	I	12102-32333
24	4685.14	I	11044-32382	1.4	4953.13	I	9439-29623
5	4694.51	I	16981-38277	4	c 4965.37	I	10923-31057
5	4695.47	I	10923-32214	6	c 4967.78	I	13012-33136
7	4697.47	I	8705-29987	2.5	4971.93	I	0-20107
10	c 4706.14	I		5	4973.14	I	12503-32605
20	4708.29	I	10923-32156	2.5	4975.14	I	12358-32452
2.5	4713.05	I	8411-29623	9	4988.97	I	695-20734
11	4713.50	I	2805-24015	3.0	4994.30	I	
5	4715.83	I	16672-37871	3.5	4997.88	I	12137-32140
5	4718.02	I		4	5000.95	I	13146-33136
4	4723.80	I	17937-39101	3.0	5002.25	I	12102-32088
4	4727.33	I	11525-32672	2.0	5013.27	I	12982-32924
5	4730.31	I	11248-32382	11	5017.75	I	392-20316
6	4733.48	I	392-21512	2.0	5019.51	I	12982-32899
8	c 4733.89	I	9043-30162	7	5026.36	I	12018-31908
4	4735.33	I	11044-32156	2.0	5030.13	I	13515-33390

## Niobium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
10	5039.04	I	154-19994	2.5	5340.80	I	11044-29763
2.0	5047.96	I	14899-34704	1.2	5343.58	I	
8	5058.01	I	0-19765	22	5344.17	I	2805-21512
3.0	5059.35	I	12692-32452	16	5350.74	I	2154-20838
6	5065.25	I	695-20432	2.0	5353.28	I	20734-39409
2.0	5077.40	I	12018-31708	1.2	5355.31	I	12358-31026
36	5078.96	I	1050-20734	2.0	5355.70	I	11525-30191
2.0	c 5094.41	I	0-19624	1.4	5359.19	I	8705-27360
20	5095.30	I	695-20316	0.8	5362.01	I	392-19037
8	5100.16	I	392-19994	1.8	5375.27	I	11248-29846
8	5120.30	I	392-19917	2.0	5381.34	I	5965-24543
4	5121.80	I	12982-32501	0.8	5388.30	I	9043-27597
4	5127.66	I	10126-29623	1.0	5395.86	I	4998-23526
2.0	5133.34	I	5298-24773	1.4	5396.33	I	8411-26937
10	5134.75	I	154-19624	1.4	5411.24	I	11044-29519
3.5	5140.58	I	12692-32140	1.0	5416.30	I	11318-29776
3.5	5147.54	I	15282-34704	3.0	5422.44	I	10923-29360
1.8	5150.64	I	11248-30658	1.0	5431.26	I	1587-19994
3.5	5152.63	I	9043-28445	5	5437.27	I	5298-23684
12	5160.33	I	392-19765	0.9	5448.31	I	10923-29272
12	5164.38	I	2154-21512	0.9	5456.19	I	20316-38638
11	5180.31	I	695-19994	1.8	5458.04	I	9043-27360
5	5186.98	I	154-19428	0.9	h 5468.10	I	19994-38277
9	5189.20	I	1050-20316	1.8	5481.00	I	18036-36276
8	5193.08	I	1587-20838	0.6	5483.09	I	
7	5195.84	I	1143-20384	0.9	5483.49	I	8705-26937
3.0	5203.22	I	8705-27919	0.6	5491.06	I	20432-38638
1.6	5205.13	I	9329-28535	0.8	5499.53	I	1587-19765
4	c 5219.10	I	9498-28653	2.0	5504.58	I	2154-20316
3	5225.16	I	11525-30658	0.8	5509.12	I	13405-31551
7	5232.81	I	9329-28434	1.6	c 5512.82	I	
4	c 5237.43	I	8411-27499	0.8	5517.39	I	
1.4	5240.39	I	8705-27783	2.5	5523.57	I	9498-27597
7	d 5251.62	I	0-19037	1.2	5541.47	I	10238-28278
	5251.81	I	392-19428	4	5551.35	I	4998-23007
3.5	5253.03	I	11248-30279	1.4	5563.00	I	10238-28208
4	5253.93	I	8827-27855	0.8	c 5571.44	I	18332-36276
2.5	5269.92	I	8827-27797	1.6	c 5576.16	I	2805-20734
13	5271.53	I	1143-20107	1.6	5578.29	I	12358-30279
1.2	5272.48	I	8705-27666	2.5	5586.97	I	1143-19037
6	c 5276.20	I	9498-28445	0.8	c 5590.95	I	
1.4	c 5279.43	I	9498-28434	0.6	5594.89	I	17476-35345
2.5	5285.26	I		0.8	c 5599.59	I	9043-26897
1.6	5296.34	I	14211-33087	2.0	5603.52	I	1587-19428
2.5	5315.55	I	5965-24773	0.6	5603.93	I	2154-19994
0.8	5317.01	I	11044-29846	1.2	5628.26	I	2154-19917
12	5318.60	I	1587-20384	3.0	5629.17	I	12358-30117
2.5	5319.49	I	8705-27499	1.6	c 5635.42	I	
3.5	5334.87	I	9043-27783	8	5642.11	I	5965-23684
1.2	5336.81	I	695-19428	1.6	5645.30	I	5298-23007

Niobium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
0.8	5654.14	I	10238-27919	2.5	6031.84	I	15439-32013
6	5664.71	I	1143-18791	2.5	6045.50	I	12982-29519
8	5665.63	I	13012-30658	1.2	6048.72	I	17476-34004
0.8	5666.86	I	15282-32924	1.4	6056.65	I	15467-31973
3 cw	5671.02	I	11345-28973	1.4	6107.71	I	15439-31808
4	5671.91	I	12137-29763	2.0	6142.51	I	14899-31175
1.2	5677.47	I	5965-23574	2.5	6148.13	I	13515-29776
1.2	5693.09	I	5965-23526	2.5	6164.32	I	13405-29623
1.6 d	5697.90	I	13629-31175	1.4	6213.06	I	15461-31551
	5698.03	I	10238-27783	3.5	6221.96	I	8705-24773
2.0	5706.16	I	15282-32802	2.0 c	6251.76	I	18332-34323
4	5706.48	I	8411-25930	1.0	6260.77	I	18036-34004
1.4	5709.33	I	13515-31026	4 c	6430.46	I	5965-21512
0.8	5715.59	I	12288-29779	2.5 c	6433.22	I	5298-20838
3.0	5716.35	I	12358-29846	0.8	6497.84	I	4998-20384
1.2	5725.66	I	18036-35496	3.0	6544.61	I	9498-24773
6	5729.19	I	1587-19037	0.7	6574.73	I	8705-23911
1.0	5737.36	I		0.9 cw	6591.00	I	
0.6	5738.20	I		0.9	6606.16	I	
4	5751.44	I	12137-29519	0.9	6607.28	I	13405-28535
5	5760.34	I	8705-26061	1.6	6614.15	I	8411-23526
3.0	5764.99	I	12018-29360	0.9	6626.98	I	5298-20384
1.4	5771.08	I	15282-32605	10 cw	6660.84	I	9498-24507
2.5 c	5776.07	I	11345-28653	7 cw	6677.33	I	9043-24015
0.8	5780.34	I	12692-29987	3.0	6701.20	I	13515-28434
4	5787.54	I	2154-19428	6 c	6723.62	I	8705-23574
0.8	5789.79	I	13012-30279	3.5	6739.88	I	8411-23244
2.5	5794.24	I	12018-29272	1.2	6795.31	I	
2.5	5804.03	I	8705-25930	4	6828.11	I	9043-23684
1.4 h	5815.33	I	12018-29209	1.2 c	6849.35	I	8411-23007
5	5819.43	I	13012-30191	0.9	6870.92	I	
1.6	5820.62	I	16829-34004	1.8	6876.36	I	8705-23244
3.5	5834.90	I	13146-30279	1.2 c	6902.89	I	9043-23526
1.2	5838.15	I	11318-28442	1.6	6908.07	I	9439-23911
6 d	5838.64	I	9043-26166	2.0	6918.32	I	13405-27855
2.5	5842.47	I	2805-19917	0.8	6946.07	I	13405-27797
0.8	5846.09	I	11345-28445	0.8	6972.49	I	14211-28549
3.0	5866.47	I	5965-23007	1.2	6986.09	I	14899-29209
1.6	5874.70	I	9043-26061	4	6990.32	I	8705-23007
0.8	5877.79	I	4998-22007	0.8 c	6996.11	I	13629-27919
2.0	5893.44	I	14211-31175	1.0	7023.48	I	14211-28445
9 cw	5900.62	I	9498-26440	0.8	7038.04	I	12692-26897
2.0 c	5903.80	I	11345-28278	9 c	7046.81	I	9498-23684
1.4	5927.41	I	15467-32333	0.4	7066.41	I	12018-26166
2.0 c	5934.16	I	17476-34323	0.4	7075.23	I	5298-19428
2.0	5957.70	I	12982-29763	1.8 c	7098.94	I	12358-26440
7	5983.22	I	5298-22007	0.8 cw	7102.01	I	9498-23574
3.0	5986.08	I	13146-29846	0.9	7119.31	I	12018-26061
4 cw	5997.93	I	9498-26166	0.7	7122.95	I	
2.5	6029.75	I	12692-29272	1.6	7126.17	I	12137-26166

Niobium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
0.8	7130.06	I	12692-26713	1.2	7757.31	I	25680-38568
6	7159.43	I	9043-23007	0.3	7787.11	I	
0.8	7191.37	I		0.6 cw	7873.41	I	14899-27597
0.9 c	7208.94	I	14211-28079	1.6	7885.31	I	11525-24203
2.5	7252.35	I	10126-23911	1.2	7938.89	I	11318-23911
0.7	7274.81	I	15467-29209	0.4	7954.76	I	9439-22007
0.6	7317.03	I	24905-38568	1.8	8135.20	I	11248-23537
0.8 c	7323.92	I	14899-28549	0.6 cw	8240.00	I	8705-20838
1.4 cw	7328.38	I	12288-25930	1.4 cw	8320.93	I	9498-21512
3.0 c	7353.16	I	8411-22007	1.4	8346.08	I	11044-23023
9 cw	7372.50	I	11345-24905	0.5	8350.04	I	8411-20384
0.6	7419.83	I	12692-26166	0.8	8439.77	I	12358-24203
0.7	7436.02	I		0.8 cw	8475.98	I	9043-20838
0.9	7478.20	I	12692-26061	1.2	8526.99	I	10923-22647
3.0	7515.93	I	8705-22007	0.6 c	8547.25	I	8411-20107
1.4 c	7519.77	I	13146-26440	0.8 c	8560.54	I	8705-20384
8 c	7574.58	I	11345-24543	0.8	8575.87	I	12358-24015
0.8 c	7583.21	I	12982-26166	1.0 c	8697.55	I	13012-24507
0.6	7639.81	I		1.0	8740.96	I	12137-23574
0.6	7647.71	I	24770-37842	1.0	8767.97	I	8705-20107
1.2	7703.33	I	25200-38178	1.4 cw	8815.56	I	9498-20838
3.5 c	7726.68	I	11345-24283	1.6	8905.78	I	12018-23244

# OSMIUM

$$\text{Os, } Z=76, M=190.2, \text{ Ratio } \frac{\text{Os}}{\text{Cu}}=2.993$$

Os I Normal state of valence electrons  $5d^8 6s^2 {}^5D_4 = 0$ . I.P.=70450 K  
 Os II Normal state of valence electrons  $5d^8 6s^1 {}^6D_{4\frac{1}{2}} = 0$ .

## References

### Wavelengths:

G. R. Harrison, Massachusetts Institute of Technology Wavelength Tables (John Wiley & Sons, New York, 1939).

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## Relative intensity of osmium lines observed in an arc of copper containing 0.1 atomic percent of osmium

### *Strong lines of osmium*

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
900	2909. 06	I	0-34365	$5d^6 6s^2 a {}^5D_4 - 5d^6 6s^1 6p^1 {}^5F_3^o$
900	3058. 66	I	0-32685	$5d^6 6s^2 a {}^5D_4 - 5d^6 6s^1 6p^1 {}^7F_4^o$
800	3301. 56	I	0-30280	$5d^6 6s^2 a {}^5D_4 - 5d^6 6s^1 6p^1 {}^7F_3^o$
480	2838. 63	I	5144-40362	$5d^7 6s^1 a {}^5F_5 - 5d^6 6s^1 6p^1 {}^3F_4^o$
460	3018. 04	I	0-33124	$5d^6 6s^2 a {}^5D_4 - 5d^6 6s^1 6p^1 {}^7P_3^o$
440	4260. 85	I	0-23463	$5d^6 6s^2 a {}^5D_4 - 5d^6 6s^1 6p^1 z {}^7D_3^o$
440	4420. 47	I	0-22616	$5d^6 6s^2 a {}^5D_4 - 5d^6 6s^1 6p^1 z {}^7D_4^o$
380	2488. 55	I	5144-45316	$5d^7 6s^1 a {}^5F_5 - 5d^7 6p^1 {}^5G_6^o$
360	2637. 13	I	0-37909	$5d^6 6s^2 a {}^5D_4 - 5d^6 6s^1 6p^1 {}^5D_4^o$
360	3752. 52	I	2740-29382	$5d^6 6s^2 a {}^5D_2 - 5d^6 6s^1 6p^1 {}^7F_3^o$
320	3156. 25	I	5144-36818	$5d^7 6s^1 a {}^5F_5 - 5d^6 6s^1 6p^1 {}^5F_5^o$
320	3262. 29	I	4159-34804	$5d^6 6s^2 a {}^5D_3 - 5d^6 6s^1 6p^1 {}^5F_4^o$
320	3167. 94	I	0-30591	$5d^6 6s^2 a {}^5D_4 - 5d^6 6s^1 6p^1 {}^7P_4^o$
300	3040. 90	I	2740-35616	$5d^6 6s^2 a {}^5D_2 - 5d^6 6s^1 6p^1 {}^5P_3^o$
280	2714. 64	I	0-36826	$5d^6 6s^2 a {}^5D_4 - 5d^6 6s^1 6p^1 {}^5D_4^o$
260	2806. 91	I	0-35616	$5d^6 6s^2 a {}^5D_4 - 5d^6 6s^1 6p^1 {}^5P_3^o$
220	2498. 41	I	8743-48756	$5d^7 6s^1 a {}^5F_4 - 48756_4^o$
220	2844. 40	I	5144-40290	$5d^7 6s^1 a {}^5F_5 - 5d^6 6s^1 6p^1 {}^5G_6^o$
220	4135. 78	I	4159-28332	$5d^6 6s^2 a {}^5D_3 - 5d^6 6s^2 6p^1 {}^7P_4^o$
200	2513. 25	I	5144-44921	$5d^7 6s^1 a {}^5F_5 - 5d^7 6p^1 {}^5G_3^o$
200	2689. 82	I	5144-42310	$5d^7 6s^1 a {}^5F_5 - 5d^6 6s^1 6p^1 {}^5G_4^o$
200	2912. 33	I	4159-38486	$5d^6 6s^2 a {}^5D_3 - 5d^6 6s^2 6p^1 {}^5P_3^o$
200	2919. 79	I	2740-36980	$5d^6 6s^2 a {}^5D_2 - 5d^6 6s^1 6p^1 {}^5D_1^o$
200	3232. 06	I	4159-35090	$5d^6 6s^2 a {}^5D_3 - 5d^6 6s^1 6p^1 {}^5P_2^o$
200	3782. 20	I	4159-30591	$5d^6 6s^2 a {}^5D_3 - 5d^6 6s^1 6p^1 {}^7P_4^o$
180	2644. 11	I	0-37809	$5d^6 6s^2 a {}^5D_4 - 5d^6 6s^1 6p^1 {}^5F_3^o$
180	2658. 60	I	5144-42747	$5d^7 6s^1 a {}^5F_5 - 5d^7 6p^1 {}^5D_4^o$

Osmium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
5	2001.45	I	0-49947	11	2283.67	I	4159-47935
7	2003.73	I	4159-54050	8	2289.32	I	4159-47828
5	2004.78			6	2297.31	I	0-43516
10	2010.15			11	2308.31	I	
19	2018.14	I	0-49534	3.5	2313.75	II	5592-48799
19	2020.26			11	2320.18	I	
10	2022.76	I	2740-52162	6	2323.98	I	
10	2028.23	I	4159-53447	13	2324.24	I	0-43011
14	2034.44	I	0-49138	3.5	2325.51	I	5144-48132
24	2045.36			7	2326.99	I	6093-49054
7	2048.28	I	2740-51546	7	2334.56	I	2740-45562
7	2049.42	I	4159-52938	17	2336.80	II	3593-46374
9	2058.69			11	2338.63	I	0-42747
	2058.78	I	4159-52716	7	2340.69	I	5144-47854
14	2061.69	I	2740-51229	11	2343.74	I	4159-46813
9	2067.21	II	3593-51952	7	2345.75	I	4159-46776
5	2070.67	II	3929-52206	11	2347.38	I	8743-51329
9	2076.95	I	0-48132	6	2350.23	II	5592-48128
9	2078.09			1.6	2351.55	I	10166-52678
18	2079.97	I	0-48062	1.6	2351.72	I	11378-53887
4	2082.54	I	4159-52162	10	2352.99	I	8743-51229
4	2089.03	I	0-47854	3.5	2355.28	II	3929-46374
4	2089.21	I	2740-50589	7	2356.92	I	
9	2097.60	I	5144-52802	7	2357.25	I	8743-51152
9	2100.63	I	2740-50330	10	2362.41	I	0-42317
4	2117.66	I	2740-49947	28	2362.77	I	0-42310
9	2117.96	I	0-47200	6	2363.33	I	8743-51043
13	2119.79			16	2367.35	II	3929-46157
4	2123.84	I	4159-51229	10	2369.24	I	8743-50937
13	2137.11	I	4159-50937	17	2370.70	I	4159-46328
7	2149.97			17	2371.18	I	8743-50903
8	2154.59	I	2740-49138	3.0	2374.33	I	4159-46264
4	2157.84	I	0-46328	3.5	2374.51	I	11031-53131
4	2158.53	I	2740-49054	3.5	2375.06	II	
8	2161.00			100	2377.03	I	5144-47200
11	2166.90	I	4159-50294	10	2377.61	I	11378-53424
4	2167.75			3.5	2378.14	I	5766-47802
8	2171.65	I	2740-48773	3.5	2378.74	I	12774-54800
4	2184.68	I	0-45759	34	2379.39	I	5144-47158
4	2194.39	II	3593-49149	7	2379.64	I	4159-46170
4	2202.49	I	0-45389	7	2379.84		
4	2227.98	I	0-44870	3.5	2380.82	I	2740-44730
8	2234.61	I	2740-47477	7	2382.46	I	11378-53338
12	2252.15	I	8743-53131	10	2384.62	I	2740-44663
19	2255.85	I	2740-47052	70	2387.29	I	0-41876
		II	0-44315				
15	2264.60	I	4159-48303	15	2394.29	I	11378-53131
4	2268.28	I	2740-46813	13	2395.39	I	2740-44475
11	2270.17	I	2740-46776	48	2395.88	I	0-41726
18	2282.26	II	0-43802	10	2396.78	I	12774-54484
				3.0	2397.61	I	11378-53073

Osmium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
5	2398.18	I	11031-52716	6	2458.76		
48	2401.13	I	8743-50377	9	2459.84	I	5766-46407
13	2402.23	I	4159-45775	150	2461.42	I	5144-45759
10	2403.54	I	10166-51759	9	2464.00		
16	2403.85	I	8743-50330	15	2464.50	I	12774-53338
5	2405.08	II		6	2465.16		
14	2405.45	I	11378-52938	9	2468.09	I	10166-50671
10	2405.96	I	8743-50294	9	2468.90	II	11460-51952
19	2408.67	I	11031-52535	5	2470.82		
13	2410.98	I	13020-54484	24	2472.28	I	5766-46202
5	2411.90			24	2474.78	I	8743-49138
5	2414.10	I	8743-50154	9	2475.69	I	11378-51759
16	2414.52	I	2740-44144	75	2476.84	I	0-40362
10	2415.32			2.5	2480.71	I	11031-51329
32	2417.99	I	4159-45503	15	2481.79		
5	2418.35	I	11378-52716	30	2482.43	I	2740-43011
32	2418.53	I	2740-44075	3.0	2484.04	I	5144-45389
3.0	2419.63			5	2485.32		
6	2420.02	II	13137-54445	44	2486.24	II	3593-43802
3.0	2421.15	I	12774-54064	380	2488.55	I	5144-45316
5	2421.86			6	2489.04	I	10166-50330
5	2421.94			24	2491.02	I	8743-48875
13	2423.07	II	7892-49149	24	2491.69	I	11031-51152
5	2424.02	II	13204-54445	30	2492.42	I	6093-46202
3.0	2424.19			15	2493.62		
32	2424.56	I	0-41232	5	2493.83	I	0-40087
95	2424.97	I	0-41225	6	2496.45		
4	2426.19	I	8743-49947	5	2496.61		
16	2426.81	I		220	2498.41	I	8743-48756
5	2427.90	II	13204-54379	28	2499.92	I	14339-54328
3.0	2429.67	I	10166-51311	8	2500.72		
26	2431.19	I	5144-46264	8	2500.91	I	14091-54064
26	2431.61	I	11378-52491	5	2501.84	I	14091-54050
10	2435.51	I	5766-46813	28	2502.29	I	11378-51329
10	2435.65	I	13020-54064	3.0	2503.16		
2.0	2436.51	I	13020-54050	8	2503.67		
5	2437.73			42	2504.39	I	2740-42658
3.0	2440.68	I	11378-52338	22	2504.51	I	4159-44075
6	2442.00	I	13365-54302	7	2506.38		
6	2445.88	I	12774-53647	7	2506.66		
28	2446.02	I	2740-43611	3.0	2507.18	II	3929-43802
3.0	2449.88			14	2508.61	I	11378-51229
75	2450.74	I	8743-49534	6	2509.71	II	17569-57403
6	2451.19	I	11378-52162	14	2509.94	I	12774-52604
44	2451.73	I	2740-43516	55	2512.87	I	8743-48526
5	2453.29	I	5766-46515	200	2513.25	I	5144-44921
44	2453.90	I	8743-49483	55	2515.04	I	5144-44893
9	2454.91	II	3593-44315	3.0	2517.61	I	13365-53073
44	2456.46	I	2740-43437	42	2517.92	I	4159-43863
6	2457.16	I	13365-54050	55	2518.44	I	5144-44839

Osmium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
17	2519.29	I	2740-42422	12	2587.49	I	13020-51656
28	2519.79	I		4	2588.26	I	14091-52716
6	2524.79	I	4159-43755	8	2588.44		
14	2526.01	I	2740-42317	8	2589.39	I	10166-48774
6	2526.83	I	12774-52338	5	2589.51	I	14848-53454
11	2527.09	I	8743-48303	95	2590.76	I	4159-42747
17	2532.44	I	14852-54328	19	2591.98	I	11378-49947
10	2534.17	I	10166-49615	3.0	2593.90	I	16212-54753
65	2538.00	II	0-39390	14	2594.14	I	12774-51311
20	2538.10	I	12774-52162	16	2596.00	II	24466-62974
11	2539.73	I	14091-53454	2.5	2596.37	I	11031-49534
14	2540.14	I	4159-43516	14	2596.69	I	4159-42658
15	2540.74	I	11031-50377	14	2597.20	I	2740-41232
6	2541.65	I	14091-53424		2597.29	I	14848-53338
85	2542.51	I	8743-48062	12	2597.58	I	0-38486
11	2543.80	I	11031-50330	10	2599.13	I	14339-52802
13	2546.17	I	11031-50294	14	2599.91	I	11031-49482
12	2547.70	I	13365-52604	10	2600.45	I	12774-51218
13	2548.10	I	14339-53572	6	2600.75	I	
2.5	2548.83	II	17569-56791	9	2602.33	I	8743-47158
26	2554.46	I	2740-41876	6	2603.22		
13	2555.11	I	11378-50503	6	2603.80	I	13365-51759
10	2555.27	I	11031-50154	18	2604.60	I	6093-44475
13	2555.80	I	14339-53454	4	2604.96	I	14339-52716
9	2556.08	I	8743-47854	20	2609.20	I	8743-47057
8	2557.77	I	8743-47828	36	2609.56	I	5766-44075
10	2558.09	I	15223-54302	38	2610.78	I	13365-51656
4	2560.19			10	2611.33	I	14848-53131
4	2560.47			44	2612.63	I	0-38264
13	2562.66	I	13365-52375	170	2613.06	I	5144-43402
16	2563.16	II	13204-52206	5	2614.06	I	10166-48409
10	2564.37	I	12774-51759	2.5	2614.50	I	11378-49615
11	2565.17	I	10166-49138	6	2615.96	I	12774-50990
5	2565.72	I	5766-44730	5	2617.18	I	13020-51218
50	2566.49	I	11378-50330	5	2619.28		
24	2566.88	I	10166-49112	75	2619.94	I	4159-42317
40	2568.83	I	11031-49947	22	2620.62	I	2740-40888
7	2571.14	I	12774-51656	50	2621.82	I	0-38130
32	2571.78	I	8743-47615	6	2623.61	I	11378-49482
7	2572.48			6	2624.57	I	16212-54302
7	2573.09	I	4159-43011	36	2628.48	I	8743-46776
4	2573.48	I	14091-52938	2.5	2631.22	II	24981-62974
2.5	2574.74	I	15223-54050	10	2632.89	I	13020-50990
8	2578.16	I	11378-50154	6	2634.29	I	14852-52802
14	2578.32	II	15606-54379	6	2634.44	I	15391-53338
12	2580.03	II	13204-51952	360	2637.13	I	0-37909
34	2581.05	I	5144-43876	6	2637.98	I	12774-50671
70	2581.96	I	5144-43863	2.5	2639.98	I	14848-52716
10	2582.62	I	5766-44475	6	2641.17	I	15223-53073
12	2586.08			16	2641.60	I	11031-48875



Osmium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
8	2643.63	I	12774-50590	10	2718.91		
180	2644.11	I	0-37809	120	2720.04	I	2740-39494
32	2646.89	I	10166-47935	80	2721.86	I	4159-40888
36	2647.73	I	2740-40498	6	2722.60		
36	2649.34	I	11378-49112	14	2727.94	I	10166-46813
6	2650.68	I	15223-52938	11	2728.27	I	2740-39383
14	2652.98	I	15391-53073	55	2730.61	I	5144-41754
14	2653.78	I	5766-43437	4	2731.36	II	15606-52206
6	2655.19	I	13020-50671	55	2732.80	I	5144-41726
5	2655.78	I	14848-52491	8	2736.39	I	5766-42300
46	2656.68	I		5	2738.33	I	13365-49873
180	2658.60	I	5144-42747	6	2738.46	I	15391-51897
60	2659.83	I	8743-46328	16	2740.32	I	14848-51329
9	2660.92	I	13020-50590	13	2740.61		
36	2661.18	I	4159-41726	12	2740.75	I	11378-47854
4	2661.93	I	12774-50330	6	2741.38	I	11378-47845
10	2662.55	I	15391-52938	4	2742.69	I	11378-47828
10	2663.22	I	12774-50312	14	2747.91	I	14848-51229
4	2664.29	II	25452-62974	12	2748.86	I	15391-51759
11	2665.99			12	2749.18	I	12774-49138
11	2666.21	I	11031-48526	8	2751.15	I	12774-49112
14	2669.53	I	10166-47615	6	2753.72	I	14848-51152
55	2674.57	I	11378-48756	10	2755.59	I	12774-49054
38	2674.88	I	10166-47540	16	2757.81	I	13365-49615
5	2679.38	I	15391-52702	13	2758.82	I	11378-47615
7	2679.74	I	13365-50671	14	2761.08	I	6093-42300
10	2682.19	I	11031-48303	65	2761.42	I	4159-40362
7	2684.36	I	16212-53454	44	2763.27	I	8743-44921
	2684.41			14	2763.94	I	11031-47200
10	2688.08	I	14852-52043	32	2765.04	I	15391-51546
10	2689.35	I	12774-49947	6	2765.45	I	8743-44893
200	2689.82	I	5144-42310	12	2767.12	I	11031-47158
14	2692.70	I	14091-51218	15	2769.88	I	13020-49112
13	2694.52	I	11031-48132	10	2770.10	I	14848-50937
6	2694.75	I	12774-49873	90	2770.71	I	5144-41225
4	2696.61	I	4159-41232	4	2771.04		
8	2697.24			11	2773.07	I	14852-50903
48	2699.59	I	2740-39772	11	2774.02	I	14339-50377
10	2700.75	I	8743-45759	10	2774.38	I	13020-49054
7	2702.83	I	13020-50007	10	2774.90	I	11031-47057
7	2704.45	I	13365-50330	28	2776.91	I	2740-38741
55	2706.70	I	2740-39675	4	2778.57		
17	2707.42	I	11378-48302	70	2782.55	I	4159-40087
10	2708.18			4	2783.88	II	7892-43802
18	2709.86	I	10166-47057	4	2785.04		
280	2714.64	I	0-36826	60	2786.31	I	5144-41023
55	2715.36	I	5766-42583	12	2786.80	I	2740-38614
14	2715.64	I	14339-51152	6	2790.90	I	15223-51043
6	2716.80	I	11031-47828	22	2793.99	I	11378-47158
10	2718.71	I	15391-52162	22	2794.19	I	14852-50630

Osmium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
2.0	2796.11	I	13020-48774	9	2874.15	I	13020-47802
50	2796.73	I	2740-38486	4	2874.59	I	16212-50990
3.5	2799.53			34	2874.96	I	8743-43516
9	2801.93	I	11378-47057	18	2877.35	I	11031-45775
30	2804.07	I	15391-51043	28	2878.40	I	5766-40498
260	2806.91	I	0-35616	3.5	2879.39	II	11654-46374
4	2807.48	I	10166-45775	3.0	2880.20	II	17242-51952
4	2807.80			3.0	2883.94	I	14091-48756
3.0	2808.24	I	15391-50990	8	2884.41	I	8743-43402
44	2808.94	I	2740-38331	2.0	2886.06	I	19411-54050
2.0	2811.56	I		4	2886.50	I	14848-49482
40	2813.84	I	14848-50377	4	2890.85	I	4159-38741
70	2814.20	I	2740-38264	5	2891.83	I	25013-59583
4	2814.84	I	4159-39675	8	2892.35	I	10166-44730
4	2815.27	I	13365-48875	9	2895.06	I	11031-45562
28	2815.78	I	2740-38244	24	2896.06	I	13020-47540
4	2817.51	I	14848-50330	6	2901.32	I	13020-47477
13	2820.18	I	15223-50671	6	2903.07	I	18902-53338
9	2820.56	I	14091-49534	12	2903.21	I	14091-48526
18	2821.25	I	11378-46813	18	2905.73	I	6093-40498
12	2824.17	I	11378-46776	10	2905.97		
4	2824.67			3.0	2908.03	I	16212-50590
2.0	2829.03	I	10166-45503	900	2909.06	I	0-34365
40	2829.27	I	4159-39494	10	2909.67	I	11031-45389
2.0	2831.59	I	14848-50154	3.5	2911.34	I	19109-53447
12	2832.24	I	11031-46328	200	2912.33	I	4159-38486
22	2837.42	I	11031-46264	13	2913.84	I	10166-44475
44	2838.17	I	4159-39383	7	2914.71	I	18417-52716
480	2838.63	I	5144-40362	50	2917.26	I	8743-43011
10	2840.44	I	14339-49534	12	2917.83	I	5144-39406
70	2841.60	I	2740-37922	200	2919.79	I	15223-49461
220	2844.40	I	5144-40291	5	2921.07	I	15391-49615
8	2844.68	I	14339-49482	3.5	2923.18		
40	2846.39	I	5766-40888	10	2924.49	I	11378-45562
14	2846.55	I	8743-43863	4	2925.28	I	13365-47540
40	2848.25	I	14848-49947	28	2925.57	I	4159-38331
9	2849.05	I	15223-50312	34	2929.51	I	0-34126
4	2849.30	I	10166-45252	10	2930.19		
140	2850.76	I	2740-37809	11	2930.57	I	22616-56729
12	2855.34	I	8743-43755	48	2931.28	I	4159-38264
5	2857.54	I	18902-53887	4	2932.45	I	15391-49482
10	2860.06	I	16212-51166	4	2933.98	I	18301-52375
140	2860.96	I	5144-40087	24	2934.64	I	2740-36806
3.5	2863.37	II	11460-46374	2.5	2936.81	I	14091-48132
4	2864.26	I	15391-50294	12	2936.99	I	12774-46813
8	2865.68	I	11378-46264	4	2938.38	I	19109-53131
4	2867.59			10	2942.20	I	10166-44144
4	2869.39	I	12774-47615	19	2942.85	I	4159-38130
16	2872.40	I	0-34804	100	2948.23	I	5766-39675
16	2873.42	I	11378-46170	130	2949.53	I	2740-36634

Osmium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
20	d 2949.81	I	11031-44921	6	3045.32		
	2949.90	I	15223-49112	10	3049.04	I	12774-45562
12	2952.34	I	11031-44893	24	3049.46	I	6093-38876
8	2955.00	I	15223-49054	22	3050.39	I	22616-55389
9	2957.08			12	3051.17	I	5144-37909
5	2958.34	I	14339-48132	10	3054.97	I	11031-43755
28	2961.01	I	4159-37922	16	3055.21	I	14091-46813
50	2962.15	I	4159-37909	900	3058.66	I	0-32685
10	2962.33	I	15391-49138	30	3060.30	I	4159-36826
42	2964.06	I	5766-39494	60	3062.19	I	4159-36806
5	2964.62	I	15391-49112	8	3066.12	I	15223-47828
3.5	2965.10			22	3069.94	I	5766-38331
3.0	2968.45	I	14848-48526	38	3074.08	I	6093-38614
3.5	2970.69	I	15223-48875	30	3074.96	I	22616-55127
70	2970.97	I	4159-37809	19	3077.06	I	8743-41232
10	2972.25	I	25013-58648	30	3077.44	I	11031-43516
12	2973.06	I	18417-52043	120	3077.72	I	8743-41225
10	2975.34			38	3078.11	I	5766-38244
42	2977.64	I	8743-42317	24	3078.38	I	4159-36634
10	2978.21	I	8743-42310	16	3083.74	I	22616-55034
9	2978.53	I	21303-54868	6	3084.60	I	13365-45775
8	2979.43	I	12774-46328	6	3086.27	I	15223-47615
7	2982.56			24	3090.08	I	14848-47200
48	2982.90	I	11378-44893	15	3090.30	I	2740-35090
32	2983.49			12	3090.49	I	14852-47200
12	2985.61	I	15391-48875	6	3091.25	I	17667-50007
6	2988.26	I	14848-48303	28	3093.59	I	18902-51218
10	2989.13	I	19893-53338	32	3101.53	I	13020-45253
14	2992.11	I	13365-46776	10	3104.98	I	13365-45562
10	2993.57	I	12774-46170	38	3105.99	I	4159-36346
24	2997.65	I	10166-43516	6	3107.38	I	14091-46264
16	3003.48	I	11378-44663	32	3108.98	I	5766-37922
10	3007.90	I	18902-52138	65	3109.38	I	6093-38244
34	3013.07	I	2740-35920	26	3111.09	I	10166-42300
12	3015.65	I	13365-46515	12	3114.81	I	12774-44870
60	3017.25	I	8743-41876	12	3116.48	I	14091-46170
460	3018.04	I	0-33124	10	3118.12	I	22616-54677
50	3019.38	I	5766-38876	32	3118.33	I	11378-43437
10	3020.86			13	3129.23	I	17667-49615
120	3030.70	I	5144-38130	50	3131.12	I	14848-46776
12	3031.01	I	8743-41726	10	3140.31	I	15223-47057
8	3031.30	I	14848-47828	10	3152.07	I	11031-42747
10	3032.81	I	13365-46328	26	3152.67	I	10166-41876
300	3040.90	I	2740-35616	30	3153.61	I	12774-44475
12	3042.74	II	11460-44315	320	3156.25	I	5144-36818
22	3043.50	I	5766-38614	26	3156.78	I	23463-55132
12	3043.64	I	10166-43011	14	3157.24	I	23463-55127
6	3044.07	I	16212-49054	13	3161.44	I	19049-50671
6	3044.41	I	13365-46202	12	3161.73	I	8743-40362
16	3044.91	I	11031-43863	9	3164.61	I	15223-46813

Osmium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
32	3166.51	I	23463-55034	17	3372.08	I	13365-43011
13	3168.28	I	15223-46776	13	3378.68	I	19893-49482
13	3173.20	I	13365-44870	32	3384.00	I	12774-42317
19	3173.93	II	7892-39390	9	3384.60	I	14339-43876
44	3178.06	I	4159-35616	20	3385.94	I	12774-42300
11	3180.12	I	19893-51329	9	3386.14	I	14339-43863
24	3181.88	I	14339-45758	65	3387.84	I	10166-39675
18	3182.57	I	14091-45503	7	3394.59		
24	3185.33	I	2740-34126	10	3395.72	I	15223-44663
32	3186.98	I	11378-42747	13	3401.17	I	23323-52716
6	3187.34	I	13365-44730	65	3401.86	I	8743-38130
32	3189.46	I	8742-40087	26	3402.51	I	0-29382
32	3194.23	I	14091-45389	10	3406.28		
20	3195.38	I	11031-42317	10	3406.67	I	14091-43437
13	3195.97	I	11378-42658	13	3408.76	I	10166-39494
16	3213.31	II	13204-44315	13	3412.74	I	13365-42658
200	3232.06	I	4159-35090	13	3421.69	I	10166-39383
30	3238.63	I	5766-36634	7	3427.44	I	23323-52491
20	3241.04	I	11031-41876	16	3427.67	I	8743-37909
13	3248.00	I	13365-44144	7	3435.26	I	12774-41876
20	3254.91	I	14848-45562	10	3439.49	I	8743-37809
20	3256.92	I	11031-41726	26	3440.60	I	11031-40087
20	3260.30	I	8743-39406	13	3444.46	I	14852-43876
320	3262.29	I	4159-34804	17	3445.55	I	14848-43863
40	3262.75	I	8743-39383	32	3449.20	I	11378-40362
320	3267.94	I	0-30592	7	3455.03	I	13365-42300
65	3269.21	I	5766-36346	13	3458.38	I	14848-43755
20	3272.16	I	15223-45775	13	3465.44	I	17667-46515
55	3275.20	I	5766-36290	13	3478.53	I	17667-46407
34	3277.97	I	5766-36264	13	3482.11	I	10166-38876
7	3280.92			7	3482.23	I	11378-40087
7	3286.67	I	13020-43437	7	3487.25	I	14848-43516
20	3288.84	I	28372-58769	13	3487.46		
130	3290.26	I	2740-33124	13	3490.33		
800	3301.56	I	0-30280	10	3491.50	I	19893-48526
26	3306.23	I	12774-43011	5	3495.62		
65	3310.91	I	11031-41225	17	3498.54	I	10166-38741
13	3315.42	I	5766-35920	26	3501.16	I	14848-43402
10	3315.69	I	13365-43516	65	3504.66	I	4159-32685
10	3316.69			46	3512.99	I	12774-41232
26	3324.33	I	13365-43437	10	3513.86	I	16212-44663
32	3327.42	I	14848-44893	7	3516.63	I	19049-47477
100	3336.15	I	4159-34126	32	3518.72		
11	3351.74	I	6093-35920	12	3520.00		
13	3353.91			50	3523.64	I	0-28372
24	3357.97	I	14091-43863	13	3526.04	I	11031-39383
26	3361.15	I	8743-38486	130	3528.60	I	0-28332
20	3364.12	I	2740-32457	24	3530.06	I	10166-38486
13	3370.20	I	14091-43755	24	3532.80	I	4159-32457
100	3370.59	I	5144-34804	13	3533.41	I	15223-43516

Osmium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
7	3541.91	I	14091-42317	60	3790.14	I	14848-41225
24	3542.71	I	14091-42310	17	3790.73	I	14852-41225
10	3555.97	I	12774-40888	36	3793.91	I	18902-45252
100	3559.79	I	8743-36826	4	3794.66	I	28332-54677
130	3560.86	I	8743-36818	8	3795.67	I	24292-50630
13	3562.34	I	8743-36806	8	3827.14	I	22616-48737
32	3569.78	I	11378-39383	24	3836.06	I	8743-34804
13	3574.08	I	14339-42310	13	3840.30	I	29099-55132
7	3586.51	I	18902-46776	13	3841.29	I	25013-51039
13	3587.32	I	13020-40888	7	3843.66	I	15223-41232
7	3592.32	I	23323-51152	17	3849.94	I	12774-38741
65	3598.11	I	2740-30525	20	3857.09	I	4159-30078
20	3601.83	I	10166-37922	20	3865.47	I	25275-51138
10	3604.48	II	11654-39390	65	3876.77	I	11031-36818
7	3609.15			22	3881.86	I	10166-35920
26	3616.57	I	10166-37809	3.5	3886.75	I	13020-38741
13	3619.43	I	15391-43011	3.5	3895.18	I	15223-40888
7	3629.95	I	5144-32685	12	3900.39	I	2740-28372
44	3640.33	I	14848-42310	17	3901.71	I	8743-34365
5	3648.81	I	19760-47158	3.0	3907.65	I	14091-39675
22	3654.49	I	15391-42747	3.0	3911.81	I	12774-38331
32	3656.90	I	2740-30078	3.0	3918.97	I	27954-53464
12	3666.31	I	18902-46170	3.0	3922.03	I	12774-38264
46	3670.89	I	11031-38264	3.0	3925.10	I	12774-38244
12	3675.45	I	15223-42422	3.0	3926.77	I	18417-43876
8	3681.57	I	19109-46264	4	3928.41	I	11378-36826
24	3689.06	I	11031-38130	4	3928.54	I	5144-30592
3.5	3698.83	I	14848-41876	9	3930.00	I	14852-40291
18	3703.25	I	17667-44663	7	3931.52	I	11378-36806
12	3706.56	I	23323-50294	22	3938.59	I	8743-34126
12	3709.14	I	11378-38331	8	3939.57	I	13365-38741
8	3712.84	I	15391-42317	9	3949.78	I	13020-38331
22	3713.73	I	15391-42310	5	3952.77	I	14091-39383
8	3718.34	I	11378-38264	4	3955.37	I	15223-40498
20	3719.52	I	14848-41726	8	3960.51	I	24292-49534
22	3720.13	I	8743-35616	18	3961.02	I	14848-40087
3.5	3721.96	I	24292-51152	90	3963.63	I	4159-29382
6	3729.22	I	17667-44475	9	3964.96	I	2740-27954
8	3730.73	I	14091-40888	13	3969.67	I	14852-40036
17	3746.47	I	14339-41023	10	h 3975.44	I	12774-37922
360	3752.52	I	2740-29382	65	3977.23	I	5144-30280
10	3757.12	I	12774-39383	4	3979.36	I	30280-55403
13	3766.30	I	11378-37922	9	3988.18	I	14339-39406
12	3768.14	I	11378-37909	3.5	3988.62	I	19411-44475
12	3774.40	I	18902-45389	3.5	3991.49	I	2740-27787
11	3774.62	I	15391-41876	4	3994.93	I	21303-46328
12	3776.25	I	13020-39494	3.5	3996.80	I	0-25013
28	3776.99	I	10166-36634	5	3998.93	I	19893-44893
200	3782.20	I	4159-30592	13	4003.48	I	15391-40362
8	3789.11	I	14848-41232	9	4004.02	I	11378-36346

Osmium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
13	4005.16	I	18902-43863	9	4338.75	I	15223-38264
6	h 4015.04	I	13365-38264	9	4351.53	I	18902-41876
14	4018.26	I	13365-38244	6	h 4354.46	I	10166-33124
5	h 4029.32	I	30592-55403	4	4357.98	I	15391-38331
8	4032.92	I	23985-48773	6	4358.14	I	30525-53464
9	4037.84	I	5766-30525	19	4365.67	I	13020-35920
5	4038.64	I	19109-43863	10	4370.66	I	15391-38264
25	4041.92	I	19411-44144	4	4376.90	I	37809-60649
14	4048.05	I	15391-40087	8	4391.08	I	19109-41876
5	4051.43	I	16212-40888	46	4394.86	I	11378-34126
85	4066.69	I	22616-47199	14	4397.26	I	14091-36826
22	4070.86	I	14848-39406	5	4400.58	I	32685-55403
17	4071.56	I	14852-39406	14	4402.74	I	28332-51039
20	4074.68	I	14848-39383	5	4404.21	I	15223-37922
6	4088.44	I	15223-39675	3.5	4411.13	I	16212-38876
44	4091.82	I	6093-30525	440	4420.47	I	0-22616
5	4098.10	I	14091-38486	9	4432.41	I	13365-35920
11	4100.30	I	8743-33124	26	4436.32	I	2740-25275
5	4103.62	I	27787-52149	4.5	4437.09	I	15391-37922
110	4112.02	I	5766-30078	9	4439.64	I	15391-37909
16	4124.60	I	11378-35616	3.5	4445.69	I	14339-36826
16	4128.96	I	4159-28372	20	4447.35	I	14339-36818
220	4135.78	I	4159-28332	7	d 4459.53	I	15391-37809
13	4137.84	I	15223-39383	3.0	4462.29	I	21034-43437
6	4158.78	I	14091-38130	3.0	4465.94	I	38264-60649
6	4159.96	I	12774-36806	8	4479.81	I	12774-35090
16	4172.57	I	10166-34126	11	4484.76	I	10166-32457
110	4173.23	I	5144-29099	3.5	4488.60	I	2740-25013
55	4175.63	I	8743-32685	3.0	4518.89	I	19109-41232
11	4184.13	I	18417-42310	3.0	4520.32	I	19109-41225
28	4189.91	I	12774-36634	6	4524.87	I	11031-33124
5	4195.14	I	14091-37922	6	4529.67	I	13020-35090
16	4201.45	I	4159-27954	2.5	4537.62	I	16212-38244
22	4202.06	I	14339-38130	6	4539.92	I	25594-47615
110	4211.86	I	23463-47199	10	4548.66	I	14848-36826
11	4213.86	I	25013-48737	48	4550.41	I	14848-36818
9	4215.16	I	14091-37809	12	4551.30	I	14852-36818
5	4226.53	I	15223-38876	3.0	4579.04	I	19893-41726
15	4233.46	I	13020-36634	8	4595.04	I	29382-51138
440	4260.85	I	0-23463	8	4597.16	I	11378-33124
9	4264.75	I	13365-36806	2.5	4605.04	I	16212-37922
11	4269.61	I	18902-42317	15	4616.78	I	11031-32685
5	4277.15	I	19049-42422	15	4631.83	I	15223-36806
9	4285.90	I	13020-36346	3.0	4634.77	I	23323-44893
50	4293.95	I	14848-38130	3.0	4641.83	I	8743-30280
6	4296.22	I	13365-36634	12	4663.82	I	15391-36826
5	4308.88	I	19109-42310	2.5	4682.31	I	12774-34126
50	4311.40	I	5144-28332	6	4692.06	I	11378-32685
10	4326.25	I	15223-38331	2.5	4732.80	I	15223-36346
30	4328.68	I	11031-34126	2.0	4738.04	I	25070-46170

Osmium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
4	4738.35			1.0	5447.76	I	11031-29382
4	4743.89	I	17667-38741	1.8	5449.37	I	14339-32685
2.5	4752.16	I	34365-55403	1.8	5453.40	I	23985-42317
3.0	4763.10	I	38613-59602	2.0	5457.30	I	5144-23463
60	4793.99	I	4159-25013	2.5	5470.00	I	14848-33124
2.0	4813.80	I	14848-35616	1.2	5474.58	I	25602-43863
2.0	4815.50	I	13365-34126	1.2	5475.13	I	21124-39383
4	4815.96	I	30280-51039	0.8	5477.27	I	17667-35920
2.0	4826.66	I	14091-34804	1.4	5481.85	I	19893-38130
2.0	4843.87	I	8743-29382	2.0	5509.33	I	30592-48737
10	4865.60	I	30592-51138	0.8	5516.01	I	28140-46263
4	4899.22	I	28332-48737	24	5523.53	I	29099-47199
6	4912.60	I	12774-33124	2.0	5546.82	I	34125-52149
2.5	4935.81	I	17667-37922	0.8	5549.79	I	33124-51138
2.5	4942.94	I	15391-35616	1.2	5552.88	I	11378-29382
3.5	4979.32	I	16212-36290	1.0	5560.62	I	35616-53595
5	5031.83	I	15223-35090	1.4	5580.66	I	33124-51039
4	5039.12	I	18902-38741	7	5584.44	I	15223-33124
3.0	5072.88	I	16212-35920	0.7	5600.50	I	36826-54677
3.0	5074.77	I	15391-35090	3.0	5620.08	I	10166-27954
3.0	5079.09	I	12774-32457	0.8	5637.41	I	15391-33124
8	5103.50	I	8743-28332	2.0	5642.56	I	19109-36826
5	5110.81	I	11031-30592	2.5	5645.25	I	19109-36818
2.0	5122.23	I	14848-34365	0.6	5648.98	I	19109-36806
2.0	5145.54	I	18902-38331	0.8	5660.21		
12	5149.74	I	15391-34804	0.6	5674.38	I	18301-35920
2.5	5152.01	I	36818-56223	2.5	5680.88	I	34804-52402
2.5	5168.98	I	38486-57827	1.0	5709.37	I	37909-55419
3.5	5193.52	I	11031-30280	15	5721.93	I	5144-22616
24	5202.63	I	10166-29382	0.7	5737.89	I	17667-35090
3.0	5203.23	I	11378-30592	0.7	5739.72	I	25594-43011
1.8	5250.46			2.0	5765.05	I	11031-28372
4	5255.82	I	19109-38130	15	5780.82	I	15391-32685
5	5265.15	I	23323-42310	3.5	5800.60	I	15223-32457
1.8	5283.89	I	19411-38331	0.7	5842.49	I	22564-39675
1.8	5295.65	I	16212-35090	10	5857.76	I	15391-32457
3.5	5298.78	I	28332-47199	2.5	5860.64	I	13020-30078
1.2	5302.58	I	19411-38264	1.0	5882.92	I	11378-28372
1.6	5336.23	I	15391-34126	1.0	5903.98	I	19893-36826
1.0	5346.03	I	11378-30078	1.0	5906.84	I	19893-36818
1.2	5352.25	I	17667-36346	0.6	5908.95	I	30280-47199
10	5376.79	I	14091-32685	0.6	5981.36	I	18902-35616
1.4	5403.43	I	36346-54847	1.0	5983.22	I	25602-42310
1.2	5412.14	I	21033-39505	6	5996.00	I	34365-51039
11	5416.34	I	30280-48737	1.8	6015.79	I	21303-37922
4	5416.69	I	4159-22616	0.6	6054.63	I	27351-43863
2.5	5417.51	I	32685-51138	1.8	6144.53	I	8743-25013
1.4	5441.82	I	19893-38264	1.0	6158.03	I	34804-51039
5	5443.31	I	14091-32457	3.0	6227.70	I	32685-48737
2.0	5446.93	I	32685-51039	0.6	6241.70	I	13365-29382

Osmium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
2.0	6269.41	I	43012-58957	1.2	6956.02	I	34365-48737
1.0	6274.94	I	40291-56222	0.8	6984.95	I	16212-30525
1.0	6286.83	I	18902-34804	2.0	7060.67	I	15223-29382
0.8	6398.86	I	25602-41225	3.0	7145.54	I	15391-29382
2.0	6403.15	I	33124-48737	1.4	7149.89	I	11031-25013
0.8	6448.13	I	41225-56729	0.6	7184.10	I	38486-52402
0.5	6520.85	I	21303-36634	1.4	7206.33	I	8743-22616
0.6	6528.87	I	21034-36346	0.7	7209.96	I	16212-30078
0.6	6533.14	I	15223-30525	1.2	7251.16	I	21303-35090
1.0	6538.30	I	14091-29382	0.8	7253.49	I	18902-32685
1.0	6576.83	I	15391-30592	0.8	7375.07	I	18902-32457
0.7	6614.56	I	24292-39406	1.2	7407.95	I	23323-36818
0.4	6615.43	I	40291-55403	3.5	7602.95	I	15223-28372
0.6	6661.81	I	13365-28372	0.6	7701.46	I	15391-28372
3.0	6729.56	I	15223-30078	1.0	7789.96	I	34365-47199
2.0	6791.53	I	8743-23463	1.0	7852.17	I	15223-27954
1.6	6806.61	I	15391-30078	0.8	7981.20	I	24292-36818
0.6	6878.70	I	14848-29382	0.9	8041.29	I	11031-23463
0.5	6901.58	I	25602-40087				



# PALLADIUM

Pd,  $Z=46$ ,  $M=106.4$ , Ratio  $\frac{\text{Pd}}{\text{Cu}}=1.674$

Pd I Normal state of valence electrons  $4d^{10} 1S_0 = 0$ . I.P. = 67236 K  
 Pd II Normal state of valence electrons  $4d^9 2D_{3/2} = 0$ . I.P. = 156700 K

## References

Wavelengths:

G. R. Harrison, Massachusetts Institute of Technology Wavelength Tables (John Wiley & Sons, New York, 1939).

Classification:

Pd I, A. G. Shenstone, Phys. Rev. **36**, 669 (1930).  
 Pd II, A. G. Shenstone, Phys. Rev. **32**, 30 (1928).

Relative intensity of palladium lines observed in an arc of copper containing 0.1 atomic percent of palladium

### *Strong lines of palladium*

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
2600	3404. 58	I	6564-35928	$5s^1 3D_3-5p^1 3F_4$
2200	3609. 55	I	7755-35451	$5s^1 3D_2-5p^1 3F_3$
2200	3634. 70	I	6564-34069	$5s^1 3D_3-5p^1 3P_2$
1400	3421. 24	I	7755-36976	$5s^1 3D_2-5p^1 3D_3$
1300	3516. 94	I	7755-36181	$5s^1 3D_2-5p^1 3P_1$
1300	3553. 08	I	11722-39858	$5s^1 1D_2-5p^1 1F_3$
1200	3242. 70	I	6564-37394	$5s^1 3D_3-5p^1 3D_3$
1100	3481. 15	I	10094-38812	$5s^1 3D_1-5p^1 3F_2$

Palladium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
65	2447.91	I	0-40839	280	4212.95	I	11722-35451
100	2476.42	I	0-40369	20	4473.59	I	11722-34069
3.0	2486.53	II	27094-67299	6	h 4788.18	I	34069-54948
8	2488.92	II	25081-65247	5	h 4817.51	I	34069-54821
3.5	2498.78	II	32278-72285	4	4875.43	I	34069-54574
160	2763.09	I	0-36181	6	5110.81	I	35451-55012
2.0	2854.58	II	32278-67299	8	5117.02	I	38812-58349
44	2922.49	I	6564-40771	17	5163.84	I	35451-54811
55	3002.65	I	6564-39858	6	5234.86	I	35928-55025
4	3009.78	I	25101-58317	13	5295.63	I	35928-54806
130	3027.91	I	7755-40771	2.0	5312.57	I	36181-54998
95	3065.31	I	7755-40369	1.6	5345.10	I	39858-58562
220	3114.04	I	7755-39858	4	5395.24	I	39858-58388
30	3142.81	I	25101-56911	6	5542.80	I	36976-55012
1200	3242.70	I	6564-37394	4	5547.02	I	36976-54998
300	3251.64	I	10094-40839	3.0	5619.44	I	40771-58562
380	3258.78	I	10094-40771	1.7	5642.69	I	40839-58556
50	3287.25	I	6564-36976	1.5	5655.42	I	40771-58448
400	3302.13	I	10094-40369	8	5670.07	I	37394-55025
550	3373.00	I	7755-37394	1.2	5690.14	I	40839-58408
2600	3404.58	I	6564-35928	6	h 5695.09	I	37394-54948
1400	3421.24	I	7755-36976	2.0	5736.61	I	37394-54821
550	3433.45	I	11722-40839	2.5	6774.54	I	25101-39858
700	3441.40	I	11722-40771	7	6784.52	I	34069-48804
850	3460.77	I	6564-35451	0.4	h 6833.42	I	40369-54998
1100	3481.15	I	10094-38812	1.2	7016.44	I	38088-52336
220	3489.77	I	11722-40369	1.4	h 7310.06	I	38812-52488
1300	3516.94	I	7755-36181	8	7368.12	I	35451-49020
1300	3553.08	I	11722-39858	3.0	7391.92	I	38812-52336
500	3571.16	I	10094-38088	1.8	7486.90	I	35451-48804
2200	3609.55	I	7755-35451	13	7764.03	I	35928-48804
2200	3634.70	I	6564-34069	3.0	7786.67	I	36181-49020
600	3690.34	I	11722-38812	5	7915.80	I	39858-52488
150	3718.91	I	10094-36976	2.0	7961.08	I	28214-40771
160	3799.19	I	7755-34069	6	8132.82	I	25101-37394
160	3832.29	I	10094-36181	5	8300.83	I	36976-49020
240	3894.20	I	11722-37394	1.0	h 8353.58	I	40369-52336
160	3958.64	I	11722-36976	2.0	h 8532.74	I	40771-52488
32	4087.34	I	11722-36181	1.8	h 8599.10	I	37394-49020
10	4169.84	I	10094-34069	7	8761.35	I	37394-48804

# PHOSPHORUS

$$P, Z=15, M=30.975, \text{Ratio } \frac{P}{Cu}=0.487$$

P I Normal state of valence electrons  $3s^2 3p^3 {}^4S_{1/2}=0$ . I.P.= 84580 K  
 P II Normal state of valence electrons  $3s^2 3p^2 {}^3P_0=0$ . I.P.=159100 K

## References

### Wavelengths:

G. R. Harrison, Massachusetts Institute of Technology Wavelength Tables (John Wiley & Sons, New York, 1939).

### Classification:

P I, C. C. Kiess, J. Research NBS 8, 393 (1932) RP425.  
 P I and P II, W. C. Martin, J. Opt. Soc. Am. 49, 1071 (1959).

## Relative intensity of phosphorus lines observed in an arc of copper containing 0.1 atomic percent of phosphorus

### *Strong lines of phosphorus*

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
60	2535.65	I	18748-58174	$3s^2 3p^3 {}^2P_{1/2} - 3s^2 3p^2 4s^1 {}^2P_{1/2}$

## Phosphorus — All Observed Lines

Intensity and Character	Wave- length in A	Spec- trum	Energy Levels in K	Intensity and Character	Wave- length in A	Spec- trum	Energy Levels in K
1.0	2135.47	I	11362-58174	22	2534.01	I	18722-58174
10	2136.20	I	11376-58174	60	2535.65	I	18748-58174
9	2149.11	I	11362-57877	38	2553.28	I	18722-57877
1.0	2152.95	I	18722-65157	15	2554.93	I	18748-57877
2.0	2154.08	I	18748-65157				

# PLATINUM

Pt,  $Z=78$ ,  $M=195.09$ , Ratio  $\frac{\text{Pt}}{\text{Cu}}=3.070$

Pt I Normal state of valence electrons  $5d^9 6s^1 {}^3D_3 = 0$ . I.P. = 72300 K  
 Pt II Normal state of valence electrons  $5d^9 {}^2D_{3/2} = 0$ . I.P. = 149700 K

## References

### Wavelengths:

G. R. Harrison, Massachusetts Institute of Technology Wavelength Tables (John Wiley & Sons, New York, 1939).

### Classification:

Pt I, A. C. Haussman, *Astrophys. J.* **66**, 333 (1927).

J. J. Livingood, *Phys. Rev.* **34**, 185 (1929).

Pt II, A. G. Shenstone, *Phil. Trans. Roy. Soc. (London)* [A]**237**, 453 (1938).

## Relative intensity of platinum lines observed in an arc of copper containing 0.1 atomic percent of platinum

### *Strong lines of platinum*

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
320	3064. 71	I	0-32620	$5d^9 6s^1 a {}^3D_3 - 5d^9 6p^1$ $1\frac{1}{2}$
280	2659. 45	I	0-37591	$5d^9 6s^1 a {}^3D_3 - 5d^9 6p^1$ $7\frac{1}{2}$
200	2702. 40	I	776-37769	$5d^9 6s^1 a {}^3D_2 - 5d^9 6p^1$ $8\frac{1}{2}$
180	2733. 96	I	776-37342	$5d^9 6s^1 a {}^3D_2 -$ $6\frac{1}{2}$
180	2997. 97	I	776-34122	$5d^9 6s^1 a {}^3D_2 - 5d^9 6p^1$ $3\frac{1}{2}$
170	2929. 79	I	0-34122	$5d^9 6s^1 a {}^3D_3 - 5d^9 6p^1$ $3\frac{1}{2}$
160	2705. 89	I	824-37769	$5d^9 6s^2 a {}^3F_4 - 5d^9 6p^1$ $8\frac{1}{2}$
140	2830. 30	I	0-35322	$5d^9 6s^1 a {}^3D_3 - 5d^9 6s^1 6p^1 4\frac{1}{2}$
130	2719. 04	I	824-37591	$5d^9 6s^2 a {}^3F_4 - 5d^9 6p^1$ $7\frac{1}{2}$
110	2628. 03	I	776-38816	$5d^9 6s^1 a {}^3D_3 -$ $10\frac{1}{2}$

## Platinum — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
3.0	2030.63	I		14	2524.30	I	6568-46170
4	2032.41	I		4	2529.41	I	13496-53019
6	2049.37	I	0-48779	5	2536.49	I	10132-49545
2.0	2067.50	I	0-48352	16	2539.20	I	824-40194
5	2084.59	I	824-48779	1.8	2549.46	I	13496-52708
2.0	2103.33	I	824-48352	5	2552.25	I	10117-49286
2.5	2128.61	I	776-47741	5	2596.00	I	15502-54011
6	2144.23	I	0-46622	7	2603.14	I	10132-48536
		II	4787-51408	5	2619.57	I	6568-44730
2.5	2165.17	I	0-46170	110	2628.03	I	776-38816
7	2174.67	I		13	2639.35	I	6568-44444
2.5	2202.22	I	776-46170	100	2646.89	I	0-37769
2.5	2222.61	I	6568-51546	50	2650.86	I	824-38536
1.6	2249.30	I	0-44444	2.0	2658.17	I	10132-47741
2.5	2268.84	I		280	2659.45	I	0-37591
4	2274.38	I	776-44730	4	2674.57	I	6568-43946
2.5	2289.27	I	776-44444	44	2677.15	I	0-37342
2.5	2292.40	I	824-44433	20	2698.43	I	6140-43188
5	2308.04	I	6568-49881	200	2702.40	I	776-37769
2.0	2315.50	I		160	2705.89	I	824-37769
5	2318.29	I	824-43946	6	2713.13	I	10117-46965
2.5	2326.10	I	6568-49545	130	2719.04	I	824-37591
5	2340.18	I	6568-49286	13	2729.92	I	6568-43188
10	2357.10	I	776-43188	180	2733.96	I	776-37342
7	2368.28	I	6568-48779	7	2738.48	I	10117-46623
6	2383.64	I	10132-52072	7	2747.61	I	13496-49881
2.0	2386.81	I	776-42660	8	2753.86	I	10132-46434
6	2389.53	I	824-42660	20	2754.92	I	10132-46420
2.0	2396.17	I	13496-55217	3.0	2769.84	I	6568-42660
4	2401.87	I	10132-51752	50	2771.67	I	776-36845
12	2403.09	I	6140-47741	4	2773.24	I	13496-49545
7	2418.06	I	13496-54839	2.0	2774.00	I	10132-46170
6	2428.04	I	6568-47741	5	2793.27	I	13496-49286
4	2428.20	I	10117-51287	1.6	2794.21	II	13311-49089
2.0	2429.10	I	10132-51287	14	2803.24	I	6140-41803
15	2436.69	I	776-41803	1.0	2808.51	I	15502-51098
60	2440.06	I	0-40970	5	2818.25	I	824-36296
6	2450.97	I	0-40788	140	2830.30	I	0-35322
44	2467.44	I	0-40516	7	2834.71	I	10132-45398
3.5	2471.01	I	13496-53953	1.6	2853.11	I	13496-48536
100	2487.17	I	0-40194	2.5	2888.20	I	10117-44730
2.5	2488.74	II		2.5	2893.22	I	15502-50055
20	2490.12	I	824-40970	60	2893.86	I	776-35322
16	2495.82	I	6568-46623	30	2897.87	I	824-35322
24	2498.50	I	776-40788	6	2905.90	I	6568-40970
5	2505.93	I		12	2912.26	I	10117-44444
12	2508.50	I	6568-46420	12	2913.54	I	10132-44444
5	2514.07	I	10117-49881	7	2919.34	I	13496-47741
6	2515.03	I	10132-49881	3.0	2921.38	I	6568-40788
24	2515.58	I	776-40516	170	2929.79	I	0-34122

Platinum — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
3.0	2942.76	I	30157-64129	8	3818.69	I	10117-36296
3.0	2944.75	I	6568-40516	4	3900.73	I	34122-59751
2.5	2959.10	I	15502-49286	11	3922.96	I	30157-55641
6	2960.75	I		3.5	3948.40	I	13496-38816
180	2997.97	I	776-34122	10	3966.36	I	10117-35322
22	3002.27	I	824-34122	2.0	3996.57	I	15502-40516
3.0	3017.88	I	13496-46623	11	4118.69	I	13496-37769
13	3036.45	I	13496-46420	8	4164.56	I	10117-34122
80	3042.64	I	824-33681	4	4192.43	I	13496-37342
320	3064.71	I	0-32620	1.8	4327.06	I	33680-56784
3.0	3071.94	I	10117-42660	1.8	4391.83	I	21967-44730
13	3100.04	I	6568-38816	8	4442.55	I	10117-32620
32	3139.39	I	776-32620	1.4	4445.55	I	10132-32620
14	3156.56	I	10132-41803	2.5	4498.76	I	30157-52379
12	3200.71	I	13496-44730	1.2	4520.90	I	37769-59882
32	3204.04	I	6568-37769	3.5	4552.42	I	33680-55641
3.0	3230.29	I	13496-44444	1.2	4879.53	I	36296-56784
2.0	3233.42	I	15502-46420	1.4	5044.04	I	15502-35322
2.0	3250.36	I		3.0	5059.48	I	32620-52379
4	3251.98	I	10132-40874	3.5	5227.66	I	13496-32620
16	3255.92	I	6140-36845	4	5301.02	I	36782-55641
2.5	3268.42	I		1.2	5368.99	I	15502-34122
2.5	3281.97	I	33681-64141	1.2	5390.79	I	34122-52667
12	3290.22	I	10132-40516	1.4	5475.77	I	34122-52379
50	3301.86	I	6568-36845	1.4	5478.50	I	38536-56784
6	3315.05	I	0-30157	0.6	5763.57	I	35322-52667
3.5	3323.80	I	10117-40194	2.0	5840.12	I	15502-32620
34	3408.13	I	824-30157	0.8	5844.84	I	38536-55641
3.5	3427.93	I	13496-42660	0.6	6026.04	I	40194-56784
6	3483.43	I	10117-38816	0.7	6318.37	I	36845-52667
16	3485.27	I	10132-38816	0.8	6326.58	I	21967-37769
12	3628.11	I	6568-34122	0.9	6523.45	I	37342-52667
7	3638.79	I	10117-37591	1.0	6710.42	I	37769-52667
7	3643.17	I	18567-46007	2.0	6760.02	I	37591-52379
3.5	3699.91	I	13496-40516	6	6842.60	I	37769-52379
1.8	3706.53	I		2.0	7113.73	I	18566-32620
2.0	3801.05			1.0	8224.74	I	21967-34122

# POTASSIUM

$$K, Z=19, M=39.100, \text{Ratio } \frac{K}{Cu}=0.615$$

K I Normal state of valence electrons  $3p^6 4s^1 \ ^2S_{0\frac{1}{2}}=0$ . I.P.= 35010 K  
 K II Normal state of valence electrons  $3p^6 \ ^1S_0=0$ . I.P.=256637 K

## References

### Wavelengths:

G. R. Harrison, Massachusetts Institute of Technology Wavelength Tables (John Wiley & Sons, New York, 1939).

### Classification:

K I, A. Fowler, Report on Series in Line Spectra, p. 101 (Fleetway Press, London, 1922).

### Intensities:

A. Filippov, Phys. Z. Sowjetunion **5**, 1 (1934).

E. F. M. van der Held and J. H. Heierman, Physica **3**, 31 (1936).

## Relative intensity of potassium lines observed in an arc of copper containing 0.1 atomic percent of potassium

### Strong lines of potassium

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
1800	7664.91	I	0-13043	$3p^6 4s^1 \ ^2S_{0\frac{1}{2}} - 3p^6 4p^1 \ ^2P_{\frac{1}{2}}$
900	7698.98	I	0-12985	$3p^6 4s^1 \ ^2S_{0\frac{1}{2}} - 3p^6 4p^1 \ ^2P_{\frac{3}{2}}$

## Potassium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
32	4044.14	I	0-24720	2.5 hl	6911.30	I	12985-27451
16	4047.20	I	0-24701	5 hl	6938.98	I	13043-27451
1.0 1	5782.60	I	12985-30274	1800	7664.91	I	0-13043
1.4 1	5801.96	I	13043-30274	900	7698.98	I	0-12985

PRASEODYMIUM

Pr,  $Z=59$ ,  $M=140.91$ , Ratio  $\frac{\text{Pr}}{\text{Cu}}=2.218$

Pr I Normal state of valence electrons  $4f^3 6s^2 4I_{4\frac{1}{2}}^{\circ}=0$ . I.P.  $\approx 45000$  K  
 Pr II Normal state of valence electrons  $4f^3 6s^1 5I_4^{\circ}=0$ .

References

Wavelengths:

- A. Gatterer and J. Junkes, *Spektren der Seltenen Erden* (Specola Vaticana, Vatican, 1945).  
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 A. S. King, *Astrophys. J.* **68**, 194 (1928).  
 G. R. Harrison, *Massachusetts Institute of Technology Wavelength Tables* (John Wiley & Sons, New York, 1939).  
 N. Rosen, G. R. Harrison, and J. R. McNally, *Phys. Rev.* **60**, 722 (1941).  
 Numerous lines were measured on the plates of this investigation.

Classification:

- Pr I and Pr II, (Spectrum assignment only)  
 A. S. King, *Astrophys. J.* **68**, 194 (1928).  
 R. Zalubas, unpublished material (1961).  
 Pr II, N. Rosen, G. R. Harrison, and J. R. McNally, *Phys. Rev.* **60**, 722 (1941).

Molecular Spectra:

- PrO, W. W. Watson, *Phys. Rev.* **53**, 639 (1938).

Relative intensity of praseodymium lines observed in an arc of copper containing 0.1 atomic percent of praseodymium

*Strong lines of praseodymium*

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
460	4179. 42	II	1649-25569	$4f^3 6s a^5 I_3 - 4f^3 6p z^5 K_7$
340	4222. 98	II	442-24115	$4f^3 6s a^5 I_3 - 4f^3 6p z^5 K_6$
340	4225. 33	II	0-23660	$4f^3 6s a^5 I_3 - 4f^3 6p z^5 I_4$
320	3908. 43	II	2998-28578	$4f^3 6s a^5 I_7 - 4f^3 6p z^3 I_7$
300	4062. 82	II	3403-28010	$4f^3 6s a^3 I_3 - 4f^3 6p z^3 K_7$
260 c	4100. 75	II	4437-28816	$4f^3 6s a^5 I_3 - 4f^3 6p z^5 K_9$
240	4143. 14	II	2998-27128	$4f^3 6s a^5 I_7 - 4f^3 6p z^5 K_8$
220	4189. 52	II	2998-26861	$4f^3 6s a^5 I_7 - 4f^3 6p z^5 I_7$
220 c	4206. 74	II	4437-28202	$4f^3 6s a^5 I_3 - 4f^3 6p z^5 I_8$
200	4054. 85	II	1744-26398	$4f^3 6s a^3 I_3 - 22_8$
200	4056. 54	II	5079-29724	$4f^3 6s a^3 I_7 - 4f^3 6p z^3 K_8$
190 c	3982. 06	II	3403-28509	$4f^3 6s a^3 I_3 - 4f^3 6p z^5 H_5$
180 c	3877. 23	II		
170	4008. 71	II	5079-30018	$4f^3 6s a^3 I_7 - 4f^3 6p z^5 H_7$
150 c	4118. 48	II	442-24716	$4f^3 6s a^5 I_3 - 4f^3 6p z^5 I_5$
150 c	4164. 19	II	1649-25657	$4f^3 6s a^5 I_3 - 4f^3 6p z^5 I_6$
150	4408. 84	II	0-22675	$4f^3 6s a^5 I_4 - 4f^3 6p z^5 K_5$
140	3816. 17	II		
140 c	3964. 83	II	442-25657	$4f^3 6s a^5 I_3 - 4f^3 6p z^5 I_6$
140	3994. 83	II	442-25468	$4f^3 6s a^5 I_3 - 4f^3 6p z^5 H_4$
130 c	3918. 86	II	2998-28509	$4f^3 6s a^5 I_7 - 4f^3 6p z^5 H_6$
130 c	4141. 26	II	4437-28578	$4f^3 6s a^5 I_3 - 4f^3 6p z^3 I_7$
130	4305. 76	II	442-23660	$4f^3 6s a^5 I_3 - 4f^3 6p z^5 I_5$
120 c	3850. 83	II		
120	3989. 72	II	442-25500	$4f^3 6s a^5 I_3 - 16_5$
120	4333. 91	II	1649-24716	$4f^3 6s a^5 I_3 - 4f^3 6p z^5 I_5$
110	4368. 33	II	0-22886	$4f^3 6s a^5 I_4 - 5_5$
100	3830. 72	II		
100	3852. 81	II		
100	3925. 46	II	0-25468	$4f^3 6s a^5 I_4 - 4f^3 6p z^5 H_4$
100 c	3965. 26	II	1649-26861	$4f^3 6s a^5 I_3 - 4f^3 6p z^5 I_7$
100	4297. 76	II	0-23261	$4f^3 6s a^5 I_4 - 7_5$
100	4351. 85	II	1744-24716	$4f^3 6s a^5 I_3 - 4f^3 6p z^5 I_5$



## Praseodymium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
2.0	2558.55	II		4	2971.40	II	
2.0	2578.32				2971.45		
2.5	2579.30			5	2985.02	II	
3.0	2598.05	h		3.0	2986.19	II	
2.0	2608.89			3.0	2990.22	II	
2.0	2615.75	II		8	3013.46	II	
2.0	2648.47			5	3029.28	II	
2.5	2654.75			2.5	3032.69		
2.0	2666.67			5	3045.21	II	
1.6	2672.48			4	3046.77		
2.5	2685.18	II		2.0	3049.21		
3.5	2685.70			8	3053.26	II	
5	2698.92			4	3062.06	II	
6	2700.35			8	3063.66	II	
3.0	2702.22			3.5	3068.68		
10	2707.35	h	II	6	3069.24	II	
2.0	2714.18		II	2.5	3074.56		
6	2720.18		II	3.5	3078.99		
3.0	2721.87		II	11	3082.11	II	
5	2726.49		II	3.0	3084.90	II	
					3085.03	II	
1.2	2731.77		II	5	3085.86	II	
2.5	2733.13		II	3.5	3091.34	II	
5	2734.30		II	5	3097.78	II	
2.5	2737.85		II	8	3098.50	II	
4	2742.10		II				
2.5	2744.66		II	4	3101.27	II	
2.0	2746.24		II	2.0	3103.10	II	
6	2760.39		II	4	3105.40	II	
5	2769.60		II	4	3109.76	II	
5	2775.93	d	II	4	3110.58	II	
	2776.05		II				
4	2778.82		II	10	3111.34	II	
5	2783.32		II	3.0	3114.14	II	
3.0	2789.08		II	3.0	3119.03	II	
3.5	2792.50		II	14	3121.57	II	
				4	3123.00	II	
5	2802.06		II	10	3129.20	II	
2.0	2823.11		II	3.0	3135.35	II	
2.0	2824.10		II	5	3136.79	II	
2.0	2828.32		II	6	3146.47	II	
2.0	2843.01		I	7	3151.54	II	
2.0	2844.03		II	7	3153.20	II	
2.0	2850.64		I	6	3153.83	II	
2.5	2854.02		II	10	3158.65	II	
3.0	2865.65			16	3163.74	II	
5	2881.62		I	9	3164.82	II	
3.0	2882.33		II	32	3168.24	II	
3.0	2884.90		II	3.0	3169.37	II	
3.0	2943.95		II	2.5	3171.23	I	
3.0	2967.58			19	3172.31	II	
3.0	2971.11		II	10	3182.45	II	

## Praseodymium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
13	3191.41	II		3.0	3460.66		
8	3191.69	II		13	3465.76	II	
24	d 3196.04	II		5	3466.75		
13	3199.05	II		4	3467.04	II	
3.5	3204.81	II		8	3473.85	II	
12	3207.89	II		6	3487.57	II	
6	3213.58	II		3.0	3491.53		
4	3214.40	II		3.0	3491.94	II	
22	3219.55	II		3.0	3494.30	II	
4	3230.22	II		7	3499.09	II	
12	3234.22	II		6	3499.57	II	
3.0	3235.43	II		8	3503.06	II	
5	3238.87	II		6	3504.27	II	
12	3245.46	II		6	3508.21	II	
6	3276.67	II		3.0	3537.31	II	
9	3295.53	II		6	h 3539.92	II	
3.0	3296.39	II		4	3542.39		
3.0	3303.19	II		3.0	3548.09	II	
5	3314.38	II		3.0	3549.53	II	
5	3324.55	II		6	d 3551.41	I	
2.5	3341.47	II		3.0	3551.96	II	
5	3350.28	II		5	3555.20	II	
16	3355.67	II		3.0	3557.70	II	
2.5	3359.27	II		5	3562.22	II	
5	h 3363.25	II		5	3562.55	II	
5	d 3370.30	II		3.0	3568.67	II	
5	3372.51	II		6	3569.56	II	
5	3376.66	II		3.0	3570.56	I	
5	3379.76	II		6	3574.96	II	
4	3383.38	II		3.0	3575.54		
5	3383.73	II		9	d 3577.47	II	
5	3388.04	II		3.0	h 3579.09		
13	3394.61	II		6	h 3579.95	II	
2.5	3403.57	II		6	h 3582.25	II	
8	3415.71	I		24	3584.26	II	
8	3418.47	II		5	d 3587.87	II	
4	3419.24	II		3.0	3588.60	II	
2.5	3421.11	II		6	3589.47	II	
5	3427.59	II		3.0	h 3593.04	II	
10	3430.28	II		9	3596.19	II	
5	3430.51	II		9	3600.75	II	
2.5	3431.62	II		11	3605.05	II	
10	h 3433.55	II		6	3605.96		
3.5	3434.76	II		3.0	h 3607.82	II	
3.5	3442.76	II		15	3611.94	II	
4	h 3447.84	I		3.0	3612.72	II	
5	3448.21	II		6	3615.16	II	
5	3449.83	II		9	3616.68	II	
3.0	3451.48	II		3.0	3618.08		
6	3455.97	II		3.0	3619.10	II	

## Praseodymium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
6	3621.09	II		6	3712.35	II	
8	3622.38	II		6	3713.28	II	
3.0	3622.74	h		30	3714.06	II	
20	3630.97	II		6	3715.62	I	
3.0	3634.47			10	3716.20	II	
11	3635.28	II		6	3717.84	II	
5	3637.65	II		6	3718.02		
3.0	3638.58	II		6	3719.44	II	
11	3641.62	II		3.0	3720.22	II	
8	3643.32	II		3.0	3722.07	II	
3.0	3644.54	II		4	3723.58	I	
12	3645.54	II		8	3725.03	II	
30	3645.66	II		5	3726.31	II	
30	3646.30	II		3.5	3729.11	II	
12	3648.30	II		5	3729.40	II	
8	3650.18	II	0-27388	9	c 3730.58	II	
6	3651.04	II		5	3731.50	II	
4	3652.38	II		12	c 3733.03	II	
6	3657.42	II		22	c 3734.41	II	
6	3658.21	II		6	3735.31	II	
9	3659.04	II		26	3735.76	II	
5	3660.08	II		20	3736.50	II	
18	c 3660.38	II		42	3739.19	II	
12	3661.62	II		15	3741.01	II	
5	3662.46	I		12	3743.99	II	
5	3664.64	I		3.5	3747.27		
3	3667.14	II		4	3747.47	II	
11	3667.67	II		3.0	3748.50	II	
44	3668.83	II		6	3748.82		
5	3669.52			8	3750.13	II	
5	3670.26	II		8	3750.49	II	
5	3671.92	II		20	3751.00	II	
6	3674.14	II		5	c 3751.60	II	
2.5	3674.88	I		6	3752.29	II	
6	3679.99			6	3753.38	II	
6	h 3681.86	II		5	3754.41		
3	3685.27	II		9	c 3754.98	II	
30	3687.04	II		5	3756.81		
18	3687.20	II		14	3759.61	II	
12	3689.71	II		12	3760.08	II	
6	3691.48			70	3761.87	II	
6	3693.36	I		3.5	3762.37	II	
6	3693.49	II		3.0	3762.56	I	
3	3696.66			6	3763.03		
16	3698.07	II		3.0	3764.09	II	
6	3699.51	I		24	3764.81	II	
10	3701.81	II		3.0	3765.99	I	
4	3704.32	II		6	3766.48	II	
24	3706.77	II		24	3768.93	II	
18	c 3711.10	II	442-27380	10	3769.70	II	442-26962

## Praseodymium — All Observed Lines

Intensity and Character	Wave-length in A	Spectrum	Energy Levels in K	Intensity and Character	Wave-length in A	Spectrum	Energy Levels in K
6	3770.48	II		100	3830.72	II	
18	d 3772.76	II		6	3831.76		
	3772.84	II		8	3833.04		
18	3774.06	II		8	3833.60		
8	3776.09	I		14	3834.92	II	
6	c 3777.10	II		50	3841.01	II	
14	3777.63	II		28	3842.36	II	
6	3778.75	II		6	3843.39	II	
9	3780.27	II		6	3843.76	II	
18	3780.66	II		16	c 3844.56	II	
3.0	3781.93	II		60	3846.61	II	
5	3782.35	II		10	3846.91	II	
5	c 3783.40	II		120	3850.83	II	
3.5	3783.86			75	c 3851.62	II	
	3783.99	II		3.5	3852.11		
15	3785.50	II		100	3852.81	II	
4	3785.97	II		10	3855.88	II	
16	3786.88	II		10	c 3857.00	II	
2.5	3788.06	II			3857.11		
4	3790.60	II		12	3858.26	II	
22	3792.52	II		11	3859.14	II	
5	3792.93	I		8	3861.31	II	
6	3793.42	II		8	3862.05	II	
20	3794.95	II		8	3864.06	II	
5	3795.77			50	c 3865.46	II	
4	3796.30			22	3867.55	II	
70	3800.30	II		7	3868.58	II	0-25842
10	c 3801.35	II		8	3869.16	II	
3	3802.30	II		10	3869.91	II	
30	3804.85	II		8	3870.35	II	
6	3806.13	II		22	3870.73	II	
14	3809.16	II		4	3872.72	I	
6	3809.96			5	3873.02	II	
40	3811.85	II		3.5	3873.40	II	
4	3813.89	II		10	3874.45	II	
140	3816.17	II		50	3876.18	II	
12	3817.63			180	c 3877.23	II	
10	3817.87	II		10	3878.31	II	1649-27425
70	3818.28	II		28	3879.21	II	
4	3818.71			70	3880.47	II	
12	3819.07	II		8	3880.78	II	
32	3821.82	II		9	3882.32	II	
6	3822.80	II		4	h 3884.04	II	1649-27388
16	c 3823.18	II		46	c 3885.19	II	1649-27380
4	3823.57	II	0-26146	3.5	3888.06	II	
10	3824.07	II		5	3888.29	II	
10	c 3826.29	II		46	c 3889.33	II	442-26146
12	3826.71	II	3893-30018		3889.42		
4	3828.71	II		2.5	h 3889.97		
3.5	c 3829.35	II		12	c 3891.70	II	

## Praseodymium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
5	3892.52	II		3.0	3936.69	II	
3.0	3894.14	II		3.0	3937.03	II	
3	3894.94	I		26	3938.31	II	
5	3895.08	II		10	c 3940.15	II	
4	3896.84	II		3.0	3941.51		
7	3897.04	II		12	3942.26	II	
20	3897.28	II		5	3942.92	I	
4	3897.72	II		5	c 3943.37	I	
22	3898.84	II		6	3943.75	II	
9	c 3899.56	II	1744-27380	8	3944.05	II	
26	3902.47	II		3.0	3944.62	II	
7	3903.91	II		6	3944.90	II	
3.5	3904.80	II		6	3945.42	I	
7	3906.09	II		10	3945.66	II	
3.0	3907.30			16	3946.95	II	
80	c 3908.03	II	4437-30018	65	c 3947.63	II	1649-26974
320	3908.43	II		80	c 3949.44	II	1649-26962
11	3909.62	II		4	c 3950.66	II	
4	3911.31			6	3951.18		
3.5	3911.80			3.0	3951.84	I	
4	3911.99	II		6	3952.02	II	
5	3912.27	II		4	3952.36	II	
7	3912.61	II		80	c 3953.52	II	4437-29724
65	3912.90	II	1649-27198	3.5	3955.00		
32	3913.56	II		5	3955.42	II	
22	3914.76	II		5	hc 3956.52	II	
18	3915.47	II		34	3956.76	II	
2.5	3916.80	II		5	3957.68		
10	3917.23	II		6	3958.19		
8	c 3917.92	II		6	3958.50		
130	c 3918.86	II	2998-28509	17	3959.41	II	
44	3919.62	II			3959.52		
26	3920.52	II	0-25500	4	3959.78		
7	3922.25	II		8	c 3960.60	II	
10	3923.56	II		5	3961.28	II	
13	3924.14	II		42	3962.45	II	1744-26974
5	3925.00			14	c 3963.15	II	
100	3925.46	II	0-25468	4	3963.71		
50	3927.45	II	1744-27198	50	3964.26	II	1744-26962
12	3927.71	II		140	c 3964.83	II	442-25657
9	3928.62	II		100	c 3965.26	II	1649-26861
7	3928.91	II		4	3965.62	I	
38	3929.26	II		50	c 3966.57	II	2998-28202
9	3929.88	II		14	3967.13	II	
3.5	3930.62			14	3968.16	II	
3.0	3932.13			5	3970.07	II	
13	3932.98	II		44	3971.16	II	3403-28578
5	3934.26	II		28	3971.69	II	
11	c 3935.13	II		55	c 3972.16	II	442-25610
38	3935.82	II	442-25842	5	3973.12	I	

Praseodymium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
5	c			8			
8	c			42			
28		II		10			
5				6			
7		II		32			
9		II		20			
5				20			
3.5	h	I		32	c		
3.5				6			
8		II		13			
8				65	c		1649-26445
6	h	II		20			
190	c	II	3403-28509	13			
9	h	II		85			2998-27782
8	h			20			1744-26524
8		II		6	c		
8	c	II		6			
6		II		20		II	
11				65		II	0-24755
8		II		5			
120	c	II	442-25500	42		II	1649-26398
4		II		120		II	0-24716
20		II		20		II	
30		II		20		II	
6	h	II		30		II	
4	c			16		II	
8				40		II	
140		II	442-25468	8		II	
24		II		200		II	1744-26398
50	c	II	2998-28010	200		II	5079-29724
20		II		12		II	
28		II		40		II	
55	c	II	1649-26641	10		II	
10		II		10	h	II	5108-29724
8	c			20		II	
6		I		300		II	3403-28010
4				19		II	
65		II		15		II	
13		II		17		II	
6		II		8		II	
170		II	5079-30018	5			
8		II		44	c	II	
6		I		44	c	II	1649-26146
55		II		70		II	
8				44		II	
10		II		9	c	II	
8				9		II	
65		II	1744-26641	5		II	
2.5		II		5		II	
55		II		6			

## Praseodymium — All Observed Lines

Intensity and Character	Wave-length in A	Spectrum	Energy Levels in K	Intensity and Character	Wave-length in A	Spectrum	Energy Levels in K
18	4087.21	II		240	4143.14	II	2998-27128
3.5	4088.87			2.5	4144.23	II	
3.5	4089.07			24	4146.54	II	
5	4089.47	II		2.5	4147.14		
5	4089.87	II		4	4147.55		
7	4090.74	II		24	4148.46	II	1744-25842
7	4092.63	II		3.5	4149.32	II	
3.5	4092.85			7	4150.04	II	
8	4094.97	II		3.5	4151.01	II	
7	4095.97	II		2.5	4151.74	II	
7	4096.34	II		8	4154.05	II	
50	4096.82	II	1744-26146	18	4156.52	II	
34	4098.41	II		3	4156.90		
5	4098.65			5	4157.77	II	
14	4100.22	II	2998-27380	3.5	4159.47		
260	4100.75	II	4437-28816	2.5	4159.83		
3.0	4104.86	II		4	4160.47	II	
10	4105.73	II		150	4164.19	II	1649-25657
2.5	4107.11			24	4168.08	II	3403-27388
3.0	4107.50			20	4169.46	II	3403-27380
8	4107.75	II		55	4171.82	II	2998-26962
6	4108.34	II		65	4172.27	II	1649-25610
3.0	4109.09			3.5	4173.70	II	
3.0	4109.41			22	4175.30	II	
2.5	4110.11	II		22	4175.64	II	
5	4110.47	II		9	4176.33	II	
4	4110.92	I		18	4178.64	II	
13	4111.87	II	442-24755	460	4179.42	II	1649-25569
2.5	4112.74			3.5	4180.40	II	
24	4113.89	II		6	4180.68	II	1744-25657
5	4114.84			3.5	4182.33	II	
4	4115.83	II		3.5	4182.67	II	
150	4118.48	II	442-24716	5	4182.92	II	
4	4119.37			10	4184.24	II	
8	4119.80	II		3.5	4184.62	II	
3	4120.00	I		12	4185.15	II	
2.5	4120.96			4	4185.82	II	
8	4124.06			5	4186.40	II	
8	4124.35	II		6	4187.79	II	
8	4125.06	II		220	4189.52	II	2998-26861
5	4126.15	II		4	4190.64	II	
22	4129.15	II		50	4191.62	II	1649-25500
30	4130.77	II		4	4192.50	II	
15	4132.23	II	1649-25842	5	4194.62	II	
18	4133.62	II		5	4195.52	II	
3.0	4137.16			5	4195.96	II	
3.0	4138.19			10	4196.79	II	
2.5	4140.32			3.0	4197.10	II	
130	4141.26	II	4437-28578	2.0	4197.29	II	
6	4142.00	II		26	4201.18	II	

## Praseodymium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
10	c	4201.53	II	11		4276.19	II
220	c	4206.74	II	11		4278.04	II
11		4207.81	II	8		4278.99	II
44		4208.31	II	42	c	4280.11	II
28		4211.86	II	70	c	4282.44	II
							4437-27782
4		4213.26	II	4		4285.54	
16		4213.57	II	4		4286.98	II
5		4213.96	II	4	c	4288.46	II
11	hc	4216.04	II	7		4289.42	II
7		4217.19	II	11		4289.89	II
			1744-25468				
28		4217.81	II	5		4290.40	II
14		4219.65	II	5		4290.99	II
340		4222.98	II	7	h	4291.63	II
8		4223.51	II	10	c	4293.14	II
340		4225.33	II	12		4293.58	II
			442-24115				1649-24947
			0-23660				
14	h	4225.54	I	14	c	4294.70	II
8	c	4228.50	II	8		4295.11	II
8	c	4229.10	II	100		4297.76	II
6		4229.80	II	40	c	4298.92	II
8		4230.67	I	9	c	4302.10	II
							0-23261
28		4233.13	II	26		4303.59	II
28	c	4236.21	II	130		4305.76	II
12		4236.64	II	10		4306.08	II
6		4237.01	I	4		4307.67	II
6		4238.35	II	9	c	4308.89	II
			1649-25249				442-23660
24		4240.03	II	7		4311.10	II
85		4241.02	II	4		4311.92	II
15	c	4241.30	II	7		4315.52	II
30		4243.53	II	7		4316.06	II
6		4245.46	II	4		4317.05	II
			4437-28010				
6		4246.15	II	8		4317.84	II
75	c	4247.66	II	10		4319.00	II
8		4249.08	II	5	h	4320.17	II
8		4249.48	II	19		4323.55	II
17		4250.40	II	5		4328.20	
			442-23978				5079-28202
14	c	4251.49	II	16		4328.42	II
6		4253.03	I	14		4328.99	II
44		4254.42	II	24		4329.42	II
12	c	4261.80	II	5		4330.44	
17		4262.31	II	5		4331.29	II
			5079-28578				1744-24835
8		4262.80	II				
8		4263.15	II	5		4333.15	II
24	c	4263.81	II	120		4333.91	II
9		4267.78	II	8		4334.62	II
28		4269.10	II	18		4335.75	II
			2998-26445	32		4338.69	II
							3403-26445
14		4271.76	II	6		4339.68	II
70	c	4272.27	II	7	c	4342.81	II
8	c	4275.17	II	4		4343.89	II
		4275.32	II	55	cw	4344.33	II
8		4275.82	II	4		4346.89	II
			2998-26398				



Praseodymium — All Observed Lines

Intensity and Character	Wave-length in A	Spectrum	Energy Levels in K	Intensity and Character	Wave-length in A	Spectrum	Energy Levels in K
42	c 4347.49	II	3403-26398	10	4432.34	II	
30	4350.40	II		2.0	4434.85		
100	4351.85	II	1744-24716	8	4438.18	II	
40	4354.91	II		5	c 4444.01	II	
4	4355.19	II		6	4445.87	II	
4	4357.50	II		8	4446.99	II	
12	4359.11	II		65	4449.87	II	1649-24115
36	c 4359.80	II	5079-28010	7	c 4450.21	II	
4	4361.26	II		12	4451.95	II	
4	4361.82	II		6	4454.38	II	442-22886
9	4362.98	II		12	4454.70	II	
9	4363.22	II		8	h 4458.34	II	4437-26861
110	4368.33	II	0-22886	6	h 4461.29	II	
8	4370.80	II		9	4465.98	II	
28	4371.61	II		85	4468.71	II	1744-24115
7	4373.82	II		2.0	4469.66		
11	4374.41	II		5	4472.93	II	
3.5	4379.34	II		5	4473.84	II	5079-27425
10	4380.32	II		12	c 4477.26	II	1649-23978
14	4382.42	II		3.0	4483.49	II	
5	c 4382.82	II		4.0	4485.54		
10	c 4384.14	II		2.5	4487.82	II	442-22718
7	4384.80	II		6	4488.17	II	
3.5	d 4385.31			5	c 4492.43	II	3403-25657
	4385.48	I		3.0	d 4492.93	I	
					4493.12	II	2998-25249
4	4391.51	II		3.0	4493.71	II	
16	4395.01	II		3.0	4494.19	II	
16	4395.79	II	3403-26146	95	4496.43	II	442-22675
24	4396.12	II		3.5	4501.83	II	3403-25610
2.5	4396.87	II		5	c 4504.59	II	
5	4398.27	II		70	4510.16	II	3403-25569
16	4399.33	II		2.0	4516.46	II	
8	4400.03	II		18	c 4517.60	II	442-22571
7	4400.25	II		5	4520.78	II	
6	4403.28	II		5	4531.09	II	
15	4403.61	II	5079-27782	30	c 4534.15	II	5079-27128
9	4405.15	II		30	4535.92	II	0-22040
38	4405.85	II	4437-27128	5	h 4539.29	II	
6	4406.67	II		6	4542.54	II	
150	4408.84	II	0-22675	2.5	4543.97	II	
7	h 4412.16	II	2998-25657	7	4548.54	II	
36	4413.77	II	1744-24394	3.5	4549.84	II	
7	4414.40	II		2.5	4550.06	II	5226-27198
14	4419.06	II		3.0	4550.88	II	1649-23617
17	4419.67	II		6	4552.26	I	
14	c 4421.23	II	2998-25610	18	4563.13	II	
2.0	4424.18	II		2.0	h 4568.55	II	5079-26962
14	4424.60	II		6	h 4570.57	II	1744-23616
110	c 4429.24	II	2998-25569	2.5	4571.61	II	
2.0	4431.89	I					

Praseodymium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
2.0	4572.13	I		6	d 4755.98		
6	h 4576.32	II	3403-25249		4756.13	II	
5	h 4578.14	II	2998-24835	7	c 4757.94	II	6414-27425
2.0	4592.15	II		9	4762.73	II	3403-24394
2.5	4593.93	II		6	c 4765.22	II	2998-23978
2.5	4595.87	II	5108-26860	1.8	c 4775.17	I	
6	4596.95	II		2.5	c 4779.20	II	7660-28578
2.0	4598.95	I		10	4783.35	II	2998-23898
3.0	4600.39	II		1.4	4788.28	I	
2.0	4603.81	I		1.2	4799.94	II	1744-22571
3.5	h 4606.45	II		8	4801.15	II	3893-24716
12	4612.07	II	0-21676	2.5	4808.19	I	
2.0	4617.73	I		4	4814.34	II	8958-29724
2.0	4618.01	II		8	4822.98	II	
3.0	4627.05	II	3893-25500	3.0	4827.25	I	
24	c 4628.75	II	442-22040	3.5	c 4832.07	II	
12	4632.28	I		4	c 4837.04	II	
12	4635.69	I		3.5	4839.54	II	4098-24755
18	4639.56	I		2.5	4840.74	I	
7	4640.21	I		1.0	4845.97	I	
10	c 4643.51	II		3.5	c 4848.55	II	
12	4646.06	II	1744-23261	3.0	4853.68	I	
5	4646.99	I		2.0	4857.37	I	
18	c 4651.52	II	1649-23141	1.4	4858.59	I	
2.5	4658.09	II		2.5	4859.04	II	3403-23978
3.0	4658.73	I		5	4865.24	II	6414-26962
5	h 4660.92	I		2.0	4869.33	I	
12	4664.65	II	3403-24835	3.0	4876.26	II	5108-25610
24	c 4672.08	II	1744-23141	8	c 4877.82	II	3403-23898
5	4678.17	II	4098-25468	1.0	c 4879.12	II	5079-25569
3.5	4679.11	II	5079-26445	2.5	4882.25	I	
5	c 4684.94	II		1.2	4884.46	I	
16	4687.81	I		2.5	4886.05	II	5108-25569
26	4695.77	I		5	4890.26	II	
5	4707.54	II	1649-22886	4	4896.14	I	
6	4707.94	II	442-21676	2.5	4901.48	II	7806-28202
6	4708.16	II		10	4906.98	I	
12	4709.52	I		5	4912.63	II	7660-28010
8	4713.10	I		12	4914.03	I	
8	4714.15	I		2.0	4915.42	I	
5	4728.63	II	1744-22886	18	4924.59	I	
16	4730.69	I		2.0	4925.32	I	
2.0	4733.75	I		2.5	4925.63	II	1744-22040
4	c 4734.18	II	2998-24115	2.5	4932.17	I	
22	4736.69	I		12	4936.00	I	
2.5	4741.50	I		3.5	4938.90	I	
9	4744.16	I		28	4939.74	I	
8	4744.93	II	1649-22718	14	4940.30	I	
13	4746.93	II	5226-26287	2.5	4943.74	II	3893-24115
				34	4951.36	I	

## Praseodymium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
2.5	4956.06	I		18	5195.31	II	6414-25657
7	c 4956.65	II	5079-25249	7	5195.48	I	
5	4960.26	I		32	5206.56	II	7660-26861
2.5	4967.89	I		13	5207.90	II	6414-25610
2.5	4970.92	I		4	5216.76	II	4098-23261
7	4974.92	I		32	5219.05	II	6414-25569
10	4975.75	I		50	5220.11	II	6418-25569
7	4976.40	I		10	5228.01	I	
8	4989.27	II		2.0	c 5230.27	I	
8	5002.45	II	6414-26398	2.0	c 5242.67	I	
4	5004.58	II	7806-27782	1.8	5243.69	II	
2.5	5015.54	II	1744-21676	2.0	5249.84	I	
11	5018.58	I		6	c 5251.74	II	5079-24115
18	5019.76	I		60	5259.74	II	5108-24115
18	5026.97	I		16	5263.88	II	3893-22886
3.0	5031.98	II		1.4	5272.72	II	
9	5033.38	I		2.0	c 5277.32	II	
24	5034.42	II	8958-28816	8	5285.63	I	
6	c 5037.46	II		4	5289.35	I	
10	5043.83	I		30	c 5292.10	II	5079-23970
28	5045.53	I		30	5292.63	II	5226-24115
14	5053.40	I		20	5298.11	II	5108-23978
3.5	5063.39	I		2.0	5308.96	II	6418-25249
2.5	c 5064.84	II	3403-23141	8	5311.12	II	8958-27782
2.5	c 5070.01	I		6	cw 5312.33	II	5079-23898
4	c 5075.68	II		2.5	5313.39	II	
16	5087.11	I		1.4	5316.61	I	
32	5110.38	II	4098-23660	8	5321.09	II	4098-22886
50	5110.77	II	9255-28816	3.5	5321.81	II	7660-26445
3.5	5117.27	I		38	5322.78	II	3893-22675
2.0	c 5118.02	II	4437-23970	6	5331.48	II	5226-23978
36	5129.52	II	5226-24716	1.4	cw 5341.6	I	
24	5133.42	I		1.8	5342.55	II	
24	5135.13	II	7660-27128	5	5343.86	II	
9	5139.80	I		18	5352.40	II	3893-22571
2.5	5147.46	I		3.0	5358.99	I	
2.5	5149.87	I		1.6	5372.37	I	
9	c 5152.21	II		1.6	5374.24	I	
7	5156.49	II		1.2	5377.44	II	
18	5161.74	II	3893-23261	1.6	5381.26	II	4098-22675
2.5	5168.31	I		1.6	5381.70	II	
55	5173.90	II	7806-27128	2.5	c 5395.89	I	
7	5175.19	II		1.2	5400.95	I	
4	c 5175.83	II	3403-22718	2.5	5402.59	I	
4	5177.37	I		1.6	5404.81	II	
4	5183.85	II	5108-24394	4	cw 5410.60	II	
2.0	5188.24	II		5	5411.56	II	4098-22571
18	5191.34	II		7	cw 5413.19	II	
11	5194.41	I		2.5	5422.42	I	
13	5195.11	II	8958-28202	1.6	5427.27	I	

Praseodymium — All Observed Lines

Intensity and Character	Wave-length in A	Spectrum	Energy Levels in K	Intensity and Character	Wave-length in A	Spectrum	Energy Levels in K
1.6	5428.00	II		2.0	5594.92	I	
2.5	5432.07	II		2.0	5597.29	II	
1.6	5432.64	II		1.2	5601.31	II	
1.6	5432.91	I		8	5605.64	II	
2.5	c 5437.37	I		1.2	5606.68		
1.4	h 5445.43	I		2.5	5608.98	II	
1.6	5457.06	I		5	5610.22	II	9379-27198
2.5	5460.25	I		1.0	5620.07	II	
1.0	5469.71	I		1.8	5620.25	I	
2.0	5469.92	I		4	c 5621.85	II	3893-21676
3.0	c 5475.67	II		10	5623.05	II	
3.5	5479.73	I		8	5624.43	II	
1.4	5481.76	I		1.0	h 5633.02	I	
1.4	5485.53	I		2.0	5636.46	II	
1.4	5486.61	I		5	c 5638.79	II	
4	d 5487.41	I		1.4	5640.34	I	
	5487.58	I		1.4	cw 5643.20	I	
1.4	5488.93	I		2.0	5645.39	II	
1.4	5490.56	I		3.0	5654.25	II	
2.5	5492.37	II		5	5659.84	II	
1.4	c 5497.24	I		3.0	h 5661.56	I	
1.4	5501.47	I		1.4	5662.19	II	8490-26146
3.5	5508.79	II		6	c 5668.45	I	
6	5509.15	II	3893-22040	4	5669.55	II	
1.4	c 5511.66			3.0	5670.02	II	
5	5513.58	II		1.4	5674.13	II	
2.5	5515.11	II		1.4	5677.04	II	5108-22718
1.2	5519.38	II	11611-29724	5	5681.90	II	9379-26974
1.8	c 5519.84			1.2	5685.61	II	9379-26962
4	c 5522.80	I		1.4	5686.50	I	
2.5	c 5524.14	I		2.0	h 5687.19	II	4098-21676
2.5	c 5525.90	II		6	5688.46	II	
1.4	c 5527.88			2.0	5689.18	II	11005-28578
1.2	5530.19	I		5	d 5690.95	PrO	
4	5531.15	I			5691.04	II	
13	5535.18	II		2.0	5695.93	II	9647-27198
2.5	5538.37	I		2.0	5704.39	I	
1.8	5538.77	II		6	5707.61	I	
5	5545.01	II		3.5	5711.65	II	11005-28509
1.8	5548.31	II		2.0	5713.83	I	
1.0	5553.40	II		1.4	5716.08		
2.0	5561.46	II		4	5719.09	II	6418-23898
4	c 5562.06	I		4	d 5719.63		
1.2	5565.54	I			5719.81		
1.2	5566.92	II		1.0	5728.36	I	
4	5571.84	II	4098-22040	3.5	5731.87	II	
1.0	5574.60	II		1.8	5747.14	II	
1.0	5578.81	I		2.0	c 5747.88		
1.2	5582.40	II	8490-26398	2.0	5753.02	II	
1.0	5584.01	II		8	5756.17	II	

## Praseodymium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
1.4	5759.39	II		3.5	5920.76	I	
2.0	5760.21	I		3.5	5930.67	I	
2.0	5769.15	II		1.4	5936.31	I	
1.4	5769.78	II		14	5939.91	II	
4	5773.11	II		6	5940.73	II	
1.4	5773.95			2.0	5941.65	I	
1.0	5775.92	II	7447-24755	3.0	5947.20		
1.4	5777.29	II		2.0	c 5949.79	I	
8	5779.29	I		5	5951.28	II	
6	c 5785.30	II		1.8	5951.78	II	
6	5786.18	II		8	5956.62	II	
1.4	h 5788.30	I		1.2	5959.31	I	
1.4	5788.92	II		1.8	5962.21	I	
1.4	5790.87	II		2.5	5963.02	I	
4	5791.38	II	9379-26641	10	5967.84	II	9647-26398
2.0	5792.96	I		1.2	c 5976.96	I	
3.5	5810.62	II	11611-28816	1.2	5978.88	I	
1.4	5813.59	II	11005-28202	6	5981.21	II	
14	d 5815.18	II		3.5	5986.14	I	
	5815.37	I		4	c 5987.15	I	
5	5818.57	II		1.2	5991.26	I	
3.5	5820.62	I		1.2	c 5994.92	I	
1.4	h 5821.35	I		1.0	5996.05	I	
5	5822.63	II		2.6	6002.45	II	
8	5823.72	II	8490-25657	8	6006.35	II	
4	5830.97	II		1.2	6008.61	I	
3.5	5835.13	I		5	6016.49	II	
3.0	c 5844.64	II		13	6017.80	II	
3.5	5845.00	II		2.5	c 6019.90	I	
6	5847.13	II		13	6025.72	II	11611-28202
6	c 5850.65	II		3.0	6042.87	II	
4	c 5852.63	II		5	6046.68	II	
1.0	c 5854.43	I		3.0	6049.26	I	
4	5856.08			2.5	6050.03	II	
5	5856.92	II		1.0	6050.88	I	
8	5859.69	II		12	6055.13	I	
7	5868.83	II		1.2	6067.24	II	
2.0	5873.87	II		1.2	6085.85		
3.0	5874.73	I		2.5	6086.15	II	
3.0	5878.11	I		6	6087.51	II	
3.0	5879.07	I		1.8	6090.37	II	
7	5879.25	II	11005-28010	2.5	6093.04	I	
3.0	c 5884.70	I		1.6	6096.35	I	
5	5892.23	II	11611-28578	2.0	6106.76	II	
2.0	5894.29	I		1.6	6109.06	I	
3.5	5903.13	II		6	6114.40	II	
4	5904.45	II		2.0	c 6118.02	I	
3.5	5908.67	II		2.0	c 6122.24	I	
1.0	5915.31	I		3.0	6141.51	II	9379-25657
1.0	5915.98	I		6	6148.25	I	

## Praseodymium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
2.0	6157.80	II		1.4 c	6453.44	I	
1.2	6159.09	II	9379-25610	0.8	6454.87	II	8490-23978
17	6161.19	II	8490-24716	0.8	6456.20	I	
1.6	6165.26	I		0.8 h	6460.30	I	
24	6165.95	II	7447-23660	1.6	6467.76		
5	6182.34	II	11611-27782	0.8 h	6475.29	II	7447-22886
1.2	6187.98	I		3.0 cw	6478.03	II	
3.0	6197.46	II		4	6486.56	I	
3.0	6200.79	II	11005-27128	0.8 h	6486.95	II	
1.2	6205.65	II		3.5 h	6491.76	I	
1.2	6210.59	I		0.8	6493.49	I	
2.0	6212.73	I		1.0	6494.90	I	
1.6	6218.08	I		2.0 c	6497.18	I	
1.8 h	6236.83	I		1.6	6498.94	II	
1.8 h	6241.11	I		2.0	6500.73	I	
4	6244.34	II	9647-25657	0.8	6504.10	I	
3.0	6255.10	II		0.7	6517.15	I	
3.5	6262.54	II	9647-25610	1.4	6518.81	II	
1.6	6264.60			0.7	6534.64	I	
2.0 c	6274.74			1.4	6540.48	I	
3.5	6278.68	II	9647-25569	0.6 h	6553.30	I	
10	6281.31	II		2.0	6564.63	II	7447-22675
1.6 c	6289.03	I		4	6566.75	II	
1.0 c	6297.99			0.6	6571.04	I	
1.0	6302.02			0.5	6578.00	I	
3.0	6302.36	I		0.5	6584.59	II	
1.4	6304.03	I		0.8 h	6593.69	I	
3.0	6305.26	II	11005-26861	1.2	6595.47	I	
1.0 h	6318.12	I		1.6	6609.85	I	
4 c	6322.37	I		6	6616.65	I	
2.0 h	6343.94	I		1.2	6618.42		
2.5	6347.13	II		0.7 h	6631.1	I	
1.6 c	6350.98	I		1.4 h	6632.04	I	
2.0 c	6357.24	I		1.5	6647.12	I	
5 c	6359.04	I		8	6656.83	II	
1.0 h	6363.59	II		6	6673.41	II	
1.4	6377.62	I		8	6673.78	II	
1.4	6378.62	I		0.5 h	6687.6	II	
1.0	6389.59	I		0.4 h	6699.32	I	
1.6 c	6392.10	I		1.4	6736.89	I	
3.5	6393.19	I		4 c	6747.17	I	
4	6398.00	II	8490-24115	2.0 c	6749.28	I	
0.9 h	6410.66	I		0.8 c	6785.12		
5	6411.30	I		6 cw	6798.68	I	
3.5	6413.70	II		1.2	6811.88	II	
0.9	6415.53	I		1.8 cw	6812.91		
4	6429.65	II		1.4	6814.10	II	
4	6431.86	II		1.0	6817.70	I	
0.6 h	6442.81	I		3.5 cw	6827.70	II	
0.8 h	6443.94	II		2.0	6830.57	II	

Praseodymium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
1.0	6844.48	I	7447-22040	0.9 cw	7324.36	I	
1.0 h	6845.54	II		0.9	7328.47		
1.0	6846.72			0.9	7344.86		
1.8 c	6850.55	II		2.0	7407.60		
1.2	6852.90	I		2.5 c	7451.71		
1.2 c	6870.55	I		1.4 h	7495.62		
0.9	6884.72	I		0.8 h	7499.45	II	
1.0	6892.76	I		1.8	7541.02	II	
1.0 h	6970.38			0.7	7574.92	I	
1.0 c	6980.18	I		2.5	7645.67	II	
5	7021.54	II	9379-23617	0.9	7704.96	II	
1.2	7024.59	I		2.0	7721.81	I	
1.6	7042.54	I		0.7 h	7786.11	I	
1.0	7044.60	II		0.8 cw	7841.02		
0.9	7051.06	I		1.8	7871.65	II	
1.2	7080.02	I		0.7	7880.95		
1.4 c	7095.28			0.7 cw	7888.40		
2.5	7114.55	I		0.7	7915.07	II	
1.2 h	7116.88	I		0.7	8031.80	II	
1.4	7118.19			0.7	8055.32	I	
0.9	7137.28	II	1.8	8067.31			
1.2 h	7159.87	I	1.2 cw	8122.67			
0.9	7167.75	II	1.4	8141.05	I		
0.9 h	7189.96	I	0.6	8181.21	II		
1.2 c	7208.81	II	0.6 c	8211.90	I		
3.0	7227.71	I	0.7	8289.84	I		
1.6	7231.49	I	0.7	8379.77			
0.9 c	7243.24	I	0.7 h	8427.79	I		
0.9 c	7259.22	I	0.7 h	8605.20	II		
0.9 c	7287.71	I	1.2	8714.43			
0.9 h	7289.14	I					

# RHENIUM

Re,  $Z=75$ ,  $M=186.22$ , Ratio  $\frac{\text{Re}}{\text{Cu}}=2.931$

Re I Normal state of valence electrons  $5d^5 6s^2 {}^6S_{2\frac{1}{2}}=0$ . I.P.=63530 K  
 Re II Normal state of valence electrons  $5d^5 6s^1 {}^7S_3=0$ .

### References

Wavelengths:

W. F. Meggers, J. Research NBS **49**, 187 (1952).

Classification:

Re I, P. F. A. Klinkenberg, W. F. Meggers, R. Velasco, and M. A. Catalán, J. Research NBS **59**, 319 (1957).

Re II, W. F. Meggers, M. A. Catalán, and M. Sales, J. Research NBS **61**, 441 (1958).

### Relative intensity of rhenium lines observed in an arc of copper containing 0.1 atomic percent of rhenium

#### Strong lines of rhenium

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
5500 c	3460.46	I	0-28890	$5d^5 6s^2$ $a {}^6S_{2\frac{1}{2}}-5d^5 6s^1 6p^1 z {}^6P_{3\frac{1}{2}}$
4000 c	3464.73	I	0-28854	$5d^5 6s^2$ $a {}^6S_{2\frac{1}{2}}-5d^5 6s^1 6p^1 z {}^6P_{3\frac{1}{2}}$
1600 c	3451.88	I	0-28962	$5d^5 6s^2$ $a {}^6S_{2\frac{1}{2}}-5d^5 6s^1 6p^1 z {}^6P_{1\frac{1}{2}}$
800	3424.62	I	11754-40946	$5d^5 6s^1$ $a {}^6D_{4\frac{1}{2}}-5d^5 6s^1 6p^1 y {}^6D_{3\frac{1}{2}}$
500	2999.60	I	11754-45083	$5d^5 6s^1$ $a {}^6D_{4\frac{1}{2}}-5d^5 6p^1 y {}^6F_{5\frac{1}{2}}$
400	3399.30	I	11754-41164	$5d^5 6s^1$ $a {}^6D_{4\frac{1}{2}}-$ 41164 $3\frac{1}{2}$
400	3725.76	I	23632-50464	$5d^5 6s^1 6p^1 z {}^8P_{3\frac{1}{2}}-5d^5 6s^1 6d^1 e {}^8D_{5\frac{1}{2}}$
360 c	4227.46	I	18950-42598	$5d^5 6s^1 6p^1 z {}^8P_{2\frac{1}{2}}-5d^5 6s^1 7s^1 e {}^8S_{3\frac{1}{2}}$
260	2887.68	I	11754-46374	$5d^5 6s^1$ $a {}^6D_{4\frac{1}{2}}-5d^5 6p^1 y {}^6F_{4\frac{1}{2}}$
260	4513.31	I	20448-42598	$5d^5 6s^1 6p^1 z {}^8P_{3\frac{1}{2}}-5d^5 6s^1 7s^1 e {}^8S_{3\frac{1}{2}}$
220 cw	4889.14	I	0-20448	$5d^5 6s^2$ $a {}^6S_{2\frac{1}{2}}-5d^5 6s^1 6p^1 z {}^8P_{3\frac{1}{2}}$
200	3338.18	I	20448-50396	$5d^5 6s^1 6p^1 z {}^8P_{3\frac{1}{2}}-5d^5 6s^1 6d^1 e {}^8D_{4\frac{1}{2}}$
180	4136.45	I	11754-35923	$5d^5 6s^1$ $a {}^6D_{4\frac{1}{2}}-5d^5 6s^2 6p^1 z {}^6D_{4\frac{1}{2}}$
160	2428.58	I	0-41164	$5d^5 6s^2$ $a {}^6S_{2\frac{1}{2}}-$ 41164 $3\frac{1}{2}$
160	2992.36	I	0-33409	$5d^5 6s^2$ $a {}^6S_{2\frac{1}{2}}-5d^5 6s^2 6p^1 z {}^6D_{3\frac{1}{2}}$
160	3067.40	I	0-32592	$5d^5 6s^2$ $a {}^6S_{2\frac{1}{2}}-5d^5 6s^2 6p^1 z {}^6D_{1\frac{1}{2}}$
160	3342.24	I	20448-50359	$5d^5 6s^1 6p^1 z {}^8P_{3\frac{1}{2}}-5d^5 6s^1 6d^1 e {}^8D_{3\frac{1}{2}}$
160 cw	5275.56	I	0-18950	$5d^5 6s^2$ $a {}^6S_{2\frac{1}{2}}-5d^5 6s^1 6p^1 z {}^8P_{3\frac{1}{2}}$
150 c	2508.99	I	0-39845	$5d^5 6s^2$ $a {}^6S_{2\frac{1}{2}}-5d^5 6s^1 6p^1 x {}^6P_{3\frac{1}{2}}$
150 c	3691.48	I	16327-43409	$5d^5 6s^1$ $a {}^6D_{1\frac{1}{2}}-$ 43409 $1\frac{1}{2}$
140	2965.76	I	11754-45463	$5d^5 6s^1$ $a {}^6D_{4\frac{1}{2}}-$ 45463 $3\frac{1}{2}$
130	5270.95	I	23632-42598	$5d^5 6s^1 6p^1 z {}^8P_{4\frac{1}{2}}-5d^5 6s^1 7s^1 e {}^8S_{3\frac{1}{2}}$
120	2715.47	I	11754-48570	$5d^5 6s^1$ $a {}^6D_{4\frac{1}{2}}-$ 48570 $5\frac{1}{2}$
110	3184.76	I	18950-50341	$5d^5 6s^1 6p^1 z {}^8P_{2\frac{1}{2}}-5d^5 6s^1 6d^1 e {}^8D_{2\frac{1}{2}}$
110	3185.57	I	18950-50333	$5d^5 6s^1 6p^1 z {}^8P_{2\frac{1}{2}}-5d^5 6s^1 6d^1 e {}^8D_{1\frac{1}{2}}$
110 c	3204.25	I	16307-47507	$5d^5 6s^2$ $a {}^4G_{5\frac{1}{2}}-$ 47507 $5\frac{1}{2}$



Rhenium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
13	2003.53	I	0-49895	6	2365.32	I	
10	2017.87	I	0-49541	36	2365.90	I	0-42254
24	2049.08	I	0-48786	18	2367.68	I	15058-57281
5	2074.70	I	0-48184	6	2368.53	II	14930-57139
5	2083.92	I	0-47971	17	2369.27	I	11755-53949
14	2085.59	I	0-47932	7	2370.76	II	14883-57050
7	2092.41	II		7	2371.52	I	11584-53738
14	2097.12	I	0-47669	5	2373.48	II	14930-57050
5	2109.22	I		11	2375.07	I	14217-56308
9	2139.04	II		5	2375.82	I	11584-53662
4	2142.74	II		3.5	2377.33	I	
	2142.97	I	0-46649	2.5	2378.53	II	27746-69776
11	2156.67	I	0-46353	14	2379.77	I	
17	2167.94	I	0-46112	7	2380.22	I	16619-58619
13	2176.21	I	0-45937	2.5	2380.89	I	16307-58295
24	c 2214.26	II	0-45148	7	2381.14	I	11754-53738
13	2214.58	I		7	2383.46	I	14217-56160
12	2226.42	I	0-44901	7	2386.90	II	20976-62859
7	2235.44	I	0-44720	3.5	2387.46	I	16307-58180
4	2255.73	I	11584-55902	14	2388.57	I	
8	2256.19	I	0-44309	7	2389.11	I	0-41844
20	2264.39	I	0-44148	7	2390.43	I	
24	2274.62	I	0-43950	3.5	2391.28	I	11584-53390
60	c 2275.25	II	0-43938	10	2393.65	I	13826-55590
20	2281.62	I	0-43815	14	2394.37	I	11584-53336
40	2287.51	I	0-43702	15	2396.79	I	11584-53294
40	2294.49	I	0-43569	9	2397.31	I	15166-56866
6	2298.09	II	27628-71128	3.5	2398.71	I	16619-58295
6	2299.77	I	11755-55224	3.5	2398.89	I	
10	2302.99	I	0-43408	10	d 2400.72	I	15058-56699
					2400.89	I	
11	2306.54	I	0-43342				
4	2312.97	I	15058-58280	10	2401.68	I	11754-53379
4	2313.34	I		7	2402.60	I	
4	2319.19	I	16307-59412	3.5	2403.04	II	23341-64942
7	2320.16	I	16307-59394	7	2404.34	I	
15	2322.49	I	0-43044	70	2405.06	I	11754-53321
6	2328.66	I	11584-54514	36	2405.60	I	0-41557
6	2334.33	I	11584-54410	16	2406.70	I	
6	2335.73	I	11754-54554	14	2410.37	I	11584-53059
5	2336.10	I	16619-59412	6	2410.99	I	
6	2337.95	I	11754-54514	10	2413.22	I	
22	2344.78	I		7	2414.59	I	15770-57173
3.5	2345.28	I	13826-56452	7	2416.30	I	
3.5	2347.06	I	11584-54177	7	2416.44	I	11584-52954
6	2349.39	I	14621-57173	7	2417.66	I	16307-57657
6	d 2350.46	I		3.5	2418.20	II	25988-67328
18	2352.07	I	11584-54087	10	2419.40	I	15770-57090
6	d 2353.95	I		70	2419.81	I	0-41313
	2354.08	I	11754-54221	10	2421.38	I	15166-56452
7	2356.50	I	11754-54177	17	2421.73	I	14621-55901

## Rhenium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
17	2421.88	I		32	2485.81	I	16307-56523
3.5	2423.50	I	15058-56308	10	2486.78	I	11754-51955
3.5	2423.84	II		5	2486.97	I	
3.5	2425.38	I		80	2487.33	I	11755-51946
6	2426.64	I	16328-57524	6	2490.16	II	30982-71128
160	2428.58	I	0-41164	16	2492.84	I	13826-53929
7	2429.65	I	16307-57453	12	2495.26	I	11584-51648
34	2431.54	I		30	2496.04	I	14217-54268
28	2432.18	I	11754-52857	3.0	2496.70	I	17331-57372
10	2432.70	I	15166-56260	16	2498.22	I	13826-53843
12	2433.28	I	16307-57391	9	2498.86	I	11584-51590
7	2433.61	I		6	2500.31	I	22160-62143
7	2436.05	I	16619-57657	11	2500.57	I	23956-63935
14	2438.46	I	13826-54823	30	2501.72	I	14217-54177
10	2439.06	I	11754-52741	46	2502.35	II	20976-60927
5	2440.41	I		19	2504.60	II	17224-57139
5	2440.58	I		6	2505.43	I	
25	c 2441.47	I	0-40946	22	2505.94	I	11754-51648
17	2442.51	I	15770-56699	12	2507.40	I	14217-54087
7	2444.09	I		150	c 2508.99	I	0-39845
20	2444.94	I	11584-52472	6	2512.55	I	14621-54410
50	2446.98	I	15058-55912	6	c 2514.51	I	
10	2448.20	I		5	2515.47	I	
7	2449.03	II	18846-59666	10	2516.12	I	11754-51486
7	2449.52	II	26237-67049	4	2517.08	I	
50	2449.71	I	0-40809	46	2520.01	I	0-39670
7	2450.89	I	11584-52373	44	2521.50	I	14621-54268
7	2453.14	I	16619-57372	9	2525.55	I	
16	2455.83	II	14352-55059	5	2526.81	I	13826-53390
5	2455.99	I		11	2529.50	I	14217-53738
7	2460.24	I	11584-52218	12	2533.31	I	13826-53288
32	2461.20	I	11754-52373	12	2534.10	II	14352-53802
65	c 2461.84	II		30	2534.80	I	11754-51193
7	2462.54	I		9	2539.33	I	17331-56699
9	2463.31	I	13826-54410	46	2540.51	I	11584-50934
10	2465.13	I	16619-57173	9	2543.67	I	15166-54467
16	2467.57	II	14930-55444	5	2543.84	I	13826-53125
10	2467.85	II	26768-67276	9	2544.22	I	16619-55912
12	c 2469.36	II	18846-59330	60	d 2544.74	I	11584-50869
5	h 2470.05	I			2544.88		
10	2470.61	II	20463-60927	30	2545.48	I	11754-51028
6	2471.05	II	19140-59596	9	2548.14	I	13826-53059
12	2473.72	II		12	2548.88	I	14621-53842
13	2474.73	I	15058-55454	5	2549.37	I	17238-56452
13	2475.17	II	23894-64282	13	2550.09	II	20463-59666
6	2476.28	I	11584-51955	24	2552.02	I	14217-53390
6	2477.43	II		3.0	2552.73	I	14217-53379
16	2479.02	I	17331-57657	12	c 2553.59	II	17224-56372
15	2480.82	I	14217-54514	6	2554.18	I	
100	2483.92	I	11754-52001	30	2554.63	II	20463-59596

## Rhenium — All Observed Lines

Intensity and Character	Wave-length in Å	Spectrum	Energy Levels in K	Intensity and Character	Wave-length in Å	Spectrum	Energy Levels in K
5	2554.93	I	13826-52954	8	2617.44	I	16619-54813
85	2556.51	I	14217-53321	15	2620.03	I	14217-52373
12	2558.06	I	17331-56411	15	2620.34	I	21775-59927
20	2559.08	I	0-39065	18	2622.76	I	
6	2559.71	I	13826-52881	8	2623.28	I	11754-49863
6	2559.88	I	15770-54823	4	2625.04	I	11584-49667
12	2561.46	I	15058-54087	5	c 2630.75	I	15058-53059
12	2563.01	I		8	2631.57	I	11584-49573
28	2564.19	I	11584-50571	4	2633.01	I	15770-53738
6	2565.84	I	21775-60737	12	2633.61	I	15166-53125
3.0	2566.57	I		28	2635.83	II	17224-55151
44	2568.64	II	14883-53802	50	2636.64	I	0-37916
12	2571.26	I	11584-50464	17	2637.01	II	19140-57050
30	2571.81	II	14930-53802	8	2641.02	II	14824-52677
12	2573.76	I	14217-53059	24	2642.75	I	11754-49583
4	2574.21	I	16619-55454	14	2647.13	I	0-37766
6	2576.32	I	17331-56134	6	2648.46	II	14930-52677
4	2578.12	I		24	2649.05	I	14217-51955
12	2579.01	I	15166-53929	4	2649.58	I	17238-54969
8	2580.31	I	15770-54514	60	2651.90	I	0-37698
12	2581.44	I	11584-50311	12	2652.91	I	15058-52741
9	2582.77			36	2654.12	I	11584-49250
6	2584.77	I	15166-53842	4	2655.18	I	13826-51477
34	2586.79	I	11754-50401	4	2655.84	I	16307-53949
6	2587.00	I	13826-52469	6	2659.02	I	14621-52218
6	2591.13	I	17331-55912	6	2659.79	I	26349-63935
16	2591.59	I	11584-50159	4	2660.54	I	
8	h 2592.84	I	11755-50311	20	2663.63	I	11755-49286
14	c 2594.85	I	11584-50110	6	2664.22	I	15770-53294
16	2595.23	I	0-38521	6	2664.81	I	16327-53842
10	2596.40	I		6	2667.13	I	17331-54813
14	2596.78	I	15770-54268	6	2670.24	I	11584-49023
10	2596.95	I	16327-54823	10	2670.79	I	14217-51648
6	2597.96	I		14	2671.84	I	11754-49171
26	2599.86	I	13826-52278	7	2672.77	I	
6	2600.87	I	14621-53059	85	2674.34	I	0-37381
8	2601.87	I	16307-54730	14	2677.03	I	
5	2602.55	I		12	2677.76	I	14621-51955
8	2602.93	I	15770-54177	12	2679.10	I	15058-52373
12	2603.46	I		14	2679.91	I	22160-59464
26	2603.89	I		12	2683.56	I	22160-59412
5	2607.32	I		6	2685.31	I	
60	2608.50	II	14352-52677	20	2688.53	I	15770-52954
55	d 2611.54	I	11584-49863	10	h 2690.25	I	16307-53467
	2611.60	I		4	h 2690.79	I	
10	2613.74	I	15770-54018	7	2694.39	I	11754-48858
14	2614.56	I	14621-52857	14	2695.56	I	15770-52857
5	2615.68	I		8	2697.26	I	0-37064
14	c 2616.72	II	18846-57050	4	2698.79	I	16619-53662
9	2617.11	I		3.0	2699.58	I	11754-48786

Rhenium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
7	2702.67	I		50	2783.57	I	11754-47669
12	2704.37	I	16327-53294	14	2785.21	I	14217-50110
4	2706.06	I	15058-52001	5	2786.14	I	21775-57657
3.0	2707.40	I		11	2786.56	I	15058-50934
4	2710.22	I		8	c 2789.27	I	13826-49667
6	2712.48	I	14621-51477	13	2790.94	I	15770-51590
8	2713.02	I	16619-53467	20	2791.29	I	16307-52122
6	2713.16	I	17331-54177	4	2793.66	I	
120	2715.47	I	11754-48570	9	2798.10	I	17331-53059
16	2715.77	I	14217-51028	13	h 2800.75	I	
6	2716.75	I	16327-53125	5	h 2802.25	I	
4	2719.54	I	16619-53379	11	2803.28	II	13777-49439
16	2722.21	I		9	2807.86	I	11754-47358
17	2722.70	I	14217-50934	5	2812.07	I	17331-52881
9	2723.84	I	15770-52472	7	2812.36	I	16328-51874
10	2727.55	I	14217-50869	5	2813.11	I	14621-50159
4	2728.63	I	13826-50464	15	2813.96	I	17331-52857
6	2729.64	I	16327-52952	20	2814.68	I	11584-47102
4	2730.83	I	14621-51230	15	2816.32	I	22160-57657
18	2731.56	II	18846-55444	9	2816.96	I	14621-50110
20	2732.21	I	15058-51648	7	2819.78	II	17224-52677
55	2733.04	II	17224-53802	80	2819.95	I	11754-47206
5	2734.31	I	14621-51183	10	2822.12	I	13826-49250
8	2738.32	I	15770-52278	10	2824.25	I	21775-57173
11	2739.94	I		9	2825.46	I	16619-52001
6	d 2741.97	I	22160-58619	10	2827.52	I	14217-49573
6	2742.74	I		5	2830.35	I	
	2742.86	I	15770-52218	28	2834.08	I	14621-49896
8	2743.87	I	16307-52741	18	2837.55	I	22160-57391
13	2747.44	I	11584-47971	18	2840.35	I	13826-49023
7	2752.85	I	11584-47899	20	2843.00	I	15770-50934
12	2753.05	I	14621-50934	9	2844.16	I	11584-46133
10	h 2753.64	II	19140-55444	9	2846.97	I	
5	2755.21	I	13826-50110	24	2850.98	I	11584-46649
5	2757.49	I		8	2852.84	I	17331-52373
20	2758.00	I	14621-50869	5	2860.07	I	14217-49171
5	2758.71	I	16619-52857	5	2860.25	I	14621-49573
10	2761.93	I	11584-47780	5	2864.56	I	27244-62143
8	2763.30	I	11754-47932	22	2867.19	I	16619-51486
19	2763.79	I	15058-51230	14	2871.82	I	14217-49028
18	2766.39	I	27130-63268	5	2872.30	I	15058-49863
28	2767.74	I	11584-47704	4	2872.67	I	15770-50571
20	2768.85	I	11754-47860	18	2875.28	I	11584-46353
20	2769.32	I		6	2879.27	I	16307-51028
32	2770.42	I	11584-47669	18	2883.44	I	17331-52001
15	2773.11	I	17238-53288	6	2884.04	I	23956-58619
7	2777.71	I	17331-53321	10	2884.64	I	
8	2778.09	I		6	2887.31	I	17331-51955
7	2778.50	I	14218-50197	260	2887.68	I	11754-46374
16	2781.43	I	14217-50159	12	c 2888.06	II	14824-49439

Rhenium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
8	2889.45	I	11754-46353	20	2982.19	I	
9	2891.48	I	16619-51193	6	2984.75	I	19458-52952
16	2891.88	I	14217-48786	20	2988.47	I	14217-47669
14	2892.63	I	19458-54018	160	2992.36	I	0-33409
10	2894.32	I	15770-50311	6	2992.82	I	
4	2895.65	I	15058-49583	15	2995.40	I	30560-63935
44	2896.01	I	0-34520	500	2999.60	I	11754-45083
3.0	2898.79	I	20482-54969	32	3001.14	I	14621-47932
75	2902.48	I	18950-53392	20	3004.14	I	14621-47899
19	2905.58	I	14621-49028	6	3004.34	I	13826-47102
16	2906.02	I	14621-49023	18	3006.42	I	15770-49023
9	2908.34	I		13	3011.92	I	11754-44946
50	2909.82	I	16307-50663	19	3013.14	I	13826-47004
5	2910.08	I	11584-45937	50	3016.02	I	11754-44901
6	2913.15	I	17331-51648	30	3016.49	I	14217-47358
6	2916.73	II	25321-59596	4	3016.97	I	11584-44720
6	2918.88	I	16619-50869	12	3021.88	I	14621-47704
9	2919.41	I	16327-50571	6	3022.99	I	17331-50401
14	2924.60	I	11754-45937	38	3030.45	I	14217-47206
11	2925.20	I	26661-60837	6	3031.27	I	23155-56134
6	2926.93	I	17331-51486	6	3032.79	I	16619-49583
75	2927.42	I	11754-45904	13	3034.55	I	20448-53392
16	2929.53	I	15770-49895	6	3036.55	I	16327-49250
24	2930.61	I	15058-49171	10	3037.96	I	13826-46733
6	2932.31	I	15770-49863	13	3040.03	I	14217-47102
12	2936.50	I	16619-50663	10	3041.00	I	15058-47932
4	2941.56	I	20482-54467	6	3041.99	I	16307-49171
40	2943.14	I	14217-48184	6	3042.29	I	
6	2944.32	I	13826-47780	10	3044.08	I	15058-47899
6	2946.57	I	20482-54410	24	3047.25	I	28030-60837
11	2949.09	I	17331-51230	10	3053.63	I	21775-54514
6	2949.88	I	16307-50197	13	3054.90	I	11584-44309
12	2950.83	I	11584-45463	9	3057.66	I	16327-49023
11	2954.34	I	13826-47665	20	3058.78	I	13826-46509
12	2957.91	II	23341-57139	13	3060.32	I	16619-49286
13	2961.74	I	14217-47971	10	3061.61	I	22160-54813
24	2962.27	I	11584-45332	7	3064.60	I	17238-49860
6	2962.87	I	22160-55901	160	3067.40	I	0-32592
65	2965.11	I	14217-47932	32	3069.94	I	11584-44148
140	2965.76	I	11754-45463	26	3071.16	I	16619-49171
8	2967.25	I	16619-50311	20	3072.96	I	17331-49863
16	2968.04	I	14217-47899	9	3076.14	I	15166-47665
8	2968.98	II		10	3078.86	I	11754-44225
7	2975.02	I	17331-50934	55	3082.43	I	14217-46649
11	2975.25	I	19458-53059	18	3084.21	I	15770-48184
28	2976.29	I	0-33589	9	3087.15	I	14621-47004
6	2977.30	I	16619-50197	34	3088.76	I	11584-43950
19	2978.15	I	16327-49895	11	3089.94	I	22160-54514
20	2980.82	I	11584-45122	20	3093.64	I	13826-46141
6	2981.01	I	19758-53294	20	3095.06	I	15058-47358

Rhenium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
18	3095.79	I	14217-46509	12	3214.11	I	26349-57453
10	3096.41	I	13826-46112	15	3227.46	I	15166-46141
70	3100.67	I	16327-48569	7	3228.73	I	15770-46733
14	3103.06	II	17224-49439	38	3235.94	I	13826-44720
14	3103.26			15	3237.51	I	15058-45937
14	3104.65	I	15770-47971	8	3241.47	I	14621-45463
70	3108.81	I	14217-46374	8	3248.55	I	16327-47102
34	3110.86	I	14217-46353	15	3252.26	I	15770-46509
14	3111.56	I	15770-47899	60	3258.85	I	16327-47004
34	c 3118.19	I	11754-43815	60	3259.55	I	11584-42254
34	3121.36	I	14621-46649	20	3261.56	I	15166-45817
7	3123.16	I	15770-47780	12	3262.77	I	17331-47971
7	3125.52	I	11584-43569	12	3266.85	I	17331-47932
42	3128.94	I	16619-48569	15	3268.48	I	16619-47206
26	3134.02	I	15770-47669	30	3268.89	I	15770-46353
7	3139.79	I	17331-49171	16	3277.71	I	14621-45122
7	3139.94	I	15166-47004	16	3285.64	I	17238-47665
25	3141.38	I	11584-43408	8	3287.13	I	27244-57657
14	3142.65	I		20	3294.83	I	15770-46112
7	3151.16	I	19458-51183	28	3296.70	I	18950-49275
44	3151.64	I	14217-45937	28	3296.99	I	16327-46649
33	3153.79	I	11754-43453	8	3300.97	I	15058-45343
36	c 3158.31	I	11754-43408	28	3301.60	I	14621-44901
22	3164.52	I	15058-46649	24	3302.23	I	15058-45332
5	3167.16	I	16619-48184	32	3303.21	II	14883-45148
70	3168.37	I	16307-47860	28	3303.75	I	11584-41844
14	3173.09	I	13826-45332	8	3307.01	I	27161-57391
22	3174.61	I	14621-46112	8	3308.25	I	
14	3174.78	I	27130-58619	8	3312.29	I	16327-46509
44	3177.71	I	11584-43044	24	3313.95	I	15770-45937
26	3178.61	I	15058-46509	16	3318.67	I	13826-43950
7	3182.66	I	19458-50869	60	3322.48	I	11754-41844
60	3182.87	I	18950-50359	7	3324.93	I	16307-46374
110	3184.76	I	18950-50341	20	3331.52	I	14217-44225
110	3185.57	I	18950-50333	16	3335.36	I	11584-41557
12	3186.29	I	27244-58619	200	3338.18	I	20448-50396
15	3190.17	I	16328-47665	14	3339.68	I	17238-47173
26	3190.78	I	17238-48569	160	3342.24	I	20448-50359
26	3192.36	I	14621-45937	80	3344.32	I	20448-50341
14	3193.20	I	22160-53467	32	3346.20	I	13826-43702
20	3194.50	I	15058-46353	13	3353.21	I	16327-46141
22	3198.58	I	14621-45876	16	3355.29	I	22423-52218
7	3199.49	I	14217-45463	24	d 3356.33	I	22160-51946
15	3200.04	I	16619-47860		3356.46	I	16327-46112
10	3200.72	I	15770-47004	20	3358.02	I	17331-47102
110	c 3204.25	I	16307-47507	16	3359.22	I	23632-53392
7	3205.42	I	24724-55912	16	3361.14	I	13826-43569
14	3211.75	I	14217-45343	20	3362.74	I	11584-41313
12	3212.94	I	14217-45332	16	d 3365.73	I	23155-52857
7	3213.49				3365.84	I	21775-51477

Rhenium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
24	3377.74	I	16307-45904	12	3534.82	I	16619-44901
32	3379.06	II	14352-43938	32	3537.46	I	11584-39845
32	3379.70	I	11584-41164	16	3539.33	I	19458-47704
16	3384.45	I	27161-56699	6	3539.94	I	22160-50401
20	3385.76	I	14621-44148	24	3549.89	I	11754-39916
24	3389.43	I	17238-46733	16	3551.29	I	22160-50311
20	3390.25	I	22160-51648	16	3553.65	I	17331-45463
8	3394.12	I	21775-51230	16	3558.94	I	11754-39845
8	3397.21	I	26349-55777	8	3564.73	I	15770-43815
400	3399.30	I	11754-41164	16	3568.23	I	24724-52741
8	3401.17			24	3570.26	I	17331-45332
65	3404.72	I	11584-40946	36	3579.12	I	15770-43702
65	3405.89	I	14217-43569	80	c 3580.15	II	17224-45148
24	3408.67	I	14621-43950	65	3580.97	I	16307-44225
32	3409.83	I	17331-46649	80	3583.02	I	11754-39656
8	3413.74	I	16619-45904	7	3590.88	I	22423-50263
32	3417.77	I	15058-44309	8	3595.16	I	21775-49583
80	3419.41	I	14217-43453	16	3596.39	I	11754-39552
16	3420.75	I	11584-40809	8	3598.77	I	23155-50934
800	3424.62	I	11754-40946	8	3604.39	I	22423-50159
40	3426.19	I	17331-46509	16	3610.49	I	16307-43996
30	3427.61	I	15058-44225	32	3617.08	I	15770-43409
32	3437.71	I	14621-43702	8	3617.25	I	15770-43408
8	3441.25	I		16	3621.46	I	16619-44225
6	3442.97	I	16307-45343	16	3625.91	I	15770-43342
40	3449.37	I	15166-44148	6	3629.20	I	19458-47004
1600	c 3451.88	I	0-28962	14	3637.06	I	13826-41313
8	3453.28	I	15770-44720	80	3637.84	I	11584-39065
24	3453.50	I	14621-43569	3.5	3642.99	I	11754-39197
16	3458.88	I	17238-46141	8	3651.66	I	16619-43996
5500	c 3460.46	I	0-28890	44	3651.97	I	16327-43702
4000	c 3464.73	I	0-28854	8	3653.62	I	23632-50994
40	3467.96	I	20448-49275	6	3660.52	I	27244-54554
16	3472.72	I	14621-43409	4	3662.13	I	27514-54813
24	3476.44	I	15058-43815	12	3669.78	I	16327-43569
8	3477.14	I	27161-55912	8	3670.36	I	23956-51193
40	3480.38	I	16619-45343	32	3670.53	I	14217-41453
32	3480.85	I	14621-43342	8	3672.41	I	14621-41844
24	3482.23	I	22160-50869	6	3676.00	I	16619-43815
11	3490.86	I	17238-45876	3.5	3680.21	I	24425-51590
8	3494.72	I	17331-45937	3.5	3681.28	I	26132-53288
13	c 3495.90	I		85	c 3689.50	I	14217-41313
8	3502.73	I	20482-49023	150	c 3691.48	I	16327-43409
56	3503.06	I	15770-44309	10	3697.71	I	27141-54177
10	c 3512.28	I	16619-45083	3.5	3700.37	I	
32	3516.65	I	13826-42254	52	3703.24	I	13826-40822
32	3517.33	I	14621-43044	7	3704.45	I	
8	c 3520.72	I	15058-43453	6	3704.84	I	13826-40810
8	3524.54	I		10	3705.02	I	13826-40809
6	3529.21	I	16619-44946	24	3709.93	I	14217-41164

Rhenium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
3.5	3715.02	I	17238-44148	3.5	3983.91	I	
36 c	3717.28	I	17331-44225	4	3984.25	I	
400	3725.76	I	23632-50464	3.5	3991.03	I	14621-39670
14	3731.87	I	16619-43408	10	4004.93	I	19758-44720
14	3732.28	I	15058-41844	6	4012.26	I	26661-51578
24 c	3735.01	I	11754-38521	3.5	4018.40	I	27244-52122
80	3735.31	I	23632-50396	14	4022.96	I	18950-43801
4	3736.84	I	24724-51477	10	4023.31	I	14217-39065
90	3740.10	I	14217-40946	6	4028.53	I	23155-47971
14	3740.41	I	23632-50359	11 c	4029.63	I	13826-38635
13	3742.26	II	17224-43938	22	4033.31	I	15058-39845
30 cw	3745.44	I	14621-41313	11	4037.49	I	15166-39927
8	3755.62	I	17331-43950	20	4048.99	I	16307-40998
14	3766.48	I	14621-41164	5	4061.86	I	15058-39670
12	3768.26	I		24	4081.43	I	16327-40822
14	3777.66	I	17238-43702	5	4083.36	I	16327-40810
70	3787.52	I	15058-41453	5	4083.58	I	16327-40809
16	3796.59	I	11584-37916	4	4089.92	I	14621-39065
16	3797.59	I	14621-40946	14	4104.42	I	19458-43815
19	3807.74	I	15058-41313	24 c	4110.89	I	17238-41557
12	3815.66	I	14621-40822	5	4113.40	I	14217-38521
12	3836.30	I	14434-40494	19	4121.64	I	20448-44703
24	3869.94	I	16307-42140	5	4132.28	I	13826-38019
24	3875.26	I	11584-37381	24 cw	4133.42	I	16307-40494
24	3876.86	I	15770-41557	180	4136.45	I	11754-35923
8	3887.49	I	27141-52857	5	4137.60	I	21775-45937
8	3887.95	I	17331-43044	70	4144.36	I	17331-41453
7	3889.96	I	22160-47860	14	4149.96	I	13826-37916
8	3896.11	I	20482-46141	7	4152.29	I	33589-57665
8	3900.91	I	14217-39845	5	4152.63	I	15770-39845
4	3901.09	I	11754-37381	9	4159.92	I	27161-51193
10	3908.21	I	27161-52741	16	4170.40	I	27514-51486
13	3913.92	I	15770-41313	22	4182.90	I	15770-39670
38 c	3917.27	I	16619-42140	22	4183.06	I	14621-38521
6 c	3920.85	I	27244-52741	9	4194.67	I	17331-41164
7 c	3927.59	I	14217-39670	9	4204.52	I	22160-45937
55	3929.85	I	14217-39656	7	4213.27	I	27141-50869
6	3931.20	I	21775-47206	65	4221.08	I	11584-35268
14	3936.90	I	15770-41164	3.5	4223.18	I	
6	3941.54	I	19758-45122	360 c	4227.46	I	18950-42598
11	3944.72	I	27514-52857	3.5	4232.96	I	17695-41313
18	3945.91	I	14217-39552	4	4236.24	I	16327-39927
7	3950.64	I	14621-39927	3.0	4238.59	I	18950-42536
3.5	3954.43	I	22423-47704	9	4241.16	I	17238-40810
28	3961.04	I	13826-39065	15	4241.39	I	17238-40809
35 c	3962.48	I	16327-41557	7	4246.82	I	34520-58061
6	3963.27	I	16619-41844	4	4255.75	I	17331-40822
3.0	3964.81	I	23956-49171	26 c	4257.60	I	14217-37698
7	3967.39	I	22160-47358	12 c	4291.17	I	16619-39916
3.5	3975.65	I	16307-41453	8	4291.65	I	14621-37916



Rhenium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
3.0	4299.92	I	23956-47206	4	4662.49	I	13826-35268
20	4304.40	I	16619-39845	5	4682.32	I	19458-40809
3.0	4314.58	I	21775-44946	2.5	4687.86	I	27244-48570
8	4318.58	I	27514-50663	2.5	4694.99	I	15770-37064
4	4319.53	I	14621-37766	4	4700.44	I	21775-43044
20	4332.25	I	14621-37698	6	4705.04	I	22160-43408
4	4357.98	II		2.5	4725.93	I	23155-44309
38	4358.69	I	11584-34520	6	4727.60	I	16619-37766
19	4367.58	I	16307-39197	6	4748.38	I	16327-37381
14	4391.34	I	11754-34520	2.5	4749.03	I	14217-35268
7	cw 4392.45	I	14621-37381	4	4758.83	I	11584-32592
36	cw 4394.38	I	15770-38521	2.0	4763.67	I	17238-38225
6	4396.80	I	16327-39065	19	c 4791.42	I	15058-35923
8	4402.60	I	15058-37766	220	cw 4889.14	I	0-20448
11	cw 4406.40	I	16307-38995	5	4915.02	I	12251-32592
18	4415.82	I	15058-37698	22	4923.90	I	14217-34520
6	4440.44	I	17331-39845	8	4946.72	I	15058-35268
3.0	c 4453.92	I	35923-58369	5	4956.76	I	23632-43801
3.0	4454.62	I	14621-37064	8	4985.98	I	17331-37381
3.0	4463.53	I	35268-57665	4	5058.56	I	13826-33589
3.0	4467.54	I	24724-47102	7	5096.50	I	16307-35923
8	4467.92	I	16619-38995	2.0	5120.32	I	24425-43950
15	4475.08	I	17331-39670	2.5	5161.65	I	17695-37064
8	4477.99	I	17331-39656	4	c 5178.89	I	16619-35923
12	4478.39	I	15058-37381	2.0	5181.74	I	22160-41453
2.5	4496.43	I	19758-41991	3.5	5234.31	I	23155-42254
12	c 4507.04	I	28854-51035	5	5248.86	I	21775-40822
5	4508.01	I	28854-51031	130	5270.95	I	23632-42598
260	4513.31	I	20448-42598	160	cw 5275.56	I	0-18950
26	4516.64	I	28854-50988	10	5278.24	I	16327-35268
8	4519.76	I	28854-50973	3.0	5305.56	I	
50	4522.73	I	28890-50994	2.0	5317.28	I	26661-45463
12	4523.88	I	28890-50988	3.5	5321.28	I	14621-33409
8	4526.01	I	20448-42536	5	5327.46	I	13826-32592
7	4528.97	I	28962-51035	2.0	5331.90	I	15770-34520
12	4529.95	I	28962-51031	2.0	5332.76	I	
5	4530.89	I	22160-44225	2.0	5333.85	I	27161-45904
4	4541.80	I	28962-50973	3.5	5369.48	I	24425-43044
10	4545.17	I	15770-37766	5	c 5369.80	I	13826-32444
5	4559.27	I	15770-37698	10	c 5377.10	I	17331-35923
7	4559.68	I	13826-35751	2.5	5431.90	I	39656-58061
5	c 4565.30	I	15166-37064	1.4	5437.03	I	22423-40810
12	4580.68	I	11584-33409	1.4	5447.92	I	15058-33409
2.5	4591.68	I	20482-42254	2.5	5460.64	I	19458-37766
12	4605.73	I	14217-35923	1.4	h 5520.05	I	28030-46141
2.5	cw 4614.66	I	17331-38995	2.5	5521.10	I	28542-46649
10	4621.38	I	21775-43408	5	c 5532.68	I	21775-39845
2.5	h 4625.96	I	15770-37381	5	c 5563.24	I	14621-32592
8	c 4630.82	I	16327-37916	2.5	5573.47	I	17331-35268
9	4652.33	I	14434-35923	2.5	5584.72	I	16619-34520

Rhenium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
1.0 h	5607.21	I	27514-45343	8 d	6350.75	I	28962-44703
1.2 h	5612.27	I		1.6 h	6382.94	I	29800-45463
10	5667.88	I	15770-33409	1.4	6411.47	I	26661-42254
2.5	5711.43	I	22423-39927	5	6511.47	I	17238-32592
1.8	5716.95	I	26661-44148	1.4	6515.25	I	30560-45904
11 c	5752.93	I	11584-28962	1.2	6544.91	I	22423-37698
11 cw	5776.83	I	11584-28890	3.5 c	6577.11	I	28854-44054
1.8	5791.60	I	16327-33589	4 cw	6592.52	I	28890-44054
1.0 c	5815.92	I	17331-34520	10 cw	6605.19	I	13826-28962
55	5834.31	I	11754-28890	3.0 c	6623.91	I	28962-44054
1.0	5919.86	I	24425-41313	1.0 c	6637.25	I	19458-34520
6	5943.24	I	15770-32592	3.0 cw	6652.39	I	13826-28854
1.0	5950.21	I	28542-45343	1.6 h	6683.28	I	22423-37381
1.8 h	5969.77	I	26661-43408	1.0 c	6711.30	I	17695-32592
1.0	5989.99	I	23155-39845	3.5	6751.22	I	
1.8 h	5995.73	I	27141-43815	0.6 c	6761.19	I	20482-35268
3.0	6114.22	I	17238-33589	20 c	6813.41	I	14217-28890
3.5 c	6145.81	I	27141-43408	28	6829.90	I	14217-28854
5	6146.82	I	16327-32592	10	6971.53	I	14621-28962
1.8	6203.24	I	16327-32444	4 cw	7006.63	I	14621-28890
2.5	6217.97	I	17331-33409	8 cw	7024.15	I	14621-28854
3.0 cw	6229.42	I	28854-44903	8 cw	7246.67	I	15058-28854
3.5 cw	6243.24	I	28890-44903	1.6 cw	7292.72	I	28890-42598
3.5 d	6260.02	I		5 cw	7578.73	I	15770-28962
	6260.24	I		1.6	7611.89	I	19458-32592
1.8 c	6271.37	I	28962-44903	0.8 cw	7620.25	I	15770-28890
1.8	6278.76	I	21775-37698	6 cw	7640.94	I	15770-28854
1.0	6286.41	I	27141-43044	8 cw	7912.94	I	16327-28962
1.0	6303.42	I	26132-41992	4 cw	7980.77	I	16327-28854
20	6307.70	I	28854-44703	5	8417.13	I	11754-23632
20	6321.90	I	28890-44703	3.5 cw	8527.73	I	17238-28962

# RHODIUM

Rh,  $Z=45$ ,  $M=102.91$ , Ratio  $\frac{\text{Rh}}{\text{Cu}}=1.620$

Rh I Normal state of valence electrons  $4d^8 5s^1 {}^4F_{4/2}=0$ . I.P.= 60197 K

Rh II Normal state of valence electrons  $4d^8 {}^3F_4=0$ . I.P.=145800 K

## References

Wavelengths:

G. R. Harrison, Massachusetts Institute of Technology Wavelength Tables (John Wiley & Sons, New York, 1939).

H. Kayser and R. Ritschl, Tabelle der Hauptlinien der Linienspektren aller Elemente (Julius Springer, Berlin, 1939).

Classification:

Rh I, J. P. Molnar and W. J. Hitchcock, J. Opt. Soc. Am. **30**, 523 (1940).

Rh II, F. J. Sancho, Anales Real. Soc. Esp. Fis. y Quim. **54A**, 41 (1958).

## Relative intensity of rhodium lines observed in an arc of copper containing 0.1 atomic percent of rhodium

### *Strong lines of rhodium*

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
800	3692.36	I	0-27075	$5s a {}^4F_{4/2}-5p z {}^4D_{3/2}$
750	3528.02	I	1530-29866	$5s a {}^4F_{3/2}-5p z {}^4F_{3/2}$
700	3434.89	I	0-29105	$5s a {}^4F_{4/2}-5p z {}^4G_{5/2}$
700	3657.99	I	1530-28860	$5s a {}^4F_{3/2}-5p z {}^4D_{3/2}$
650	3700.91	I	1530-28543	$5s a {}^4F_{3/2}-5p z {}^4G_{1/2}$
500	3462.04	I	2598-31474	$5s a {}^4F_{2/2}-5p z {}^4F_{2/2}$
500	3502.52	I	0-28543	$5s a {}^4F_{4/2}-5p z {}^4G_{1/2}$
500	3597.15	I	3310-31102	$4d^9 a {}^2D_{2/2}-5p z {}^4G_{3/2}$
500	3856.52	I	5691-31614	$5s a {}^2F_{3/2}-5p z {}^2G_{1/2}$
480	3396.85	I	0-29431	$5s a {}^4F_{4/2}-5p z {}^4F_{1/2}$
420	3799.31	I	5691-32004	$5s a {}^2F_{3/2}-5p z {}^2F_{3/2}$
400	3470.66	I	3473-32277	$5s a {}^4F_{1/2}-5p z {}^4F_{1/2}$
400	3474.78	I	3473-32243	$5s a {}^4F_{1/2}-5p z {}^4G_{3/2}$
400	3583.10	I	1530-29431	$5s a {}^4F_{3/2}-5p z {}^4F_{1/2}$
400	3596.19	I	2598-30397	$5s a {}^4F_{2/2}-5p z {}^4D_{1/2}$
360	3323.09	I	1530-31614	$5s a {}^4F_{3/2}-5p z {}^2G_{1/2}$
360	4374.80	I	5691-28543	$5s a {}^2F_{3/2}-5p z {}^4G_{1/2}$

## Rhodium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
1.6	2276.21	II	28835-71359	2.0	2482.04		
1.6	2288.57	I	2598-46280	4	2483.33	I	3473-43729
1.6	2309.82	I	3473-46753	12	2487.47		
1.0	2318.36	I	5691-48811	8	2490.77	II	16885-57021
1.6	2319.10	I	5691-48798	2.5	2492.30	I	3310-43421
1.6	2321.73	I	1530-44588	6	h 2494.51		
6	2322.58	I	0-43042	1.2	2499.02		
2.5	2326.47	I	3310-46280	3.0	2500.58		
1.4	2328.64	I	7791-50721	10	2502.46	I	3473-43421
4	2334.77	II	16885-59702	1.2	2503.84	II	20647-60573
1.2	2345.41			24	2504.29		
1.4	2352.47	I	0-42495	3.0	2505.10	II	19792-59699
1.4	2359.18	I	1530-43905	12	2505.67	I	2598-42495
8	2361.92	I	0-42325	28	2509.70	I	2598-42431
3.0	2368.34	I	3473-45683	4	2510.66	II	18540-58358
10	2382.89	I	0-41953	24	2511.03		
8	2383.40			6	2513.36		
1.4	2384.65	I	7791-49713	16	2515.75	I	3310-43048
10	2386.14			10	2520.53	II	16885-56547
4	2407.88	I	1530-43048	1.0	2525.99	I	9221-48798
1.2	2408.19	I	1530-43042	1.0	2531.74	I	5691-45178
1.2	2410.25	I	3310-44787	4	2532.66		
4	2415.84	II	19793-61173	1.0	2533.59		
3.0	2418.64			4	2534.07		
2.5	2419.75	I	3473-44787	9	2536.71		
2.5	2420.18	II	33845-75152	9	2537.04	II	34243-73646
3.5	2420.98	II	20647-61940	2.5	2539.72		
5	2423.94			3.0	2544.22		
4	2427.11	II	18540-59729	28	2545.70		
8	2427.68	I	2598-43777	1.0	2548.60		
14	2429.52	I	3473-44621	44	2555.36	I	3310-42431
2.5	2431.85	II	21180-62288	2.0	2558.62		
2.5	2432.66	I	5658-46753	4	2565.79	I	5658-44621
1.2	2437.08	I	7791-48811	3.5	2566.04	I	3473-42431
8	2437.80			2.0	2566.92	II	38687-77633
24	2440.34	I	1530-42495	4	2567.28		
4	h 2444.27			2.0	2574.66		
5	2448.84	I	2598-43421	2.0	2575.75	I	14788-53600
4	2449.04	I	5691-46511	1.0	2576.23		
6	2450.56			3.0	2587.29	II	27439-66078
2.5	2455.70	II	20647-61356	2.5	2598.07		
5	2458.90	II	19792-60448	2.5	2603.32	II	32605-71006
7	2461.04	II	18540-59161	6	2606.44	II	41045-79399
2.5	2463.61			6	2613.60		
6	2470.39	I	3310-43777	12	2622.58	I	5658-43777
7	2471.47	I	2598-43048	18	2625.88	I	5658-43729
2.5	2472.51			8	2630.42	I	2598-40603
10	2473.09	I	1530-41953	3.0	2634.99		
1.2	2475.64	II	31730-72112	2.5	2638.74	II	34243-72128
1.2	2477.54			6	2643.00		

## Rhodium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
9	2647.28	I	5658-43421	2.0	2904.81	I	14382-48798
32	2652.66	I	2598-40285	13	2907.21	I	2598-36985
2.5	2659.01	I	1530-39127	5	2910.17	II	25377-59729
2.5	2671.06	I	3473-40900	6	2912.62	I	5658-39981
5	2676.11	I	5691-43048	7	2915.42	I	5691-39981
2.0	2680.28			2.5	2923.10	I	9221-43421
8	2680.63	I	3310-40603	14	2924.02	I	2598-36787
2.5	2681.78	I	14788-52065	10	2929.11	I	5658-39788
2.5	h 2686.50			10	2931.94	I	5691-39788
2.5	h 2686.91			2.5	2955.41	I	9221-43048
4	2694.31	I	3473-40577	18	2968.66	I	3310-36985
32	2703.73	I	3310-40285	2.0	2974.03	I	11006-44621
3.0	2705.63	II	25377-62326	13	2977.68	I	5658-39231
3.0	2707.23	I	2598-39525	36	2986.20	I	3310-36787
6	2714.41	I	11968-48798	7	2986.99	I	5658-39127
8	2715.31	II	25377-62194	4	2987.45	I	10313-43777
6	2717.51	I	0-36787	9	3004.46	I	9221-42495
14	2718.54	I	5658-42431	4	3019.54	I	10313-43421
5	2720.14			10	3023.91	I	5658-38718
2.5	2720.52	I	13975-50721	4	3028.43	I	5658-38669
13	2728.94	I	2598-39231	2.5	3045.77	I	3310-36133
3.0	2736.76	I	2598-39127	2.5	3046.76	I	7791-40603
6	2741.75	I	9221-45683	2.0	3057.89	I	16119-48811
4	2767.73	I	2598-38718	5	3067.30	I	12723-45316
8	2771.51	I	2598-38669	14	3083.96	I	1530-33946
4	2778.06	I	7791-43777	2.5	3087.42	I	5658-38038
6	2779.54	I	10313-46280	6	3114.91	I	3310-35404
10	2783.03	I	3310-39231	12	3121.76	I	3310-35334
2.0	2791.16	I	3310-39127	20	3123.70	I	0-32004
6	2796.63	I	11006-46753	3.0	3130.79	I	3473-35404
12	2826.43	I	10313-45683	8	3137.71	I	3473-35334
14	2826.68	I	9221-44588	4	3151.36	I	14788-46511
2.5	2827.31	I	3310-38669	4	3152.60	I	5658-37369
6	2834.12	I	11006-46280	11	3155.78	I	9221-40900
3.5	2835.44	I	1530-36787	6	3179.73	I	7791-39231
6	2836.69	I	5658-40900	7	3185.59	I	9221-40603
4	2856.16	I	3473-38474	12	3189.05	I	2598-33946
4	d 2860.68	I	5658-40605	40	3191.19	I	5658-36985
	2860.76	I	5658-40603	16	3197.13	I	2598-33867
22	2862.94	I	5658-40577	6	3214.32	I	0-31102
5	2864.40	I	3310-38211	7	3237.66	I	7791-38669
4	2871.35			44	3263.14	I	3310-33946
2.5	2873.62			44	3271.61	I	3310-33867
9	2878.66	I	3310-38038	200	3280.55	I	1530-32004
6	2880.76	I	3310-38013	9	3281.70	I	11968-42431
11	2882.37	I	9221-43905	200	3283.57	I	2598-33044
6	2885.97	I	7791-42431	24	3289.14	I	3473-33867
6	2889.11	I	1530-36133	4	3289.64	I	14788-45178
6	2889.84	I	5691-40285	18	3294.28	I	12723-43070
5	2899.96	I	10313-44787	4	3296.72	I	12723-43048

## Rhodium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
22	3300.46	I	10313-40603	750	3528.02	I	1530-29866
360	3323.09	I	1530-31614	75	d 3538.14	I	5691-33946
5	3331.09	I	5658-35670		3538.26	I	14788-43042
4	3331.24	I	9221-39231	24	3541.91	I	11006-39231
28	3338.54	I	1530-31474	100	3543.95	I	5658-33867
6	3342.90	I	9221-39127	150	3549.54	I	3310-31474
7	3344.20	I	11006-40900	20	3564.13	I	14382-42431
5	3359.90	I	13975-43729	100	3570.18	I	3473-31474
24	3360.80	I	5658-35404	400	3583.10	I	1530-29431
5	3362.18	I	3310-33044	10	3583.53	I	10313-38211
36	3368.38	I	2598-32277	400	3596.19	I	2598-30397
4	3369.68	I	10313-39981	500	3597.15	I	3310-31102
95	3372.25	I	2598-32243	26	3605.86	I	10313-38038
9	3377.14	I	12723-42325	260	3612.47	I	3473-31147
7	3377.71	I	11006-40603	20	3614.78	I	16121-43777
9	3385.78	I	13521-43048	17	3620.46	I	7791-35404
480	3396.85	I	0-29431	150	3626.59	I	9221-36787
70	3399.70	I	2598-32004	8	3627.80	I	11968-39525
14	3406.55	I	14382-43729	26	3639.51	I	11006-38474
70	3412.27	I	16018-45316	30	3654.87	I	5691-33044
5	3420.16	I	12723-41953	700	3657.99	I	1530-28860
28	3421.20			24	3661.86	I	16121-43421
10	d 3424.38	I	7791-36985	110	3666.22	I	2598-29866
700	3434.89	I	0-29105	15	3666.91	I	11968-39231
120	3440.53	I	16121-45178	12	3674.76	I	11006-38211
3	3442.63	I	14382-43421	48	3681.04	I	11968-39127
10	3447.74	I	7791-36787	160	3690.70	I	3310-30397
5	3448.58	I	14788-43777	800	3692.36	I	0-27075
10	3450.29	I	13521-42495	5	3694.95	I	13521-40577
5	3451.15	I	3310-32277	80	3695.52	I	16018-43070
34	3455.22	I	3310-32243	24	3698.26	I	11006-38038
5	3455.42	I	11968-40900	32	3698.60	I	16018-43048
15	3457.07	I	10313-39231	650	3700.91	I	1530-28543
19	3457.93	I	13521-42431	80	3713.02	I	3473-30397
500	3462.04	I	2598-31474	5	3713.43	I	16121-43042
15	3469.62	I	10313-39127	4	3714.83	I	9221-36133
400	3470.66	I	3473-32277	1.4	3724.94	I	11968-38807
10	3472.25	I	9221-38013	55	3735.28	I	13521-40285
400	3474.78	I	3473-32243	36	3737.27	I	11968-38718
180	3478.91	I	3310-32046	36	3744.17	I	11968-38669
8	3484.04	I	3310-32004	100	3748.22	I	10313-36985
7	3491.07	I	11968-40605	20	3754.12	I	13975-40605
9	3494.44	I	11968-40577	32	3754.27	I	13975-40603
100	3498.73	I	3473-32046	42	3755.58	I	5658-32277
500	3502.52	I	0-28543	85	3760.40	I	5658-32243
5	3505.41	I	11006-39525	200	3765.08	I	5691-32243
240	3507.32	I	2598-31102	42	3769.97	I	14382-40900
5	3511.78	I	16121-44588	6	3775.72	I	16018-42495
5	3513.10	I	13975-42431	32	3778.13	I	13521-39981
5	3519.54	I	10313-38718	85	3788.47	I	5658-32046

## Rhodium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
110	3792.18	I	11006-37369	180	4135.27	I	5691-29866
320	3793.22	I	5691-32046	20	4154.37	I	12723-36787
420	3799.31	I	5691-32004	28	4196.50	I	9221-33044
65	3805.92	I	13521-39788	6	4206.62	I	3310-27075
110	3806.76	I	2598-28860	280	4211.14	I	5691-29431
4	3809.50	I	11968-38211	2.5	4230.20	I	10313-33946
8	3812.45	I	14382-40605	3.5	4244.44	I	10313-33867
40	3815.01	I	16121-42325	5	4273.43	I	13975-37369
65	3816.47	I	14382-40577	5	4278.60	I	11968-35334
110	3818.19	I	9221-35404	70	4288.71	I	7791-31102
320	3822.26	I	7791-33946	6	4296.77	I	13521-36787
200	3828.48	I	9221-35334	2.0	4342.44	I	9221-32243
170	3833.89	I	7791-33867	4	4373.04	I	11006-33867
4	3834.75	I	11968-38038	360	4374.80	I	5691-28543
500	3856.52	I	5691-31614	8	4379.92	I	9221-32046
42	3870.01	I	16121-41953	2.0	4433.32	I	16119-38669
6	3872.39	I	5658-31474	3.0	4492.47	I	9221-31474
32	3877.34	I	5691-31474	2.5	4503.78	I	14788-36985
6	3888.34	I	13521-39231	2.0	4528.72	I	7791-29866
2.5	3904.22	I	13521-39127	1.4	4544.27	I	14788-36787
2.0	3912.83	I	3310-28860	3.0	4548.73	I	11968-33946
10	3913.51	I	1530-27075	3.5	4551.64	I	10313-32277
20	3922.19	I	5658-31147	1.6	4560.89	I	16119-38038
170	3934.23	I	5691-31102	1.4	4565.19	I	11968-33867
4	3934.98	I	14382-39788	11	4569.00	I	9221-31102
42	3935.84	I	11968-37369	1.2	4571.31		
50	3942.72	I	10313-35670	2.5	4608.12	I	13975-35670
8	3958.24	I	13975-39231	1.2	4619.91		
320	3958.86	I	7791-33044	2.0	4643.18	I	16944-38474
4	3964.54			13	4675.03	I	5691-27075
32	3975.31	I	13521-38669	1.6	4721.00	I	9221-30397
20	3984.40	I	10313-35404	6	4745.11	I	7791-28860
20	3995.61	I	10313-35334	1.0	4755.58	I	14382-35404
32	3996.15	I	11968-36985	2.0	4810.49	I	27075-47857
10	4023.14	I	14382-39231	1.8	4842.43	I	9221-29866
5	4048.41	I	13975-38669	4	4843.99	I	27075-47714
2	4049.04	I	13521-38211	5	4851.63		
3.5	4053.44	I	11006-35670	5	4963.71	I	11006-31147
2.0	4056.34	I	9221-33867	5	4977.75	I	10313-30397
6	4077.57	I	13521-38038	3.5	4979.18	I	11968-32046
48	4082.78	I	7791-32277	1.2	5085.52		
1.6	4084.28	I	2598-27075	6	5090.63	I	9221-28860
4	4087.79	I	16121-40577	2.0	5120.69	I	13521-33044
5	4088.50	I	7791-32243	1.6	5130.76	I	14382-33867
12	4097.52	I	11006-35404	5	5155.54	I	11006-30397
4	4107.49	I	14788-39127	1.2	5157.09	I	28543-47928
6	4116.33	I	14382-38669	3.5	5158.69	I	28860-48239
10	4119.68	I	16018-40285	5	5175.97	I	28543-47857
90	4121.68	I	7791-32046	1.0	5177.27	I	32046-51356
130	4128.87	I	7791-32004	3.0	5184.19	I	7791-27075

## Rhodium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
8	5193.14	I	28543-47793	0.6	5907.31	I	16121-33044
1.4	5206.95			0.8	5918.54	I	11968-28860
1.4	5211.52	I	31102-50285	0.6	5941.46	I	31102-47928
1.6	5212.73	I	11968-31147	11	5983.60	I	12723-29431
1.4	5214.79	I	28543-47714	0.8	5991.19	I	14788-31474
1.6	5222.66	I	32277-51419	3.0	6102.72	I	12723-29105
1.6	5230.62	I	32243-51356	0.5	6116.15	I	13521-29866
4	5237.16	I	31102-50191	0.7	6128.06	I	14788-31102
0.8	5237.80			0.7	6186.89	I	16119-32277
1.2	5269.27	I	28860-47832	1.2	6199.99	I	16119-32243
0.9	h 5280.12	I	31474-50408	1.4	6253.72	I	16018-32004
1.2	5292.14	I	12723-31614	0.4	6276.66	I	16119-32046
1.2	5314.79	I	31474-50285	0.7	6277.46	I	16121-32046
3.5	h 5329.74	I	29105-47862	0.5	6293.38	I	16119-32004
1.2	h 5331.08	I	29105-47857	2.5	6319.53	I	12723-28543
0.8	5349.31	I	29105-47794	1.0	6414.72	I	28860-44445
11	5354.40	I	31614-50285	1.4	6510.41	I	16119-31474
2.0	5356.47	I	31614-50278	1.6	6519.70	I	16944-32277
4	5379.10	I	31614-50199	0.8	6627.80	I	16018-31102
8	5390.44	I	10313-28860	1.6	6630.16	I	14788-29866
2.0	h 5404.73	I	29431-47928	5	6752.35	I	27075-41881
5	h 5424.07	I	29431-47862	1.2	6796.65	I	35334-50043
1.6	5424.72	I	11968-30397	1.6	6827.33	I	14788-29431
1.6	h 5425.45	I	29431-47857	1.4	6857.68	I	29866-44445
1.0	5439.52	I	12723-31102	2.5	6879.94	I	16944-31474
1.0	h 5441.36	I	29866-48239	8	6965.67	I	12723-27075
0.8	h 5444.32	I	29431-47794	1.0	6972.91	I	31474-45812
3.0	h 5445.23			2.0	6979.15	I	31147-45471
2.0	h 5468.11	I	29431-47714	2.0	7001.58	I	16119-30397
3.0	h 5470.85	I	32004-50278	1.8	7038.76	I	16944-31147
1.0	5476.12	I	14788-33044	3.0	7101.64	I	30397-44475
1.0	5481.42	I	32046-50285	2.5	7104.45	I	14788-28860
1.4	5484.23	I	32004-50233	1.0	7142.55	I	31474-45471
0.8	5504.65	I	32046-50208	1.6	7219.06	I	16018-29866
2.5	5535.04	I	29866-47928	3.0	7268.18	I	14788-28543
1.8	l 5544.58	I	29866-47897	6	7270.82	I	28543-42293
14	5599.42	I	9221-27075	2.0	7271.94	I	16119-29866
0.6	5607.71	I	33946-16119	0.8	7273.03	I	16121-29866
1.4	5608.35	I	16121-33946	1.6	7375.57	I	13521-27075
0.4	5632.77	I	16119-33867	0.8	h 7386.64	I	32277-45812
0.8	5659.62	I	14382-32046	1.6	7430.80	I	16944-30397
3.5	5686.38	I	13521-31102	3.0	h 7442.39	I	28860-42293
0.8	h 5702.47	I	33946-51478	1.2	7446.77	I	32046-45471
0.5	5727.30	I	14788-32243	2.0	7475.74	I	31102-44475
2.5	5792.77	I	14788-32046	2.0	7495.24	I	28543-41881
0.8	5795.79			1.4	7542.02	I	36787-50043
0.8	5803.34			1.8	7557.67	I	32243-45471
3.5	5806.91	I	14788-32004	1.4	7577.22	I	32277-45471
0.5	5821.84	I	13975-31147	1.8	7690.05	I	31474-44475
3.0	5831.58	I	12723-29866	3.0	7772.90	I	29431-42293



## Rhodium — All Observed Lines

Intensity and Character	Wave- length in A	Spec- trum	Energy Levels in K	Intensity and Character	Wave- length in A	Spec- trum	Energy Levels in K
5	7791.61	I	31614-44445	5	8045.40	I	29866-42293
9	7824.91	I	29105-41881	1.2	8063.50	I	32046-44445
2.5	7830.05	I		2.5	8136.20	I	14788-27075
2.5	7846.50	I	16119-28860	1.2 h	8193.63	I	32243-44445
3.5	8029.91	I	29431-41881	0.8 h	8369.55	I	33867-45812
1.8 h	8036.11	I	32004-44445	1.4	8425.51	I	33946-45812

# RUBIDIUM

Rb,  $Z=37$ ,  $M=85.48$ , Ratio  $\frac{\text{Rb}}{\text{Cu}}=1.345$

Rb I Normal state of valence electrons  $4p^6 5s^1 {}^2S_{0\frac{1}{2}}=0$ . I.P.= 33691 K

Rb II Normal state of valence electrons  $4p^6 {}^1S_0=0$ . I.P.=221852 K

## References

### Wavelengths:

G. R. Harrison, Massachusetts Institute of Technology Wavelength Tables (John Wiley & Sons, New York, 1939).

### Classification:

Rb I, A. Fowler, Report on Series in Line Spectra (Fleetway Press, London, 1922).

### Intensities:

L. S. Ornstein and J. Key, Physica **1**, 945 (1934).

G. Stephenson, Proc. Phys. Soc. (London) **A44**, 458 (1951).

## Relative intensity of rubidium lines observed in an arc of copper containing 0.1 atomic percent of rubidium

*Strong lines of rubidium*

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
3000	7800. 23	I	0-12817	$4p^6 5s^1 {}^2S_{0\frac{1}{2}}-4p^6 5p^1 {}^2P_{\frac{1}{2}}$
1500	7947. 60	I	0-12579	$4p^6 5s^1 {}^2S_{0\frac{1}{2}}-4p^6 5p^1 {}^2P_{\frac{3}{2}}$

## Rubidium — All Observed Lines

Intensity and Character	Wave- length in A	Spec- trum	Energy Levels in K	Intensity and Character	Wave- length in A	Spec- trum	Energy Levels in K
32	4201. 85	I	0-23793	5	7408. 17	I	12817-26311
16	4215. 56	I	0-23715	7	7618. 93	I	12579-25701
1.2 h	5648. 10	I	12579-30280	11 hl	7757. 65	I	12817-25704
2.0 l	5724. 45	I	12817-30282	2.0	7759. 43	I	12817-25701
2.5	6206. 31	I	12579-28687	3000	7800. 23	I	0-12817
4 h	6298. 33	I	12817-28689	1500	7947. 60	I	0-12579
3.5 hl	7280. 00	I	12579-26311				

# RUTHENIUM

Ru,  $Z=44$ ,  $M=101.1$ , Ratio  $\frac{\text{Ru}}{\text{Cu}}=1.591$

Ru I Normal state of valence electrons  $4d^7 5s^1 {}^5F_5 = 0$ . I.P. = 59410 K  
 Ru II Normal state of valence electrons  $4d^7 {}^4F_{4\frac{1}{2}} = 0$ . I.P. = 135200 K

## References

Wavelengths:

G. R. Harrison, Massachusetts Institute of Technology Wavelength Tables (John Wiley & Sons, New York, 1939).

Supplemented by K. G. Kessler and W. F. Meggers, J. Research NBS **55**, 97 (1955).

Classification:

Ru I, K. G. Kessler, J. Research NBS **63A**, 213 (1959).

Ru II, A. G. Shenstone and W. F. Meggers, J. Research NBS **61**, 373 (1959).

## Relative intensity of ruthenium lines observed in an arc of copper containing 0.1 atomic percent of ruthenium

### *Strong lines of ruthenium*

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
1000	3728.03	I	0-26816	$5s^1 a {}^5F_5-5p^1 z {}^5F_5^o$
850	3498.94	I	0-28572	$5s^1 a {}^5F_5-5p^1 z {}^5G_6^o$
800	3726.93	I	1191-28015	$5s^1 a {}^5F_4-5p^1 z {}^5F_4^o$
700	3593.02	I	2713-30537	$5s^1 a {}^5F_2-5p^1 z {}^5G_3^o$
700	3798.90	I	1191-27507	$5s^1 a {}^5F_4-5p^1 z {}^5D_3^o$
700	3799.35	I	0-26313	$5s^1 a {}^5F_5-5p^1 z {}^5D_4^o$
700	4199.90	I	6545-30348	$5s^1 a {}^3F_4-5p^1 z {}^3F_4^o$
650	3436.74	I	1191-30280	$5s^1 a {}^5F_4-5p^1 z {}^5G_5^o$
650	3589.22	I	3105-30959	$5s^1 a {}^5F_1-5p^1 z {}^5G_2^o$
650	3596.18	I	2092-29891	$5s^1 a {}^5F_3-5p^1 z {}^5G_4^o$
650	3730.43	I	2092-28891	$5s^1 a {}^5F_3-5p^1 z {}^5F_3^o$
600	3661.35	I	1191-28495	$5s^1 a {}^5F_4-5p^1 z {}^3G_5^o$
550	3790.51	I	2092-28466	$5s^1 a {}^5F_3-5p^1 z {}^5D_2^o$
550	4080.60	I	6545-31044	$5s^1 a {}^3F_4-5p^1 y {}^5F_3^o$
500	3428.31	I	0-29161	$5s^1 a {}^5F_5-5p^1 z {}^7F_6^o$
500	4212.06	I	6545-30280	$5s^1 a {}^3F_4-5p^1 z {}^5G_5^o$
500	4554.51	I	6545-28495	$5s^1 a {}^3F_4-5p^1 z {}^3G_5^o$
360	3786.06	I	2713-29118	$5s^1 a {}^5F_2-5p^1 z {}^5D_1^o$
340	4297.71	I	8084-31346	$5s^1 a {}^3F_3-5p^1 z {}^3G_4^o$
320	3417.35	I	2092-31346	$5s^1 a {}^5F_3-5p^1 z {}^3G_4^o$
320	3742.28	I	2713-29427	$5s^1 a {}^5F_2-5p^1 z {}^5F_2^o$
300	3634.93	I	2092-29595	$5s^1 a {}^5F_3-5p^1 z {}^7F_4^o$
300	3925.92	I	0-25465	$5s^1 a {}^5F_5-5p^1 z {}^7D_4^o$
260	3745.59	I	12207-38898	$5s^1 a {}^3G_5-5p^1 z {}^3H_6^o$
220	4372.21	I	7483-30348	$5s^2 a {}^5D_4-5p^1 z {}^3F_4^o$

## Ruthenium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
4	2076.43	I	0-48144	5	2494.48	II	11304-51380
5	2083.77	I	1191-49165	9	2495.69	II	27545-67602
5	2090.89	I		7	2496.56	I	7483-47526
9	2255.52	I	0-44322	15	2498.42	II	11304-51317
4	2259.53	I	0-44243	15	2498.57	II	10852-50863
12	2272.09	I	0-43999	9	2499.78	I	
4	2278.19	I	1191-45071	3.5	2500.84	I	9073-49048
14	2279.57	I		8	2501.48	I	9073-49037
3.0	2285.38	I	0-43743	6	2501.89	I	9184-49141
7	2302.54	I	1191-44608	28	2507.01	II	11304-51179
13	2317.80	I	1191-44322	14	2508.27	I	7483-47339
4	2322.01	I	1191-44243	12	2509.07	I	9121-48964
4	2334.96	II	10151-52964	3.5	2511.56	I	
8	2340.69	I	2092-44801	12	2512.81	I	8084-47868
7	h 2342.85	II	10151-52820	12	2513.32	II	11604-51380
7	2349.34	I	1191-43743	7	2515.28	I	8044-47789
12	2351.33	I	2092-44608	12	2517.32	II	11604-51317
7	2357.91	II	9152-51549	6	2517.62	I	9058-48766
6	2360.56	I	2092-44442	3.5	2519.95	I	
8	2370.17	I	2713-44891	6	2521.61	I	9121-48766
12	2375.27	I	2713-44801	3.0	2525.17	I	8575-48165
4	2375.63	II	11604-53685	8	2526.83	I	7483-47047
10	2392.42	I	3105-44891	6	2528.88	I	9073-48604
6	2396.71	II	9152-50863	6	2530.64	I	8044-47547
50	2402.72	II	9152-50758	5	2533.24	I	7483-46947
10	2407.92	II	11304-52820	16	2535.59	II	26911-66338
4	2410.89	I		5	2541.28	I	8771-48109
4	2414.82	II	10151-51549	7	2543.25	II	25952-65260
10	2420.82	I		30	2544.22	I	8575-47868
4	2422.92	I		13	2546.67	I	8084-47339
4	2429.60	I	8575-49722	30	2549.48	I	7483-46695
6	2432.93	I	6545-47635	60	2549.58	I	6545-45756
3.5	2447.45	I	9492-50339	2.5	2555.86	I	
3.5	2450.58	I	6545-47339	3.5	2556.00	I	9492-48604
7	2454.92	I	8044-48766	4	2556.31	I	9058-48165
20	2455.53	II	10151-50863	5	2558.54	I	8084-47157
16	2456.44	II	10852-51549	14	2560.26	I	8771-47818
40	2456.57	II	10151-50845	13	2560.83	I	
7	h 2458.62	I	7483-48144	12	2563.15	I	8044-47047
6	2462.94	I	8575-49165	3.0	2564.58	I	9184-48165
9	2464.70	I	8044-48604	6	2566.59	I	8575-47526
3.5	2474.04	I	9620-50028	17	2568.77	I	7483-46401
12	2475.41	I	7483-47868	3.0	2569.74	I	8044-46947
11	2476.88	I	8044-48405	11	2570.97	I	
30	2478.93	II	10852-51179	3.0	2572.28	I	8771-47635
3.0	2481.11	II	29019-69311	6	2572.41	I	8084-46947
3.5	2489.91	I	6545-46695	3.0	h 2575.24	I	6545-45365
2.0	2491.78	I	9184-49304	11	2578.57	I	8575-47345
7	2493.69	II	26109-66199	6	2578.95	I	8575-47339
9	2494.02	I	9058-49141	5	2579.22	I	8044-46804

## Ruthenium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
11	2579.53	I	8771-47526	1.4	2656.69	I	8771-46401
10	2580.80	I	9073-47809	5	2658.40	I	9184-46789
8	2581.14	I	9058-47789	44	2659.62	I	7483-45071
7	2581.91	I	8084-46804	2.5	2661.17	II	25952-63518
6	2583.04	I	8044-46746	36	2661.61	II	9152-46711
8	2584.14	I	8575-47262	22	2664.76	I	1191-38706
5	2585.74	I	8084-46746	3.5	2667.40	II	26109-63588
11	2589.57	I	9184-47789	4	2667.97	I	9058-46528
7	2590.97	I	7483-46067	6	2673.48	I	9073-46466
18	2591.12	I	8575-47157	5	2673.60	I	8084-45476
4	2591.64	I	8771-47345	75	2678.76	II	9152-46471
13	2592.02	I	8771-47339	24	2686.29	I	8575-45790
11	2593.70	I	12817-51360	3.0	2687.50	II	26109-63308
12	2594.85	I	6545-45071	3.5	2688.11	I	26118-63308
5	2597.33	I	9058-47547		2688.16	II	
9	2601.46	I		2.0	2689.90	I	10624-47789
8	2605.35	I	8575-46947	36	2692.06	II	10151-47285
7	2605.86	I	9184-47547	4	2693.29	I	9073-46191
40	2609.06	I	8084-46401	10	2699.88	I	8044-45071
5	2609.48	I	10624-48934	12	2701.34	I	9184-46191
9	2611.05	I	9058-47345	12	2702.83	I	8084-45071
90	2612.07	I	7483-45756	4	2707.97	I	2092-39009
10	2614.07	I	1191-39434	18	2709.20	I	8575-45476
6	2614.59	I	2713-40949	22	2712.41	II	10852-47708
11	2615.09	I	8575-46804	8	2713.19	I	9620-46466
8	2617.79	I	9620-47809	5	2717.40	I	3105-39895
10	2619.67	I	9184-47345	2.5	2718.83	I	
9	2620.61	I	8044-46191	75	2719.52	I	7483-44243
3.0	2623.83	I	16191-54292	10	2721.56	I	9058-45790
6	2627.65	I	7483-45529	14	2722.65	I	9073-45790
24	2631.30	I	7483-45476	8	2724.06	I	9492-46191
6	2631.57	I	9058-47047	15	2725.47	II	11304-47984
5	2632.13	I	10624-48604	6	2728.83	I	9121-45756
5	2632.50	I	8771-46746	2.5	2729.46	I	8575-45202
3.0	2633.46	I	11447-49409	6	2730.33	I	2092-38706
24	2635.86	I	9620-47547	10	2730.93	I	9183-45790
18	2636.67	I	12207-50122	5	2733.59	I	9620-46191
10	2638.51	I	9058-46947	34	2734.35	II	10151-46711
8	2639.12	I	9620-47501	200	2735.72	I	0-36543
12	2640.33	I	9184-47047	18	2739.22	I	8575-45071
50	2642.96	I	8575-46401	8	2743.94	I	6545-42978
3.0	2646.02	I	10624-48405	14	2744.45	I	8771-45197
12	2647.32	I	9184-46947	4	2747.97	II	11604-47984
3.5	2648.45	I	8044-45790	8	2752.45	II	10151-46471
3.0	2648.78	I	12207-49949	8	2752.77	II	19379-55695
7	2649.51	I	9058-46789	10	2753.44	I	
12	2651.29	I	8084-45790	4	2762.31	I	8044-44235
36	2651.84	I	6545-44243	28	2763.42	I	1191-37367
3.0	2656.25	II	25952-63588	4	2765.44	II	20515-56665
1.4	2656.56	I		10	2768.93	II	11604-47708

## Ruthenium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
4	2774.48	I		4	2913.17	I	11786-46103
11	2778.38	II	11304-47285	4	2914.30	I	11753-46056
6	2785.65	I	9184-45071	120	2916.26	I	1191-35471
12	2787.83	II	10852-46711	3.0	2917.77	I	8084-42347
4	2792.64	I	8044-43842	16	2919.61	I	3105-37347
15	2802.81	I	8575-44243	3.0	2927.12	I	14700-48854
4	2806.74	II	21646-57263	4	2927.54	II	20515-54663
38	2810.03	I	2092-37668	4	2939.94	I	11786-45790
190	2810.55	I	1191-36760	6	2940.36	I	7483-41483
6	2812.82	I		8	2943.92	I	8575-42534
8	2817.09	I	2713-38200	20	2945.67	II	19379-53317
38	2818.36	I	0-35471	20	2946.99	I	8084-42007
4	2818.95	I	8771-44235	40	2949.50	I	6545-40439
12	2822.03	I	8084-43509	4	2952.50	I	3105-36965
22	2827.87	I	1191-36543	16	2954.49	I	8043-41881
44	2829.16	I	6545-41881	8	2958.00	I	8084-41881
14	2834.00	I	2092-37367	3.0	2959.74	I	7483-41260
4	2836.57	I	9058-44301	8	2961.69	I	11447-45202
16	2840.54	I	6545-41739	2.0	2963.40	II	21246-54981
4	2841.68	II	20515-55695	6	2963.72	I	6545-40277
8	2843.17	I	9073-44235	60	2965.16	I	2092-35807
4	2846.32	I	9121-44244	18	2965.55	II	20515-54225
9	2848.58	I	3105-38200	6	2968.48	I	10624-44301
70	2854.07	I	2092-37119	9	2968.95	I	8084-41756
20	2860.02	I	2713-37668	4	2973.99	I	9492-43108
46	2861.41	I	6545-41483	3.0	2974.34	I	10624-44235
60	2866.64	I	2092-36965	15	2976.59	II	19379-52964
9	2868.19	I	9121-43976	60	2976.92	I	1191-34773
12	2868.31	I		5	2977.23	II	21646-55224
10	2871.64	I		8	2979.72	I	15054-48604
						II	20515-54065
200	2874.98	I	0-34773	8	2979.96	II	21246-54794
24	2879.76	I	6545-41260	6	2981.94	I	2713-36239
5	2881.28	I	3105-37802	150	2988.95	I	0-33447
6	2882.12	II	19379-54065	4	2989.66	I	8044-41483
14	2883.60	I	2092-36760	4	2991.62	II	21246-54663
7	2884.51	I	9184-43842	12	2993.27	I	8084-41483
80	2886.54	I	2713-37347	50	2994.96	I	2092-35471
8	2888.00	I	1191-35807	6	2996.90	I	9058-42416
4	2891.65	I	15550-50122	3.0	2997.43	I	10624-43976
20	2892.56	I		10	2998.35	I	
8	2896.53	I	3105-37620	6	3001.64	I	8575-41881
6	2898.54	I	8044-42534	48	3006.59	I	2713-35964
12	2901.94	I	8084-42534	4	3008.26	I	9184-42416
6	2902.10	I	10624-45071	6	3008.80	I	9121-42347
2.0	2903.08	I	9073-43509	6	3012.92	I	8575-41756
15	2905.65	I	2713-37119	6	3013.36	I	8084-41260
7	2905.83	I	6545-40949	36	3017.24	I	3105-36239
8	2906.32	I	7483-41881	2.0	3019.37	I	8771-41881
40	2908.88	I	3105-37473	34	3020.88	I	2713-35807
3.5	2909.22	I	8575-42939				

## Ruthenium — All Observed Lines

Intensity and Character	Wave- length in Å	Spec- trum	Energy Levels in K	Intensity and Character	Wave- length in Å	Spec- trum	Energy Levels in K
26	3033.45	I	7483-40439	8	3254.54	I	2713-33431
7	3034.06	I	9058-42007	6	3254.71	I	9058-39774
6	3035.47	I	9073-42007	28	3260.35	I	1191-31853
6	3038.18	I	8044-40949	12	d 3264.55	I	3105-33729
20	3040.31	I	1191-34072		3264.66	I	8084-38706
22	3042.48	I	3105-35964	12	3266.44	I	10655-41260
6	3042.83	I	10655-43510	20	3268.21	I	13646-44235
11	3045.71	I	9184-42007	20	3273.08	I	8044-38587
6	3048.50	I	7483-40277	20	3274.71	I	10655-41183
11	3048.78	I	2092-34882	10	3277.57	I	14700-45202
15	3054.94	I	8044-40768	50	3294.11	I	0-30348
40	3064.84	I	9121-41739	6	3296.11	I	13646-43976
9	3068.26	I		6	3297.96	I	9121-39434
9	3073.34	I	11447-43976	38	3301.59	I	0-30280
9	3080.90	I	11786-44235	22	3306.17	I	8771-39009
6	3086.07	I	11447-43842	6	3315.05	I	8044-38200
17	3089.14	I	9121-41483	30	3315.23	I	1191-31346
12	3089.80	I	8084-40439	30	3316.39	I	10624-40768
6	3090.23	I	17097-49448	6	3317.89	I	8575-38706
6	3091.87	I	2713-35047	6	3318.82	I	14700-44823
					3318.91	I	9620-39742
34	3096.57	I	12207-44492				
12	3097.60	I	10624-42897	10	3325.00	I	3105-33172
85	3099.28	I	1191-33447	4	3332.05	I	31385-61388
75	3100.84	I	1191-33431	12	3335.69	I	11786-41756
9	3110.55	I	9121-41260	95	3339.55	I	8771-38706
6	3124.17	I	2092-34091	24	3341.66	I	9121-39037
12	3125.96	I	2092-34072	6	3344.53	I	0-29891
9	3132.88	I	10624-42534	20	3361.15	I	17046-46789
9	3136.56	I	8044-39917	6	3362.00	I	11447-41183
9	3140.97	I	9121-40949	38	3368.45	I	2713-32392
9	3144.26	I	14700-46495	10	3371.86	I	9058-38706
6	3150.69	I	8044-39774	13	3374.65	I	8044-37668
12	3153.82	I	8044-39742	12	3378.02	I	0-29595
6	3158.89	I	9121-40768	10	3379.60	I	10655-40235
30	3159.92	I	2092-33729	13	3380.18	I	8044-37620
20	3168.52	I	11447-42998	13	3385.14	I	12207-41739
6	3177.05	II	19379-50845	13	3388.71	I	11447-40949
18	3186.04	I	2713-34091	10	3389.50	I	2713-32208
24	3188.34	I	2092-33447	6	3391.89	I	14828-44301
24	3189.98	I	2092-33431	38	3392.54	I	0-29468
18	3196.59	I	3105-34380	32	3401.74	I	9620-39009
6	3212.97	I	9121-40235	32	3409.28	I	8044-37367
6	3216.52	I	2092-33172	19	3411.64	I	8044-37347
18	3223.27	I	2713-33729	320	3417.35	I	2092-31346
11	3226.37	I	3105-34091	7	3420.08	I	11786-41017
10	3227.88	I	8771-39742	500	3428.31	I	0-29161
22	3228.53	I	8044-39009	13	3428.63	I	1191-30348
22	3238.53	I	15054-45923	19	3429.54	I	10624-39774
12	3241.24	I	9073-39917	50	3430.77	I	2713-31853
12	3243.50	I	6545-37367	10	3432.21	I	9073-38200

Ruthenium — All Observed Lines

Intensity and Character	Wave-length in A	Spectrum	Energy Levels in K	Intensity and Character	Wave-length in A	Spectrum	Energy Levels in K
32	3432.74	I	9121-38243	17	3631.71	I	6545-34072
19	3433.26	I	10624-39742	8	3633.92	I	17097-44608
16	3435.19	I	3105-32208	300	3634.93	I	2092-29595
650	3436.74	I	1191-30280	12	3635.52	I	9620-37119
26	3438.37	I	8044-37119	20	3637.47	I	13699-41183
22	3440.20	I	7483-36543	4	3638.02	I	15054-42534
16	3448.95	I	11447-40433	19	3640.64	I	12817-40277
10	3452.90	I	2092-31044	16	3646.11	I	12817-40235
7	3456.62	I	15054-43976	28	3650.32	I	8084-35471
7	3463.14	I	2092-30959	6	3652.32	I	2713-30085
26	3473.75	I	10655-39434	30	3654.40	I	16240-43597
24	3481.30	I	8044-36760	5	3660.81	I	16240-43549
13	3483.16	I	1191-29892	600	3661.35	I	1191-28495
13	3483.29	I	1191-29891	80	3663.37	I	7483-34773
13	3494.25	I	9058-37668	60	3669.49	I	12207-39451
13	3495.97	I	8771-37367	22	3678.32	I	2713-29892
850	3498.94	I	0-28572	4	3685.95	I	13646-40768
7	3502.42	I	8575-37119	24	3696.59	I	10624-37668
65	3514.49	I	2092-30537	10	3697.76	I	8771-35807
34	3519.64	I	1191-29595	12	3700.99	I	17097-44109
20	3528.68	I	2713-31044	2.5	3702.24	I	8044-35047
13	3531.39	I	9058-37367	10	3712.30	I	17046-43976
24	3532.81	I	14700-42998	5	3715.56	I	9058-35964
10	3535.37	I	1191-29468	10	3716.18	I	6545-33447
13	3535.83	I	9073-37347	38	3717.00	I	8575-35471
40	3537.95	I	2092-30348	24	3719.33	I	17097-43976
80	3539.37	I	2713-30959	16	3724.97	I	8044-34882
20	3541.63	I	6545-34773	5	3725.49	I	11753-38587
13	3550.27	I	2092-30250	50	3726.10	I	12207-39037
13	3553.85	I	11786-39917	800	3726.93	I	1191-28015
10	3556.63	I	11786-39895	1000	3728.03	I	0-26816
13	3564.56	I	9073-37119	650	3730.43	I	2092-28891
13	3567.16	I	13982-42007	8	3732.03	I	13646-40433
70	3570.59	I	15550-43549	8	3733.05	I	9184-35964
20	3574.58	I	8575-36543	26	3737.40	I	9058-35807
7	3579.77	I	2092-30018	5	3737.74	I	9492-36239
40	3587.20	I	16240-44109	4	3738.63	I	13699-40439
650	3589.22	I	3105-30959	10	3738.91	I	16240-42978
700	3593.02	I	2713-30537	38	3739.46	I	13699-40433
650	3596.18	I	2092-29891	320	3742.28	I	2713-29427
130	3599.76	I	8771-36543	80	3742.78	I	15550-42261
13	3605.64	I	9620-37347	26	3744.22	I	8771-35471
10	3608.73	I	9058-36760	38	3744.40	I	16240-42939
6	3616.95	I	9121-36760	260	3745.59	I	12207-38898
10	3619.20	I	12817-40439	70	3753.54	I	12817-39451
6	3620.28	I	13646-41260	28	3755.09	I	9184-35807
6	3623.64	I	10655-38243	80	3755.93	I	12817-39434
34	3625.20	I	10624-38200	110	3759.84	I	7483-34072
36	3626.74	I	17097-44662	34	3760.03	I	3105-29694
4	3627.29	I	13699-41260	55	3761.51	I	13699-40277



## Ruthenium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
55	3767.35	I	13699-40235	3	3894.24	I	11447-37119
5	3773.17	I	10624-37119	9	3897.24	I	9121-34773
140	3777.59	I	3105-29570	9	3898.36	I	8084-33729
14	3778.70	I	12817-39273	14	3901.24	I	1191-26816
42	3781.18	I	20056-46495	12	3908.76	I	14700-40277
55	3782.74	I	27289-53718	70	3909.08	I	13699-39273
360	3786.06	I	2713-29119	9	3912.11	I	9492-35047
550	3790.51	I	2092-28466	14	3914.85	I	8044-33580
22	3794.92	I	16191-42534	24	3920.92	I	8575-34072
		I	9620-35964	140	3923.47	I	12817-38297
8	3795.18	I	10624-36965	6	3924.63	I	20056-45529
70	3798.05	I	3105-29427	300	3925.92	I	0-25465
700	3798.90	I	1191-27507	55	3931.76	I	9620-35047
700	3799.35	I	0-26313			I	12817-38243
28	3800.26	I	8575-34882	28	3933.55	I	2092-27507
8	3803.20	I	20242-46528	11	3937.90	I	8044-33431
28	3808.68	I	14700-40949	6	3941.65	I	8084-33447
55	3812.72	I	12817-39037	8	3942.06	I	3105-28466
14	3814.86	I	15054-41260	6	3944.19	I	8084-33431
70	3817.27	I	15550-41739	70	3945.57	I	16240-41578
70	3819.03	I	2713-28891	3.5	3946.31	I	11786-37119
5	3819.77	I	11447-37620	6	3949.42	I	11447-36760
60	3822.09	I	16191-42347	11	3950.04	I	20056-45365
50	3824.93	I	10624-36760	42	3950.21	I	6545-31853
12	3828.71	I	8771-34882	14	3950.41	I	9073-34380
70	3831.80	I	12207-38297	6	3951.21	I	8771-34072
20	3835.05	I	14700-40768	28	3952.68	I	16191-41483
28	3838.07	I	8044-34091	3.5	3957.45	I	9620-34882
85	3839.70	I	12207-38243	42	3964.90	I	0-25214
14	3840.82	I	8044-34072	3.0	3969.79	I	10624-35807
8	3843.16	I	3105-29119	8	3974.50	I	8575-33729
44	3846.68	I	9058-35047	55	3978.44	I	8044-33172
70	3850.43	I	7483-33447	55	3979.42	I	1191-26313
12	3852.14	I	17046-42998	80	3984.86	I	8084-33172
44	3856.46	I	2092-28015	2.5	3987.80	I	16191-41260
120	3857.55	I	14700-40616	5	3993.53	I	9058-34091
20	3860.72	I	15054-40949	26	3995.98	I	9073-34091
60	3862.69	I	17097-42978	2.5	3996.51	I	9058-34072
12	3865.40	I	9184-35047	13	4005.64	I	8771-33729
120	3867.84	I	6545-32392	8	4006.60	I	9120-34073
24	3873.52	I	9073-34882	5	4007.54	I	14827-39774
3	3876.08	I	13982-39774	8	4008.27	I	13646-38587
9	3882.01	I	2713-28466	8	4013.50	I	7483-32392
12	3884.02	I	14700-40439	5	4021.00	I	15054-39917
9	3884.68	I	13699-39434	140	4022.16	I	8575-33431
9	3887.77	I	15054-40768	55	4023.83	I	1191-26036
14	3890.20	I	9184-34882	8	4031.00	I	6545-31346
6	3891.41	I	16191-41881	14	4032.20	I	2713-27507
60	3892.21	I	8044-33729	3.5	4037.74	I	9620-34380
3	3892.77	I	20242-45923	28	4039.21	I	14700-39451

## Ruthenium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
3.0	4040.48	I	22519-47262	14	4196.87	I	13982-37802
16	4045.76	I	17046-41756	50	4197.58	I	8575-32392
6	4049.41	I	15054-39742	50	4198.88	I	8044-31853
130	4051.40	I	8771-33447	700	4199.90	I	6545-30348
16	4052.20	I	9058-33729	140	4206.02	I	8084-31853
65	4054.05	I	8771-33431	17	4207.64	I	14828-38587
5	4062.85	I	20056-44662	500	4212.06	I	6545-30280
11	4062.99	I	13982-38587	70	4214.44	I	13646-37367
10	4064.10	I	9492-34091	85	4217.27	I	6545-30250
34	4064.46	I	8575-33172	34	4220.68	I	13982-37668
18	4067.61	I	16191-40768	10	4225.09	I	20242-43903
70	4068.37	I	14700-39273	7	4226.66	I	15054-38706
14	4071.40	I	13646-38200	17	4229.31	I	13982-37620
18	4073.00	I	9184-33729	50	4230.31	I	8575-32208
90	4076.73	I	9058-33580	14	4232.32	I	8771-32392
550	4080.60	I	6545-31044	10	4236.67	I	14700-38297
7	4082.79	I	11753-36239	70	4241.05	I	8771-32343
28	4085.43	I	16713-41183	70	4243.06	I	7483-31044
10	4091.06	I	17046-41483	10	4244.83	I	9620-33172
10	4097.03	I	8771-33172	17	4246.33	I	14700-38243
85	4097.79	I	9184-33580	34	4246.73	I	20056-43597
7	4100.37	I	2092-26473	3.5	4248.14	I	15054-38587
32	4101.74	I	9058-33431	28	4258.99	I	13646-37119
7	4102.28	I	7483-31853	7	4260.00	I	10624-34091
12	4107.84	I	14700-39037	3.0	4263.40	I	10624-34072
2.5	4109.65	I	9120-33447	7	4265.61	I	10655-34091
170	4112.74	I	8084-32392	3.0	4277.26	I	14827-38200
15	4113.38	I	16713-41017	3.5	4278.69	I	13982-37347
3.0	4114.13	I	8044-32343	4.0	4281.93	I	15550-38898
6	4118.50	I	1191-25464	7	4282.22	I	6545-29891
15	4120.99	I	8084-32343	70	4284.33	I	9058-32392
15	4123.06	I	9184-33431	17	4287.05	I	13646-36965
6	4123.81	I	16191-40433	20	4293.28	I	9058-32343
11	4127.44	I	2092-26313	24	4294.79	I	8575-31853
11	4127.87	I	13982-38200	50	4295.93	I	9121-32392
9	4137.23	I	8044-32208	340	4297.71	I	8084-31346
180	4144.16	I	8084-32208	85	4307.60	I	9183-32392
60	4145.74	I	9058-33172	3.5	4309.21	I	26036-49235
24	4146.77	I	9620-33729	10	4314.30	I	25214-48386
8	4148.38	I	9073-33172	7	4316.64	I	9184-32343
5	4150.30	I	9492-33580	34	4318.43	I	9058-32208
3.0	4159.17	I	16240-40277	50	4319.87	I	8044-31186
12	4161.66	I	13646-37668	3.5	4320.58	I	17097-40235
10	4166.88	I	6545-30537	3.0	4321.30	I	9073-32208
80	4167.51	I	9184-33172	3.0	4322.96	I	25201-48327
10	4170.05	I	13646-37620	16	4325.05	I	13646-36760
5	4175.43	I	20056-43999	16	4326.82	I	10624-33729
10	4182.46	I	17046-40949	10	4327.43	I	8084-31186
6	4182.64	I	7483-31385	9	4331.16	I	8771-31853
3.0	4189.46	I	7483-31346	3.5	4332.50	I	23453-46528

## Ruthenium — All Observed Lines

Intensity and Character	Wave- length in Å	Spec- trum	Energy Levels in K	Intensity and Character	Wave- length in Å	Spec- trum	Energy Levels in K
7	4336.42	I	7483-30537	6	4530.85	I	15054-37119
16	4337.27	I	6545-29595			I	20934-42998
3.0	4338.68	I	20934-43976	2.5	4543.69	I	9184-31186
4.0	4340.34	I	16240-39273	16	4547.33	I	7483-29468
3.5	4341.04	I	16713-39742	10	4547.85	I	13982-35964
50	4342.07	I	9184-32208	2.5	4549.43	I	8044-30018
10	4346.48	I	8044-31044	4	4549.96	I	23393-45365
32	4349.70	I	13982-36965	4	4552.11	I	8575-30537
65	4354.13	I	8084-31044	500	4554.51	I	6545-28495
13	4354.80	I	10624-33580	10	4559.98	I	9121-31044
80	4361.21	I	6545-29468	2.0	4562.60	I	15054-36965
3.0	4370.42	I	8084-30959	3.5	4564.69	I	9058-30959
6	4371.20	I	17046-39917	6	4580.07	I	11753-33580
220	4372.21	I	7483-30348	160	4584.44	I	8084-29891
3.0	4381.27	I	16191-39009	4	4587.10	I	11786-33580
9	4383.36	I	10624-33431	10	4591.10	I	9184-30959
80	4385.39	I	7483-30280	14	4592.52	I	10624-32392
120	4385.65	I	9058-31853	6	4596.71	I	23453-45022
9	4386.27	I	14827-37620	30	4599.08	I	10655-32392
2.5	4388.99	I	22419-45197	5	4601.76	I	11447-33172
160	4390.44	I	8575-31346	3.5	4605.66	I	15054-36760
8	4391.03	I	7483-30250	2.0	4612.32	I	8575-30250
3.0	4394.96	I	15550-38297	14	4635.69	I	9620-31186
16	4397.80	I	9121-31853	17	4645.09	I	20056-41578
3.5	4399.59	I	9620-32343	60	4647.61	I	8084-29595
3.0	4404.82	I	17046-39742	24	4654.32	I	9058-30537
150	4410.03	I	9184-31853	2.0	4669.14	I	14827-36239
6	4420.84	I	8771-31385	6	4669.98	I	7483-28891
15	4421.46	I	8575-31186	8	4674.65	I	11786-33172
3.5	4424.78	I	11786-34380	24	4681.79	I	9184-30537
30	4428.46	I	8771-31346	16	4684.02	I	8084-29427
42	4439.76	I	10655-33172	24	4690.11	I	8575-29891
8	4444.51	I	8044-30537	120	4709.48	I	9121-30348
40	4449.34	I	8575-31044	2.5	4720.92	I	16191-37367
100	4460.04	I	8771-31186	12	4731.33	I	9121-30250
2.0	4467.26	I	20242-42621	10	4733.52	I	8771-29891
17	4473.93	I	6545-28891	2.5	4738.40	I	
2.5	4479.41	I	13646-35964	3.0	4743.02	I	22519-43597
14	4480.45	I	15054-37367	6	4756.23	I	8575-29595
3.0	4482.03	I	11786-34091	42	4757.84	I	7483-28495
8	4488.39	I	8771-31044	1.8	4764.40	I	27507-48490
5	4490.24	I	8084-30348	8	4769.30	I	6545-27507
4	4491.68	I	13982-36239	1.8	4773.15	I	11447-32392
32	4498.14	I	9121-31346	3.0	4774.00	I	20242-41183
11	4510.10	I	8084-30250	4	4784.27	I	11447-32343
8	4511.20	I	13646-35807	3.0	4794.38	I	8575-29427
20	4516.89	I	11447-33580	3.0	4795.57	I	8044-28891
20	4517.82	I	9058-31186	4	4798.44	I	9058-29892
10	4520.95	I	9073-31186	5	4804.88	I	8084-28891
				1.6	4806.19	I	

## Ruthenium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
22	4815.52	I	11447-32208	14	5195.02	I	8771-28015
1.6	4817.34	I	15054-35807	6	5199.87	I	29160-48386
6	4833.00	I		3.5	5202.12	I	20056-39273
4	4839.01	I	26313-46972	3.5	5213.43	I	28495-47671
1.6	4839.77	I	8771-29427	5	5223.55	I	12207-31346
10	4844.56	I	9058-29694	3.0	5242.38	I	10624-29694
2.0	4854.56	I	26313-46906	4	5251.67	I	12817-31853
7	4861.87	I	10624-31186	3.0	5257.07	I	30537-49554
46	4869.15	I	7483-28015	3.0	5266.47	I	20934-39917
6	4895.32	I	8044-28466	3.0	5266.83	I	20056-39037
12	4895.60	I	10624-31044	3.0	5280.82	I	8575-27507
6	4899.25	I	11447-31853	10	5284.08	I	6545-25465
36	4903.05	I	10655-31044	3.0	5291.16	I	9121-28015
3.0	4905.02	I	8084-28466	6	5304.86	I	9620-28466
9	4907.89	I	9058-29427	20	5309.27	I	7483-26313
20	4921.07	I	8575-28891	1.0	5315.33	I	20934-39742
14	4938.43	I	9184-29427	3.0	5332.93	I	13646-32392
7	4955.26	I	26816-46991	3.5	h 5334.70	I	
3.5	4959.86	I	26816-46972	8	5335.93	I	8771-27507
12	4968.90	I	8771-28891	10	5361.77	I	
2.5	4974.12	I	22162-42261	5	5377.84	I	28495-47085
7	4976.20	I	26816-46906	5	5385.88	I	13646-32208
12	4980.35	I	9620-29694	8	h 5401.04	I	
4	4983.45	I	9058-29119	3.0	5401.39	I	13699-32208
4	4987.26	I	9073-29119	3.0	5418.86	I	9058-27507
9	4992.74	I	7483-27507	4	5427.59	I	28572-46991
12	5011.23	I	9620-29570	2.0	l 5439.21	I	
7	5014.95	I	9184-29119	1.0	5452.71	I	28572-46906
7	5026.18	I	8575-28466	6	h 5454.82	I	31186-49513
5	5028.16	I	10655-30537	7	5456.13	I	9184-27507
2.5	5040.35	I	20934-40768	1.0	h 5475.18	I	31346-49605
2.5	5040.74	I	9058-28891	4	5479.40	I	31346-49591
5	5047.31	I	9620-29427	2.0	5480.30	I	30280-48522
34	5057.33	I	6545-26313	6	5484.32	I	8084-26313
1.6	5062.64	I	13982-33729	1.4	5484.64	I	12817-31044
7	5072.97	I	9184-28891	2.0	5496.69	I	20056-38243
9	5076.32	I	10655-30348	1.0	5501.02	I	30348-48522
15	5093.83	I	9492-29119	10	5510.71	I	12207-30348
6	5107.07	I	12817-32392	1.5	5512.37	I	30250-48386
1.8	5123.73	I	11447-30959	0.6	5517.86	I	15054-33172
4	5127.26	I	9620-29119	0.9	5521.78	I	31186-49291
5	5133.89	I	13699-33172	0.9	5530.99	I	20934-39009
40	5136.55	I	8044-27507	1.8	5540.66	I	12207-30250
13	5142.76	I	8575-28015	0.9	5556.52	I	8044-26036
19	5147.24	I	8084-27507	7	5559.75	I	7483-25465
8	5151.07	I	9058-28466	0.8	5569.03	I	8084-26036
4	5153.20	I	11786-31186	1.6	5578.40	I	
38	5155.14	I	9073-28466	1.6	5603.14	I	10624-28466
4	5160.00	I	9121-28495	0.6	5603.55	I	
70	5171.03	I	7483-26816	1.0	5606.73	I	29160-46991

Ruthenium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
0.8	5629.79	I	22519-40277	1.4	6730.45	I	16191-31044
22	5636.24	I	8575-26313	0.7	6756.54	I	32392-47188
0.8	5641.66	I	12817-30537	2.0	6766.95	I	29119-43892
0.5	5649.56	I	9121-26816	3.0	6775.02	I	17097-31853
0.5	5653.30	I	12207-29891	1.2	6787.23	I	15550-30280
0.8	5665.20	I	13699-31346	0.8	6813.51	I	22293-36965
1.2	5679.63	I	22293-39894	1.4	6823.88	I	29694-44344
14	5699.05	I	8771-26313	2.0	6824.17	I	28466-43116
1.0	5724.82	I	12817-30280	0.7	6831.52	I	25643-40277
1.0	5725.73	I	8575-26036	3.0	6911.48	I	29427-43892
1.2	5745.99	I	13646-31044	12	6923.23	I	26816-41256
1.2	5747.47	I	21643-39037	3.0	6982.01	I	27507-41825
0.8	5752.02	I	8084-25465	3.0	7027.98	I	28891-43116
0.8	5756.83	I	11753-29119	1.0	7086.06	I	16240-30348
0.8	5767.92	I	11786-29119	1.4	7087.35	I	12207-26313
1.2	5804.39	I	23393-40616	0.4	7141.72	I	17046-31044
5	5814.98	I	9121-26313	0.7	7219.26	I	25603-39451
0.6	5828.06	I	15054-32208	4.0	7238.92	I	28015-41825
1.2	h 5833.21	I	30348-47487	0.8	7266.96	I	
4	5919.34	I	8575-25465	0.9	7323.56	I	16240-29891
6	5921.45	I	10624-27507	1.8	7393.93	I	29595-43116
1.6	5926.87	I	16713-33580	2.0	7468.91	I	30959-44344
2.0	5932.38	I	9184-26036	1.4	7475.40	I	
0.6	5936.65	I	30348-47188	3.0	7485.79	I	30537-43892
0.6	5951.15	I	15054-31853	8	7499.75	I	28495-41825
1.6	h 5973.38	I	30348-47085	0.8	7532.07	I	24927-38200
0.6	5974.17	I	20934-37668	3.0	7559.61	I	29891-43116
1.2	5988.67	I	8771-25465	0.6	7612.94	I	31044-44176
2.5	5993.65	I	11786-28466	2.0	7621.50	I	31853-44970
1.4	6116.77	I	9121-25465	2.0	7722.87	I	15550-28495
2.0	6199.42	I	17046-33172	0.6	7729.91	I	30959-43892
2.0	6225.20	I	11447-27507	2.5	7791.86	I	31346-44176
0.7	6284.49	I	22293-38200	0.5	7797.89	I	
1.4	6295.22	I	23393-39273	0.5	7806.82	I	37367-50173
1.0	6330.62	I	25465-41256	0.3	7813.43	I	20934-33729
0.7	6336.12	I	22519-38297	0.5	h 7829.81	I	30250-43019
0.7	h 6363.41	I	28466-44176	0.6	h 7833.39	I	32208-44970
0.7	6376.45	I	12817-28495	0.7	h 7841.90	I	36543-49291
1.2	6390.23	I	23393-39037	3.5	7847.80	I	30280-43019
0.6	6417.57	I	34773-50351	9	7881.49	I	28572-41256
2.0	h 6444.84	I	27507-43019	1.8	7890.37	I	30348-43019
0.6	6496.44	I	27507-42895	1.8	7924.43	I	30280-42896
0.8	6528.74	I		0.6	7948.15	I	32392-44970
0.3	6560.45	I	23005-38243	1.0	7967.84	I	30348-42895
0.3	6593.74	I	17046-32208	1.0	8112.47	I	31853-44176
0.7	6618.20	I	16240-31346	2.0	8264.96	I	29161-41256
2.0	6663.14	I	28015-43019	1.2	8348.98	I	31044-43019
5	6690.00	I	26313-41256	0.7	8352.94	I	32208-44176
1.0	6707.52	I	23393-38297	0.4	8435.77	I	31044-42895
1.4	6718.30	I	28015-42895	1.2	8473.64	I	33172-44970

Ruthenium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
1.2	8483.56	I	32392-44176	1.6	8724.98	I	20934-32392
2.5	8710.84	I	30348-41825	1.0	8777.36	I	33580-44970

# SAMARIUM

Sm,  $Z=62$ ,  $M=150.35$ , Ratio  $\frac{\text{Sm}}{\text{Cu}}$  2.366

Sm I Normal state of valence electrons  $4f^6 6s^2 {}^7F_0 = 0$ . I.P. = 45000 K  
 Sm II Normal state of valence electrons  $4f^6 6s^1 {}^8F_{0\frac{1}{2}} = 0$ . I.P. = 92000 K

## References

### Wavelengths:

- A. Gatterer and J. Junkes, Spektren der Seltenen Erden (Specola Vaticana, Vatican, 1945), below 2900 Å.  
 A. S. King, Astrophys. J. **82**, 140 (1935), above 2900 Å.

### Classification:

- Sm I, W. Albertson, Phys. Rev. **47**, 370 (1935).  
 F. W. Paul, Phys. Rev. **49**, 156 (1936) (Spectrum assignment only).  
 W. Albertson, Phys. Rev. **52**, 644 (1937).  
 Sm II, W. Albertson, Astrophys. J. **84**, 26 (1936).

## Relative intensity of samarium lines observed in an arc of copper containing 0.1 atomic percent of samarium

### *Strong lines of samarium*

Intensity	Wavelength Å	Spectrum	Energy levels K	Term combination
350	3568.27	II	3910-31926	$4f^6 6s a {}^8F_{6\frac{1}{2}} - {}^8G_{7\frac{1}{2}}$
350	3592.60	II	3053-30880	$4f^6 6s a {}^8F_{5\frac{1}{2}} - {}^8G_{6\frac{1}{2}}$
280	3609.49	II	2238-29935	$4f^6 6s a {}^8F_{4\frac{1}{2}} - {}^8G_{5\frac{1}{2}}$
280	3634.29	II	1489-28997	$4f^6 6s a {}^8F_{3\frac{1}{2}} - {}^8G_{4\frac{1}{2}}$
280	3885.29	II	3910-29641	$4f^6 6s a {}^8F_{6\frac{1}{2}} - 4f^6 6p \quad 115_{6\frac{1}{2}}$
220	3739.12 3739.20 3854.21	II	327-27063	$4f^6 6s a {}^8F_{1\frac{1}{2}} - {}^8G_{1\frac{1}{2}}$
200		II		
200		II		
180	4424.34	II	3910-26506	$4f^6 6s a {}^8F_{6\frac{1}{2}} - 4f^6 6p \quad 56_{5\frac{1}{2}}$
180	3661.36	II	327-27631	$4f^6 6s a {}^8F_{1\frac{1}{2}} - {}^8G_{2\frac{1}{2}}$
180	3670.84	II	838-28073	$4f^6 6s a {}^8F_{3\frac{1}{2}} - {}^8G_{3\frac{1}{2}}$
170	3922.40	II	3053-28540	$4f^6 6s a {}^8F_{5\frac{1}{2}} - 4f^6 6p \quad 98_{5\frac{1}{2}}$
160	3731.26	II	838-27631	$4f^6 6s a {}^8F_{2\frac{1}{2}} - {}^8G_{2\frac{1}{2}}$
150	4280.79	II	3910-27263	$4f^6 6s a {}^8F_{6\frac{1}{2}} - 4f^6 6p \quad 75_{7\frac{1}{2}}$
150	4467.34	II	5318-27696	$4f^6 6s a {}^6F_{5\frac{1}{2}} - 4f^6 6p \quad 84_{5\frac{1}{2}}$
140	3306.39	II	3910-34145	$4f^6 6s a {}^8F_{6\frac{1}{2}} - 162_{6\frac{1}{2}}$
140	3604.28	II	3910-31646	$4f^6 6s a {}^8F_{6\frac{1}{2}} - 128_{7\frac{1}{2}}$
140	3621.23	II	838-28445	$4f^6 6s a {}^8F_{2\frac{1}{2}} - 97_{3\frac{1}{2}}$
140	3760.69	II	1489-28072	$4f^6 6s a {}^8F_{3\frac{1}{2}} - {}^8G_{3\frac{1}{2}}$
130	3928.28	II	1489-26938	$4f^6 6s a {}^8F_{3\frac{1}{2}} - 66_{3\frac{1}{2}}$
130	4118.55	II	5318-29591	$4f^6 6s a {}^6F_{5\frac{1}{2}} - 114_{4\frac{1}{2}}$
130	4318.94	II	2238-25385	$4f^6 6s a {}^8F_{4\frac{1}{2}} - 4f^6 6p \quad 38_{5\frac{1}{2}}$
120	3728.47	II	5318-32131	$4f^6 6s a {}^6F_{5\frac{1}{2}} - 143_{6\frac{1}{2}}$
120	3735.98	II	2238-28997	$4f^6 6s a {}^8F_{4\frac{1}{2}} - {}^8G_{4\frac{1}{2}}$
120	3793.97	II	838-27188	$4f^6 6s a {}^8F_{2\frac{1}{2}} - 4f^6 6p \quad 73_{3\frac{1}{2}}$
120	3797.73	II		
120	3826.20	II	4386-30514	$4f^6 6s a {}^6F_{4\frac{1}{2}} - 127_{4\frac{1}{2}}$
120	3843.50	II	3499-29510	$4f^6 6s a {}^6F_{3\frac{1}{2}} - 113_{3\frac{1}{2}}$
120	3896.98	II	327-25980	$4f^6 6s a {}^8F_{1\frac{1}{2}} - 4f^6 6p \quad 47_{3\frac{1}{2}}$
120	4329.02	II	1489-24583	$4f^6 6s a {}^8F_{3\frac{1}{2}} - 4f^6 6p \quad 24_{2\frac{1}{2}}$
120	4434.32	II	3053-25598	$4f^6 6s a {}^8F_{5\frac{1}{2}} - 4f^6 6p \quad 43_{4\frac{1}{2}}$
110	3788.12	II	2003-28394	$4f^6 6s a {}^6F_{1\frac{1}{2}} - 95_{3\frac{1}{2}}$
110	4296.74	I	4021-27288	$4f^6 6s^2 a {}^7F_6 - 4f^6 6s 6p \quad z {}^7G_7$
110	4390.86	II	1489-24257	$4f^6 6s a {}^8F_{3\frac{1}{2}} - 4f^6 6p \quad 21_{4\frac{1}{2}}$
110	4433.88	II	3499-26046	$4f^6 6s a {}^6F_{3\frac{1}{2}} - 4f^6 6p \quad 49_{4\frac{1}{2}}$
110	4674.60	II	1489-22875	$4f^6 6s a {}^8F_{3\frac{1}{2}} - 4f^6 6p \quad 12_{3\frac{1}{2}}$

Samarium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
2.5	2610.07	I		10	3034.84	II	
5	2640.27			7	3039.13	II	
2.0	2649.17			8	3046.93	II	
3.0	2657.68			3.0	3050.80	II	
5	2662.42	I		6	3065.78	II	327-32935
8	2675.15			10	3067.54		
7	2688.60			8	3071.29	II	
3.0	2690.90			7	3086.45	II	
9	2693.34			6	3096.68	II	1489-33773
3.0	2693.74	I		8	3096.88	II	
4	2696.08			7	h 3102.30	II	
6	2707.96			17	3106.52	II	2238-34419
3.5	2732.42	I		15	3110.20	II	
2.5	2739.87			4	3115.05	II	2238-34331
2.0	2762.28			14	3117.72	II	
2.5	2764.18			7	3134.18	II	
6	2767.85			22	3136.30	II	
4	2774.77	I		12	3139.97	II	
6	2776.11			7	3143.30	II	
6	2779.23			12	3147.19	II	2689-34454
6	2786.64			15	3152.10	II	3053-34768
10	2789.38			34	3152.52	II	
9	h 2796.70			7	3162.15	II	2238-33853
6	2807.36			12	3162.30	II	
10	2809.50			30	3169.88	II	2238-33776
8	2810.86			7	3170.21	II	2238-33773
6	2817.20			15	3178.12	II	1489-32945
2.0	2820.96			60	3183.92	II	
15	2830.94			7	3186.02	II	
4	2840.30			26	3187.01	II	1489-32858
4	2847.49			36	3187.22	II	3053-34419
4	2851.35			30	3187.79	II	2238-33599
8	2866.09	I		7	3188.72	II	2689-34040
5	2868.40			30	3193.01	II	
5	2881.34			30	3196.18	II	3053-34331
6	2881.68	I		12	3201.80	II	
4	2883.09			12	3204.90	II	2689-33882
3.0	2889.06			30	3207.18	II	0-31171
4	2891.34			15	3208.17	II	
6	d 2907.88			50	3211.73	II	
	2907.99						
9	2910.28	II		12	3214.12	II	2003-33107
6	2937.48	II		22	3215.26	II	3053-34145
5	2943.49	II		44	3216.85	II	838-31916
10	2953.19	II		50	3218.61	II	
				12	3219.43	II	
6	2962.74	II		22	3226.86	II	
11	2969.02	II		15	3228.50	II	
7	2983.43	II		22	3228.78	II	4386-35349
4	2991.57	II		60	3230.56	II	1489-32435
7	3021.01			30	3231.53	II	838-31775



## Samarium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
12	3231.95	II	2003-32935	7	3319.56	II	
36	3233.68	II		36	3320.16	II	1489-31600
60	3236.64	II		9	3320.59	II	
12	3237.89	II	3499-34375	100	3321.18	II	3053-33154
60	3239.66	II	3910-34768	28	3323.77	II	
44	3241.16	II	327-31171	28	3325.26	II	
15	3241.59	II	1518-32359	14	3325.48	II	
15	3242.04	II		28	3327.88	II	
12	3244.69	II		7	3329.62	II	3910-33935
7	3245.80	I	1490-32290	7	3332.70	II	2689-32686
20	3249.75	II		14	3333.64	II	4386-34375
60	3250.37	II	0-30757	7	3335.03	II	
30	3253.40	II		14	3336.12	II	2238-32204
22	3253.94	II	3053-33776	70	3340.58	II	327-30253
70	3254.38	II	327-31045	7	3341.43	II	838-30757
9	3255.63	II	2238-32945	20	3343.49	II	
7	3258.25	II	2003-32686	9	3343.64	II	
30	3262.28	II	2689-33333	20	3344.35	II	3053-32945
36	3264.94	II	2238-32858	7	3346.35	II	5318-35192
15	3270.49	II		7	3346.91	II	
15	3270.68	II		14	3347.30	II	3910-33776
36	d 3272.48	II		20	3348.68	II	
	3272.60	II		18	3350.88	II	
36	3272.81	II	3052-33599	34	d 3354.18	II	3053-32858
7	3273.32	II	3499-34040		3354.30	II	
36	3273.48	II		14	3354.72	II	
7	3275.87	II	1489-32007	7	3361.43	II	
36	3276.75	II	3910-34419	7	3364.80	II	
22	3280.84	II		100	3365.86	II	
15	3285.66	II	1489-31916	12	3367.27	II	3910-33599
36	3286.23	II	3910-34331	28	3368.57	II	2238-31916
7	3286.54	II	2689-33107	7	3369.04	II	
60	d 3290.28	II		28	3369.46	II	2689-32359
	3290.39	II	3499-33882	14	3370.59	II	327-29986
15	3290.65	II		28	3371.21	II	4386-34040
20	3293.37	II	2003-32359	12	3376.48	II	3499-33107
30	3295.44	II		6	3377.81	II	2003-31600
36	3295.81	II	838-31171	100	3382.40	II	1489-31045
60	3298.10	II		42	3384.66	II	3053-32589
14	3300.98	II	1489-31775	12	3384.86		
28	3301.68	II	3910-34189	5	3385.39	II	2238-31768
28	3304.52	II	0-30253	12	3387.66	II	
28	3305.18	II	2689-32935	34	3389.32	II	4386-33882
140	3306.39	II	3910-34145	12	3391.11	II	1489-30969
14	3306.61	II		34	3396.19	II	3499-32935
70	3307.02	II		12	3397.76	II	
28	3309.52	II	838-31045	12	3399.84	II	
70	3310.66	II	2238-32435	50	3402.46	II	3053-32435
50	3312.42	II	1489-31670	17	3403.09	II	
34	3316.58	II		70	3408.68	II	

## Samarium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
7	3411.30	II		10	3552.30	II	0-28143
7	3413.90	II	2238-31522	20	3554.15	II	2689-30817
22	3418.15	II		14	3556.74	II	2238-30346
36	3418.51	II	3910-33154	14	3557.38	II	327-28429
14	3419.77	II		42	3559.10	II	
10	3424.78	II		7	3560.27	II	
14	3426.20	II		14	3561.59	II	
7	3427.97	II		18	3566.84	II	
8	3429.75	II	838-29986	350	3568.27	II	3910-31926
14	3433.68	II		22	3577.79	II	0-27942
5	3435.27	II	5318-34419	7	3579.67		
12	3437.10	II	2689-31775	32	3580.94	II	
14	3438.06	II	3053-32131	7	3582.67	II	
20	3440.50	II	5318-34375	26	3583.39	II	1489-29388
7	3444.62	II		14	3584.26	II	838-28730
6	3449.56	II	2689-31670	14	3585.83		
7	3452.78	II	3053-32007	11	3587.46	II	
14	3453.56	II		7	3589.50		
7	3454.97	II	3499-32435	7	3591.74	II	838-28672
14	3459.20	II		350	3592.60	II	3053-30880
10	3459.42	II		7	3593.73	II	4386-32204
20	3461.14	II		28	3601.69	II	1489-29246
7	3462.69	II	5318-34189	140	3604.28	II	3910-31646
10	3464.07	II		280	3609.49	II	2238-29935
6	3464.43	II	1489-30346	9	3612.43	II	
14	3467.87	II	5318-34145	14	3613.58	II	
11	3473.96	II	3053-31830	11	3615.24	II	2003-29656
11	3479.53	II	2238-30969	14	3620.10	II	327-27942
11	3480.26	II		20	3620.58	II	3910-31522
14	3480.56	II		140	3621.23	II	838-28445
14	3487.41	II		14	3622.50	II	327-27924
7	3492.62	II	1489-30113	20	3623.32	II	838-28429
14	3493.61	II		70	3627.01	II	2238-29801
5	3495.92	II		14	3627.97	II	838-28394
18	3499.84	II		14	3630.67	II	
14	3500.54	II	4386-32945	70	3631.13	II	
10	3506.85	II	3499-32007	280	3634.29	II	1489-28997
10	3507.09	II		20	3634.93	II	327-27830
11	3509.10	II		10	3636.06	II	
28	3511.23	II	838-29310	34	3638.77	II	
14	d 3512.93	II	5318-33776	14	3642.76	II	4386-31830
	3513.06	II		30	3645.29	II	1489-28914
7	3516.30			25	3645.39	II	2689-30113
11	3523.12	II		14	3645.90	II	1518-28939
7	3525.51	II	2689-31045	7	3647.29	II	
26	3530.60	II	1489-29805	55	3649.53	II	3053-30446
18	3532.57	II		28	3650.19	II	2003-29391
22	3535.65	II	3499-31775	14	3651.00	II	4386-31768
7	3536.77	II		11	3654.86	II	2238-29591
7	3542.46	II	3910-32131	28	3656.22	II	

## Samarium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
14	3659.62	II	3499-30817	14	3738.27	II	
180	3661.36	II	327-27631	220	3739.12	II	
14	3662.27	II	2689-29986		3739.20	II	327-27063
18	3662.69	II		60	3741.29	II	
14	3662.90	II	3053-30346	90	3743.87	II	2689-29391
28	3667.93	II	2238-29494	70	3745.46	I	1490-28181
28	3670.68	II			3745.60	II	0-26690
180	3670.84	II	838-28073	36	3747.62	II	2238-28914
14	3674.07	II	0-27210	12	d 3748.52	I	293-26962
28	3677.79	II			3748.63	II	2003-28672
11	3680.98	I	3125-30284	6	3750.66	II	
22	3681.73	II		12	3751.57	II	327-26974
7	3687.10	II		1.6	3753.09	II	
22	3688.42	II	838-27942	12	3754.86	II	1518-28143
7	3690.08	I	2273-29365	60	3755.28	II	2689-29310
7	3690.93	II	838-27924	60	3756.41	I	812-27426
22	3692.22	II	2238-29314			II	3499-30113
10	3692.76	II		22	3756.53	II	
85	3693.99	II	0-27063	90	3757.53	II	
14	3694.30	II		34	3758.45	II	0-26599
22	3700.60	II	3499-30514	50	3758.97	II	
22	3700.92	II		26	3760.04	II	3053-29641
8	3701.56	II	2238-29246	140	3760.69	II	1489-28072
36	3706.75	II	3910-30880	50	3762.59	II	2003-28513
36	3706.98	II		85	3764.37	II	2689-29246
8	3707.17	II	2689-29656	10	3765.43	II	
36	3708.41	II	327-27285	36	3767.36	II	3910-30446
70	3708.65	II	1489-28445	36	3767.76	II	
10	3709.52	II		10	3770.73	II	5318-31830
12	3710.87	II	1489-28429	6	3771.35	II	
36	3711.54	II	2003-28939	16	d 3772.64	II	
18	3712.11	II		28	3773.33	I	
26	3712.76	II	2003-28930		3773.42	II	1518-28012
70	3718.88	II	3053-29935	22	3774.29	II	2238-28726
10	3720.57	II		14	3774.68	II	0-26485
7	3721.03	I	1490-28356	7	3777.08	II	
70	3721.85	II		10	3777.84	II	
3.0	3724.02	II		85	3778.14	II	
32	3724.90	II	327-27165	10	3779.56	II	5318-31768
1.4	3726.24	II		50	3780.76	II	
14	3726.80	II	1489-28314	32	3780.93	II	3053-29494
4	3727.38	II	2689-29510	7	3782.42	II	4386-30817
120	3728.47	II	5318-32131	3.5	3782.68	I	
7	3728.93	II		7	3783.06	II	2003-28429
16	3729.75	II		10	3783.36	II	1518-27942
4	3730.74	I	2273-29070	14	3785.35	II	
160	3731.26	II	838-27631	24	3787.20	II	327-26724
120	3735.98	II	2238-28997	110	3788.12	II	2003-28394
60	3737.14	II		20	3791.28	II	
24	3737.48	II	3053-29801	20	3792.02	II	327-26690

## Samarium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
120	3793.97	II	838-27188	14	3858.52	I	1490-27399
32	3797.28	II	838-27165	30	3858.74	I	2273-28181
120	3797.73	II		50	3862.05	II	838-26724
38	3799.54	II	1518-27830	26	3862.23	II	2689-28573
20	3800.37	II	3499-29805	14	h 3863.42	II	
60	3800.89	II	2238-28540	11	3864.05	II	
12	3803.94	I	0-26281	24	3865.24	II	327-26191
24	3805.63	II	838-27108	6	3865.69	II	3053-28914
2.0	3806.04	II		60	3871.78	II	1489-27310
14	3806.47	I	4021-30284	10	3873.22	II	3499-29310
10	3806.77	II	3053-29314	14	3873.47	II	
14	3807.92	II	0-26254	2.0	3874.39	II	
32	3808.46	II	2689-28939	30	3875.19	II	
24	3809.75	II	2689-28930	42	3875.54	II	1489-27285
24	3809.88	II	838-27078	12	3877.20	II	
32	3810.43	II		18	3877.49	I	4021-29803
38	3812.07	II	838-27063	60	3880.77	II	838-26599
36	3813.63	II		34	3881.38	II	2689-28445
8	3813.83	I	4021-30234	34	3881.79	II	
32	3814.63	II	2238-28445	24	3882.50	II	
3.5	3818.36	I	1490-27671	2.0	3883.80	II	2689-28429
70	d 3820.82			280	3885.29	II	3910-29641
40	3824.18	II	1489-27631	18	3885.91	II	4386-30113
120	3826.20	II	4386-30514	5	3887.11	II	
10	3826.56	II		50	3889.16	II	2689-28394
					3889.22	II	
18	3828.05	II		46	3890.08	II	1489-27188
40	3830.29	II	838-26938	24	3891.21	II	1518-27210
85	3831.50	II	3499-29591	30	3894.05	II	3053-28726
8	3832.81	I	2273-28356	3.5	3895.09	II	
40	3833.83	II	2238-28314	3.5	3895.42	II	
42	3834.48	I	4021-30093	120	3896.98	II	327-25980
42	3834.60	II		3.5	3897.26	II	5318-30969
28	3835.72	II	1489-27553	20	3900.89	II	2003-27631
38	3838.94	II	2689-28730	5	3902.32	II	1489-27108
30	3840.45	II	327-26358	100	3903.42	II	
6	3840.61	II		4	3906.81	II	1489-27078
20	3842.36	II	2238-28256	6	3909.95	I	3125-28694
120	3843.50	II	3499-29510	6	3910.09	II	2689-28256
20	3843.77	II	2003-28012	3.5	3910.92	II	5318-30880
8	h 3844.50	II	1489-27493	8	3912.98	II	4386-29935
5	3846.28	I		8	3913.37	II	
12	3846.76	I	293-26281	6	3913.62	II	
40	3847.51	II	2689-28672	4	3916.36	II	
48	3848.78	II		42	3917.44	II	838-26358
32	3851.88	II	2238-28192	13	3918.62	II	1489-27001
40	3853.30	I	3125-29070	3.5	3920.10	II	
200	3854.21	II		13	3922.05	II	2003-27493
36	3854.56	I	1490-27426	170	3922.40	II	3053-28540
60	3855.90	II	327-26254	6	3922.70	II	1489-26974
36	3857.91	II	2238-28151				

## Samarium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
20	3925.22	I	812-26281	19	4003.46	II	2003-26974
130	3928.28	II	1489-26938	6	4003.72	II	
2.5	3931.16	II	3499-28930	3.5	4004.26	II	1518-26485
6	3932.97	II	4386-29805	13	4006.60	II	838-25790
20	3933.58	II	4386-29801	6	4006.82	II	2238-27188
3.5	3935.18	II	3910-29314	32	4007.48	II	3499-28445
32	3935.76	II	2238-27638	10	4008.10	II	2689-27631
20	3937.06	II		10	4008.33	II	
2.0	3938.43	II	2689-28073	6	4011.73	II	0-24920
3.5	3939.64	II	838-26214	4	4015.77	II	3499-28394
85	3941.87	II	0-25361	8	4019.84	II	2238-27108
42	3943.24	II	838-26191	19	4019.98	II	1489-26358
34	3946.51	II	1489-26821	6	4022.73	II	327-25178
20	3947.84	II	2689-28012	60	4023.23	II	327-25175
50	3948.11	II	838-26160	10	4032.98	II	
3.5	3949.85	I	2273-27583	50	4035.11	II	2689-27464
32	3951.89	I		12	4037.10	II	2238-27001
8	3954.20	II	1489-26772	10	4038.10	II	3499-28256
2.0	3954.97			40	4041.68	II	1518-26254
3.5	3957.52	II		50	4042.72	II	327-25056
8	3958.72	II	2689-27942	60	4042.90	II	838-25566
25	3959.53	II		16	4044.11	II	
13	3961.80	II		38	4045.05	II	838-25553
6	3962.13	I		30	4046.16	II	838-25546
6	3962.24	II	3499-28730	50	4047.16	II	1489-26191
100	3963.00	II		7	4047.35	II	2238-26938
42	3966.04	II	2003-27210	14	4048.62	II	3499-28192
6	3966.34	II	4386-29591	5	4049.58	II	2003-26690
32	3967.68	II	5318-30514	40	4049.81	II	0-24686
50	3970.53	II	0-25178	30	4058.87	II	3910-28540
100	3971.40	II	3499-28672	38	4063.54	II	327-24929
13	3974.45	II		19	4064.32	II	
42	3974.66	I	2273-27426	95	4064.58	II	2689-27285
11	3975.22	II	2238-27387	55	4066.74	II	2238-26821
65	3976.27	II	838-25980	48	4068.33	II	3499-28073
70	3976.43	II	2689-27830	55	4075.84	II	4386-28914
65	3979.20	II	4386-29510	19	4076.65	II	838-25361
3.5	3980.88	II		6	4076.86	II	327-24848
50	3983.14	II	3053-28151	7	4079.83	I	2273-26777
10	3986.00	II	1518-26599	16	4080.56	II	2689-27188
2.0	3986.21	II		9	4081.97	II	1489-25980
50	3986.68	II	1489-26566	28	4082.60	II	5318-29805
10	3986.90	II		6	4083.24	II	5318-29801
25	3987.43	II	2238-27310	19	4083.58	II	2003-26485
100	3990.00	II	0-25056	15	4084.40	II	2689-27165
	3990.02	I	3125-28181				
10	3991.02	I		3.0	4086.16		
50	3993.31	II	327-25361	2.0	4089.48		
6	3995.59	II		70	4092.27	II	0-24430
13	3998.35	I		3.5	4093.04	II	3499-27924
				20	4094.05	II	2689-27108

## Samarium — All Observed Lines

Intensity and Character	Wave-length in A	Spectrum	Energy Levels in K	Intensity and Character	Wave-length in A	Spectrum	Energy Levels in K
8	4098.97	II	2689-27078	11	4192.16	II	838-24686
4	4099.96	I		3.0	4197.90	II	1489-25304
16	4104.13	II	327-24686	18	4199.45	II	4386-28192
6	4106.62	II	4386-28730	1.8	4201.22	II	2689-26485
55	4107.28	II	838-25178	44	4202.92	II	3910-27696
	4107.39	II	4386-28726				
4	4107.80	II	838-25175	75	4203.05	II	3499-27285
9	4108.32	II	3053-27387	3.5	4204.82	II	3053-26828
28	4109.40	II	2238-26566	11	4205.78	I	
19	4110.19	II	5318-29641	45	4206.13	II	3053-26821
				18	4206.62	II	4386-28151
28	4113.90	II	1489-25790	45	4210.35	II	838-24583
13	4116.46	II	2689-26974	7	4213.05	II	3910-27639
130	4118.55	II	5318-29591	1.8	4213.94	II	
10	4119.57	II	2238-26506	7	4218.63	I	
28	4121.36	II	3053-27310	3.5	4219.31	I	293-23986
8	4121.54	II	327-24583	12	4220.14	II	3499-27188
19	4122.51	II	2003-26254	50	4220.66	II	4386-28072
48	4123.96	II	3910-28151	10	4223.70	II	2689-26358
4	4125.23	I		3.5	4224.23	II	3499-27165
6	4125.85	II		70	4225.33	II	1518-25178
2.0	4128.12			10	4226.18	I	812-24467
19	4129.23	II	2003-26214	50	4229.70	II	327-23962
7	4133.19	II	2003-26191	3.5	4230.73	I	0-23630
17	4135.14	II	5318-29494	42	4234.57	II	3499-27108
3.0	4135.50	I	1490-25664	80	4236.74	II	5318-28914
3.5	4138.97	II	4386-28540	34	4237.66	II	838-24430
5	4142.81	II		3.0	4240.45	I	1490-25065
5	4145.24	I		42	4244.70	II	2238-25790
11	4146.75	II	1489-25598	8	4245.18	II	2003-25553
22	4147.71	II	327-24430	3.5	4247.39	II	1518-25056
55	4149.83	II	838-24929	14	4249.55	II	2689-26214
80	4152.21	II	1489-25566	17	4251.78	II	3053-26566
36	4153.33	II	5318-29388	4	4253.72	II	3499-27001
38	4155.22	II	4386-28445	140	4256.39	II	3053-26540
9	4156.25	II	3499-27553	14	4258.58	II	3499-26974
7	4159.40	II	1518-25553	3.5	4259.39	II	2689-26160
7	4159.51	II	2689-26724	85	4262.68	II	3053-26506
11	4163.14	II		34	4265.08	II	1489-24930
7	4163.72	II	838-24848	8	4266.31	I	812-24245
3.0	4165.54	II		2.5	4269.77	II	2003-25417
3.5	4166.34	II		3.5	4270.73	II	1489-24898
55	4169.48	II	2003-25980	10	4270.84	II	5318-28726
28	4171.57	II	3499-27464	3.5	4271.86	I	2273-25676
13	4174.43	II	3053-27001	3.5	4272.01	II	1518-24920
30	4178.02	II	4386-28314	80	4279.68	II	2238-25598
					4279.75	II	1489-24848
36	4181.10	II	2689-26599	16	4279.94	II	2003-25361
14	4183.33	I	1490-25387	6	4280.32	II	838-24194
36	4183.76	II	327-24222	150	4280.79	II	3910-27263
70	4188.13	II	4386-28256	13	4281.01	II	
28	4191.93	II					

Samarium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
48	4282.21	I	3125-26471	30	4373.46	II	3499-26358
32	4282.83	I	2273-25616	22	4374.98	II	327-23177
16	4283.50	I	812-24151	60	4378.24	II	5318-28151
2.5	4284.53	II		36	4380.42	I	1490-24312
3.5	4285.50	II	2238-25566	20	4384.29	II	4386-27188
24	4286.64	II	3499-26821	8	4386.22	I	2273-25065
2.5	4291.62	II		1.4	4388.99	II	
24	4292.18	II	2689-25980	110	4390.86	II	1489-24257
4	4295.74	II	3499-26772	1.4	4392.60	II	0-22759
110	4296.74	I	4021-27288	14	4393.35	I	1490-24245
6	4299.14	I	293-23547	20	4397.34	I	812-23547
6	4299.34	II	4386-27639	6	4399.88	II	4386-27108
3.0	4301.28	I	812-24054	28	4401.17	I	3125-25840
22	4304.94	II	5318-28540	55	d 4403.06	II	1489-24194
60	4309.01	II	1489-24690		4403.13	I	2273-24978
16	4312.85	I	2273-25453	28	4403.36	II	1518-24222
12	4313.73	II	2003-25178	2.5	4405.67	II	3499-26191
5	d 4315.35	II		4	4407.52	II	2003-24686
	4315.38	II	4386-27553	35	4409.33	II	2689-25361
130	4318.94	II	2238-25385	20	4411.58	I	1490-24151
32	4319.53	I	1490-24634	8	4411.83	I*	2238-24898
40	4323.28	II	838-23962	26	4417.58	II	3910-26540
16	4324.46	I	2273-25391	32	4419.33	I	293-22914
3.0	4327.51	II	2689-25790	100	4420.53	II	2689-25304
120	4329.02	II	1489-24583	65	4421.14	II	3053-25665
30	4330.02	I	293-23381	5	4423.38	I	293-22893
8	4331.45	I		200	4424.34	II	3910-26506
90	4334.15	II	2238-25304	2.5	4426.01	II	
60	4336.14	I	3125-26182	12	4427.58	II	2003-24583
3.0	4336.78			5	4427.81	II	2238-24816
6	4338.96	I	812-23852	32	4429.66	I	812-23381
2.5	4339.92	I	812-23847	8	4433.08	I	293-22844
2.5	h 4342.38	II		110	4433.88	II	3499-26046
38	4345.86	II	838-23842	120	4434.32	II	3053-25598
6	4346.49	II	4386-27387	36	4441.81	I	1490-23997
75	4347.80	II	3053-26046	30	4442.28	I	812-23317
38	4350.46	II	3910-26889	7	4442.51	II	
1.6	4350.82	I	1490-24467	3.5	4443.27	I	2273-24773
38	4352.10	II		48	4444.26	II	
1.6	4357.90	I	3125-26066	48	4445.15	I	3125-25616
38	4360.72	II	2003-24929	2.5	4445.88		
15	4361.07	II	4386-27310	3.0	4446.96	II	3499-25980
55	4362.04	II	3910-26828	90	4452.73	II	2238-24690
30	4362.91	I	0-22914	17	4452.95	I	4021-26471
15	4363.45	II	1518-24430	80	4454.63	II	4386-26828
1.6	4364.05	II		6	4456.11	II	4386-26821
3.0	4365.95	I	812-23710	70	4458.52	II	838-23261
34	4368.03	II	3053-25940	17	4459.29	I	812-23231
14	4369.92	II	2689-25566	2.0	4463.90	I	2273-24669
3.0	4370.48	II	5318-28192	150	4467.34	II	5318-27696

## Samarium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
6	4469.66	II		20	4581.58	I	812-22632
55	4470.89	I	2273-24634	30	4581.73	I	4021-25840
32	4472.43	II	1489-23842	38	4584.83	II	3499-25304
42	4473.02	II	2238-24588	3.0	4589.43	II	
5	4475.18	II	838-23177	20	4591.82	II	1489-23261
3.5	4477.50	I	3125-25453	26	4593.54	II	3053-24816
50	4478.66	II		2.5	4594.59	II	
8	4480.32	I	0-22314	38	4595.29	II	3910-25665
2.0	4485.57	II		16	4596.74	I	
1.8	4490.02	I	3125-25391	6	4598.35	II	2689-24430
1.6	4495.14	II	2689-24929	4	4603.12	II	
25	4499.11	I	1490-23710	15	4604.18	II	327-22040
25	4499.48	II	2003-24222	20	4606.51	II	0-21702
4	4501.38	II	2689-24898	3.0	4606.88	II	
16	4503.38	I	293-22492	5	4611.25	I	812-22492
12	4505.05	II	2003-24194	5	4613.50	II	2689-24358
8	4511.33	I	4021-26182	20	4615.44	II	4386-26046
38	4511.83	II	1489-23647	32	4615.69	II	1518-23177
30	4515.09	II		2.0	4616.49	II	0-21655
2.0	4517.27	II		1.0	4620.25	II	
60	4519.63	II	4386-26506	1.6	4624.97	II	10214-31830
4	4522.55	I	1490-23595	2.0	4629.43	I	4021-25616
30	4523.04	II	327-22429	10	4630.21	II	838-22429
	4523.18	I	812-22914	6	4636.26	II	
44	4523.91	II	3499-25598	60	4642.24	II	3053-24588
4	4527.42	I	812-22893	20	4645.40	I	293-21813
5	4532.44	I	1490-23547	20	4646.68	II	2238-23753
20	4533.80	I	2273-24324	6	4647.53	II	5318-26828
18	4536.51	II	838-22875	16	4648.16	II	0-21508
48	4537.95	II	3910-25940	26	4649.49	I	812-22314
10	4538.53	II		10	4655.13	II	3910-25385
20	4540.19	II	2238-24257	20	4663.56	I	2273-23710
26	4542.06	II		5	4665.13	II	3499-24929
55	4543.95	II	2689-24690	50	4669.40	II	838-22248
7	4544.83	II	2689-24686	42	4669.65	II	2238-23647
2.0	4545.81	II	5318-27310	32	d 4670.75	I	1490-22894
3.0	4550.03	I	2273-24245		4670.83	I	1490-22893
28	4552.66	II	2003-23962	110	4674.60	II	1489-22875
18	4554.45	II	838-22789	70	4676.91	II	327-21702
6	d 4556.54	II		22	4681.55	I	1490-22844
	4556.63	I	3125-25065	8	4682.69	II	3499-24848
16	4560.43	II	327-22248	38	4687.18	II	327-21655
1.2	4561.19	II	3499-25417	38	4688.73	I	2273-23595
4	4564.10	II	0-21904	4	4689.57	II	327-21645
32	4566.21	II	2689-24583	13	4693.63	II	1489-22789
4	4566.77	I	1490-23381	12	4699.34	II	2689-23962
2.5	4569.58	I	2273-24151	55	4704.40	II	0-21251
40	4577.69	II	2003-23842	6	4710.64	II	5318-26540
3.0	4578.72	II		28	4713.06	II	4386-25598
5	4579.09	II		8	4714.62	II	3053-24257



## Samarium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
13	4715.26	II	838-22040	1.4	4914.30	II	3499-23842
75	4716.10	I	3125-24324	44	4918.99	I	1490-21813
28	4717.07	I	0-21194	8	4920.38	II	8679-28997
22	4717.72	II	3499-24690	6	4923.83	II	4386-24690
20	4718.33	II	5318-26506	11	4924.04	I	4021-24324
3.0	4718.64	I	3125-24312	3.0	4929.56	II	5318-25598
28	4719.84	II	327-21508	6	4936.03	II	3499-23753
3.5	4720.12	II	4386-25566	16	4938.10	II	2003-22248
3.0	4721.39	II	2003-23177	13	4946.32	I	1490-21701
13	4726.02	II	2689-23842	24	4948.63	II	4386-24588
80	4728.42	I	1490-22632	16	4952.37	II	2689-22875
5	4741.72	II	3499-24583	6	4953.03	II	1518-21702
48	4745.68	II	838-21904	4	d 4955.95	II	
15	4750.72	I	2273-23317		4956.13	II	13604-33776
4	4755.37	II	2238-23261	24	4961.94	II	3499-23647
75	4760.27	I	812-21813	6	4964.56	II	1518-21655
11	4770.20	I	2273-23231	8	4972.16	II	7525-27631
11	4774.15	II	1489-22429	5	4973.74	II	2689-22789
20	4777.85	II	327-21251	24	4975.98	I	0-20091
7	4781.84	II	3910-24816	6	4981.73	II	5318-25385
60	4783.10	I	293-21194	4	4983.38	II	
36	4785.86	I	812-21701	5	4989.44	II	2003-22040
16	4789.96	I	3125-23997	10	4992.02	II	8046-28072
24	4791.58	II	838-21702	6	5001.22	II	1518-21508
1.6 h	4804.90	II	838-21645	6	5016.61	II	7135-27063
44	4815.81	II	1489-22248	8	5023.50	II	2003-21904
9	4816.01	II	3499-24257	20	5028.44	II	12045-31926
13	4829.57	II	3053-23753	4	5031.18	II	12045-31916
4	4833.32	II	8046-28730	55	5044.28	I	1490-21308
8	4834.62	II	3910-24588	6	5049.51	I	293-20091
3.5	4836.67	II	838-21508	28	5052.76	II	11094-30880
4	4837.65	II	10214-30880	9	5057.74	II	8679-28445
100	4841.70	I	4021-24669	8	5059.85		
32	4844.21	II	2238-22875	10	5060.93	I	1490-21243
14	4847.76	II	5318-25940	4	5064.24	II	2689-22429
28	4848.32	I	2273-22893	3.0	5066.86	II	11791-31522
12	4854.36	II	3053-23647	24	5069.46	II	10214-29935
9	4859.55	II	2689-23261	75	5071.20	I	
8	4869.98	II	9407-29935	9	5076.69		
0.8	4873.19	II		8	5079.86	I	
22	4883.77	I	293-20763	4	5087.08	II	2003-21655
75	4883.97	I	3125-23595	4	5087.65	II	
1.2	4891.94	II		8	5088.32	I	812-20459
8	4893.35	II	4386-24816	3.0	5088.97	II	12790-32435
3.5	4894.30	II	2003-22429	24	5100.22	II	12045-31646
4	4900.73	II	8046-28445		5100.39	I	
2.5	4901.90	II	9407-29801	36	5103.09	II	9407-28997
18	4904.97	I	812-21194	20	5104.48	II	8046-27631
65	4910.40	I	2273-22632	19	5116.70	II	7525-27063
36	4913.25	II	5318-25665	70	5117.16	I	

## Samarium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
48	5122.14	I	3125-22643	5	h 5355.88	I	
7	5124.86	II		3.0	5364.39	II	
5	5132.21	I		20	5368.36	I	4021-22643
5	5135.86	I		2.0	5369.18	II	
8	5154.23	II		3.0	5370.06	I	
50	5155.03	II	8679-28072	2.0	h 5378.09	I	
8	5155.86	I		5	5387.97	I	
9	5157.07	II	10960-30346	3.0	5389.85	I	
	5157.23	I	293-19677	3.0	5392.69	I	
4	5162.86			4	5394.48	II	
3.0	5164.62			13	5403.70	I	1490-19990
11	5166.06	II	11094-30446	18	5405.23	I	293-18788
7	5168.35	I		8	5411.39	I	3125-21600
7	5169.57	II		5	5415.98	II	
34	5172.74	I	2273-21600	1.2	5419.07	I	
65	5175.42	I		6	5421.57	I	2273-20713
10	h 5178.01	II		2.5	5425.63	I	
6	5187.09	I	1490-20763	2.5	5433.55	I	
6	5194.73	I		2.5	5433.82	I	812-19210
34	5200.59	I	1490-20713	4	5436.33	I	
4	5201.45	I		30	5453.00	I	3125-21459
8	5202.73	II	2689-21904	2.5	5461.55	I	
8	5209.92	I		19	5466.72	I	1490-19777
8	5218.40	I		3.5	5478.29	II	10181-28429
4	5221.12	I		9	5485.42	I	0-18225
8	h 5228.80	I		32	5493.72	I	812-19010
6	h 5234.18	II		11	5498.21	I	293-18475
4	h 5237.58	I		4	5511.09	I	2273-20413
36	5251.92	I	2273-21308	11	5512.10	I	812-18949
5	5252.77	II	8046-27078	32	5516.09	I	2273-20397
3.0	5253.80	I		1.4	5525.61	I	
3.5	5265.67	I	0-18986	4	5537.07	II	13466-31522
55	5271.40	I	812-19777	7	5548.95	I	
3.5	5272.82	II		20	5550.40	I	1490-19501
34	5282.91	I	1490-20413	2.0	5561.37	I	812-18788
3.5	h 5289.94	I		6	5573.42	I	3125-21063
5	5294.65	I		4	5574.89	I	293-18225
5	5303.23	I		5	5588.20	I	2273-20163
3.0	5309.50	I		7	5600.86	II	11791-29641
5	5312.23	II	2689-21508	7	5621.79	I	293-18076
3.0	5313.76	I		10	5626.01	I	0-17770
26	5320.60	I	2273-21063	2.0	5637.30	II	
2.5	h 5321.82	I		12	5644.10	I	
3.0	hd 5324.99	I		3.0	5656.34	I	
2.5	5332.09	I		20	5659.86	I	812-18475
15	5341.29	I	293-19010	1.2	5661.54	II	
4	5348.08	I	293-18986	3.0	5663.91	I	
6	5348.74	I		4	5686.84		
5	5349.14	I	812-19501	2.0	5686.98	I	4021-21600
6	5350.62	I		1.2	5692.05	I	

## Samarium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
3.0	5696.24			5	5860.78	I	3125-20183
16	5696.73	I		9	5867.79	I	3125-20163
12	5706.20	I	1490-19010	6	5868.61	I	4021-21056
3.0	5706.75	I		5	5871.06	I	3125-20153
3.0	5709.73	I		7	5874.21	I	812-17831
5	5710.93	I		1.2	5875.10	I	
2.0	5711.45	I	2273-19777	1.8	5875.92	I	1490-18503
4	5717.92	I		1.8	5878.11	II	10181-27188
2.0	5719.16			3.5	5891.41	I	
4	5720.19	I	293-17770	3.0	5895.16	I	
3.0	5721.38			6	5897.39	II	12045-28997
1.6	5724.45	I		7	5898.96	I	
2.0	5729.30	I		4	5902.60	I	2273-19210
1.4	5730.13			4	5903.50	II	
7	5732.95	I	4021-21459	2.5	5906.05	I	1490-18417
3.0	5736.84	I		3.0	5909.04	I	
4	5738.01	II	14504-31926	1.2	5910.83	I	
3.0	5740.89	I		4	5912.61	I	
1.4	5741.19	I	812-18225	3.0	5913.56	I	
7	5743.35	II	14115-31522	2.0	5915.56	I	
1.2	5745.50	I		2.0	5916.36	I	293-17190
4	5748.09	I		3.0	5919.33	II	
3.0	5757.97	I		3.0	5921.01	I	
6	5759.52	II	12988-30346	3.0	5923.34	I	
4	5763.91	I		3.0	5924.66	I	
10	5773.77	I		3.5	5932.18	I	
8	5778.33	I		3.5	5932.90	II	12790-29641
6	5779.24	I	1490-18788	5	5938.90	II	7525-24358
6	5781.93	II		3.0	5942.33	I	
10	d 5786.98	II	13604-30880	3.5	5946.37	I	
	5787.15	I		3.5	h 5955.82	II	
2.0	5787.53	I		3.5	5956.76	I	
8	5788.38	I	3125-20397	3.0	5957.52	II	9410-26191
8	5800.52	I		3.5	5960.09	I	
2.0	5801.24	I		3.5	5963.22	II	12232-28997
1.2	h 5801.66	II	10960-28192	9	5965.71	II	10874-27631
9	5802.84	I	2273-19501	5	h 5968.82	II	11791-28540
2.0	5806.77	I		1.8	5969.49	I	
6	5814.89	I		3.5	5979.38	I	1490-18210
1.6	5816.34	I		5	5984.29	I	
1.8	5818.32	I		1.8	h 5993.85		
2.5	5820.68	II		3.5	5994.64	II	11395-28072
4	5830.51	I		4.0	5995.09	I	2273-18949
6	5831.02	II	12790-29935	3.0	6001.94	I	
3.0	h 5831.74	II	14504-31646	3.0	6004.18	I	812-17462
6	5836.37	II	8046-25175	3.5	6011.22	II	11799-28429
3.0	5842.60	II	8679-25790	1.6	6016.80	I	
3.0	5843.76	I		2.5	6017.39	II	10214-26828
3.0	5848.67	II	12842-29935	3.5	6027.16	I	3125-19712
2.0	5860.42	II	7135-24194	3.5	6027.52	I	1490-18076

## Samarium — All Observed Lines

Intensity and Character	Wave-length in A	Spectrum	Energy Levels in K	Intensity and Character	Wave-length in A	Spectrum	Energy Levels in K
2.5	6033.23	II	9410-25980	2.5	6201.13	I	
4	6041.40	I		3.5	6203.86	I	
2.5	6042.84	I		3.0	6206.87	I	
7	6045.00	I	2273-18811	1.4	6207.13	I	
6	6045.39	I		2.5	6217.17		
1.2	h 6053.88	I		1.4	6225.48		
1.6	6067.78	II		2.5	6226.70	I	2273-18329
7	6070.06	I	1490-17959	4	6237.66	II	12045-28072
1.6	h 6075.72	I		2.5	6238.30	I	
6	6084.12	I	812-17244	3.5	h 6244.21	II	8679-24690
1.6	6088.62	I		6	6246.76	II	8579-24583
5	h 6091.40	I		2.0	6248.11	I	
2.0	6096.78	I		6	6256.54	I	
2.0	h 6099.90	I	293-16682	6	6256.66	II	9407-25385
2.5	6101.96			14	6267.28	II	9410-25361
3.0	6103.37			1.4	6279.49		
6	6110.66	II	11791-28151	3.5	6289.90	II	9410-25304
1.6	h 6112.98	I		7	6291.82	II	11395-27285
2.5	6114.58	II	10960-27310	2.0	6292.94	I	
3.0	6114.73	I		4	6294.68	II	
2.5	6122.75	I		3.0	6301.12	II	10181-26046
3.0	6123.60	II	10214-26540	2.5	6302.40	II	12567-28429
2.0	6124.88	II	12988-29310	4	6303.15	II	
2.0	6126.33	I		1.8	6305.19	II	
1.6	6130.62	I		5	6307.06	II	8579-24430
3.0	6135.85	I		1.8	6315.78	II	
2.5	6138.05	I		3.5	6321.75	II	
2.5	6139.33	I		1.8	6322.51	I	
3.0	6140.60	I		2.5	6325.54	II	
2.5	6143.09	I		10	6327.47	II	10181-25980
1.6	6143.59	I		1.8	6328.01	I	
4	6149.10	II	12988-29246	3.5	6340.10	I	
2.0	6156.90	II		3.0	6353.54		
2.0	h 6157.55	II	11395-27631	1.8	6355.35	I	
6	h 6159.56	I	2273-18503	4	6357.18		
3.0	6160.42	II	10960-27188	2.0	6367.41	I	1490-17190
1.6	6164.51	II		3.0	6368.28	II	12842-28540
2.5	6165.84	I		0.8	6371.01	I	4021-19712
1.6	h 6168.33	II	12790-28997	0.7	6380.05	I	
2.5	6173.95	I		2.0	h 6386.77	I	
2.5	6174.45	I	812-17003	4	6389.85	II	9410-25056
2.5	6174.96	II		3.5	6390.81	II	8579-24222
2.5	6179.41	I		1.2	h 6403.98		
3.0	h 6179.82	II	10181-26358	1.6	h 6406.24	II	10960-26566
2.5	6181.05	II	13466-29641	4	6417.50	II	8679-24257
4	h 6182.89	II	11094-27263	6	6426.64	II	14085-29641
3.0	6188.00	II	9410-25566	3.0	6428.32	II	
4	6192.64			1.4	6428.94	I	
2.5	6194.39	I	3125-19265	3.0	6431.00	II	10960-26506
1.4	6198.14	II		1.4	6431.96	II	11395-26938

## Samarium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
1.4	6435.34	I		10	6693.55	II	13604-28540
1.0	6447.56			1.6 h	6694.69	II	12232-27165
1.6	6452.08	I		2.0	6703.61	I	17655-32568
2.0	6455.60	II	11799-27285	3.0 h	6707.45	II	7525-22429
1.4	6456.25	II		2.0	6712.62	II	12045-26938
1.4	6457.55	I		6 d	6723.07	I	
0.6	6459.36	I			6723.26	I	
2.5 h	6470.46	II	10214-25665	4	6724.73	I	16859-31726
1.4	6471.59	I		3.0	6725.88	I	0-14864
6	6472.34	II	11094-26540	17 d	6731.84	II	9407-24257
5	6484.52	II	10181-25598	10 d	6734.06	II	11094-25940
4	6487.62	II	9407-24816	6 d	6734.81	II	12045-26889
4	6490.82	II	12790-28192	8	6741.47	II	8046-22875
5	6498.67	II	8579-23962	2.5 h	6754.68	II	11799-26599
1.2	6502.00	II	12567-27942		6754.85	I	
1.8 h	6507.70			2.5	6759.25	I	4021-18811
4 hl	6509.44	I	o 293-15651	2.0	6766.52	II	11791-26566
1.8 h	6526.64	II		3.0	6778.19	II	11791-26540
2.5 h	6528.02	I	2273-17587	6 h	6778.61	II	10181-24929
2.5 h	6529.70	I		2.0 h	6780.03	II	
2.5 h	6532.25	I	812-16116	2.5 h	6781.17	II	8046-22789
	6533.96	I	812-16112	3.0	6782.95	II	
7	6542.76	II	11799-27078	9	6790.00	II	7525-22248
2.5	6544.57	II	9410-24686	2.0 h	6792.55	II	12567-27285
2.5 h	6549.77	II	8579-23842	14	6794.20	II	11791-26506
1.8 h	6551.80	I	1490-16748	3.0 h	6802.96	I	812-15507
20	6569.31	II	12045-27263		6803.1	I	
5 h	6570.67	II	8046-23261	1.4	6807.50	I	
4	6574.38	II		3.0 h	6808.31	I	15507-30191
6 h	6585.21	II	9407-24588	1.2	6813.4	II	
1.0 h	6587.54	I		2.0 h	6820.91	I	14380-29037
4	6588.91	I	3125-18298	4	6829.86	II	10960-25598
16	6589.72	II	10214-25385	2.5	6830.54	I	14916-29552
1.8	6591.50			1.8 h	6837.20		
6	6601.83	II	12045-27188	2.5	6838.33	I	
14	6604.56	II	14504-29640	1.4 h	6839.64	II	
1.6	6617.61	II		3.0 h	6841.75	I	15579-30191
0.9	6625.28	II		8	6844.71	II	10960-25566
3.0 h	6628.88	II		4 d	6846.54	II	10214-24816
2.0 h	6630.61	II	12232-27310	2.0	6848.16	II	12567-27165
					6848.31	I	
6 h	6632.28	II	8679-23753	1.4 h	6853.54	I	
1.8 h	6646.22	I		2.0 h	6854.50	II	11395-25980
3.0 h	6649.02	II		11	6856.03	II	8679-23261
3.0	6651.61	II	11791-26821	1.4 h	6858.12	I	16345-30922
4	6656.19	II	9410-24430	17	6860.93	I	293-14864
2.5 h	6667.22	II	10181-25175		6861.10	II	11094-25665
7	6671.51	I	4021-19006	6	6862.82	II	7135-21702
10	6679.21	II	8679-23647	1.2	6867.11	I	
2.5 h	6681.53	II	11395-26358	4 h	6872.43	II	13604-28151
2.5 h	6687.79	II					

## Samarium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
1.4 h	6875.27	II	12567-27108	1.6	7189.57	II	
1.8 h	6877.10	II		1.4	7210.95	I	
2.0	6879.50	I	17194-31726	3.5	7213.82	I	2273-16132
4 h	6885.16	II	12790-27310	4 d	7218.09	II	8579-22429
2.5 h	6887.42	II		2.0	7220.07	I	16345-30191
1.4	6900.28	II	10874-25361	2.0	7237.02	II	12232-26046
1.4	6904.51	II		9	7240.90	II	11791-25598
2.5	6906.22	I		1.4	7257.11	II	12790-26566
2.0	6909.81	II	12842-27310	1.4 d	7261.45	II	9410-23177
2.0 d	6918.78	I		2.0	7279.25	I	3125-16859
	6919.03	I	18119-32568	4	7281.47	II	10960-24690
2.5	6927.03	II	9410-23842	1.2	7282.21	I	17194-30922
1.8	6929.60	II		3.0	7283.33	II	
2.5	6930.41	II	10960-25385	2.5	7288.92	II	12790-26506
2.5	6941.56	II	10181-24583	2.0	7290.23	I	
1.8	6949.23	II		4 h	7300.72	II	
5	6950.51	II	8046-22429	2.0	7327.08	II	
18	6955.29	II	10214-24588	2.0	7332.65	I	4021-17655
1.4	6958.97	II		1.2	7338.04	I	
2.5	6968.65	II	9407-23753	4	7347.30	I	18119-31726
2.0	6984.16	II		4	7376.69	II	12045-25598
2.0	6988.36	I		2.0	7393.98	II	
2.0	6993.40	II		5	7444.56	I	
14	7020.44	II	9407-23647	4	7445.41	I	
2.0	7036.73	II		4 d	7453.03	II	12567-25980
14	7039.22	II	8046-22248	2.0	7470.76	I	
14	7042.24	II	8679-22875	4	7481.99	II	13466-26828
2.0	7049.15	II		3.5 h	7502.39	II	8579-21904
14	7051.52	II	7525-21702	1.6 h	7517.00	II	
2.5	7054.97	II	11395-25566	3.5 h	7541.42	II	12790-26046
3.0	7074.67	I		1.4	7544.74	I	
14	7082.37	II	7135-21251	1.6	7546.57	I	
6 d	7085.52	II	8679-22789	1.8 h	7560.15	II	13604-26828
4	7088.30	I	812-14916	3.0	7562.94	II	
2.5	7091.16	I	4021-18119	3.5	7570.95	II	12842-26046
5	7095.50	I	1490-15579	3.5	7572.29	II	
2.5	7096.33	I	293-14380	3.0	7578.09	II	14504-27696
5	7104.54	I	2273-16345	5	7585.77	II	14085-27263
3.0	7106.23	I	3125-17194	3.5	7588.31	II	
4	7115.96	I		1.6	7598.01	I	
3.5	7117.51	II		3.5 d	7607.48	II	
4 h	7119.81	II			7607.74	I	15567-28708
1.8	7122.40	II	14115-28151	1.8	7613.94	II	11799-24929
3.5 h	7125.11	II	12790-26821	1.6 h	7631.77	II	11799-24898
2.0	7131.80	I	1490-15507	3.5	7637.94	II	10874-23962
1.6	7136.01	I		7	7645.09	II	8579-21655
1.8	7139.39	II		1.8	7645.82	I	
6 d	7143.98	II	8046-22040	3.0	7648.02	II	12232-25304
13 d	7149.60	II	7525-21508	1.6	7655.78	II	12988-26046
1.6	7172.67	I	2273-16211	3.0	7667.20	II	13466-26506

## Samarium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
1.2	7672.49	II		7	8068.46	II	14115-26506
1.6 h	7678.79	II	9410-22429	1.4 w	8117.16	II	12988-25304
1.6 h	7695.78	I		1.4	8125.12	II	10874-23177
3.5	7712.04	II	14115-27078	4	8161.90	II	10181-22429
5	7728.56	II	13604-26540	3.0 w	8195.50	II	13466-25665
5	7736.26	II		1.0	8206.30	II	
5	7749.30	II	13604-26506	4 w	8218.76	II	11799-23962
3.5	7755.20	II	11799-24690	1.4	8230.33	I	
1.6	7794.50	I	16211-29037	2.5	8240.98	II	13466-25598
1.6	7801.54	I	19753-32568	3.0 w	8289.26	II	13604-25665
1.2 h	7812.75	II		1.6	8300.88	II	11799-23842
2.5	7820.15	II	11799-24583	6 w	8305.79	II	14504-26540
1.6	7831.40	II		1.6	8315.45	I	
6 w	7835.08	II	14504-27263	3.0 w	8348.68	II	12842-24816
4	7837.27	II	12842-25598	3.0	8383.71	I	
1.6	7844.82	II	14085-26828	3.0	8387.77	II	13466-25385
1.0	7859.53	I	19006-31726	5 w	8432.64	II	14085-25940
3.0	7863.65	II	14115-26828	3.0 w	8473.54	II	12790-24588
1.6 h	7880.07	II	10960-23647	7 w	8485.99	II	13604-25385
2.5	7895.96	I	16891-29552	5 w	8510.90	II	12842-24588
4	7914.96	II	11799-24430	3.5	8543.22	II	12988-24690
14	7928.14	II	12988-25598	3.5 w	8617.03	II	12045-23647
1.4	7931.92	I	17587-30191	3.5 w	8632.82	II	14085-25665
3.0	7937.09	II	12790-25385	1.8 w	8677.93	II	
2.5	7948.12	II	12988-25566	2.0	8706.32	II	14115-25598
3.0 w	8001.61	II	9410-21904	7 w	8708.43	II	11395-22875
3.0 w	8014.92	II	13466-25940	5 w	8717.89	II	12790-24257
3.5	8025.12	II	12232-24690	5 w	8758.28	II	12232-23647
3.5 w	8026.32	II	14085-26540	2.5 w	8780.59		
2.5	8032.03	II	11395-23842	3.5 w	8788.83	II	10874-22248
6	8048.70	II	14085-26506	4	8859.76		
2.5	8065.16	I		15	8913.66	II	12045-23261

# SCANDIUM

Sc,  $Z=21$ ,  $M=44.96$ , Ratio  $\frac{\text{Sc}}{\text{Cu}}=0.708$

Sc I Normal state of valence electrons  $3d^1 4s^2 {}^2D_{1/2}=0$ . I.P.= 52920 K  
 Sc II Normal state of valence electrons  $3d^1 4s^1 {}^3D_1=0$ . I.P.=103240 K

## References

### Wavelengths:

- A. Gatterer and J. Junkes, Spektren der Seltenen Erden, (Specola Vaticana, Vatican, 1945), below 7000 Å.  
 G. R. Harrison, Massachusetts Institute of Technology Wavelength Tables (John Wiley & Sons, New York, 1939), above 7000 Å.  
 The last five lines in the table are new.

### Classification:

Sc I and Sc II, H. N. Russell and W. F. Meggers, Sci. Papers NBS **22**, 329 (1927).

### Molecular Spectra:

ScO, W. F. Meggers and J. A. Wheeler, J. Research NBS **6**, 239 (1931).

### Intensities:

Y. I. Ostrovskii and N. P. Penkin, Optika i Spektroskopiya **3**, 391 (1957).

## Relative intensity of scandium lines observed in an arc of copper containing 0.1 atomic percent of scandium

### *Strong lines of scandium*

Intensity	Wavelength Å	Spectrum	Energy levels K	Term combination
2500	3613.84	II	178-27841	$3d^1 4s^1 a {}^3D_3 - 3d^1 4p^1 z {}^3F_4$
2100	3911.81	I	168-25725	$3d^1 4s^2 a {}^2D_{2\frac{1}{2}} - 3d^1 4s^1 4p^1 y {}^2F_{3\frac{1}{2}}$
1800	3630.75	II	68-27602	$3d^1 4s^1 a {}^3D_2 - 3d^1 4p^1 z {}^3F_3$
1800	3907.49	I	0-25585	$3d^1 4s^2 a {}^2D_{1\frac{1}{2}} - 3d^1 4s^1 4p^1 y {}^2F_{3\frac{1}{2}}$
1800	4020.40	I	0-24866	$3d^1 4s^2 a {}^2D_{1\frac{1}{2}} - 3d^1 4s^1 4p^1 y {}^2D_{1\frac{1}{2}}$
1800	4023.69	I	168-25014	$3d^1 4s^2 a {}^2D_{2\frac{1}{2}} - 3d^1 4s^1 4p^1 y {}^2D_{3\frac{1}{2}}$
1400	4246.83	II	2541-26081	$3d^1 4s^1 a {}^1D_2 - 3d^1 4p^1 z {}^1D_2$
1200	3572.53	II	178-28161	$3d^1 4s^1 a {}^3D_3 - 3d^1 4p^1 z {}^3D_3$
1200	3642.79	II	0-27444	$3d^1 4s^1 a {}^3D_1 - 3d^1 4p^1 z {}^3F_2$
900	3353.73	II	2541-32350	$3d^1 4s^1 a {}^1D_2 - 3d^1 4p^1 z {}^1F_3$
900	3576.35	II	68-28021	$3d^1 4s^1 a {}^3D_2 - 3d^1 4p^1 z {}^3D_2$
700	3580.94	II	0-27918	$3d^1 4s^1 a {}^3D_1 - 3d^1 4p^1 z {}^3D_1$
600	3372.15	II	178-29824	$3d^1 4s^1 a {}^3D_3 - 3d^1 4p^1 z {}^3P_2$
600	3558.55	II	68-28161	$3d^1 4s^1 a {}^3D_2 - 3d^1 4p^1 z {}^3D_3$
600	3645.31	II	178-27602	$3d^1 4s^1 a {}^3D_3 - 3d^1 4p^1 z {}^3F_3$



## Scandium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
4	2429.16			8	3439.41	I	15757-44823
7	2438.62			6	3440.18		
42	2545.22	II	68-39345	6	3448.49	I	16027-45016
220	2552.37	II	178-39345	24	3457.45	I	16211-45126
42	2555.82	II	0-39114	16	3462.19	I	16141-45016
170	2560.25	II	68-39114	12	d 3469.65	I	16010-44823
85	2563.21	II	0-39002	10	3471.13	I	16022-44823
3.0	2611.22	II	26081-64366	18	3498.91	I	16027-44599
1.4	2684.23	II	39345-76588	240	3535.73	II	2541-30816
10	2692.78	I	0-37126	600	3558.55	II	68-28161
5	2699.11	III	25537-62576	550	3567.70	II	0-28021
30	2706.77	I	0-36934	1200	3572.53	II	178-28161
17	2707.95	I	168-37086	900	3576.35	II	68-28021
48	2711.35	I	168-37040	700	3580.94	II	0-27918
2.5	2819.54	II	27918-63374	360	3589.64	II	68-27918
3.0	2822.15	II	28021-63444	360	3590.48	II	178-28021
5	2826.68	II	28161-63528	2500	3613.84	II	178-27841
28	2965.86	I	0-33707	10	3617.43		
100	2974.01	I	0-33615	1800	3630.75	II	68-27602
120	2980.75	I	168-33707	1200	3642.79	II	0-27444
28	2988.95	I	168-33615	600	3645.31	II	178-27602
180	3015.36	I	0-33154	10	3646.90		
220	3019.34	I	168-33279	480	3651.80	II	68-27444
30	3030.76	I	168-33154	10	3664.25	II	2541-29824
2.5	3039.93	II	32350-65236	26	3666.54	II	178-27444
6	3045.72	II	27444-60267	5	3675.26	II	2541-29742
7	3052.93	II	27602-60348	3.5	3678.35	II	32350-59528
10	h 3056.31			7	h 3717.10		
11	3065.11	II	27841-60457	24	3833.07	II	0-26081
4	3139.75	II	28161-60002	55	3843.03	II	68-26081
90	3251.32	II	68-30816	8	3894.97		
140	3255.69	I	0-30707	1800	3907.49	I	0-25585
400	3269.91	I	0-30573	2100	3911.81	I	168-25725
500	3273.63	I	168-30707	4	3923.51	II	2541-28021
10	d 3343.28	II	27841-57743	400	3933.38	I	168-25585
24	3352.05	II	0-29824	4	3952.27		
900	3353.73	II	2541-32350	4	3989.06	II	2541-27602
6	d 3357.30			500	3996.61	I	0-25014
180	3359.68	II	68-29824	48	4014.49	II	2541-27444
150	3361.27	II	0-29742	1800	4020.40	I	0-24866
150	3361.94	II	0-29736	1800	4023.69	I	168-25014
360	3368.95	II	68-29742	20	4030.67	I	16023-40826
600	3372.15	II	178-29824	13	4031.39	I	15757-40555
8	3416.68	I	15757-45016	9	4034.23	I	16022-40803
12	3418.51	I	15882-45126	20	4043.80	I	15882-40604
6	3419.36	I	15673-44910	18	4046.48	I	16097-40803
18	3429.21	I	15757-44910	240	4047.79	I	168-24866
18	3429.48	I	15673-44823	11	4049.95	I	16141-40826
24	3431.36	I	15882-45016	500	4054.55	I	0-24657
48	3435.56	I	16027-45126	20	4056.59	I	16027-40671

Scandium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
14	h	4074.97	I	16022-40555	2.5		4988-27602
14		4078.57	I	16010-40521	4		4883-27444
550		4082.40	I	168-24657	6		14926-36934
18		4086.67	I	16141-40604	8		15042-37040
36		4087.16	I	16211-40671	11	h	21400-43337
3.5	h	4093.13	I	16097-40521	14	h	21480-43337
6		4094.85	I	16141-40555	6	h	21400-43167
5	h	4098.35	I	16211-40604	6	h	21480-43221
6		4100.33	I	15042-39424	5	h	
40	h	4133.00	I	15673-39861	4		4609.53
48	h	4140.30	I	15757-39903	4		4609.95
6	h	4147.40	I	15757-39861	36		4670.40
65		4152.36	I	15882-39958	4	h	4680.49
5	h	4154.72			5		4698.29
8	hd	4161.88	I	15882-39903	12		4706.97
100	h	4165.19	I	16027-40028	12		4709.34
6	h	4171.56	I	15757-39722	20		4728.77
4	h	4186.45			50		4729.23
6	h	4187.62	I	15882-39755	4	h	4732.30
7		4205.20	I	16027-39800	60		4734.10
6		4212.34	I	16022-39755	6		4735.08
4		4212.49	I	16023-39755	70		4737.65
7	h	4216.10	I	16010-39722	80		4741.02
10	h	4218.26	I	16022-39722	120		4743.81
10	h	4219.73	I	16010-39701	20		4753.16
3.5		4221.88	I	16022-39701	22		4779.35
8	d	4225.59	I	16141-39800	9		4791.50
16		4231.93			10		4827.28
18		4233.61	I	16141-39755	10		4833.67
9		4237.82			17		4839.44
36		4238.05	I	16211-39800	4		4840.47
8		4239.57	I	16141-39722	8		4847.68
9		4246.12	I	16211-39755	8		4852.68
1400		4246.83	II	2541-26081	14	ld	4857.79
5		4283.56					4858.09
26		4294.77	II	4883-28161	8		4906.67
32		4305.71	II	4803-28021	9		4909.76
380		4314.09	II	4988-28161	10		4922.84
300		4320.74	II	4883-28021	10		4934.25
220		4325.01	II	4803-27918	5		4935.74
2.5		4348.53	I	15882-38872	8		4941.33
16		4354.61	II	4883-27841	19		4954.06
10		4358.64	I	16023-38959	14		4973.66
5		4359.08			17		4980.37
2.5		4364.92			9		4983.45
180		4374.46	II	4988-27841	16		4991.92
12		4384.81	II	4803-27602	9		5018.39
4	h	4389.60	I	16097-38872	8		5020.14
100		4400.37	II	4883-27602	9		5021.51
80		4415.56	II	4803-27444	60		5031.02

## Scandium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
6	5032.74			30	5446.20	I	16211-34567
28	5064.32	I	11610-31351	2.0	5447.39	I	14926-33279
9	5068.86	II	16023-35746	13	5451.34	I	16141-34480
60	5070.23	I	11558-31275	3.5	5455.21	I	16097-34423
28	5075.81	I	11520-31216	2.0	5465.20	I	18856-37148
240	5081.56	I	11677-31351	6	5468.40	I	16141-34423
140	5083.72	I	11610-31275	7	5472.19	I	16211-34480
120	5085.55	I	11558-31216	2.0	5474.64		
85	5086.95	I	11520-31173	85	5481.99	I	15042-33279
44	5087.14	I	20237-39889	60	5484.62	I	14926-33154
30	5089.89	I	20240-39881	65	5514.22	I	14926-33056
5	5092.46			1.8	5515.39	I	15673-33799
44	5096.73	I	11558-31173	75	5520.50	I	15042-33151
70	5099.23	I	11610-31216	5	5526.06	I	15673-33764
42	5101.12	I	11677-31275	75	5526.82	II	14261-32350
20	5109.06			6	5541.04	I	15757-33799
17	5112.86			3.5	5546.40	I	15882-33906
36	5116.69			2.0	5550.40	I	18504-36516
8	b 5133.68	ScO		0.6	5552.25	II	11736-29742
5	b 5171.06	ScO		4	5553.59	I	18571-36573
44	5210.52	I	20237-39424	1.8	5561.10	I	18516-36493
5	5211.28			8	5564.86	I	15882-33847
32	5219.67	I	20240-39392	2.0	5571.24	I	18571-36516
40	5239.82	II	11736-30816	1.6	5579.76	I	15882-33799
32	5258.33	I	20237-39249	12	5591.33	I	16027-33906
4	5284.97	I	20237-39153	4	h 5593.38	I	21086-38959
24	5285.76	I	20240-39153	2.5	5604.19	I	21033-38872
4	5301.94	I	0-18856	2.5	5631.02	I	16010-33764
2.5	5318.35	II	10945-29742	9	5640.98	II	12101-29824
8	5331.77	I	15673-34423	5.0	5646.36	I	16141-33847
1.6	5334.23	II	12074-30816	1.8	5647.60	I	16097-33799
11	5339.41	I	15757-34480	6	5649.56	I	16211-33906
14	5341.05	I	15673-34390	28	5657.88	II	12154-29824
11	5342.96	I	0-18711	7	5658.34	II	12074-29742
40	5349.30	I	14926-33615	6	5667.16	II	12101-29742
13	5349.71	I	168-18856	8	5669.04	II	12101-29736
7	5350.30	I	15882-34567	170	5671.81	I	11677-29304
24	5355.75	I	15757-34423	11	5684.20	II	12154-29742
60	5356.10	I	15042-33707	140	5686.84	I	11610-29190
1.6	5357.19	II	12154-30816	120	5700.21	I	11558-29096
30	5375.35	I	15882-34480	22	5708.61	I	11677-29190
42	5392.08	I	16027-34567	100	5711.75	I	11520-29023
5	5416.12	I	16022-34480	26	5717.28	I	11610-29096
5	5425.57	I	16141-34567	20	5724.08	I	11558-29023
5	5429.41	I	16010-34423	6	bl 5736.85	ScO	
4	5432.94	I	16022-34423	6	bl 5764.45	ScO	
6	5433.23	I	16023-34423	11	bl 5772.74	ScO	
5	5438.22	I	16097-34480	6	bl 5775.32	ScO	
6	5439.03	I	16010-34390	8	bl 5809.84	ScO	
6	h 5442.60	I	16022-34390	8	bl 5811.60	ScO	

## Scandium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
11 bl	5847.73	ScO		2 b	6575.85	ScO	
8 bl	5849.07	ScO		7	6604.60	II	10945-26081
8 b	5887.38	ScO		3.0 bl	6609.99	ScO	
4 bl	5918.04	ScO		2.0 bl	6617.94	ScO	
3.5	5919.11	I	18856-35746	2.0 bl	6645.08	ScO	
7 bl	5928.10	ScO		2.5 bl	6654.42	ScO	
4	5961.49	I	21086-37856	3.0 bl	6661.01	ScO	
7 bl	5968.25	ScO		2.0 b	6700.48	ScO	
4	5969.19	I	21033-37781	2.0 b	6705.93	ScO	
10	5988.42	I	17013-33707	8	6737.87	I	
18 bl	6017.07	ScO		4	6739.40		
7	6026.18	I	17025-33615	4	6817.08	I	
70 bl	6036.17	ScO		6	6819.52	I	21086-35746
55 bl	6064.31	ScO		3.5	6829.54	I	21033-35671
50 bl	6072.65	ScO		6	6835.03	I	
70 bl	6079.30	ScO		0.7 b	6963.12	ScO	
36 bl	6101.87	ScO		0.7 bl	6990.68	ScO	
42 bl	6109.93	ScO		0.6 bl	7025.72	ScO	
42 bl	6115.97	ScO		1.0 b	7035.77	ScO	
20 b	6148.70	ScO		0.6 b	7072.37	ScO	
17 b	6153.93	ScO		0.6 b	7094.38	ScO	
17 b	6188.09	ScO		1.6 h	7138.14	I	24866-38872
17 b	6192.90	ScO		1.8	7169.13	I	25014-38959
70	6210.68	I	0-16097	1.6	7257.57	I	31351-45126
10	6239.41	I	0-16023	1.0	7275.57	I	31275-45016
36	6239.78	I	0-16022	0.4 h	7300.62	I	31216-44910
14	6245.63	II	12154-28161	1.6 h	7524.13	I	25585-38872
12	6249.96	I	18571-34567	1.8 h	7553.96	I	25725-38959
28	6258.96	I	168-16141	2.0 h	7574.44	I	24657-37856
7	6262.25	I	18516-34480	1.4	7617.45	I	24657-37781
6	6276.31	I	168-16097	1.8 h	7665.72	I	20237-33279
5	6279.76	II	12101-28021	4.0	7697.73	I	25585-38572
2.0	6300.70	II	12154-28021	2.4	7729.72	I	25725-38658
85	6305.67	I	168-16023	7	7741.17	I	20237-33151
3.0	6309.90	II	12074-27918	0.7 h	7750.37	I	29023-41922
1.8	6320.85	II	12101-27918	0.7	7752.72	I	29190-42085
3.0	6344.83	I	0-15757	0.8 h	7771.06	I	29096-41961
7	6378.82	I	0-15673	2.0	7785.17	I	25014-37856
6 bl	6408.41	ScO		1.0	7794.68	I	29190-42016
10	6413.35	I	168-15757	4	7800.44	I	20240-33056
3.0 b	6437.08	ScO		1.4	7821.64	I	29304-42085
6 bl	6446.24	ScO		1.4 h	8196.98	I	25585-37781
3.0 b	6457.78	ScO		2.0	8241.13	I	25725-37856
4 b	6485.40	ScO		2.5 h	8761.40	I	24866-36277
3.0 b	6495.90	ScO		1.4 h	8774.8		
6 b	6525.62	ScO		2.0 h	8794.72	I	29304-40671
2.5 b	6535.30	ScO		2.0 h	8823.8		
5 b	6557.84	ScO		4	8834.45	I	25014-36330
4 b	6566.88	ScO					

# SELENIUM

Se,  $Z=34$ ,  $M=78.96$ , Ratio  $\frac{\text{Se}}{\text{Cu}}=1.243$

Se I Normal state of valence electrons  $4s^2 4p^4 \ ^3P_2 = 0$ . I.P. = 78658 K  
 Se II Normal state of valence electrons  $4s^2 4p^3 \ ^4S_{3/2}^o = 0$ . I.P. = 173557 K

## References

Wavelengths and Classification:

Se I, J. E. Ruedy and R. C. Gibbs, Phys. Rev. **46**, 880 (1934).

## Relative intensity of selenium lines observed in an arc of copper containing 0.1 atomic percent of selenium

*Strong line of selenium*

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
40	2039.85	I	1989-50997	$4s^2 4p^4 \ ^3P_1 - 4s^2 4p^3 5s^1 \ ^3S_1^o$

## Selenium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
34	1960.26	I	0-50997	3.0	2074.79	I	0-48182
40	2039.85	I	1989-50997	5	8918.80	I	48182-59391
15	2062.79	I	2534-50997				

# SILICON

Si,  $Z=14$ ,  $M=28.09$ , Ratio  $\frac{\text{Si}}{\text{Cu}}=0.442$

Si I Normal state of valence electrons  $3s^2 3p^2 {}^3P_0 = 0$ . I.P. = 65743 K  
 Si II Normal state of valence electrons  $3s^2 3p^1 {}^2P_{3/2} = 0$ . I.P. = 131818 K

## References

Wavelengths:

C. C. Kiess, J. Research, NBS **21**, 185 (1938).

Classification:

Si I, C. C. Kiess, *ibid.*

Intensities:

P. Hey, Z. Physik **157**, 79 (1959).

**Relative intensity of silicon lines observed in an arc of copper containing 0.1 atomic percent of silicon**

*Strong lines of silicon*

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
360	2516. 11	I	223-39955	$3s^2 3p^2 {}^3P_2 - 3s^2 3p^1 4s^1 {}^3P_2$
260	2881. 60	I	6299-40992	$3s^2 3p^2 {}^1D_2 - 3s^2 3p^1 4s^1 {}^1P_1$

## Silicon — All Observed Lines

Intensity and Character	Wave- length in A	Spec- trum	Energy Levels in K	Intensity and Character	Wave- length in A	Spec- trum	Energy Levels in K
6	2124. 11	I	6299-53362	120	2519. 21	I	77-39760
2.0	2207. 97	I	0-45276	240	2524. 11	I	77-39683
2.0	2210. 88	I	77-45294	200	2528. 51	I	223-39760
3.5	2216. 67	I	223-45322	24	2631. 28	I	15394-53387
26	2435. 16	I	6299-47352	260	2881. 60	I	6299-40992
170	2506. 90	I	77-39955	15	2987. 65	I	6299-39760
160	2514. 32	I	0-39760	11	3905. 53	I	15394-40992
360	2516. 11	I	223-39955				

# SILVER

Ag,  $Z=47$ ,  $M=107.880$ , Ratio  $\frac{Ag}{Cu}=1.698$

Ag I Normal state of valence electrons  $4d^{10}5s^1\ ^2S_{0\frac{1}{2}}=0$ . I.P.= 61106 K  
 Ag II Normal state of valence electrons  $4d^{10}\ ^1S_0=0$ . I.P.=173300 K

## References

### Wavelengths:

G. R. Harrison, Massachusetts Institute of Technology Wavelength Tables (John Wiley & Sons, New York, 1939).

### Classification:

Ag I, A. G. Shenstone, Phys. Rev. **57**, 894 (1940).  
 Ag II, A. G. Shenstone, Phys. Rev. **31**, 317 (1928).

### Intensities:

A. Filippov and I. Islamov, Z. Physik **85**, 409 (1933).  
 J. Terpstra and J. A. Smit, Physica **24**, 937 (1958).

## Relative intensity of silver lines observed in an arc of copper containing 0.1 atomic percent of silver

### *Strong lines of silver*

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
5500	3280.68	I	0-30473	$4d^{10}5s^1\ ^2S_{0\frac{1}{2}}-4d^{10}5p^1\ ^2P_{1\frac{1}{2}}$
2800	3382.89	I	0-29552	$4d^{10}5s^1\ ^2S_{0\frac{1}{2}}-4d^{10}5p^1\ ^2P_{0\frac{1}{2}}$

## Silver — All Observed Lines

Intensity and Character	Wave- length in A	Spec- trum	Energy Levels in K	Intensity and Character	Wave- length in A	Spec- trum	Energy Levels in K
2.0	2331.37	II	40741-83621	5	hl	I	29552-51887
10	2413.18	II	40741-82168	6	hl	I	30473-51887
8	2437.79	II	39164-80172	100		I	29552-48744
3.0	2447.93	II	46046-86884	100		I	30473-48764
6	2721.77	I	30242-66972	10		I	30473-48744
5500	3280.68	I	0-30473	32		I	29552-42556
2800	3382.89	I	0-29552	50		I	30473-42556
9	hs 4210.94	I	30473-54214				

# SODIUM

Na,  $Z=11$ ,  $M=22.991$ , Ratio  $\frac{\text{Na}}{\text{Cu}}=0.3618$

Na I Normal state of valence electrons  $2p^6 3s^1 \ ^2S_{0\frac{1}{2}}=0$ . I.P.= 41450 K  
 Na II Normal state of valence electrons  $2p^6 \ ^1S_0=0$ . I.P.=381528 K

## References

### Wavelengths:

G. R. Harrison, Massachusetts Institute of Technology Wavelength Tables (John Wiley & Sons, New York, 1939).

### Classification:

Na I, A. Fowler, Report on Series in Line Spectra (Fleetway Press, London, 1922).

### Intensities:

R. Minkowski, Z. Physik **36**, 839 (1926).

A. Filippov and W. Prokofiev, Z. Physik **56**, 458 (1929).

## Relative intensity of sodium lines observed in an arc of copper containing 0.1 atomic percent of sodium

### *Strong lines of sodium*

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
2000	5889.95	I	0-16973	$2p^6 3s^1 \ ^2S_{0\frac{1}{2}} - 2p^6 3p^1 \ ^2P_{1\frac{1}{2}}$
1000	5895.92	I	0-16956	$2p^6 3s^1 \ ^2S_{0\frac{1}{2}} - 2p^6 3p^1 \ ^2P_{0\frac{1}{2}}$

## Sodium — All Observed Lines

Intensity and Character	Wave- length in A	Spec- trum	Energy Levels in K	Intensity and Character	Wave- length in A	Spec- trum	Energy Levels in K
30	3302.32	I	0-30273	2000	5889.95	I	0-16973
15	3302.99	I	0-30267	1000	5895.92	I	0-16956
1.0	1	5149.09	I	3.0	1	6154.23	I
2.0	1	5153.64	I	6	1	6160.76	I
7	1	5682.66	I	110		8183.27	I
14	1	5688.22	I	220		8194.81	I
			16956-36373				16956-33201
			16973-36373				16973-33201
			16956-34549				16956-29173
			16973-34549				16973-29173



# STRONTIUM

Sr,  $Z=38$ ,  $M=87.63$ , Ratio  $\frac{\text{Sr}}{\text{Cu}}=1.379$

Sr I Normal state of valence electrons  $4p^6 5s^2 \ ^1S_0 = 0$ . I.P. = 45926 K

Sr II Normal state of valence electrons  $4p^6 5s^1 \ ^2S_{0\frac{1}{2}} = 0$ . I.P. = 88964 K

## References

### Wavelengths:

G. R. Harrison, Massachusetts Institute of Technology Wavelength Tables (John Wiley & Sons, New York, 1939).

### Classification:

Sr I, F. J. Sullivan, Univ. of Pittsburgh Bull. **35**, 1 (1938).

Sr II, F. A. Saunders, E. G. Schneider and E. Buckingham, Proc. Nat. Acad. Sci. U.S. **20**, 291 (1934).

### Intensities:

J. W. Schuttevaer, M. J. de Bont, and T. H. van den Broek, Physica **10**, 544 (1943).

A. Eberhagen, Z. Physik **143**, 392 (1955).

Y. I. Ostrovskii, N. P. Penkin, and L. N. Shabanova, Doklady Akad. Nauk S.S.S.R. **120**, 66 (1958).

## Relative intensity of strontium lines observed in an arc of copper containing 0.1 atomic percent of strontium

### *Strong lines of strontium*

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
4600	4077. 71	II	0-24517	$4p^6 5s^1 \ ^2S_{0\frac{1}{2}} - 4p^6 5p^1 \ ^2P_{1\frac{1}{2}}$
3200	4215. 52	II	0-23715	$4p^6 5s^1 \ ^2S_{0\frac{1}{2}} - 4p^6 5p^1 \ ^2P_{0\frac{1}{2}}$
650	4607. 33	I	0-21698	$4p^6 5s^2 \ ^1S_0 - 4p^6 5s^1 5p^1 \ ^1P_1$

Strontium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
5	2152.84	II	14556-60992	20	5225.11	I	18159-37292
6	2165.96	II	14836-60992	20	5229.27	I	18219-37336
1.2	2428.10	I	0-41172	28	5238.55	I	18219-37302
1.2	2569.47	I	0-38907	48	5256.90	I	18319-37336
2.0	2931.83	I	0-34098	3.5 h	5329.82	I	20150-38907
3.0	3301.73	I	14318-44596	15	5450.84	I	18219-36560
3.0	3329.99	I	14504-44526	70	5480.84	I	18319-36560
4	3351.25	I	14899-44730	11	5486.12	I	18159-36382
3.0	3366.33	I	14899-44596	35	5504.17	I	18219-36382
65	3380.71	II	23715-53286	26	5521.83	I	18159-36264
95	3464.46	II	24517-53373	20	5534.81	I	18319-36382
12	3474.89	II	24517-53286	20	5540.05	I	18219-36264
3.0 h	3940.80	I	14318-39686	2.5 h	5543.36	I	21698-39733
6	3969.26	I	14504-39691	2.0 h	5970.10	I	21698-38444
3.0	3970.04	I	14504-39686	2.5 h	6345.75	I	18219-33973
13	4030.38	I	14899-39703	2.5 h	6363.94	I	18159-33868
3.0	4032.38	I	14899-39691	3.5 h	6369.96	I	18159-33853
4600	4077.71	II	0-24517	10	6380.75	I	18159-33827
20	4161.80	II	23715-47737	9	6386.50	I	18319-33973
3200	4215.52	II	0-23715	6	6388.24	I	18219-33868
34	4305.45	II	24517-47737	90	6408.47	I	18319-33919
3.5 h	4438.04	I	14899-37425	2.5	6446.68	I	18319-33827
650	4607.33	I	0-21698	2.5 h	6465.79	I	21698-37160
32	4722.28	I	14504-35675	55	6504.00	I	18219-33590
22	4741.92	I	14318-35400	10	6546.79	I	18319-33590
14	4784.32	I	14504-35400	17	6550.26	I	21698-36961
48	4811.88	I	14899-35675	30	6617.26	I	18159-33267
36	4832.08	I	14504-35194	8	6643.54	I	18219-33267
		I	14318-35007	18	6791.05	I	14318-29039
5	4855.04	I	18159-38750	48	6878.38	I	14504-29039
6	4868.70	I	18219-38752	12	6892.59	I	0-14503
30	4872.49	I	14504-35022	55	7070.10	I	14899-29039
6	4876.06	I	14504-35007	0.6	7153.09	I	21698-35675
20	4876.32	I	14899-35400	2.5 h	7167.24	I	20150-34098
10	4891.98	I	18319-38755	2.0	7232.27	I	20150-33973
80	4962.26	I	14899-35045	25	7309.41	I	20150-33827
13	4967.94	I	14899-35022	5	7621.50	I	20150-33267
8 h	5156.07	I	20150-39539	4	7673.06	I	21698-34727
14	5222.20	I	18159-37302				

## TANTALUM

$$\text{Ta}, Z=73, M=180.95, \text{Ratio } \frac{\text{Ta}}{\text{Cu}}=2.848$$

Ta I Normal state of valence electrons  $5d^3 6s^2 4F_{1/2}=0$ . I.P.=63600 K  
 Ta II Normal state of valence electrons  $5d^3 6s^1 5F_1=0$ .

### References

Wavelengths:

G. R. Harrison, Massachusetts Institute of Technology Wavelength Tables (John Wiley & Sons, New York, 1939).

C. C. Kiess, unpublished material.

Classification:

Ta I, P. F. A. Klinkenberg, G. J. van den Berg, and J. C. van den Bosch, *Physica* **16**, 861 (1950).

G. J. van den Berg, P. F. A. Klinkenberg, and J. C. van den Bosch, *Physica* **18**, 221 (1952).

C. C. Kiess and H. K. Kiess, unpublished material.

Ta II, C. C. Kiess, G. R. Harrison, and W. J. Hitchcock, *J. Research NBS* **44**, 245 (1950).

C. C. Kiess, *J. Research NBS* **66A**, No. 2 (Mar.-Apr. 1962).

### Relative intensity of tantalum lines observed in an arc of copper containing 0.1 atomic percent of tantalum

#### *Strong lines of tantalum*

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
300	2653. 27	I	2010-39688	$5d^3 6s^2 a \ ^4F_{2\frac{1}{2}}$ — 39688 $\frac{3}{2}$
300	2714. 67	I	0-36826	$5d^3 6s^2 a \ ^4F_{1\frac{1}{2}}$ — $5d^3 6s 6p \ y \ ^4G_{\frac{3}{2}}$
280	2647. 47	I	0-37761	$5d^3 6s^2 a \ ^4F_{1\frac{1}{2}}$ — 37761 $\frac{1}{2}$
240	3012. 54	II	5331-38516	$5d^2 6s^2 a \ ^3P_1$ — $5F_2^{\frac{5}{2}}$
220	2656. 61	I	0-37630	$5d^3 6s^2 a \ ^4F_{1\frac{1}{2}}$ — 37630 $\frac{2}{2}$
220	2850. 98	{ I II	5621-40686 14581-49647	$5d^3 6s^2 a \ ^4F_{4\frac{1}{2}}$ — $5d^3 6s 6p \ y \ ^4G_{4\frac{1}{2}}$ $5d^3 6s^1 b \ ^3F_3$ — 49647 $\frac{3}{2}$
200	2933. 55	I	0-34078	$5d^3 6s^2 a \ ^4F_{1\frac{1}{2}}$ — 34078 $\frac{1}{2}$
180	2661. 34	I	5621-43185	$5d^3 6s^2 a \ ^4F_{4\frac{1}{2}}$ — 43185 $\frac{3}{2}$
180	2685. 17	II	4125-41355	$5d^2 6s^2 a \ ^3P_0$ — 41355 $\frac{1}{2}$
180	2963. 32	I	2010-35746	$5d^3 6s^2 a \ ^4F_{2\frac{1}{2}}$ — 35746 $\frac{3}{2}$
170	2850. 49	I		
160	2608. 63	I	2010-40333	$5d^3 6s^2 a \ ^4F_{2\frac{1}{2}}$ — 40333 $\frac{3}{2}$
140	2400. 63	II	6187-47830	$5d^3 6s^1 a \ ^5F_5$ — $z \ ^5G_6^{\frac{5}{2}}$
140	2635. 58	II	1031-38962	$5d^3 6s^1 a \ ^5F_2$ — $5G_3^{\frac{5}{2}}$
140	2710. 13	I	3964-40851	$5d^3 6s^2 a \ ^4F_{3\frac{1}{2}}$ — 40851 $\frac{3}{2}$
140	2748. 78	I	3964-40333	$5d^3 6s^2 a \ ^4F_{3\frac{1}{2}}$ — 40333 $\frac{3}{2}$
140	2940. 22	I	0-34001	$5d^3 6s^2 a \ ^4F_{1\frac{1}{2}}$ — 34001 $\frac{3}{2}$
140	3311. 16	I	5621-35813	$5d^3 6s^2 a \ ^4F_{4\frac{1}{2}}$ — 35813 $\frac{5}{2}$
130	3626. 62	I	3964-31530	$5d^3 6s^2 a \ ^4F_{3\frac{1}{2}}$ — 31530 $\frac{3}{2}$
120d	{ 2526. 35 2526. 45 2559. 43 2698. 30 2758. 31	{ I I I I I	{ 2010-41581 3964-43533 0-39060 2010-39060 2010-38253	{ $5d^3 6s^2 a \ ^4F_{2\frac{1}{2}}$ — $5d^4 6p \ y \ ^6F_{\frac{3}{2}}$ $5d^3 6s^2 a \ ^4F_{3\frac{1}{2}}$ — 43533 $\frac{3}{2}$ $5d^3 6s^2 a \ ^4F_{1\frac{1}{2}}$ — 39060 $\frac{3}{2}$ $5d^3 6s^2 a \ ^4F_{2\frac{1}{2}}$ — 39060 $\frac{3}{2}$ $5d^3 6s^2 a \ ^4F_{2\frac{1}{2}}$ — 38253 $\frac{3}{2}$
100	2636. 90	I	5621-43533	$5d^3 6s^2 a \ ^4F_{4\frac{1}{2}}$ — 43533 $\frac{3}{2}$
100	2749. 83	I	9705-46061	$5d^3 6s^2 a \ ^2G_{3\frac{1}{2}}$ — 46061 $\frac{3}{2}$
100	3607. 41	I	2010-29723	$5d^3 6s^2 a \ ^4F_{2\frac{1}{2}}$ — 29723 $\frac{3}{2}$
90	2675. 90	II	4416-41775	$5d^3 6s^1 a \ ^5F_4$ — 41775 $\frac{4}{2}$
90	2775. 88	I	0-36014	$5d^3 6s^2 a \ ^4F_{1\frac{1}{2}}$ — $5d^3 6s 6p \ z \ ^4G_{\frac{3}{2}}$
90	2891. 84	I	2010-36580	$5d^3 6s^2 a \ ^4F_{2\frac{1}{2}}$ — $5d^3 6s 6p \ y \ ^4F_{1\frac{1}{2}}$
90	2965. 13	II	0-33715	$5d^3 6s^1 a \ ^5F_1$ — 33715 $\frac{2}{2}$
90	2965. 54	I	2010-35721	$5d^3 6s^2 a \ ^4F_{2\frac{1}{2}}$ — 35721 $\frac{1}{2}$
90	3318. 84	I	2010-32132	$5d^3 6s^2 a \ ^4F_{2\frac{1}{2}}$ — 32132 $\frac{3}{2}$

Tantalum — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
3.5	2140.13	II		4	2335.75	II	12705-55505
5	2146.87	II	1031-47596	9	2338.28	II	6988-49741
2.5	2150.62	II	1031-47515	6	2340.94	II	6831-49536
2.5	2165.01	II	0-46175	6	2341.61	II	12436-55128
3.5	2178.03	II	3180-49080	4	2343.64	II	
6	2182.71	II	1031-46831	3.0	2346.42	II	
3.0	2193.20	II	2642-48223	3.0	2351.99	II	
6	2193.88	II	6187-51754	6	2353.86	II	5331-47801
9	2196.03	II	4416-49938	4	2355.22	II	
9	2199.67	II	0-45447	6	2356.05	II	9690-52121
3.5	2207.14	II		5	2356.90	II	4416-46831
9	d 2210.03	II	0-45234	9	2357.30	I	0-42408
	2210.19	II	4416-49647	6	2359.16	II	9746-52121
3.0	2215.60	II	4416-49536	10	2361.09	I	2010-44350
13	2239.48	II	2642-47281	6	2362.78	II	
2.5	2248.48	II	9746-54207	5	2363.32	II	
5	2249.79	II	0-44435	24	2364.24	II	6187-48470
13	2250.76	II	1031-45447	2.0	2367.24	II	4416-46646
3.0	2254.86	II	3180-47515	6	2369.32	II	2642-44835
5	2255.77	II	12436-56753	12	2370.76	II	5658-47825
4	2256.51	II	9746-54048	13	2371.58	I	3964-46117
6	2258.71	II	0-44259			II	0-42153
10	2261.42	II	0-44206	3.0	2372.80	II	6831-48963
3.0	2261.62	II	1031-45234	4	2373.94	II	10713-52825
13	2262.30	II	2642-46831	3.0	2375.91	I	
3.0	2269.56	II	12705-56753	7	2378.31	II	1031-43065
10	2271.85	II	2642-46646	20	2381.13	II	2642-44626
13	2272.59	II	3180-47169	11	2381.52	II	0-41977
3.0	2279.85	I		8	2383.72	II	5658-47596
5	2282.19	II	1031-44835	11	2384.28	II	1031-42960
2.0	2285.02	II	5331-49080	6	2385.73	I	
12	2285.25	II	2642-46387	70	2387.06	II	4416-46295
9	2286.59	II	9746-53466	4	2388.37	II	5658-47515
4	2287.27	II	12436-56142	8	2389.11	II	9690-51534
16	2289.16	II	3180-46851	4	2396.30	I	5621-47340
3.0	2292.54	II	0-43606	6	2399.15	I	
3.0	2295.18			3.0	2399.92	II	3180-44835
3.0	2301.47	II	12705-56142	140	2400.63	II	6187-47830
9	2302.24	II	5658-49080	8	2402.13	II	2642-44259
9	2302.93	II	4416-47825	6	2403.68	II	11875-53466
6	2303.49	II	1031-44430	8	2406.55	I	2010-43551
2.0	2308.46	II	5658-48963	2.5	2407.57	I	2010-43553
9	2312.60	II	1031-44259	8	2408.26	II	5658-47169
9	2315.46	II	1031-44206	2.5	d 2412.53	II	14581-56019
6	2319.16	II	12436-55543		2412.67	I	
2.5	2331.29	II	11767-54649	8	2414.32	I	9253-50660
18	2331.98	II		16	2415.21	II	6831-48223
15	2332.19	II	4416-47281	22	2416.89	II	2642-44005
3.0	2334.13	II		5	2417.33	II	0-41355
5	2334.88	II	6831-49647	16	2417.86	II	

Tantalum — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
11	2418.77	II		50	2484.95	I	0-40230
10	2421.03	I	3964-45256	12	2486.70	I	3964-44166
11	2421.85	II	14581-55859	60	2488.70	II	4416-44585
13	2423.48	II	3180-44430	50	2490.46	I	
10	2425.91	II	12436-53645	5	2496.24	I	6069-46117
28	2427.64	I	0-41180	7	2496.64	I	
5	2428.00	II	5658-46831	5	2497.77	II	0-40024
28	2429.71	II	0-41145	9	2498.33	II	4416-44430
14	2431.06	II	1031-42153	14	2501.98	II	9690-49647
5	2431.66	I		10	2503.01	II	
40	2432.70	II	6187-47281	60	2504.45	I	3964-43881
11	2433.59	II	3180-44259	10	2505.32	II	5331-45234
11	2436.51	II	12436-53466	60	2507.45	I	2010-41879
9	2437.07	I		10	2508.92	II	9690-49536
8	2437.67	I	0-41010	10	2510.71	II	15726-55544
10	2438.64	II	6831-47825	5	d 2511.69	II	
18	2439.91	I	2010-42983	24	2512.65	I	0-39787
12	2442.39	I	5621-46552	10	2513.10	II	3180-42960
10	2444.13	II	2642-43544	7	2513.88	II	11767-51534
9	2444.67	II		10	2519.78	I	6049-45724
5	2445.53	II		14	2526.02	II	5658-45234
10	2447.17	I	0-40852	120	d 2526.35	I	2010-41581
8	2449.44	II	6988-47801		2526.45	I	3964-43533
8	2454.21	I		5	2531.29	I	5621-45115
10	2454.48	I	3964-44693	60	2532.12	II	2642-42123
5	2454.70	II	11767-52493	12	2533.00	I	
10	2458.68	I		7	2534.16	I	
10	2460.55	I	9253-49882	5	2534.47	I	9705-49149
8	d 2461.06	II	10713-51334	12	2534.97	I	5621-45058
16	2463.82	II	12436-53011	16	2537.94	II	9690-49080
8	2465.26	I	5621-46172	9	d 2542.23	I	
13	2466.99	II	1031-41555		2542.35	II	11875-51197
13	2467.37	II	5658-46175	5	2544.27	I	
5	2468.41	II	15851-56351		2544.37	II	12831-52121
38	2470.90	II	6187-46646	24	2545.49	II	1031-40305
12	2471.38	I		24	2546.80	I	0-39253
12	2472.13	I	3964-44403	14	2549.38	I	3964-43177
15	2473.13	I	3964-44386	46	d 2551.07	I	2010-41198
12	2473.31	II	4416-44835		2551.19	I	5621-44807
60	2474.62	I	2010-42408	14	2551.73	II	5658-44835
12	2475.33	I	9759-50146	7	2553.18	II	
20	2476.67	II	3180-43544	46	2554.62	II	2642-41775
15	2478.22	I	0-40339	12	2554.91	II	4416-43544
8	2479.58	II	2642-42960	24	2555.05	I	3964-43090
12	2481.86	II	11875-52156	14	2556.51	II	5331-44435
10	2482.10	I		18	2557.71	II	9690-48776
10	2482.58	II		120	2559.43	I	0-39060
8	2483.46	II		18	2560.68	I	
10	2484.04	II		46	2562.10	I	3964-42983
8	2484.72	II	0-40234	8	2563.33	I	2010-41010

Tantalum — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
14	2563.70	I	0-38994	36	2615.66	I	2010-40230
14	2569.13	II	2642-41555	6	2620.18	I	
40	2571.51	II	5331-44206	20	2624.12	I	6049-44146
50	2573.54	I	0-38845	10	2625.46	I	6069-44146
46	2573.79	I	2010-40852	5	2627.43	I	
18	2574.38	I	9976-48809	8	2628.85	II	18494-56522
18	2575.47	I	9253-48070	9	2630.53	II	6831-44835
70	2577.37	II	11099-49887	12	2632.27	II	
40	2577.78	I	5621-44403	10	2633.79	II	18494-56451
8	2578.24	II	12705-51480	140	2635.58	II	1031-38962
12	2579.62	I	0-38754	8	2635.93	I	2010-39936
24	2580.16	I	2010-40756	6	2636.37	I	9705-47625
4	2581.60	II	9746-48470	55	2636.67	I	3964-41879
40	2584.03	II		100	2636.90	I	5621-43533
16	2584.49	II	13475-52156	6	2637.93	II	0-37897
17	2584.69	I	9253-47931	10	2638.67	II	5658-43544
12	2585.61	I	9705-48369	6	2639.19	II	11767-49647
4	2588.88	II	6831-45447	20	2643.89	I	6069-43880
9	2589.81	II	5658-44259	14	2644.60	II	2642-40444
2.5	2590.20	II	13560-52156	14	2645.10	II	6831-44626
8	d 2592.44	I		60	2646.22	I	
	2592.53	II	13560-52121	70	2646.37	I	2010-39787
50	2593.08	I	5621-44174	18	d 2646.74	II	11875-49647
48	2593.66	II	4416-42960		2646.89	II	11767-49536
36	2594.25	II	0-38535	280	2647.47	I	0-37761
65	2595.26	I	5621-44141	6	2650.02	I	
14	2595.59	II	0-38516	8	2650.28	I	9253-46974
10	2596.12	I	0-38508	32	2651.22	II	4416-42123
36	l 2596.45	II	2642-41145	5	2652.32	I	9705-47397
7	2596.61	I	2010-40510	300	2653.27	I	2010-39688
12	2598.21	II		2.5	2654.01	I	
5	2598.75	I	6049-44518	4	2655.68	I	
26	2600.14	I	0-38448	5	2656.08	I	
8	2600.73	II	6187-44626	220	2656.61	I	0-37630
16	2601.06	I	6049-44484	8	2657.30	I	3964-41585
10	2602.38	I	6069-44484	6	2658.14	II	
70	2603.49	II	6187-44585	14	2658.86	II	6831-44430
7	2603.82	I	9976-48369	10	2659.41	II	2642-40234
7	2605.32	I	9253-47625	4	2659.66	I	
8	2606.43	II	15851-54206	180	2661.34	I	5621-43185
14	2607.84	II		18	2661.89	I	5621-43177
6	2608.20	I	2010-40339	15	2662.10	I	
160	2608.63	I	2010-40333	3.0	2663.88	II	14628-52156
24	2609.00	I	6069-44386	6	2664.24	II	17982-55505
4	2610.13	I	6049-44350	26	2665.60	II	1031-38535
36	d 2611.34	I	3964-42247	4	2665.94	I	
	2611.46	I		5	2667.00	II	1031-38516
13	2612.61	II	1031-39296	6	2667.17	I	6069-43551
8	2615.25	I	9705-47931	26	2668.07	I	5621-43090
40	2615.46	I	9705-47928	70	2668.62	I	0-37461

## Tantalum — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
18	2669.58	II	24870-62318	3.5	2733.34	II	18554-55128
12	2671.63	I	10950-48369	12	2735.26	II	9746-46295
12	2672.50	II	5658-43065	36	2736.25	II	
6	2674.18	II	15851-53235	24	2739.26	II	5658-42153
4	2674.49	I	10690-48070	3.5	2740.70	II	17168-53645
90	2675.90	II	4416-41775	17	2741.17	I	9253-45724
6	2676.48	II	10713-48064	3.0	2742.92	I	
8	2678.80	II	18186-55505	24	2743.59	I	2010-38448
32	2680.06	II	5658-42960	60	2746.68	I	5621-42018
26	2680.66	II	4416-41709	14	2746.83	II	15726-52121
3.0	2681.63	I		10	2747.25	I	
13	2681.87	I		3.5	2747.85	I	11244-47625
70	2684.28	I	2010-39253	140	2748.78	I	3964-40333
180	2685.17	II	4125-41355	100	2749.83	I	9705-46061
4	2686.29	I	9759-46974	8	2750.41	II	11875-48223
12	2689.24	II	6831-44005	18	2752.30	I	10690-47013
4	2690.54	I	9253-46410	48	2752.49	II	2642-38962
40	2691.31	I	0-37146	8	h 2757.26	II	12705-48963
6	2691.80	II	4416-41555	120	2758.31	I	2010-38253
30	2692.40	I	5621-42752	8	2759.06	II	6831-43065
5	2692.83	II	3180-40305	50	2761.68	II	1031-37231
11	2693.34	I	6049-43167	7	2762.05	II	
6	2693.50	I	5621-42737	13	2763.37	II	0-36177
55	2694.52	II	2642-39744	6	2768.09	II	3180-39296
17	2694.76	I	6069-43167	8	2771.83	II	
5	2695.54	II	10713-47801	12	2774.88	I	15391-51418
3.0	2695.71	II	9746-46831	15	2775.11	II	5331-41355
28	2696.81	I	9253-46323	4	2775.35	II	18186-54207
120	2698.30	I	2010-39060	90	2775.88	I	0-36014
6	2700.70	I	12866-49882	3.0	2776.71	II	17231-53235
14	2702.80	II	0-36988	6	2778.82	II	13560-49536
10	2703.06	I	2010-38994	12	2779.10	I	3964-39936
10	2704.31	I		6	2779.70	I	9759-45724
55	2706.69	I	10690-47625	12	2780.34	II	1031-36988
3.5	2706.92	I		3.5	2780.89		
36	2709.27	II	9746-46646	12	2781.37	I	9705-45648
140	2710.13	I	3964-40851	3.0	2781.79	I	10950-46888
3.0	2710.72	II	24226-61106	18	2784.97	II	5658-41555
300	2714.67	I	0-36826	7	2786.77	II	2642-38516
28	2717.18	I	3964-40756	46	2787.69	I	9253-45115
17	2718.38	I	6069-42845	15	2788.30	I	
55	2720.76	I	2010-38754	6	2789.15	II	17168-53011
20	2721.83	I	6049-42779	6	2789.77	I	12235-48070
13	2725.42	II		12	2790.71	I	3964-39787
3.0	2726.32	I	2010-38679	16	2791.37	II	5331-41145
55	2727.44	II	5331-41984	14	2791.67	I	6069-41879
48	2727.78	I	10690-47340	6	2793.86	II	3180-38962
6	2730.73	II	28044-64653	6	2795.20	II	12705-48470
10	2732.06	I		80	2796.34	I	2010-37761
8	2732.92	I	0-36580	9	2796.56	I	9976-45724

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Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
80	2797.76	II	1031-36764	26	2858.44	II	5331-40305
22	2798.40	I		7	2860.88	II	6831-41775
6	2800.57	I	12235-47931	6	2861.12	I	6069-41010
44	2802.07	I	3964-39641	42	2861.98	I	9759-44689
6	2804.76	I	6049-41693	18	2864.50	I	
50	2806.30	I	6069-41693	9	2865.32	II	17231-52121
60	2806.58	I	2010-37630	8	2866.14	I	
16	2810.92	I	12235-47800	12	2867.41	II	17982-52846
8	2811.72	II		36	2868.65	I	3964-38813
12	2814.31	II	6187-41709	55	2871.42	I	2010-36826
11	2814.80	I	6069-41585	32	2873.36	I	0-34792
11	2815.01	I	2010-37524	30	2873.56	I	3964-38754
11	2815.12	I	6069-41581	24	2874.17	I	6069-40852
30	2817.10	II	5658-41145	16	2876.11	I	9759-44518
6	2817.50	I	10690-46172	10	2877.05	II	13475-48223
5	2819.14	II	10713-46175	12	2877.69	II	9690-44430
11	2819.37	I	3964-39422	8	2879.05	II	6831-41555
6	2821.99	I		4	2879.52	I	13352-48070
5	2824.81	I	12235-47625	14	2879.74	I	3964-38679
8	2826.18	I	10950-46323	44	2880.02	I	5621-40333
4	2826.42	I	10690-46061	4	2881.23	I	9705-44403
11	2827.18	I	5621-40982	4	2882.33	II	9746-44430
11	d 2827.48	II	14581-49938	10	2885.40	II	5658-40305
	2827.60	II	3180-38535	11	2889.38	I	
18	2828.58	II	31267-66610	9	2890.25	II	2642-37231
4	2829.79	II	4416-39744	10	2891.04	I	13352-47931
8	2832.70	II	6831-42123	90	2891.84	I	2010-36580
20	2833.64	I	9976-45256	12	2894.15	I	9976-44518
8	2834.41	I	9976-45246	16	2895.10	I	12866-47397
4	2836.62	I	0-35243	4	2896.41	I	
6	2837.94	I	10950-46177	4	2898.42	I	15391-49882
10	2838.24	II	15851-51074	30	2899.04	I	3964-38448
9	2840.39	II		20	2900.36	I	9705-44174
30	2842.82	I	11244-46410	7	2900.75	II	12705-47169
8	2843.51	II	18186-53344	5	2901.05	I	9705-44166
75	2844.25	I	6049-41198	65	2902.05	I	13352-47800
34	2844.46	II	1031-36177	18	2904.07	I	10690-45115
20	2844.76	I		20	2905.24	II	4125-38535
34	c 2845.35	I	5621-40756	20	2908.91	I	10690-45058
4	2845.84	I	6069-41198	4	2913.32	I	5621-39936
8	2846.75	I		4	2913.45	II	6831-41145
17	2848.05	I	9705-44807	24	2914.12	I	10950-45256
65	2848.52	I	3964-39060	3.0	2914.94	I	10950-45246
12	2849.82	I	11244-46323	20	2915.34	I	
170	2850.49	I		36	2915.49	I	3964-38253
220	2850.98	I	5621-40686	4	2917.12	I	6069-40339
		II	14581-49647	4	2917.56	II	13560-47825
7	2852.36	II	18186-53235	11	2918.96	II	17231-51480
8	2856.69	II	12601-47596	4	2922.11	II	15726-49938
12	2857.28	II	9705-44693	8	2922.84	II	



Tantalum — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
48	2925.19	I	6069-40245	6	3001.54	I	12866-46172
4	2925.66	I	9976-44146	4	3002.98	II	13560-46851
12	2926.46	I	6069-40230	8	3004.15	I	9705-42983
4	2930.99	I	12866-46974	9	3004.92	II	9690-42960
36	2932.70	I	12235-46323	5	3006.56	I	
200	2933.55	I	0-34078	14	3010.84	II	5331-38535
8	2934.85	I	9705-43769	24	3011.12	I	13352-46552
4	2938.00	II	18554-52580	28	3011.88	I	5621-38813
4	2938.43	I	12866-46888	240	3012.54	II	5331-38516
18	2939.28	I	11244-45256	9	3016.37	I	11244-44386
55	2940.06	I	10690-44693	8	3019.67	I	11244-44350
140	2940.22	I	0-34001	12	3024.09	I	5621-38679
18	2941.37	I	13352-47340	24	3025.16	I	9705-42752
7	2941.58			38	d 3027.51	I	12235-45256
28	2942.14	I	3964-37943		3027.61	II	14495-47515
4	2943.77	I		12	3028.78	I	9976-42983
4	2945.69	I	12235-46172	14	3030.29	I	6069-39059
18	2946.91	I	9253-43177	14	3037.50	II	6831-39744
4	2949.92	II	14581-48470	5	3040.70	II	5658-38535
60	2951.92	I	2010-35877	10	3040.98	I	
		II	15726-49593	38	3042.06	II	4125-36988
12	2952.99	II	9690-43544	14	3042.44	II	11767-44626
40	2953.56	I		10	3043.92	I	10690-43533
12	c 2955.32	II		14	3045.96	I	13352-46172
14	c 2956.84	II	15726-49536	24	3048.86	I	2010-34800
20	2957.60	I	5621-39422	70	3049.56	I	2010-34792
4	2957.88	II	9746-43544	14	3050.10	I	6069-38845
4	2963.06	I	10950-44689	10	3056.62	II	17231-49938
180	2963.32	I	2010-35746	14	3057.22	II	14581-47281
14	2963.91	I	9253-42983	19	3058.64	I	6069-38754
90	2965.13	II	0-33715	19	3060.29	I	3964-36631
90	2965.54	I	2010-35721	24	3063.56	I	5621-38253
11	2965.92	II	0-33706	5	3063.88	I	
4	2968.28	II	11767-45447	70	3069.24	I	12235-44807
40	2969.47	I	3964-37630	8	3073.39	I	
8	2969.90	I	13352-47013	5	3076.38	I	6049-38546
50	2975.56	I	3964-37561	48	3077.24	I	10690-43177
10	2976.10	I	9253-42845	19	3078.23	I	6069-38546
10	2976.26	II	12705-46295	14	3079.96	I	12235-44693
7	2976.76	I		24	3081.85	I	6069-38508
12	2978.18	II	18554-52121	22	3085.54	I	10690-43090
20	2978.75	I		19	3087.53	I	6069-38448
7	2981.19	I	9705-43239	8	3087.76	II	9746-42123
7	2984.36	I	9253-42752	4	3092.06	I	9253-41585
14	2986.81	II	2642-36113	24	3092.44	I	9253-41581
22	2988.58	I	10690-44141	5	3092.99	I	5621-37943
7	2989.05	I		20	3093.87	I	9705-42018
22	2989.50	I	6049-39490	24	3095.39	I	13352-45648
12	2991.25	I	6069-39490	10	3101.03	II	11767-44005
8	2999.37	II	14495-47825	5	3101.72	I	

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Intensity and Character	Wave-length in A	Spectrum	Energy Levels in K	Intensity and Character	Wave-length in A	Spectrum	Energy Levels in K
75	3103.25	I	0-32215	26	3213.91	II	5658-36764
5	3104.42	I		20	3216.93	I	6069-37146
10	3107.21	I	9705-41879	10	3221.32	I	9976-41010
5	3110.82	II		40	3223.83	I	5621-36631
13	3113.90	I		24	3227.32	I	9253-40230
10	3115.86	I	2010-34095	30	3229.24	I	
20	3117.44	I	2010-34078	11	3229.88	II	14495-45447
10	3119.59	I	10690-42737	16	3230.86	I	12235-43177
5	3120.92	I	10950-42983	11	3234.69	I	
50	3124.97	I	2010-34001	5	3236.40	I	
20	3127.76	II	9746-41709	9	3239.99	I	12235-43090
8	3129.55	I	9253-41198	16	3240.94	II	5331-36177
15	3129.95	I	5621-37561	26	3242.05	I	3964-34800
50	3130.58	I	11244-43177	26	3242.83	I	3964-34792
36	3132.64	I	3964-35877	5	3248.52	I	11244-42018
5	3133.55	I	9976-41879	5	3250.36	I	6069-36826
10	3133.89	II	5331-37231	9	3260.18	I	0-30665
24	3135.89	I	9705-41585	28	3274.95	II	3180-33706
		II	12705-44585	11	3275.68	II	5658-36177
8	3137.44	II	9690-41555	9	3279.29	I	9759-40245
8	3142.96	II	9746-41555	9	3280.87	I	9759-40230
10	c 3147.37	I	13352-45115	4	3292.48	I	9976-40339
18	3148.04	I	9253-41010	5	3293.93	I	
5	3150.85	I	9253-40982	18	3295.33	I	11244-41581
5	3155.25	II	6831-38516	16	3299.77	I	6049-36346
5	3156.76	II	11875-43544	9	3304.38	I	9976-40230
10	3157.96	II	5331-36988	10	3309.78	I	2010-32215
5	3159.05	I	12235-43881	140	3311.16	I	5621-35813
10	3162.72	I	9976-41585	28	3317.93	I	3964-34095
19	3163.13	I	9976-41581	9	3318.53	I	5621-35746
9	3163.82	I	9253-40852	90	3318.84	I	2010-32132
10	3167.53	I	6068-37630	44	d 3331.00		
9	3168.18	II	15726-47281		3331.01	I	12235-42247
42	3170.29	I	12235-43769	11	3332.41	I	9253-39253
10	3172.87	I	11244-42752	9	3337.80	I	2010-31961
36	3173.59	I	0-31501	11	3338.49	I	6069-36014
26	3176.29	I	6049-37524	17	3339.91	II	6831-36764
19	3178.16	I	5621-37077	4	3343.47	I	11792-41693
		I	6069-37524	17	c 3349.21	II	14581-44430
80	3180.95	I	0-31428	12	3350.96	I	13352-43185
14	3181.69	I	9759-41180	17	3351.51	I	9759-39588
15	3182.57	I	6049-37461	30	3358.47	I	11244-41010
32	3184.55	I	6069-37461	23	3361.64	I	13352-43090
16	3191.16	I	10690-42018	5	3362.53	I	9759-39490
10	3192.25	I		6	3366.66	I	
26	3198.67	I	3964-35218	15	3369.28	I	6049-35721
5	3201.98	I	9976-41198	85	3371.54	I	3964-33615
10	3205.00			17	3376.05	I	9976-39588
20	3206.39	I	5621-36800	6	3376.49	II	
6	3207.85	I	11244-42408	18	3379.52	II	4125-33706

## Tantalum — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
48	3385.05	I	3964-33497	20	c 3573.44	II	11767-39744
5	3387.46	I	11244-40756	14	3584.21	I	9253-37146
5	3388.82	I	9253-38754	11	3584.51	I	12866-40756
30	3398.33	I	2010-31428	20	3586.29	I	5621-33497
22	3406.66	II	6831-36177	20	3595.64	I	10950-38754
60	3406.94	I	0-29344	7	3602.48	I	11244-38994
12	3412.89	I	9253-38546	100	3607.41	I	2010-29723
18	3414.14	II	6831-36113	7	3625.24	I	5621-33198
6	3417.03	II	0-29257	130	3626.62	I	3964-31530
10	3419.75	I	3964-33198	7	3633.79	I	
19	3424.45	I	6049-35243	60	3642.06	I	5621-33070
12	3426.73	I	6069-35243	5	3653.39	I	12866-40230
24	3430.94	I		2.5	3653.83	I	15391-42752
10	3434.50	I	9705-38813	5	3656.89	I	
19	3436.00	I	11244-40339	7	3657.27	I	13352-40686
6	3438.40			7	3657.49	I	2010-29344
12	3440.24	II	14495-43554	10	3658.78	I	19658-46982
6	3445.15	I	9976-38994	8	3661.69	I	11244-38546
9	3445.91	I		8	3662.34	II	9690-36988
10	c 3446.91	II	12705-41709	4	3667.82	I	
12	3447.29	I	9253-38253	8	3674.83	I	11244-38448
31	3463.97	I	0-28862	4	3675.12	I	11792-38994
6	3472.52	I	17383-46172	5	3681.04	I	13352-40510
6	3473.90	I	9976-38754	5	3681.24		
6	3477.22	I	15391-44141	7	3683.06	I	
13	3477.45	I	9759-38508	12	3686.18	I	9705-36826
65	3480.52	I	6069-34792	12	3689.73	I	9705-36800
6	3484.62	I	0-28689	9	3693.05	I	12866-39936
10	3490.93	I	10950-39588	7	3694.52	II	14495-41555
50	3497.85	I	2010-30591	7	3695.38	I	11792-38845
10	3502.50	I	11244-39787	2.5	3701.34	I	11244-38253
17	3502.87	I	10950-39490	2.0	3710.79	I	
32	3503.87	I	9976-38508	5	3723.07	I	2010-28862
17	3504.98	I	3964-32487	16	3731.02	I	0-26795
10	3505.18	I	12235-40756	17	3736.76	I	11792-38546
65	3511.04	I	5621-34095	16	3746.36	I	
26	3513.61	I	11792-40245	13	3754.52	I	3964-30591
7	3527.06	I	11244-39588	9	3755.11	I	9253-35877
10	3528.61	I	12866-41198	2.5	3757.75	I	9976-36580
20	3531.58	I	9253-37561	5	3759.75	I	0-26590
5	3532.21	I	10950-39253	2.5	3760.21	I	9759-36346
10	3536.30	I	9253-37524	5	3762.11	I	10950-37524
7	3540.82	I		4	3770.52	I	
13	3541.88	II	1031-29257	5	3770.93	I	5621-32132
16	3549.05	I	3964-32132	12	3777.10	I	9253-35721
7	3553.42	I	0-28134	2	3784.25	I	6069-32487
7	3557.98	I	12235-40333	12	3792.02	I	0-26364
7	3564.79	I	10950-38994	10	3823.60	I	6069-32215
24	3566.72	I	6049-34078	4	3826.17	I	12866-38994
20	3571.85	I	10690-38679	9	3826.85	I	2010-28134

Tantalum — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
10	3828.95	I	10690-36800	1.8	4033.63	I	2010-26795
3.5	3830.00	II	5658-31760	7	4035.89	I	10950-35721
22	3833.74	II	3180-29257	3.5	4039.63	I	
7	3836.60	I	3964-30021	13	4040.87	I	5621-30361
9	3839.03	I	9705-35746	9	4041.06	I	0-24739
4	3844.04	I		7	4058.46	I	11244-35876
4	3846.64	I	9253-35243	44	4061.40	I	6049-30665
11	3848.05	I	5621-31601	22	4064.63	I	6069-30665
4	3849.42	I		11	4067.24	I	2010-26590
4	3859.80	I	9976-35877	33	4067.91	I	2010-26586
11	3885.20	I	11792-37524	4	4073.00	I	15391-39936
2.0	3893.03	I	12866-38546	7	4079.19	I	
2.0	bl 3896.43	TaO		2.0	4081.13	I	
3.5	3898.78	I		4	4085.80	I	17224-41693
7	3909.33	I		4	4091.26	I	15904-40339
4	3912.13	I	17224-42779	2.0	h 4095.55	II	11767-36177
4	3912.44	I		4	4097.19	I	5621-30021
22	3918.51	I	0-25513	13	4105.02	I	2010-26364
4	3919.47	I		2.0	4114.77	I	9705-34001
6	3922.42	II	6831-32318	2.0	4118.07	I	
15	3922.78	I	6069-31554	6	4123.17	I	
15	3922.92	I	9759-35243	9	4127.88	I	3964-28183
7	3930.94	I	6069-31501	22	4129.38	I	2010-26220
4	3936.55	I	12235-37630	24	4136.20	I	3964-28134
9	3937.84	I	12866-38253	24	4147.89	I	5621-29723
2.0	3942.24	I	6069-31428	8	h 4161.00	I	
7	3952.16	I	15391-40686	22	4175.21	I	9253-33198
4	3954.29	I		8	4176.90	II	14581-38516
7	3956.57	I	9976-35243		4176.99	I	12866-36800
2.0	3956.82	I		11	4177.92	I	11792-35721
3.0	3959.73	I		14	4181.15	I	9705-33615
22	3970.10	I	0-25181	9	4191.16	I	
7	3979.28	I	10690-35813	6	4193.10	I	10950-34792
2.0	3981.01	II	11875-36988	32	4205.88	I	3964-27734
9	3981.95	I	15904-41010	13	4206.40	I	
2.0	3983.82	I	9705-34800	10	4228.61	I	12235-35877
1.8	3984.98	I	9705-34792	3.5	4232.94	I	
9	3988.70	I	10950-36014	6	4235.94	II	24870-46470
4	3990.40	I		3.0	4243.99	I	11244-34800
22	3996.17	I	6049-31066	14	4245.35	I	11244-34792
11	3999.28	I	6069-31066	14	4268.26	I	15391-38813
7	4003.70	I	5621-30591	7	4271.51	I	10690-34095
20	4006.84	I	2010-26960	10	4279.06	I	0-23363
3.5	4007.23	I	15904-40852	7	4286.38	I	19178-42502
7	4012.11	I		6	4294.36	I	13352-36631
7	4013.19	I	12235-37146	17	c 4302.98	I	9253-32487
20	4026.94	I	6069-30895	10	4314.52	I	2010-25181
15	4029.94	I		7	4318.81	I	12866-36014
9	4033.07	I	11792-36580	7	4322.68	I	17383-40510
2.0	4033.38	I		9	4329.57	I	15904-38994

Tantalum — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
3.5	4336.20	I	23927-46982	1.8 h	4604.28	I	22429-44141
9	4344.31	I		3.5 h	4604.85	I	23927-45637
12	4355.14	I	22682-45637	28	4619.51	I	9253-30895
5	4360.83	I	10690-33615	3.0	4622.96	I	9976-31601
5	4364.84	I		1.6	4624.84	I	
6	4369.35	I	12866-35746	4	4633.06	I	9976-31554
3.0	4374.21	I	12866-35721	8	4661.12	I	13352-34800
5	4375.14	I	15904-38754	12	4669.14	I	9253-30665
3.0	4376.31	I		42	4681.88	I	2010-23363
3.0	4377.98	I	24982-47817	4	4684.87	I	5621-26960
11	4378.82	I	3964-26795	3.5	4685.27	I	9253-30591
2.5	4381.88	I	21168-43982	1.8	4688.84	I	17224-38546
16	4386.07	I	6069-28862	12	4691.90	I	9759-31066
12	4398.45	I	2010-24739	8	4693.35	I	22682-43982
19	4402.50	I	9253-31961	6	4701.32	I	10950-32215
14	4415.74	I	6049-28689	6	4706.09	I	11244-32487
5	4419.55	I	6069-28689	4	4722.88	I	0-21168
3.5	4424.96	I	20647-43239	8	4730.12	I	12866-34001
7	4430.41	I	12235-34800	2.5 h	4738.35	I	
3.5	4431.09	I	5621-28183	14	4740.16	I	9976-31066
4	4432.98	I	15391-37943	3.5	4745.93	I	17383-38448
6	4441.03	I	9976-32487	20	4756.51	I	3964-24982
8	4441.68	I	10690-33198	4	4758.03	I	10950-31961
8	4450.72	I	13352-35813	11	4768.98	I	12235-33198
2.0 h	4451.87	I	9759-32215	8	4780.94	I	10690-31601
10	4459.76	I	19178-41595	2.0	4786.64	I	9705-30591
10	4473.52	I	9253-31601	20	4812.75	I	0-20772
5	4480.93	I	25009-47319	8	4819.53	I	13352-34095
4	4494.97	I		8	4825.43	I	11244-31961
4	4496.50	I	2010-24243	5	4832.18	I	9976-30665
38 c	4510.98	I	5621-27783	6	4846.45	I	25009-45637
8	4511.50	I	5621-27781	3.0	4852.17	I	10950-31554
6	4521.09	I	5621-27734	1.8	4871.70	I	6069-26590
3.5	4521.71	I		1.2	4879.14	I	23913-44403
7	4527.50	I		1.0	4881.94	I	10950-31428
20	4530.85	I	6069-28134	7	4883.95	I	9253-29723
3.0	4547.15	I	9976-31961	5	4904.59	I	
14	4551.95	I	3964-25926	3.0	4907.73	I	2010-22380
5	4553.69	I	11244-33198	2.5	4914.96	I	0-20340
9	4556.35	I	11244-33185	9	4920.11	I	12866-33185
5	4559.46	I	12866-34792	8	4921.27	I	6049-26364
1.8	4561.48	I	2010-23927	1.6	4923.47	I	5621-25926
18	4565.85	I	9705-31601	2.0	4924.96	I	17224-37524
3.0	4566.86	I	25926-47817	9	4926.00	I	6069-26364
5	4573.29	I	12235-34095	12	4936.42	I	12235-32487
36	4574.31	I	0-21855	4	4937.63	I	17383-37630
3.0	4580.69	I	9705-31530	1.4	4958.11	I	
2	4583.17	I	9253-31066	2.0	4968.53	I	22380-42502
4	4601.42	I	15904-37630	3.5	4969.69	I	10950-31066
5	4602.19	I	9705-31428	1.4	4972.06	I	

Tantalum — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
2.0	4976.20	I	9253-29344	4	5349.09	I	6049-24739
6	5012.52	I	10950-30895	4	5349.57	I	12866-31554
16	5037.37	I	13352-33198	5	5354.68	I	6069-24739
7	5037.66	I	2010-21855	1.2	5365.95	I	17383-36014
7	5043.32	I	11244-31066	1.6	5373.01	I	
1.4	5044.42	I		2.0	c 5388.51	I	28767-47319
2.0	h 5058.70	I	17383-37146	7	5389.30	I	
8	5067.87	I	12235-31961	3.0	5395.99	I	9253-27781
3.5	5076.37	I	17383-37077	2.0	5397.56	I	17224-35746
2.5	5082.25	I	10690-30361	16	5402.51	I	0-18505
5	5087.37	I	11244-30895	1.0	5403.54	I	15114-33615
7	5090.71	I	9705-29344	3.5	5404.96	I	17224-35721
3.0	5095.27	I	12866-32487	1.0	5405.80	I	17383-35877
2.0	c 5109.37	II	9690-29257	2.5	5408.78	I	
1.6	5109.77	I	5621-25186	1.4	5410.55	I	9705-28183
9	5115.84	I		2.0	c 5413.48	I	6049-24517
3.0	5117.25	I	27783-47319	10	5419.13	I	6069-24517
3.5	5132.12	I		1.8	5431.66	I	
2.5	5136.47	I	6049-25513	5	5435.27	I	10950-29344
8	5141.62	I	6069-25513	2.0	5458.41	I	
8	5143.69	I	9253-28689	7	5461.29	I	5621-23927
6	5147.62	I	11244-30665	1.0	5471.56	I	
2.0	5148.78	I	17383-36800	2.5	5475.54	I	24243-42502
2.0	5150.85	I	15391-34800	1.2	5481.16	I	23355-41595
6	5153.42	I	3964-23363	1.6	5483.43	I	23363-41595
26	5156.56	I	5621-25009	3.0	5490.11	I	
6	5161.81	I	9976-29344	1.6	5494.78	I	6049-24243
5	5163.65	I	5621-24982	4	5499.44	I	13352-31530
2.0	5166.79	I	12866-32215	1.4	5500.68	I	6069-24243
1.6	5171.63	I	10690-30021	1.6	5505.66	I	9976-28134
3.0	c 5180.98	I	21855-41151	1.2	c 5516.27	I	
1.6	5188.93	I	12866-32132	7	5518.91	I	17383-35498
1.6	c 5193.99	I	17383-36631	0.7	5521.15	I	20647-38754
1.6	5206.26	I		0.8	5523.98	I	
9	5212.74	I	0-19178	1.0	5528.36	I	3964-22047
9	d 5218.45	I	2010-21168	0.8	l 5545.14	I	12866-30895
	5218.66	I	9705-28862	1.6	5548.32	I	17224-35243
3.0	5230.80	I	6069-25181	2.5	5584.02	I	27734-45637
2.5	5235.39	I	12866-31961	1.2	5598.75	I	27781-45637
2.5	5237.53	II	14628-33715	2.5	5599.52	I	27783-45637
1.4	5244.78	I	9705-28767	0.7	c 5605.50	I	17383-35218
2.5	5275.02	I		0.7	c 5617.71	I	23355-41151
1.4	5279.82	I		3.0	5620.68	I	12235-30021
1.4	5281.02	I	9759-28689	1.0	5628.20	I	
7	5295.01	I	9253-28134	1.6	5635.71	I	10950-28689
3.0	c 5318.67	I	25186-43983	3.0	5640.18	I	12866-30591
6	5328.38	I	2010-20772	12	5645.91	I	9253-26960
2.5	5336.13	I	12866-31601	10	5664.90	I	2010-19658
11	5341.05	I	3964-22682	2.5	5688.25	I	17224-34800
2.0	5342.25	I	9976-28689	3.0	5699.24	I	9253-26795

Tantalum — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
1.2	5704.31	I	21153-38679	2.0	6208.37	I	25478-41581
2.0	5706.28	I	24982-42502	3.0	6249.79	I	12866-28862
2.5	5715.24	I	10690-28183	12	6256.68	I	6069-22047
0.6	5716.53	I	12235-29723	12	6268.70	I	12235-28183
1.8	5746.71	I	26586-43983	4	6278.34	I	
2.5	5755.81	I		5	6281.33	I	10950-26866
1.2	h 5761.61	I	24243-41595	1.2	6287.36	I	
2.0	5766.56	I	9253-26590	3.0	6287.91	I	12235-28134
2.5	c 5767.91	I	9253-26586	3.0	6289.34	I	10690-26586
0.8	5771.93	I	25181-42502	4	6309.06	I	
10	5776.77	I	6049-23355	12	6309.58	I	10950-26795
2.0	5780.02	I	20647-37943	2.0	c 6312.24	I	
7	5780.71	I	6069-23363	6	6325.08	I	6049-21855
10	5811.10	I	3964-21168	4	6332.91	I	6069-21855
2.0	5816.51	I	26795-43983	5	6341.17	I	
3.5	c 5843.94	I	9759-26866	2.5	6346.02	I	9759-25513
1.0	5849.68	I	10690-27781	6	6356.14	I	9253-24982
1.2	5866.61	I		5	6360.84	I	11244-26960
19	5877.36	I	13352-30361	3.0	6373.06	I	22761-38448
10	5882.30	I	23515-40510	1.2	6379.07	I	
7	5901.91	I	11244-28183	7	6389.45	I	21153-36800
2.5	5916.51	I	11792-28689	1.8	h 6392.21	I	10950-26590
7	5918.95	I	9976-26866	5	6428.60	I	11244-26795
1.2	5925.90	I	17224-34095	20	6430.79	I	12235-27781
1.2	5930.62	I	12866-29723	1.0	6437.36	I	
1.8	5931.05	I	24739-41595	3.0	6444.61	I	
1.6	5931.68	I	17224-34078	2.5	6445.87	I	
1.4	5935.54	I	23913-40756	16	6450.36	I	12235-27734
10	5939.76	I	9759-26590	1.6	6455.83	I	9253-24739
19	5944.02	I	9976-26795	2.5	6459.92	I	9705-25181
2.0	5951.78	I		30	6485.37	I	13352-28767
1.4	5960.13	I	23913-40686	1.4	h 6502.43	I	
15	c 5997.23	I	13352-30021	5	6505.52	I	
2.0	h 6009.89	I	24517-41151	8	6514.39	I	11244-26590
2.0	6015.90	I	17383-34001	8	6516.10	I	11244-26586
8	6020.72	I	9759-26364	2.0	h 6561.60	I	10690-25926
20	6045.39	I	11244-27781	2.0	cw 6564.26	I	
8	6047.25	I	12235-28767	8	6574.84	I	9976-25181
2.0	6053.64	I	9705-26220	0.8	6585.13	I	22761-37943
2.5	6090.82	I	25181-41595	1.2	c 6587.16	I	
1.4	6092.06	I		9	6611.95	I	11244-26364
8	6101.58	I	22429-38813	6	6621.30	I	6069-21168
2.0	6140.07	I	26220-42502	1.2	cw 6662.24	I	
5	6144.56	I	10690-26960	8	6673.73	I	9759-24739
2.5	6152.54	I	27734-43983	14	6675.53	I	11244-26220
10	6154.50	I	9976-26220	2.5	6684.00	I	
3.0	6158.84	I	17383-33615	1.2	6693.61	I	
1.2	6170.46	I	27781-43983	1.2	6706.46	I	15114-30021
1.2	6189.66	I		2.0	6709.39	I	23913-38813
1.2	6193.11	I		0.8	6714.44	I	

Tantalum — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
6	c	6740.73	I	1.0	c	7174.91	I
3.0		6754.91	I	1.0		7191.35	I
1.0	c	6755.85	I	0.6		7233.45	I
1.0		6770.37	I	2.5	h	7250.27	I
6		6771.74	I	0.9	h	7264.82	I
							10950-24739
3.0	cw	6774.25	I	0.5		7272.29	I
3.0	cw	6788.99	I	2.5		7276.96	I
1.0	c	6790.06	I	0.4		7277.54	I
1.0		6799.27	I	0.7		7286.36	I
3.0	c	6810.46	I	1.0	c	7296.32	I
							11244-24982
13	c	6813.25	I	11		7301.74	I
1.6		6819.36	I	1.6		7319.84	I
1.4	c	6824.96	I	0.9	c	7322.72	I
1.0		6832.00	I	1.0		7325.95	I
1.2		6850.83	I	0.9	cw	7340.19	I
							12235-25926
1.2		6865.13	I	13		7346.41	I
17		6866.23	I	11	c	7352.86	I
14		6875.27	I	8		7356.96	I
3.0		6877.49	I	7	cw	7369.09	I
1.2		6896.77	I	13		7407.89	I
							6049-19658
3.0		6900.55	I	0.9	c	7435.19	I
12		6902.10	I	1.8		7440.17	I
11		6927.38	I	2.5		7467.75	I
11		6928.54	I	1.8		7486.01	I
0.6	h	6939.33	I	2.5		7520.56	I
							9976-23363
1.6	c	6946.87	I	0.5		7569.23	I
5		6951.26	I	0.7		7590.22	I
3.5		6953.88	I	0.5		7649.62	I
14		6966.13	I	0.9	h	7722.02	I
0.6		6969.49	I	0.9		7763.11	I
							12235-25181
0.6	c	6971.31	I	0.7	c	7779.67	I
0.7		6971.53	I	1.6	c	7842.76	I
1.8		6983.52	I	8		7882.37	I
9	d	6995.22	I	2.5		7950.19	I
		6995.49	I	0.4		7952.07	I
							13352-25926
1.6		7000.21	I	0.5		7998.75	I
3.0		7005.07	I	0.5		8022.09	I
6		7006.96	I	6		8026.50	I
4		7025.03	I	0.4		8029.04	I
1.0		7031.51	I	1.2		8039.08	I
							6049-18505
3.0		7039.07	I	0.6		8053.93	I
1.2	h	7081.30	I	1.2		8068.98	I
1.6		7085.40	I	0.4		8100.11	I
1.8		7093.02	I	1.0		8128.76	I
0.6		7108.05	I	0.7		8158.54	I
							10950-23363
1.2	c	7117.52	I	0.4	c	8180.74	I
1.6		7121.27	I	1.0	c	8248.95	I
3.0		7125.72	I	1.6	d	8264.85	I
12		7148.63	I	6		8281.62	I
9		7172.90	I	0.9		8389.06	I
							11244-23363
							9759-21855
							9976-22047



Tantalum — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
0.4	8415.73	I	9976-21855	1.2	8575.92	I	13352-25009
2.0 cw	8447.62	I	13352-25186	0.8 cw	8595.84	I	13352-24982
0.9 h	8550.49	I	12235-23927				

# TELLURIUM

Te,  $Z=52$ ,  $M=127.61$ , Ratio  $\frac{\text{Te}}{\text{Cu}}=2.008$

Te I Normal state of valence electrons  $5s^2 5p^4 \ ^3P_2 = 0$ . I.P. = 72667 K  
 Te II Normal state of valence electrons  $5s^2 5p^3 \ ^4S_{1/2}^o = 0$ . I.P. = 150000 K

## References

### Wavelengths:

G. R. Harrison, Massachusetts Institute of Technology Wavelength Tables (John Wiley & Sons, New York, 1939), above 2000 Å.  
 J. C. McLennan, A. B. McLay, and J. H. McLeod, Phil. Mag. **4**, 486 (1927), below 2000 Å

### Classification:

Te I, O. Bartelt, Z. Physik **88**, 522 (1934).

## Relative intensity of tellurium lines observed in an arc of copper containing 0.1 atomic percent of tellurium

### *Strong line of tellurium*

Intensity	Wavelength Å	Spectrum	Energy levels K	Term combination
70	2385.76	I	4751-46653	$5p^4 \ ^3P_1 - 5p^3 6s^1 \ ^3S_1^o$

## Tellurium — All Observed Lines

Intensity and Character	Wave- length in Å	Spec- trum	Energy Levels in K	Intensity and Character	Wave- length in Å	Spec- trum	Energy Levels in K
8	1994.2	I	4751-54877	6	2259.04	I	0-44253
16	2002.0	I	4751-54685	55	2383.25	I	4707-46653
10	2081.03	I	10559-58596	70	2385.76	I	4751-46653
55	2142.75	I	0-46653	12	2530.70	I	4751-44253
11	2147.19	I	10559-57116	11	2677.16	I	
1.4	2159.79	I	10559-56845	10	3175.11	I	23199-54685

# TERBIUM

Tb,  $Z=65$ ,  $M=158.93$ , Ratio  $\frac{Tb}{Cu}=2.501$

## References

### Wavelengths:

A. Gatterer and J. Junkes, *Spektren der Seltenen Erden* (Specola Vaticana, Vatican, 1945).

Supplemented by:

J. M. Eder, *Sitzber. Akad. Wiss. Wien, Math. naturw. Kl.* **131**, 199 (1922).

A. S. King, *Astrophys. J.* **72**, 221 (1930).

About 70 lines above 7000 Å were measured on our plates.

### Classification:

J. Sugar, unpublished material (1961).

### Spectrum Assignments:

From 3837 to 4677 Å the assignment of spectrum is from A. S. King, *Astrophys. J.* **72**, 221 (1930).

The rest of the assignments are from our plates.

## Relative intensity of terbium lines observed in an arc of copper containing 0.1 atomic percent of terbium

### *Strong lines of terbium*

Intensity	Wavelength Å	Spectrum	Energy levels K	Term combination
600	3509. 17	II		
460	3702. 85	II		
440	3568. 51	II		
400	3324. 40	II		
380	3676. 35	II		
340	3561. 74	II		
340	3848. 76	II		
320 w	3874. 19	II		
280	4326. 47	I	0-23107	
240	3650. 40	II		
240	3703. 92	II		
220	3899. 20	II		
200	3658. 88	II		
200 d	3976. 84	II		
200	4318. 85	I	0-23148	
190	3776. 49	II		
190	4033. 06	II		
180	4005. 57	II		
170	3568. 98	II		
170	3600. 44	II		
170	3981. 89	II		
160	3293. 07	II		
160	3765. 14	I		
160	4338. 45	I	0-23043	
150	3901. 35	I		
140	3523. 66	II		
140	3830. 29	II		
130	3219. 95	II		
120	3218. 93	II		
120	3540. 24	II		
120	3579. 20	II		
120	4061. 59	I		
110	3285. 04	II		
100 d	3711. 74	II		
100	3755. 24	II		
100	4144. 46	II		

## Terbium — All Observed Lines

Intensity and Character	Wave-length in A	Spectrum	Energy Levels in K	Intensity and Character	Wave-length in A	Spectrum	Energy Levels in K
3.0	2577.73	II		4	2796.95	II	
12	2584.61	II		19	2800.51	II	
3.0	2590.31	II		8	2800.63	II	
3.0	2591.42	II		26	2802.75	II	
2.5	2592.64	II		26	2809.32	II	
6	2597.71	II		19	2812.64	II	
4	2602.93	II		4	2818.48	II	
11	2608.57	II		4	2819.78	II	
4	2616.90			9	2827.40	II	
14	2628.69	II		8	2833.03	II	
6	2655.96	II		9	2838.72	II	
5	2661.40	II		4	2842.00	II	
2.5	2661.64	II		8	2843.96	II	
6	2667.64	II		8	2845.93	II	
5	2668.86	II		6	2851.04	II	
15	2669.29	II		20	2852.14	II	
4	2674.13	II		8	2854.17	II	
4	2674.69	II		8	2854.96	II	
3.0	2678.15	II		8	2855.69	II	
4	2683.97	II		12	2857.68	II	
3.5	2687.84	II		10	2861.34	II	
5	2691.90	II		4	2864.48	II	
3.5	2693.05	II		5	2867.42	II	
6	2693.41	II		5	2872.32	II	
3.5	2695.46	II		4	2872.55	II	
5	2696.83	II		8	2881.25	II	
3.5	2701.52	II		10	2884.70	II	
20	2704.07	II		8	2885.90	II	
10	2706.28	II		24	2886.29	II	
5	2713.22	II		8	2887.44	II	
3.5	2720.89	II		5	2888.10	II	
3.5	2724.29	II		4	2888.31	II	
3.5	2726.49	II		4	2888.82	II	
7	2730.21	II	d	8	2889.66	II	
3.5	2733.90	II		4	2892.49	II	
3.5	2735.45	II		17	2894.48	II	
3.5	2735.99	II		6	2896.03	II	
14	2736.24	II		34	2897.46	II	
7	2742.26	II		17	2898.84	II	
9	2743.50	II		11	2901.54	II	
3.5	2757.41	II		7	2903.25	II	
17	2759.47	II		4	2907.10	II	
7	2760.96	II		11	2910.30	II	
3.5	2766.57	II		8	2911.80	II	
3.5	2767.02	II		4	2912.65	II	
28	2769.53	II		4	2913.41	II	
3.5	2782.35	II		17	2914.80	II	
3.5	2783.00	II		17	2915.33	II	
14	2784.49	II		20	2915.60	II	
3.5	2785.50	II		13	2916.27	II	

## Terbium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
13	2918.89	II		18	3027.33	II	
7	2919.00	II		5	3027.58	II	
13	2924.16	II		9	3029.23	II	
13	2924.53	II		24	3031.60	II	
7	2925.94	II		9	3032.83	II	
8	2931.41	II		8	3034.12	II	
17	2932.91	II		9	3034.91	II	
8	2933.79	II		5	3037.04	II	
6	2934.82	II		9	3038.66	II	
6	2936.39	II		5	3042.07	II	
16	2940.05	II		5	3042.50	II	
9	2941.70	II		4	3042.83	II	
9	2944.91	II		10	3043.65	II	
10	2945.70	II		24	3044.97	II	
8	2946.85	II		5	3047.00	II	
6	2949.04	II		5	3050.57	II	
6	2950.06	II		20	3051.12	II	
26	2956.21	II		10	3052.18	II	
4	2957.32			14	3053.24	II	
4	2957.70	II		48	3053.55	II	
7	2960.58	II		5	3061.80	II	
6	2962.78	II		14	3062.78	II	
10	2963.97	II		24	3064.09	II	
9	2964.76	II		5	3064.51	II	
6	2965.32	II		5	h 3065.17	II	
18	2968.87	II		11	3065.69	II	
4	2974.15	II		8	3065.87	II	
18	2977.78	II		24	3067.20	II	
4	2981.99	II		28	3069.02	II	
12	2987.03	II		48	3070.05	II	
12	2988.57	II		28	3072.60	II	
4	2989.84	II		6	3074.71	II	
9	2991.96	II		10	3076.04	II	
5	2992.56	II		70	3078.86	II	
14	2996.01	II		7	3080.11	II	
12	2999.03	II		10	3081.55	II	
8	3002.45	II		7	3082.01	II	
9	3004.58	II		50	3082.36	II	
14	3005.52	II		8	3083.83	II	
6	3007.11	II		7	3085.99	II	
18	3009.30	II		13	3086.78	II	
6	3010.12	II		7	3087.54	II	
24	3010.55	II		26	3088.43	II	
7	3013.61	II		5	3089.10	II	
24	3016.18	II		50	3089.58	II	
14	3019.17	II		10	d 3091.62	II	
18	3020.29	II		10	3092.96	II	
6	3021.95	II		7	3093.20	II	
11	3023.43	II		10	3096.86	II	
8	3023.70	II		5	3097.40	II	

## Terbium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
24	3102.54	II		5	3168.59	II	
50	3102.97	II		24	3169.84	II	
10	3108.41	II		10	3171.19	II	
7	3109.15	II		20	3173.76	II	
7	3109.82	II		40	3174.66	II	
7	3112.43	II		8	3175.45	II	
5	3112.53	II		5	3179.84	II	
8	3113.62	II		40	3180.54	II	
5	3116.66	II		5	3181.22	II	
8	3117.26	II		10	3183.29	II	
30	3117.89	II		10	3183.64	II	
30	3119.62	II		15	3183.88	II	
10	3121.43	II		10	3186.23	II	
24	3121.94	II		50	3187.25	II	
8	3122.83	II		30	3188.03	II	
24	3123.05	II		10	3188.55	II	
5	3124.02	II		5	3188.83	II	
17	3124.54	II		10	3189.97	II	
10	3126.16	II		5	3190.72	II	
5	3128.88	II		7	3192.76	II	
12	3131.35	II		5	3194.18	II	
26	3134.26	II		20	3194.71	II	
10	3135.35	II		40	3195.60	II	
10	3137.22	II		5	3198.02	II	
5	3138.63	II		50	3199.56	II	
46	3139.64	II		16	3200.73	II	
20	3140.04	II		10	3202.70	II	
9	3143.38	II		7	3202.95	II	
24	3145.22	II		8	3207.09	II	
16	3146.67	II		14	3207.53	II	
32	3147.04	II		10	3207.96	II	
32	3147.13	II		7	3209.54	II	
7	3148.21	II		5	3210.01	II	
32	3148.71	II		16	3210.22	II	
7	3154.69	II		10	3215.01	II	
7	3155.10	II		120	3218.93	II	
13	3155.62	II		130	3219.95	II	
5	3156.52	II		10	3220.17	II	
5	3157.49	II		5	3222.37	II	
8	3158.66	II		10	3222.97	II	
10	3159.22	II		5	3227.48	II	
10	3159.39	II		16	3229.19	II	
14	3162.42	II		26	3230.03	II	
30	3162.93	II		26	3231.06	II	
10	3163.85	II		10	3231.46	II	
8	3164.10	II		9	3232.00	II	
10	3164.77	II		5	3232.73	II	
20	3165.74	II		10	3234.50	II	
40	3167.52	II		12	3235.79	II	
15	3168.32	II		10	3236.20	II	

## Terbium — All Observed Lines

Intensity and Character	Wave-length in A	Spectrum	Energy Levels in K	Intensity and Character	Wave-length in A	Spectrum	Energy Levels in K
22	d 3239.66	II		32	3298.66	II	
26	3240.00	II		11	3304.10	II	
20	3240.65	II		11	3304.26	II	
8	3243.20	II		22	3304.95	II	
5	3244.60	II		11	3305.37	II	
10	3245.17	II		8	3306.41	II	
5	3245.42	II		44	d 3307.44	II	
5	3247.18	II		9	3307.80	II	
7	3249.61	II		22	3308.51	II	
5	3250.75	II		11	3309.17	II	
5	3250.95	II		5	3310.10	II	
16	3251.25	II		8	3310.37	II	
50	3252.34	II		11	3310.80	II	
7	3253.54	II		16	3312.53	II	
7	3255.22	II		16	3312.80	II	
10	3259.38	II		22	3314.38	II	
20	3260.05	II		5	3314.70	II	
5	3260.66	II		11	3315.07	II	
10	3260.83	II		5	3317.58	II	
20	3261.74	II		11	3319.16	I	
10	3262.68	II		36	d 3321.15	II	
26	3262.97	II		44	3322.28	II	
5	3263.65	II		22	3323.38	II	
24	d 3263.89	II		22	3323.89	II	
5	3264.06	II		400	3324.40	II	
24	3264.90	II		16	3325.52	II	
8	3265.93	II		11	3327.11	II	
42	3266.40	II		55	3329.08	II	
20	3268.10	II		11	3333.21	II	
16	3268.52	II		13	3333.93	II	
8	3270.63	II		11	3334.25	II	
16	3272.35	II		22	3334.48	II	
26	3274.19	II		12	3335.42	II	
26	3274.33	II		26	3336.70	II	
7	3275.66	II		32	3338.03	II	
22	3277.32	II		26	3339.00	II	
11	3277.73	II		13	3339.61	II	
80	3280.28	II		5	3342.98	II	
80	3281.40	II		13	3343.77	II	
55	3283.10	II		5	3343.93	II	
5	3283.81	II		5	3346.32	II	
110	3285.04	II		22	3347.27	II	
16	3285.21	II		22	3348.07	II	
5	3286.98	II		9	3348.23	II	
32	3287.55	II		16	3348.54	II	
32	3291.56	II		80	3349.42	II	
160	3293.07	II		19	3351.44	II	
11	3294.04	II		19	3352.89	II	
22	3295.33	II		5	3356.18	II	
11	3298.20	II		13	3357.37	II	

## Terbium — All Observed Lines

Intensity and Character	Wave-length in A	Spectrum	Energy Levels in K	Intensity and Character	Wave-length in A	Spectrum	Energy Levels in K
5	3358.46	II		20	3406.01	II	
11	3359.86	II		4	3407.10	II	
5	3360.05	II		9	3408.86	II	
5	3360.29	II		17	d 3409.94	II	
34	3362.25	II		22	3410.40	II	
11	3364.24	II		22	3410.71	II	
9	3364.36	II		55	3413.76	II	
80	3364.93	II		28	3416.24	II	
11	3365.29	II		9	3417.72	II	
16	3367.18	II		6	3417.91	II	
24	d 3370.61	II		6	3418.86	II	
34	3371.50	II		6	3418.95	II	
55	3372.36	II		9	3419.54	II	
48	d 3372.72	II		42	d 3420.34	II	
20	3374.41	II		20	3422.44	II	
55	3375.03	II		8	3423.05	II	
11	3376.36	II		11	3423.96	II	
17	3376.66	II		20	d 3424.35	II	
20	3377.66	II		11	3424.66	II	
11	3378.40	II		6	3425.92	II	
34	3378.73	II		11	d 3428.16	II	
55	3378.86	II		6	3428.71	II	
9	3379.15	II		6	3429.09	II	
17	3380.60	II		22	3430.61	II	
9	3380.89	II		6	3431.86	II	
34	3382.80	II		11	3432.35	II	
11	d 3386.49	II		11	3432.90	II	
9	3388.37	II		34	3433.26	II	
6	3388.63	II		6	3434.54	II	
11	3390.02	II		8	3434.92	II	
22	3390.60	II		8	3435.53	II	
40	3391.28	II		9	3436.97	II	
8	3391.72	II		20	3438.57	II	
17	3392.01	II		8	3439.05	II	
6	3393.01	II		28	3439.72	II	
17	3393.58	II		55	3440.37	II	
11	3394.77	II		8	3441.68	II	
17	3395.02	II		34	3444.58	II	
6	3397.60	II		22	3446.40	II	
28	3398.35	II		28	3449.46	II	
9	3398.58	II		11	3450.30	II	
34	3399.10	II		11	3452.37	II	
9	3399.30	II		8	3453.46	II	
11	3399.97	II		85	3454.06	II	
28	3400.53	II		11	3455.35	II	
22	d 3400.86	II		6	3455.99	II	
44	3402.33	II		11	3456.55	II	
6	3402.78	II		17	h 3457.03	II	
6	3404.24	II		20	3458.71	II	
17	3404.71	II		40	3460.38	II	



## Terbium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
20	3461.00	II		30	3513.86	II	
24	d 3462.97	II		30	3515.04	II	
6	3464.63	II		12	3515.44	II	
11	3465.98	II		22	3516.14	II	
8	3466.92	II		17	3516.64	I	
65	3468.03	II		17	3518.96	I	
11	3469.70	II		60	3519.76	II	
8	3469.85	II		17	3520.79	II	
17	3470.36	II		6	3522.92	II	
28	3471.73	II		6	3523.20	II	
28	3472.37	II		140	3523.66	II	
85	d 3472.82	II		40	3525.14	II	
22	3473.00	II		46	3525.61	II	
6	3473.28	II		17	3525.79	II	
8	3473.79	II		9	3526.73	II	
6	3475.72	II		12	3529.76	II	
11	3476.12	II		22	3531.70	II	
11	3476.29	II		17	3532.70	II	
6	3479.29	II		15	3533.86	II	
40	3480.17	II		46	3536.32	II	
9	3481.50	II		9	3536.62		
8	3482.80	II		24	3537.11	II	
24	3483.04	II		12	3537.69		
24	3483.69	II		60	3537.94	II	
12	3487.28	II		15	3538.90		
9	3487.62	II		15	3539.81		
30	d 3489.51	II		120	3540.24	II	
12	3489.78	II		12	3541.75		
8	3491.24	II		30	3543.23	II	
22	d 3492.00	II		85	3543.86	II	
17	3492.56	II		10	3544.36	II	
12	3492.99	II		6	3545.40	II	
28	3494.21	II		8	3546.05	II	
17	3494.93	I		30	3546.52		
28	3495.36	II		12	3548.82		
6	3496.20	II		6	3549.21		
17	3499.34	I		16	3549.36	II	
17	3500.27	II		32	d 3551.03		
85	3500.84	II		34	3551.96	II	
10	3504.04	II		17	3555.29		
15	3504.75	II		6	3556.05		
12	3505.09	II		12	3556.25		
28	d 3505.90	II		8	3558.09		
8	3506.56	II		48	d 3558.77		
60	3507.45	II		6	3559.14		
600	3509.17	II		30	3559.39	I	
40	3510.10	II		24	3559.76	II	
10	3511.04	II		340	3561.74	II	
17	3512.60	II		50	3562.90	II	
34	3513.10	II		17	3565.34		

## Terbium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
60	3565.74			30	3630.28	II	
85	3567.35	II		12	3631.46	II	
440	3568.51	II		70	3633.29	II	
170	3568.98	II		20	3635.42	II	
34	3572.07	II		70	3638.46	II	
17	3575.90			17	3638.95	I	
17	3576.64			30	3639.82	II	
24	3576.83			70	3641.66	II	
24	3577.08			30	3642.68	II	
12	3578.70			8	3643.26	II	
120	3579.20	II		8	3643.76	II	
75	3585.03			10	3644.13	II	
60	3587.44	II		24	3645.38	II	
12	3587.76			12	3645.82	II	
12	3589.53			10	3646.46	II	
6	3591.39			46	3647.06	II	
12	3591.66	II		60	3647.75	II	
24	3593.10			10	3649.41	II	
12	3593.75			240	3650.40	II	
8	3594.65			30	3650.93	II	
12	3594.98	II		24	3651.86	II	
85	3596.38	II		24	3652.26	II	
46	3598.06	II		20	3652.97	II	
20	3600.04			17	3653.87	II	
170	3600.44	II		85	3654.88	II	
12	3601.75	II		24	3658.22	II	
34	3604.90	II		200	3658.88	II	
30	3606.04	II		12	3659.45	II	
30	3606.16	II		10	3660.44	II	
6	3608.25	II		20	3660.75	II	
34	3611.33	II		44	3663.12	II	
28	3611.41	II		9	3665.60	II	
17	3613.06	II		4	3668.00	II	
10	3613.36	II		8	3668.50	II	
24	3613.68	II		26	3669.62	I	
34	3614.63	II		10	3674.05	II	
34	3615.66	II		22	3675.78	II	
34	3616.58	II		380	3676.35	II	
40	3617.88	II		30	3677.89	II	
17	3618.18	II		10	3678.78	II	
12	3618.90	II		80	3682.26	II	
40	3619.73	II		22	3684.81	II	
14	3622.11	II		32	3688.15	II	
30	3623.92	II		24	3689.12	II	
12	3624.80	II		12	3689.72	II	
85	3625.54	II		60	3691.15	II	
60	3626.50	II		30	3692.95	II	
17	3626.87	II		44	3693.56	I	
30	3628.20	II		14	3694.75	II	
40	3629.43	II		17	3696.30	II	

## Terbium — All Observed Lines

Intensity and Character	Wave-length in A	Spectrum	Energy Levels in K	Intensity and Character	Wave-length in A	Spectrum	Energy Levels in K
32	3696.85	II		80	3747.34	II	
20	3699.33	II		8	3748.80	II	
44	3700.12	I		12	3749.70		
20	3701.14	I		7	d 3750.24		
15	3701.33	I		4	3751.35		
8	3701.50	II		4	3751.62		
460	3702.85	II		8	3752.99		
30	3703.07	I		8	3753.52		
8	3703.50	II		100	3755.24	II	
240	3703.92	II		4	3757.04		
24	3705.06	I		40	3757.44	II	
28	3706.34	II		40	d 3757.90	II	
10	3706.80	I		60	3759.35	I	
10	3708.45	I		19	d 3760.13		
18	3708.75	II		32	3761.12	I	
36	3709.30	II		6	3762.51	I	
100	d 3711.74	II		6	3762.74		
8	3714.37	II		8	3763.96	I	
14	3716.08	II		160	3765.14	I	
20	3716.43	II		18	3767.50	II	
10	3717.47	II		8	3769.43	I	
8	3717.88	I		4	3771.03		
4	3718.24	II		15	3775.26		
18	3718.44	II		190	3776.49	II	
30	3719.45	II		11	3777.48		
13	3723.04	II		30	3779.22		
4	3723.84	II		6	3782.18		
13	3724.92	I		5	3782.62	I	
8	3725.32	II		55	3783.54		
7	3728.65			5	3784.15	I	
12	3728.96			11	3785.38		
60	3729.91	II		38	d 3787.22		
8	3731.00	I		11	3787.60		
14	3731.51	I		8	3787.71	I	
40	3732.39	II		15	3789.00		
8	3732.65	I		11	3789.68		
12	d 3734.80			38	3789.92		
	3735.04			11	3791.07		
4	3738.45			36	3792.18		
16	3740.32			7	3793.30		
20	3741.24			55	3793.55		
20	3741.58	II		12	3796.20		
24	3741.89			7	3796.98		
16	d 3742.43			15	3798.59		
40	3743.09			18	3798.95	II	
16	3743.65	I		7	h 3801.36		
60	3745.07	I		30	3801.80	II	
7	3746.30			15	3802.17	II	
20	3746.54			11	3804.42		
80	3747.17	II		9	3806.26		

## Terbium — All Observed Lines

Intensity and Character	Wave-length in A	Spectrum	Energy Levels in K	Intensity and Character	Wave-length in A	Spectrum	Energy Levels in K	
70	d		3806.85	15			3894.46	II
3.5	d		3810.57	45			3894.60	I
22		I	3811.65	6			3895.08	I
22			3812.73	6			3895.39	I
22			3813.16	30			3895.99	II
14	d		3814.97	30			3896.58	II
11			3816.27	4			3897.26	I
22			3816.90	30			3897.89	I
14		II	3820.11	220			3899.20	II
7			3821.00	15			3899.57	II
11			3823.12	12			3900.74	I
6			3824.14	150			3901.35	I
7	h		3826.74	9			3901.68	II
140		II	3830.29	9	d		3902.00	II
7			3832.65	3.0			3903.08	I
50		I	3833.40	7			3904.14	I
17		I	3834.02	5			3906.54	II
7		I	3837.18	44			3908.08	I
14			3837.83	6			3908.68	I
85	d	II	3842.50	35			3909.16	I
17			3842.98	30			3909.54	I
34	d	II	3845.61	9			3910.14	II
17		I	3847.88	15			3910.43	I
340		II	3848.76	15			3910.85	I
4		I	3849.59	10			3912.30	I
10	w		3851.37	7			3912.77	II
24		II	3851.86	26			3913.48	I
7		I	3855.38	14			3914.63	I
16		II	3855.58	60			3915.43	I
13		II	3868.90	6			3916.67	I
42	d	II	3869.75	4			3916.90	I
8		I	3873.00	7			3917.30	I
19		II	3873.78	9			3918.78	II
320	w	II	3874.19	7			3919.00	I
22		II	3875.22	44			3919.52	II
6		I	3876.67	14			3920.72	II
12		II	3878.21	28			3922.10	II
9		I	3879.99	44			3922.74	II
9		I	3880.35	14			3923.31	II
9		I	3881.29	6	d		3924.42	II
24		II	3881.76	10			3924.81	II
18		I	3885.10	70			3925.45	II
24		II	3886.82	6			3929.75	I
15	d	II	3887.64	7			3929.89	I
15		I	3887.88	5			3930.76	II
44		I	3888.23	20			3932.37	I
9		II	3889.84	12			3934.41	I
6		I	3890.95	60			3935.24	II
15		II	3893.38	6			3937.17	I
6		I	3893.69	15			3937.64	I

## Terbium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
6	3938.07	I		14	3997.43	II	
75	d 3939.52	II		14	3998.40	II	
24	3941.21	II		10	3998.90	I	
20	3942.21	II		6	3999.24	II	
10	3942.95	I		32	3999.40	II	
9	3943.68	I		14	4000.01	II	
15	3944.88	II		17	4001.28	I	
60	3946.89	II		32	d 4002.19	II	
4	3947.25	I		90	4002.59	II	
24	3948.35	II		10	4003.78	II	
6	3949.51	II		6	4003.91	II	
19	3950.14	I		7	4004.52	II	
19	3950.44	I		180	4005.57	II	
6	3951.88	I		10	4005.97	II	
19	3954.05	I		14	4009.26	I	
4	3955.65	I		14	4009.56	II	
6	3956.18	II		28	4010.06	I	
16	3957.35	I		14	4010.85	I	
26	3957.97	II		70	4012.75	II	
32	d 3958.36	II		14	4012.86	II	
3.0	h 3960.12	II		30	4013.27	I	
6	3960.30	I		7	4017.85	II	
9	3960.70	I		10	4018.42	I	
3	3962.61	I		34	4019.14	II	
16	3965.10	I		50	4020.47	II	
16	3965.95	II		20	4022.89	I	
9	3967.22	I		17	d 4024.10	II	
20	3967.66	I		34	4024.79	I	
5	3969.94	I		16	4025.73	II	
16	d 3970.19	II		16	d 4028.31	II	
20	3971.79	I		8	4028.59	I	
16	3972.06	II		48	4031.66	II	
16	3974.29	II		80	4032.34	I	
16	3974.68	I		13	d 4032.72	I	
200	d 3976.84	II		190	4033.06	II	
24	3981.16	II		32	4036.24	I	
170	3981.89	II		4	4036.46	II	
28	3983.85	II		19	4038.86	I	
24	3984.05	II		3	4039.21	II	
14	3984.84	II		14	4039.48	I	
14	3985.08	II		14	4040.11	I	
24	3986.35	II		12	4040.41	II	
14	3987.67	I		6	4041.85	I	
7	3989.54	I		9	4042.34	II	
5	3990.22	I		4	4043.67	II	
20	3990.63	I		6	4045.36	I	
7	d 3991.58	I		14	4047.14	I	
17	d 3993.54	I		6	4048.82	I	
8	3995.15	I		5	4049.87	II	
7	d 3995.80	II		6	4051.49	II	

## Terbium — All Observed Lines

Intensity and Character	Wave-length in A	Spectrum	Energy Levels in K	Intensity and Character	Wave-length in A	Spectrum	Energy Levels in K
28	4051.86	II		5	4107.79	I	
28	4052.87	II		5	4110.09	I	
14	4054.00	I		5	4110.86	I	
40	4054.12	I		28	4112.50	I	
38	4060.40	I		12	4112.88	I	
20	4060.87	II		5	h 4114.13	II	
120	4061.59	I		5	d 4115.36	II	
20	4063.89	II		10	4117.23	I	
36	4066.22	II		5	4118.43	I	
14	4070.13	I		24	4119.96	I	
10	d 4070.54	II		10	4120.51	II	
5	4070.72	I		8	4121.03	I	
10	4071.22	I		10	4122.47	I	
12	d 4072.69	I		8	4126.71	I	
10	4073.75	II		13	4127.29	I	
7	4073.94	I		13	4130.14	I	
12	4074.16	I		5	4131.11	I	
24	4075.22	I		13	4131.45	I	
9	4078.47	II		4	4132.23		
5	d 4078.79	I		13	4132.48	I	
36	4081.24	I		8	4132.83	I	
2.5	h 4082.24	II		5	4133.51	I	
12	4082.80	I		5	d 4134.32		
10	4083.21	I		12	4135.37	I	
10	4084.27	I		3.5	4136.47	I	
10	4084.84	I		3.5	4137.03		
19	4086.62	I		5	4139.06	I	
4	4087.70	II		13	4139.79	I	
11	4089.35	II		13	4141.55	I	
5	4089.51	II		5	4142.45	I	
6	d 4091.35	I		5	4143.24	I	
19	4092.20	I		26	4143.49	I	
12	4094.05	I		13	4143.57	I	
24	4094.37	II		100	4144.46	II	
24	4094.50	I		10	4146.96	I	
11	4095.93	I		4	4148.21	II	
9	4097.36	II		10	4149.17	II	
10	4097.48	II		5	4150.54		
5	4098.62	II		5	4150.86	I	
4	4099.15			8	4152.24	I	
7	d 4099.48	II		8	4156.28	I	
12	d 4100.90	I		5	4158.28	II	
12	4101.65	I		32	4158.53	I	
8	4102.53	II		11	cw 4161.36	I	
7	4103.21	I		5	4166.51		
16	4103.36	I		22	4169.11	I	
8	4103.46	I		22	4169.31	I	
24	4103.90	II		11	4169.92	I	
60	4105.37	I		8	4170.49	I	
4	4106.35	I		22	4171.05	I	

## Terbium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
14	4171.80	I		9	4239.91	I	
22	4172.60	I		9	4242.56	II	
22	4172.82	I		9	4245.14	I	
24	4173.47	I		12	4246.59	I	
6	4175.08	I		6	4248.57	II	
8	4175.84	I		5	4250.26	II	
14	d 4178.98	II		12	4251.33	I	
6	4179.79	II		12	4251.72	II	
17	4180.40	I		9	4252.70	I	
8	4181.33	II		6	4254.04	I	
17	4184.29	I		34	4255.25	I	
6	4185.89	I		9	4256.12	I	
22	4186.24	I		44	4258.23	I	
28	4187.16	I		5	4261.84	I	
17	4188.09	I		24	4263.66	I	
7	4188.51	II		6	4264.72	I	
14	4191.08	I		7	4264.98	I	
17	4191.59	I		60	4266.34	I	
5	4193.35	I		30	4269.69	I	
7	4194.01	I		9	4271.63	I	
36	4196.73	I		9	4272.21	I	
8	4198.41	I		20	4275.21	I	
11	d 4199.06	I		10	d 4276.75	II	
42	4201.00	II		9	4277.77	I	
60	4203.72	I		70	cw 4278.52	II	
55	4206.49	I		28	4285.13	II	
6	4206.80	I		6	4285.75	II	
11	4207.53	I		6	4286.13	II	
11	d 4208.70	I		11	4286.91	II	
28	cw 4213.50	I		14	4287.11	I	
28	4214.42	II		28	4289.72	I	
44	4215.13	I		6	h 4293.13	I	
9	h 4216.67	I		6	h 4294.04	I	
28	4217.56	I		14	4295.34	I	
9	4218.86	I		8	4296.34	I	
24	4219.17	I		34	4298.37	I	
8	4220.10	II		28	4299.90	I	
5	4221.41	I		6	4301.15	I	
9	4222.71	I		22	4302.94	I	
7	4223.32	II		11	4304.00	I	
24	4224.28	I		6	4304.27	I	
44	cw 4226.45	II		22	4307.21	I	
8	4230.62	I		14	d 4308.68	II	
6	4231.34	I		42	4310.44	I	
24	4231.89	I		7	4310.96	II	
17	4232.19	II		8	4311.29	I	
44	4232.82	I		28	4311.56	I	
6	4234.22	I		10	4312.08	II	
28	4235.35	I		34	4313.25	I	
15	4239.28	I		11	h 4313.43	I	

## Terbium — All Observed Lines

Intensity and Character	Wave-length in A	Spectrum	Energy Levels in K	Intensity and Character	Wave-length in A	Spectrum	Energy Levels in K
14	4315.73	I		5	4394.03	I	
200	4318.85	I		4	4394.92	II	
14	4320.26	I		17	4396.56	I	
5	4321.49	I		4	4401.54	II	
55	4322.24	I		7	4403.18	I	
16	4322.87	I		7	4405.40	II	
8	d 4323.66	II		5	4406.76	I	
11	4325.50	I		9	d 4409.52	II	
55	4325.83	II		5	4411.14	I	
8	4326.14	I		5	4411.93	I	
280	4326.47	I		5	4413.63	I	
22	4328.95	I		18	4416.27	II	
8	4330.31	I		13	4420.20	I	
55	4332.12	I		32	4423.11	I	
5	4333.73	I		4	4427.34	I	
14	4334.68	I		4	d 4430.13	II	
80	4336.50	I		9	4430.66	I	
55	4337.64	I		10	4432.70	I	
160	4338.45	I		9	4434.47	II	
14	4339.62	I		7	4435.01	I	
8	4339.87	I		7	4435.55	II	
65	4340.62	I		22	4436.12	I	
10	4341.00	I		9	4438.97	II	
40	cw 4342.53	I		10	4439.38	I	
5	h 4343.85	I		4	4441.27	II	
4	4344.21	II		7	h 4441.48	I	
5	4346.49	I		22	4448.04	I	
10	4349.61	I		8	4451.64	I	
5	h 4350.75	I		8	d 4452.82	I	
5	4351.60	II		4	h 4459.38	II	
40	d 4353.20	II		4	4461.27	I	
26	4356.09	I		10	4467.70	I	
80	4356.84	I		6	4469.12	I	
4	4357.47	I		4	4471.72	II	
26	4360.16	I		3.5	4485.68	I	
5	w 4362.44	I		8	4488.16	I	
4	4366.00	II		6	4491.01	I	
20	4367.30	I		40	4493.08	I	
20	4372.05	I		4	4499.47	I	
5	4374.43	I		4	d 4509.04	II	
5	4376.43	II		14	h 4511.52	I	
8	4381.31	I		4	4512.96	II	
30	4382.46	I		7	4514.31	II	
4	4384.06	II		4	4519.72	II	
12	4385.68	I		4	4525.01	II	
12	4386.08	II		4	4529.76		
28	4388.25	I		4	h 4531.83	II	
5	h 4389.81	I		4	4534.13	I	
24	4390.91	I		8	d 4537.14	I	
4	4392.96	I			4537.23	I	



## Terbium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
10	4549.07	I		3.5	4778.36	II	
4	4549.72	II		3.5	4778.80	II	
10	4550.45	I		18	4786.78	I	
10	4556.46	I		4	4789.91	II	
5	4562.24	II		3.0	4801.87	II	
10	4563.69	II		10	4813.77	I	
3.0	4564.85	II		6	4837.59	II	
5	4573.19	II		2.5	4840.39	I	
19	4578.69	II		3.0	4842.69	II	
6	4584.84	II		3.0	4844.89	II	
6	4591.56	II		3.0	4854.81	I	
4	4592.38	I		2.0	4856.54	II	
4	h 4604.10	II		3.0	4858.87	II	
3.0	4611.96	I		8	4875.58	II	
4	h 4615.92	II		2.5	4876.12	II	
2.5	4617.49	I		8	4881.15	II	
3.0	4619.36	II		3.0	4894.33		
7	d 4626.32	II		10	4915.90	I	
9	4626.94	II		3.5	4924.09	I	
6	4632.07	I		3.5	4926.83	I	
6	h 4636.59	I		5	4928.93	I	
3.0	4636.99	II		7	4931.79	I	
8	4641.00	II		2.0	4940.72	II	
19	4641.98	II		2.0	4959.93	II	
24	cw 4645.28	II		2.0	4962.28	II	
8	4647.23	I		3.0	4970.99	II	
6	4658.38	I		3.0	4971.42	I	
2.0	4658.73			3.0	4973.04	I	
8	4662.80	I		3.0	4980.16	II	
5	c 4665.45	I		3.0	4980.56	I	
4	4669.40	I		9	4993.85	II	
8	4676.90	I		5	4995.84	II	
7	c 4681.87	I		6	4997.95	I	
5	4682.52	I		2.0	5004.84	I	
2.5	c 4682.79	II		3.0	5006.10	II	
8	4688.63	II		5	5022.16	I	
8	4693.11	II		3.0	5024.24	II	
3.0	h 4693.39	II		3.0	5024.65	I	
20	4702.41	II		5	5033.12	I	
11	4707.94	II		5	w 5042.06	II	
4	w 4716.07	II		6	5054.30	I	
4	4728.16	II		6	5065.79	I	
6	cw 4734.20	II		11	5078.25	I	
8	4739.93	I		2.5	5080.05	II	
7	4747.80	I		2.5	5081.11	I	
40	cw 4752.51	II		2.0	5081.80	I	
4	4758.44	II		8	5089.12	II	
4	4760.19	II		2.5	5089.66	I	
3.0	4762.37	II		2.5	5101.09	I	
2.5	4764.47	II		2.5	5108.56	I	

## Terbium — All Observed Lines

Intensity and Character	Wave-length in A	Spectrum	Energy Levels in K	Intensity and Character	Wave-length in A	Spectrum	Energy Levels in K
3.5	5118.39	I		1.6	5403.82	II	
2.5	5120.18	I		3.0	5413.65	I	
2.0	5121.61	II		3.0	5416.20	I	
5	w 5131.69	I		5	5424.10	II	
5	w 5141.08	II		2.0	5425.00	I	
5	5147.58	I		3.0	c 5426.43	I	
2.5	5164.27	I		1.4	5427.47	I	
3.0	5170.13	I		1.4	5432.45	II	
2.5	5170.61	I		1.4	5437.10	I	
5	5176.51	I		1.4	5438.12	I	
5	5179.97	I		3.5	5443.38	I	
5	5184.59	I		3.0	5457.00	I	
9	5186.16	I		6	5459.81	I	
5	5188.48	I		2.0	5464.39	I	
5	5198.86	I		3.0	w 5470.34	II	
3.5	w 5202.77	I		1.2	5476.96	I	
4	5204.55	I		2.5	5481.45	I	
4	5207.97	I		1.2	5488.26	II	
2.0	5209.34	II		1.2	5500.10	II	
4	5214.28	I		6	5509.61	I	
4	5221.99	I		5	5514.54	I	
12	5228.12	I		7	5524.12	I	
4	5235.11	I		2.5	c 5525.62	II	
8	5248.71	I		1.2	5536.26	II	
8	w 5262.11	II		1.2	5556.30	II	
1.4	5264.92			3.5	5565.93	I	
2.0	w 5272.07	II		1.2	5572.82	I	
2.5	5275.03	I		2.0	5586.96	I	
8	5281.05	I		2.0	5589.56	I	
1.4	5287.30			1.2	5591.62	II	
7	5304.72	I		1.2	5621.55	II	
3.0	5308.19	I		2.0	5636.56	I	
3.0	5309.46	I		3.0	c 5638.80	I	
11	5319.23	I		2.0	c 5645.75	I	
1.6	5322.11	II		2.0	5671.84	I	
1.6	5323.92	II		3.0	c 5685.74	II	
1.6	5329.05	I		4	c 5686.48	I	
3.5	5331.04	I		1.8	5712.45	II	
1.2	5332.58	I		9	c 5747.58	I	
7	w 5337.90	I		0.9	5761.62	II	
3.5	d 5338.59	I		2.5	5762.66	I	
1.6	5346.14	I		2.5	5785.18	II	
2.5	5347.93			8	5795.64	I	
17	5354.88	I		8	5803.13	I	
1.0	5363.62	I		7	5815.36	I	
8	5369.72	I		3.0	5842.97	I	
8	5375.98	I		7	5851.07	I	
2.0	w 5377.88	II		7	5870.62	I	
1.6	5397.90			3.5	5898.84	I	
3.0	d 5402.06	II		2.5	5902.40	I	

## Terbium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
3.5	5904.71	I		0.9	6512.19	II	
1.6	5910.10	I		3.5	6518.68	I	
7	5920.78	I		1.8	6527.63	II	
1.6	5937.09	I		2.5	6574.04	II	
5	5939.38	I		3.5	6581.82	II	
3.5	5940.17	I		1.4	6593.66	II	
2.5	5951.17	I		3.0	6607.17	II	
1.6	5951.78	I		1.6	6640.14	II	
2.0	5961.00	II		0.8	6642.27	II	
8	5967.34	II		1.8	6645.41	II	
1.6	5979.83	I		0.6	6665.94	II	
1.2	6010.65	II		9	6677.94	II	
1.6	6019.24	II		0.8	6689.51	II	
3.0	6038.97	I		1.8	6693.38	II	
3.0	6039.38	I		4	6702.61	II	
1.6	6061.83	I		2.0	6706.79	II	
1.6	6077.84	II		1.2	6714.98	II	
1.6	6084.34	II		0.7	6727.21	II	
1.6	6093.99	II		0.7	6734.86	II	
2.5	6104.29	II		0.7	6754.29	I	
1.4	6106.06	II		1.4	6755.01	II	
1.4	6134.39	II		1.4	6769.81	II	
1.4	6137.00	II		3.0	6785.12	II	
1.4	6156.29	I		1.2	6792.48	II	
1.2	6171.88			12	6794.58	II	
1.2	6193.64	II		3.5	6874.18	II	
1.2	6194.52	II		5	6896.37	II	
1.2	6195.14	II		4	6899.95	II	
1.0	6218.4	II		3.5	6902.08	II	
1.4	6222.25	II		1.2	6916.69	II	
1.0	6225.95	II		1.2	6923.09	II	
1.2	6272.36	I		1.0	6989.60	II	
2.5	6292.43	II		0.8	7005.99	II	
2.0	6303.78	II		1.6	7082.85	II	
1.0	6317.82	II		1.0	7089.22	II	
2.0	6321.59	II		1.0	7112.69	II	
2.0	6322.33	II		0.9	7187.48	II	
3.5	6331.68	II		0.9	7195.89	II	
2.5	6334.91	II		6	7204.28	II	
1.0	6336.74	II		1.8	7234.98	I	
1.2	6337.85	II		3.5	7257.73	I	
0.9	6356.40	II		1.6	7311.57	II	
0.9	6359.88	II		4	7348.88	II	
1.8	6405.97	II		0.9	7398.27	II	
1.4	6424.43	II		1.4	7424.24	II	
1.0	6441.03	II		0.9	7429.62	II	
2.5	6446.87	II		0.8	7472.15	I	
1.0	6461.74	II		2.0	7484.54	II	
1.4	6470.86	II		0.8	7495.45	I	
0.8	6501.33	II		4	7496.12	I	

## Terbium — All Observed Lines

Intensity and Character	Wave-length in A	Spectrum	Energy Levels in K	Intensity and Character	Wave-length in A	Spectrum	Energy Levels in K
1.6	7499.69	II		1.2	7998.93	I	
2.5	7511.40	II		1.6	8001.04	I	
0.8	7519.77	II		1.2 h	8010.16	II	
0.6	7557.59	II		3.0	8025.42	II	
2.5 h	7582.03	II		0.6	8046.06	I	
2.5	7587.49	II		0.6	8053.80	I	
4	7590.24	I		1.8	8067.35	II	
6	7596.44	I		3.0	8085.06	II	
1.6 h	7601.18	II		2.5	8164.17	II	
1.6	7616.01	II		1.2	8171.70		
2.0 h	7624.05	I		6	8194.82	II	
3.0	7627.81	I		9	8212.57	II	
0.8 h	7639.05	II		1.0	8214.33	I	
0.7	7672.72	II		3.0	8220.37	I	
0.7 h	7694.74	II		0.7	8259.08	I	
2.0 h	7706.16	I		3.5	8327.00	I	
2.0 h	7726.97	I		4	8387.77	I	
3.0	7737.63	I		3.5	8450.06	II	
2.0	7793.20	II		0.7 h	8465.80	II	
0.7	7807.33	II		1.4	8468.59	I	
1.5	7832.91	II		1.2	8502.70	II	
3.0	7855.79	II		3.0 h	8512.01		
1.4	7864.99	II		4	8583.45	II	
0.6 h	7885.70	II		3.0	8603.40	I	
0.6	7913.11			3.5	8661.91	I	
2.5	7927.90	II		0.8	8678.25	I	
1.2	7955.31	I		4	8688.61	I	
1.0	7998.03	I		6	8765.74	II	

# THALLIUM

$$\text{Tl}, Z=81, M=204.39, \text{Ratio } \frac{\text{Tl}}{\text{Cu}}=3.217$$

Tl I Normal state of valence electrons  $6s^2 6p^1 \ ^2P_{0\frac{1}{2}}^\circ=0$ . I.P.= 49264 K

Tl II Normal state of valence electrons  $6s^2 \ ^1S_0=0$ . I.P.=164765 K

## References

### Wavelengths:

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### Classification:

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### Intensities:

W. Kuhn, Naturwiss. **13**, 724 (1925).

W. Prokoviev and W. Soloviev, Z. Physik **48**, 276 (1928).

A. Filippov and W. Prokoviev, Z. Physik **85**, 647 (1933).

## Relative intensity of thallium lines observed in an arc of copper containing 0.1 atomic percent of thallium

### *Strong lines of thallium*

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
2000	3519.24	I	7793-36200	$6s^2 6p^1 \ ^2P_{1\frac{1}{2}} - 6s^2 6d^1 \ ^2D_{2\frac{1}{2}}$
1800	5350.46	I	7793-26478	$6s^2 6p^1 \ ^2P_{1\frac{1}{2}} - 6s^2 7s^1 \ ^2S_{0\frac{1}{2}}$
1200 cw	3775.72	I	0-26478	$6s^2 6p^1 \ ^2P_{0\frac{1}{2}} - 6s^2 7s^1 \ ^2S_{0\frac{1}{2}}$
500	3529.43	I	7793-36118	$6s^2 6p^1 \ ^2P_{1\frac{1}{2}} - 6s^2 6d^1 \ ^2D_{1\frac{1}{2}}$
440 d	2767.87	I	0-36118	$6s^2 6p^1 \ ^2P_{0\frac{1}{2}} - 6s^2 6d^1 \ ^2D_{1\frac{1}{2}}$

## Thallium — All Observed Lines

Intensity and Character	Wave- length in A	Spec- trum	Energy Levels in K	Intensity and Character	Wave- length in A	Spec- trum	Energy Levels in K
3.0	2315.98	I	0-43166	280	2918.32	I	7793-42049
40 h	2379.69	I	0-42011	44	2921.52	I	7793-42011
70	2580.14	I	0-38746	120	3229.75	I	7793-38746
6	2608.99	I	7793-46110	2000	3519.24	I	7793-36200
8	2665.57	I	7793-45296	500	3529.43	I	7793-36118
42	2709.23	I	7793-44693	1200 cw	3775.72	I	0-26478
5 h	2710.67	I	7793-44673	1800	5350.46	I	7793-26478
440 d	2767.87	I	0-36118	1.6 h	6549.77	I	26478-41741
28	2826.16	I	7793-43166	0.6 h	6713.69	I	26478-41368

# THORIUM

Th,  $Z=90$ ,  $M=232.05$ , Ratio  $\frac{\text{Th}}{\text{Cu}}=3.652$

Th I Normal state of valence electrons  $6d^2 7s^2 \ ^3F_2 = 0$ . I. P.  $\approx 50000$  K

Th II Normal state of valence electrons  $6d^1 7s^2 \ ^2D_{1/2} = 0$ .

## References

Wavelengths and Spectrum Assignments:

R. Zalubas, NBS Monograph 17 (1960).

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Th II, J. R. McNally, G. R. Harrison, and H. B. Park, J. Opt. Soc. Am. **32**, 334 (1942).

J. R. McNally, J. Opt. Soc. Am. **35**, 390 (1945).

## Relative intensity of thorium lines observed in an arc of copper containing 0.1 atomic percent of thorium

*Strong lines of thorium*

Intensity	Wavelength Å	Spectrum	Energy levels K	Term combination
300	4019. 13	II	0-24874	$6d^1 7s^2 \ a \ ^2D_{1/2} - 57\frac{3}{2}$
110	2837. 30	II		
95	3469. 92	II	4147-32957	$6d^2 7s^1 \ a \ ^4F_{3/2} - 81\frac{3}{2}$
90	3392. 03	II	1522-30994	$6d^2 7s^1 \ a \ ^4F_{2/2} - 73\frac{3}{2}$
90	3741. 19	II	1522-28244	$6d^2 7s^1 \ a \ ^4F_{2/2} - 67\frac{3}{2}$
90	4381. 86	II	6700-29515	$5f^1 6d^1 7s^1 \ a \ ^4H_{3/2} - 111\frac{4}{2}$
80	4391. 11	II	4490-27257	$5f^1 7s^2 \ a \ ^2F_{3/2} - 5f^1 7s^1 7p^1 \ ^4G_{3/2}$
75	3180. 20	II	1522-32957	$6d^2 7s^1 \ a \ ^4F_{2/2} - 81\frac{3}{2}$
75	4116. 71	II	6168-30453	$5f^1 6d^1 7s^1 \ a \ ^4H_{3/2} - 112\frac{4}{2}$
70	2832. 31	II	4147-39443	$6d^2 7s^1 \ a \ ^4F_{3/2} - 106\frac{3}{2}$
70	3351. 23	II	1522-31353	$6d^2 7s^1 \ a \ ^4F_{2/2} - 6d^1 7s^1 7p^1 \ ^4F_{1/2}$
70	3402. 70	II		
70	3434. 00	II	1860-30972	$6d^2 7s^1 \ a \ ^4F_{1/2} - 2P_{2/2}$
70	3609. 44	II	4113-31811	$6d^2 7s^2 \ a \ ^2D_{2/2} - 77\frac{3}{2}$
65	3256. 28	II		
65	3262. 67	II	6168-36809	$5f^1 6d^1 7s^1 \ a \ ^4H_{3/2} - 143\frac{3}{2}$
65	3291. 74	II	6214-36584	$6d^2 7s^1 \ a \ ^4F_{4/2} - 6d^2 7p^1 \ ^4G_{3/2}$
65	4069. 20	II	6691-31259	$5f^1 6d^1 7s^1 \ a \ ^4F_{1/2} - 114\frac{2}{2}$
60	3325. 12	II	4147-34212	$6d^2 7s^1 \ a \ ^4F_{3/2} - 84\frac{2}{2}$
60	3839. 74	II	6700-32736	$5f^1 6d^1 7s^1 \ a \ ^4H_{4/2} - 119\frac{3}{2}$
60	4108. 42	II	4490-28824	$5f^1 7s^2 \ a \ ^2F_{3/2} - 5f^1 7s^1 7p^1 \ ^4F_{2/2}$
55	3188. 23	II	1860-33216	$6d^2 7s^1 \ a \ ^4F_{1/2} - 82\frac{1}{2}$
55	3435. 98	II	0-29095	$6d^1 7s^2 \ a \ ^2D_{1/2} - 69\frac{2}{2}$
55	3721. 82	II	1860-28721	$6d^2 7s^1 \ a \ ^4F_{1/2} - 4D_{1/2}$
50	3675. 57	II	1522-28721	$6d^2 7s^1 \ a \ ^4F_{2/2} - 4D_{1/2}$
50	4085. 04	II	10189-34662	$5f^1 6d^1 7s^1 \ a \ ^4H_{3/2} - 130\frac{5}{2}$
50	4086. 52	II	0-24464	$6d^1 7s^2 \ a \ ^2D_{1/2} - 55\frac{2}{2}$
50	4094. 75	II	0-24415	$6d^1 7s^2 \ a \ ^2D_{1/2} - 54\frac{1}{2}$
50	4282. 04	II	6168-29515	$5f^1 6d^1 7s^1 \ a \ ^4H_{3/2} - 111\frac{4}{2}$
48	2870. 40	II	1860-36688	$6d^2 7s^1 \ a \ ^4F_{1/2} - 6d^2 7p^1 \ ^4G_{2/2}$
48	3078. 82	II	4113-36584	$6d^1 7s^2 \ a \ ^2D_{2/2} - 6d^1 7s^1 7p^1 \ ^4F_{3/2}$
48 d {	3511. 56	II	4490-32960	$5f^1 7s^2 \ a \ ^2F_{3/2} - 120\frac{1}{2}$
48	3511. 67	II		
48	3539. 59	II	0-28244	$6d^1 7s^2 \ a \ ^2D_{1/2} - 67\frac{2}{2}$
48 d {	3617. 02	II	15305-42944	$6d^3 \ a \ ^2H_{4/2} - 6d^1 7s^1 7p^1 \ ^4D_{3/2}$
48	3617. 12	II		
46	2747. 16	II	0-36390	$6d^1 7s^2 \ a \ ^2D_{1/2} - 6d^2 7p^1 \ ^4F_{1/2}$
46	3752. 57	II	9238-35879	$5f^1 6d^1 7s^1 \ a \ ^2G_{3/2} - 5f^1 7s^1 7p^1 \ ^2G_{3/2}$
44	2565. 60	II	1860-40826	$6d^2 7s^1 \ a \ ^4F_{1/2} - 6d^2 7p^1 \ ^4D_{0/2}$
44	3287. 79	II	1522-31929	$6d^2 7s^1 \ a \ ^4F_{2/2} - 6d^1 7s^1 7p^1 \ ^2D_{1/2}$
44	3292. 52	II	6700-37063	$5f^1 6d^1 7s^1 \ a \ ^4H_{3/2} - 145\frac{4}{2}$
44	3334. 61	II	6214-36194	$6d^2 7s^1 \ a \ ^4F_{4/2} - 6d^1 7s^1 7p^1 \ ^4F_{3/2}$
44	3337. 87	II	1860-31811	$6d^2 7s^1 \ a \ ^4F_{1/2} - 77\frac{2}{2}$
44	3358. 60	II	1860-31626	$6d^2 7s^1 \ a \ ^4F_{1/2} - 6d^1 7s^1 7p^1 \ ^4D_{0/2}$
44	4178. 06	II	7332-31259	$5f^1 6d^1 7s^1 \ a \ ^4F_{3/2} - 114\frac{2}{2}$
44	4208. 89	II	6700-30453	$5f^1 6d^1 7s^1 \ a \ ^4H_{3/2} - 112\frac{4}{2}$
42	2692. 42	II	0-37130	$6d^1 7s^2 \ a \ ^2D_{1/2} - 6d^2 7p^1 \ ^4D_{0/2}$
42	3238. 12	II		
42	3719. 44	I	0-26878	$6d^2 7s^2 \ a \ ^3F_2 - 26878\frac{3}{2}$
42	3803. 07	I	0-26287	$6d^2 7s^2 \ a \ ^3F_2 - 26287\frac{1}{2}$
42	3929. 67	II	0-25440	$6d^1 7s^2 \ a \ ^2D_{1/2} - 61\frac{2}{2}$

Thorium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
3.0	2326.93	II	1860-44822	3.0	2542.65	II	4490-43808
3.0	2354.02	II		5	2545.34	II	6214-45489
3.0	2356.75	II	0-42418	3.0	2545.74	II	4113-43383
1.6	2366.04	II		13	2547.90	II	4147-43383
4	2366.98	II		3.0	2548.14	II	9585-48818
1.8	2368.05	II	4490-46706	1.0	2549.99		
6	2373.84	II	0-42113	1.2	2551.24	II	1522-40707
4	2375.07	II		1.0	2554.65	I	
9	2377.84	II	4113-46156	1.8	2555.17	II	
3.0	2384.36	II		0.7	2560.93	II	
3.0	2388.14	II	1522-43383	7	2561.94	II	6168-45190
3.0	2393.11	II	4490-46264	44	2565.60	II	1860-40826
5	2404.17	II		24	2566.59	II	1522-40472
5	2404.51	II	4113-45689	2.5	2567.94	I	
2.5	2411.30	II		6	2574.48	II	4113-42944
6	2413.41	II	1522-42944	1.0	2576.32	I	
3.0	2423.00	II		18	2576.69	II	4147-42944
6	2423.68	II		9	2579.43	II	
2.0	2431.15	II	4490-45611	2.0	2580.35	II	
4	2432.85	II		5	2580.70	II	4490-43228
3.5	2437.54	II		3.0	2583.45	I	
3.0	2443.96	II		1.2	2586.15	II	
2.5	2444.46	II	1522-42418	1.0	2587.25	II	
2.5	2450.78	II		20	2589.06	II	1860-40472
8	2456.30	II	4490-45190	5	2595.03	II	8379-46903
2.0	2456.86	II		20	2597.05	II	0-38494
2.5	2459.01	II	0-40655	20	2600.89	II	6214-44651
8	2466.13	II	4113-44651	2.5	2607.48	II	1522-39862
5	2468.15	II	4147-44651	2.0	2608.32	II	8379-46706
4	2470.59	II		9	2609.86	II	4113-42418
3.0	2476.95	II	1860-42220	2.0	2611.62	I	
1.2	2485.05	II	9061-49289	20	2618.90	II	4147-42319
6	2489.62	II	6214-46368	24	2623.45	II	4113-42220
3.0	2494.61	II		24	2625.74	II	4147-42220
6	2495.35	II	4490-44553	2.5	2626.40	II	
1.8	2497.56	II		5	2628.81	II	4490-42519
5	2498.40	II	4490-44504	1.6	2630.02	II	
5	2498.86	II	6700-46706	4	2633.33	II	8460-46424
3.0	2502.87	II		3.5	2639.51	II	1522-39397
9	2504.28	II		1.2	2639.88	II	
3.5	2505.60	II	4490-44389	1.2	2640.27	II	
5	2507.91	II	0-39862	1.2	2640.40	II	4490-42352
2.5	2509.96	II	9585-49415	24	2641.49	II	0-37846
2.5	2516.42	II		1.2	2642.61	II	
7	2520.66	II		1.2	2643.27	II	7001-44822
1.2	2525.93	II	9712-49289	4	2649.48	II	
2.5	d 2526.22	II		4	2649.87	II	
	2526.34	II	7331-46903	15	2650.58	II	0-37716
4	2532.43	II	6214-45689	13	2658.66	II	0-37602
4	2535.87	II	7001-46424	3.0	2661.39	II	

Thorium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
5	2662.34	II	8606-46156	2.0	2736.44		
3.5	2662.86	II		6	2737.43	II	8379-44899
2.0	2664.06	II		4	2738.33	II	4147-40655
1.6	2665.89	II	6244-43744	2.0	2738.82	II	
1.0	2667.54	II		1.6	2740.48	II	
1.6	2669.45	II		16	2743.07	II	0-36445
1.6	2671.47	II		46	2747.16	II	0-36390
1.6	2672.94			1.6	2747.58	II	
3.0	2675.67	II	9061-46424	4	2747.85	II	7001-43383
1.6	2678.93	II	9585-46903	3.5	2748.81	II	
32	2684.29	II		9	2749.53	II	4113-40472
11	2687.13	II	8018-45221	1.6	2749.71	II	
1.6	2688.34	II	4490-41677	36	2752.17	II	1522-37846
2.0	2691.03	I		1.6	2753.09	II	
4	2691.18	II		1.6	2755.96	II	
42	2692.42	II	0-37130	1.6	2758.96	II	
1.6	2693.97	II		4	2759.41	II	
1.6	2695.02	II		11	2760.40	II	8606-44822
7	2695.21	II	11726-48818	13	2763.62	II	6244-42418
10	2695.56	II		9	2764.64	II	9061-45221
2.5	2695.81	II	8606-45689	9	2765.12	II	4490-40644
3.5	2696.83	II	12220-49289	24	2768.85	II	6214-42319
4	2697.54	II	1522-38582	18	2770.82	II	1522-37602
6	2698.74	II	6244-43288	18	2771.49	II	
1.6	2700.60	II	9585-46603	1.6	2772.01	II	
2.5	2701.82	II		1.6	2773.02	II	
24	2703.96	II	1522-38494	12	d 2773.96	II	13251-49289
15	2708.18	II	1522-38436		2774.07	II	
1.0	2710.48	II		4	2774.85	II	
3.0	2711.46	II		1.8	2775.08	II	
3.0	2714.61	II		6	2777.80	II	
3.5	2715.09	II		3.5	2778.04	II	1860-37846
8	2716.32	II	8018-44822	6	2778.71	II	9712-45689
3.0	2719.45	II	8460-45221	4	2780.70	II	
5	2719.93	II	9401-46156	1.6	2782.37	II	
20	2721.70	II	6214-42944	10	2783.06	II	4490-40412
15	2722.38	II	1860-38582	6	2783.49	II	7829-43744
1.6	2723.32	II		4	2784.06	II	
6	2724.89	II	0-36688	6	2784.98	II	7332-43228
3.5	2726.49	II		3.0	2785.59	II	
2.5	2727.25	II	9712-46368	1.6	2786.24	II	
4	2728.91	II	1860-38494	6	2786.92	II	
22	2729.33	II	9061-45689	9	2787.13	II	6244-42113
9	2730.27	II	8606-45221	3.0	2787.67	II	
3.5	2731.58	II		3.0	2788.68	II	
3.0	2731.92	II		4	2790.42	II	
22	2732.82	II	0-36582	6	2791.01	II	6700-42519
1.0	2733.20	II		3.0	2791.43	II	
14	2734.42	II	4147-40707	8	2794.26	II	9712-45489
2.5	2735.83	II	4113-40655	6	2797.02	II	1860-37602



Thorium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
6	2797.74	II	4490-40223	5	2857.49	II	6691-41677
5	2798.27	II	8018-43744	28	d 2861.34	II	9712-44651
2.5	2798.66	II			2861.42	II	10673-45611
5	2799.11	II	4147-39862	5	2862.61	II	
6	2800.57	II	9202-44899	6	2864.65	II	
3.0	2803.37	II	6691-42352	3.0	2866.40	II	4490-39367
5	2807.71			3.0	2866.65	II	
10	2807.83	II	9585-45190	3.0	2868.45	II	12472-47324
16	2808.99	II	9061-44651	4	2868.68	II	8379-43228
1.8	2812.42	II		6	2869.92	II	
6	2814.32	II		48	2870.40	II	1860-36688
4	2814.57	II		2.5	2870.81	II	
4	2816.07	II		6	2876.41	II	6168-40924
1.6	2817.14	II	11117-46603	3.5	2879.19	II	1860-36582
9	2819.33	II	7829-43288	2.0	2879.53	II	8379-43097
4	2820.34	II		4	2881.13	II	
3.5	2821.61	II		4	2882.00	II	11576-46264
9	2822.02	II	8379-43804	3.5	2882.51	II	8606-43288
3.0	2822.38	II	9401-44822	2.0	2883.61	II	9720-44389
1.8	2822.57	II		28	2884.29	II	4490-39151
1.8	2822.69	II		32	2885.04	II	
1.8	2823.55	II		4	2886.23	II	6691-41328
15	2826.86	II	8018-43383	4	2886.50	II	
1.8	2827.76	II		32	2887.81	II	
4	2827.99	II	9202-44553	14	2891.25	I	
1.8	2829.94	II	11576-46903	14	d 2891.73	II	
6	2830.45	II	6168-41488		2891.81	II	
70	2832.31	II	4147-39443	3.5	2892.17	II	9238-43804
5	2833.33	II	8460-43744	2.0	2894.48	II	
14	2834.49	II	8018-43288	11	2895.13	II	1860-36390
11	2836.05	II	4147-39397	6	2897.07	I	
4	2836.44	I		3.0	2898.25	II	
110	2837.30	II		4	2899.37	I	
8	d 2839.24	II	4490-39701	22	2899.72	II	6168-40644
	2839.34			4	2903.16	II	4147-38582
6	2840.15	II	0-35199	2.0	2904.26	II	12902-47324
8	2841.16	II	9202-44389	4	2905.93	II	
1.8	2841.81	II	9720-44899	2.5	2906.12	II	8018-42418
28	2842.82	II	1522-36688	7	2908.36	II	4490-38864
1.8	2843.30	II		2.0	2909.77	II	7332-41688
1.8	2845.19	II		18	2910.59	II	4147-38494
1.8	2845.83	II		8	2911.32	II	8606-42944
8	2847.36	II	9712-44822	8	2912.01	II	0-34330
1.8	2848.02	II		8	d 2912.66	II	4113-38436
24	2851.26	II	1522-36584		2912.75	II	9061-43383
7	2851.43	II	1522-36582	3.5	2916.37	I	
2.0	2852.50	II		4	2917.03	II	
4	2854.14	II		14	2917.41	II	4490-38758
2.0	2854.92	II		5	2917.78	II	
5	2855.90	II		4	2917.90	II	

Thorium — All Observed Lines

Intensity and Character	Wave-length in A	Spectrum	Energy Levels in K	Intensity and Character	Wave-length in A	Spectrum	Energy Levels in K
12	2919.83	II	4490-38729	24	2968.69	II	4490-38165
4	2920.36	II	6691-40924	2.5	2969.38	II	
4	2920.94	II	10673-44899	4	2969.82	II	
2.0	2921.36	II		10	2971.48	II	4113-37757
14	2921.56	II		7	2972.22	II	1522-35157
	2921.62	II					
6	2922.59	II		10	2973.53	II	
4	2922.79	II	12220-46424	19	2974.01	II	4490-38105
2.0	2922.99	II	8018-42220	10	2976.02	II	7332-40924
2.0	2924.10	II		2.5	2976.64	II	
				2.5	2980.10	I	
22	2925.05	II		5	2980.32	II	9401-42944
22	2928.25	II	8379-42519	14	2981.33	II	6168-39701
3.5	2928.70	II		14	2981.47	II	
3.5	2929.28	II		2.5	2981.84	II	
4	2930.90	II		2.5	2982.02	I	
2.5	2932.64	II		2.5	2983.02	II	
5	2933.09	II	9720-43804	5	2983.56	I	
5	2934.13	II			2983.66		
11	2936.19	II		12	2983.80	II	
15	2936.46	II		14	2985.24	II	4113-37602
6	2937.43	II	12902-46936	7	2986.77	II	7001-40472
2.5	2938.10	II	9202-43228	2.5	2987.68	I	3688-37149
9	2939.57	II		32	2988.23	II	4490-37945
	2939.62	II		13	2991.05	II	
6	h 2940.58	II	7332-41328	8	2991.68	II	
	2940.68	II					
2.5	2941.34	II		6	2993.65	II	
2.0	2941.89	II	9401-43383	14	2993.82	II	6214-39606
11	2942.62	II	8379-42352	2.5	2995.27	II	9720-43097
30	2942.85	II		10	2996.99	II	9061-42418
				2.5	2997.19	II	0-33355
2.0	2945.95	II		16	2999.10	II	
2.5	2946.25	II	10572-44504	2.5	2999.28	II	
13	2949.06	II	4490-38389	4	2999.80	II	
8	2949.94	II		5	3000.95	II	
7	2950.43	II	9061-42944	13	3001.27	II	8379-41688
6	2951.21	II		16	3002.39	II	1860-35157
4	2954.88	II		2.5	3006.00	II	6691-39949
5	2955.03	II	10673-44504	8	3006.93	II	
5	2955.60	II	7001-40826	9	3007.62	II	
3.0	2955.85	II		8	3007.80	II	
15	2957.58	II	4490-38292	5	3007.95	II	
8	2957.92	II		5	3008.27	II	9712-42944
6	2958.14	II		13	3008.50	II	6214-39443
2.5	2959.87	II		5	3009.76	II	0-33216
2.5	2963.61	II	4113-37846	4	3011.59	II	6700-39895
2.5	2963.87	II		6	3012.70	II	6214-39397
2.5	2964.00	II		5	3013.60	II	
5	2964.11	II	6168-39895	3.0	3014.92	II	9061-42220
10	2964.92	II		6	3015.73	II	
10	2965.49	II	6700-40412	6	3017.13	II	10673-43808

Thorium — All Observed Lines

Intensity and Character	Wave-length in A	Spectrum	Energy Levels in K	Intensity and Character	Wave-length in A	Spectrum	Energy Levels in K
8	3018.49	II	13249-46368	3.5	3081.65	II	13249-45689
8	3019.41	II	8379-41488	14	3081.98	II	4147-36584
3.0	3021.47	II		10	3082.17	II	
8	3022.09	II	7332-40412	10	3083.00	II	12472-44899
3.0	3024.68	II	9061-42113	10	3083.29	II	10673-43097
3.0	3025.43	II		17	3088.47	II	7332-39701
11	3026.57	II		9	3090.08	II	1860-34212
9	3028.57	II	6691-39701	6	3093.05	II	
3.0	3030.48	I		3.5	3096.26	II	
3.0	3030.86	II		7	3096.43	II	9202-41488
6	d 3031.19	II		10	3097.27	II	4113-36390
	3031.28	I		7	d 3099.74	II	
3.0	3031.70	II	4490-37465		3099.87	II	9238-41488
5	3032.00	I		14	d 3100.79	II	
26	3034.06	II	8379-41328		3100.93	II	
12	3035.11	II		3.5	3101.68	II	11576-43808
3.0	3035.53	II	0-32933	14	3102.66	II	6168-38389
6	3038.60	II	6168-39069	6	d 3104.96		
5	3040.05	II			3105.05	II	
9	3043.06	II	2210-35062	20	3105.74	II	
9	3045.55	II	10189-43014	3.5	3106.68	II	
12	3046.95	II		14	3107.03	II	6691-38867
30	3049.09	II	4490-37277	36	3108.29	II	
6	3049.64	II		18	3110.02	II	6691-38836
3.0	3049.86	II		3.5	3112.08	II	6168-38292
6	3050.98	II	9585-42352	3.5	3114.06	II	9585-41688
6	3051.78	II	6700-39458	3.5	3114.26	II	8606-40707
3.0	3057.63	II	6168-38864	18	3116.28	II	
2.0	3057.89	II		7	3116.48	II	
6	3058.42	II		10	3117.68	II	6691-38758
13	3060.18	II		7	3119.36	II	
6	3060.44	I	0-32666	36	3119.51	II	4147-36194
16	3061.69	II		3.5	3120.88	I	2558-34591
16	d 3063.03	II		36	3122.96	II	6168-38180
	3063.10	II		26	3124.38	II	6168-38165
6	3065.93	II	9712-42319	16	3125.21	II	
3.0	3066.41	II	12220-44822	34	3125.51	II	
32	3067.72	II		10	3125.74	II	
16	d 3068.90	II	4113-36688	6	3127.21	II	9720-41688
	3068.96	II		3.5	3129.98	II	
3.0	3069.26	II		11	3131.07	II	0-31929
19	3070.82	II		6	3133.62	II	9585-41488
26	3072.11	II	4147-36688	11	3134.42	II	
6	3072.82	II		7	3136.22	I	4962-36838
2.0	3075.83	II		3.5	3136.83	I	0-31870
6	3077.34	II	9202-41688	30	3139.30	II	
5	3077.93	II		7	3139.89	II	
48	3078.82	II	4113-36584	7	3140.27	I	2869-34704
3.5	3079.88	II		15	3141.84	II	7332-39151
34	3080.21	II		30	3142.84	II	

Thorium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
3.5	3145.63	I	0-31781	4	3203.23	II	9202-40412
22	3146.04	II	6168-37945	3.0	3203.61	II	
11	3150.46	II		4	3203.88	II	9720-40924
7	3151.64	II		4	3205.28	II	
22	3154.30	II	1522-33216	4	3206.94	II	8379-39552
22	3154.77	II	6700-38389	4	3207.78	II	
7	3155.83	II		4	3208.03	II	12220-43383
7	3156.39	II		12	3210.31	II	
3.5	3158.62	II		4	3211.20	I	2869-34001
3.5	3159.07	II	9061-40707	12	3213.57	II	6168-37277
5	3161.68	II		4	3214.08	I	2558-33662
8	3162.83	II	9720-41328	4	3214.38	I	4962-36063
8	3164.48	II	6700-38292	4	3215.78	II	
4	3165.62	II	7001-38582	12	3217.45	II	9401-40472
8	3165.82	II		4	3217.73	II	
10	3166.09	II	4490-36066	12	3220.35	II	4113-35157
6	3167.55	II		40	3221.28	II	
8	3169.32	II	6214-37757	20	3225.42	II	9712-40707
4	3170.42	II	7331-38864	4	3225.66	II	
4	3171.26	I	0-31524	4	3225.90	II	
3.0	3171.68	II	11576-43097	4	3226.12	II	8379-39367
4	3173.43	I	2869-34372	4	3226.41	II	
8	3174.19	II	1860-33355	8	3227.78	II	0-30972
30	3175.72	II	6700-38180	40	3229.01	II	7332-38292
4	3176.50	II	6244-37716	8	3230.86	II	9712-40655
4	3177.17	II	6700-38165	8	3232.13	II	
6	3178.24	I		3.0	3232.31	I	0-30929
19	3179.05	II		4	3235.00	I	3688-34591
75	3180.20	II	1522-32957	34	3235.85	II	6168-37063
8	3181.18	II	7332-38758	42	3238.12	II	
4	3181.66	II		4	3238.94	I	
6	3182.40	II	6691-38105	7	3239.29	II	
8	3182.64	II	9061-40472	8	3240.48	II	6691-37542
4	3183.13	II		4	3240.64	II	
4	3183.79	II	13251-44651	17	3241.12	II	7001-37846
22	3184.94	II	4490-35879	8	3244.46	I	0-30813
4	3187.00	II		20	3245.78	II	9061-39862
4	3187.40	II		8	3247.59	II	
55	3188.23	II	1860-33216	8	3248.53	II	6691-37465
19	d 3190.07	II	9585-40924	7	3249.87	I	0-30762
	3190.17	II		20	3251.92	I	
8	3191.08	II	1522-32850	10	3252.74	II	
6	3191.21	II		10	3254.82	II	7001-37716
4	3192.57	I	2869-34183	10	3255.51	II	
4	3193.16	II		65	3256.28	II	
4	3195.69	I	0-31283	13	3257.16	II	9585-40278
8	3198.23	II		13	3257.38	I	
8	3198.48	II		8	3259.06	I	
8	3198.71	II	6691-37945	8	3259.61	II	
6	3198.96	II		8	3260.92	II	9238-39895

Thorium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
8	3261.54	II		4	3328.25	II	13251-43288
65	3262.67	II	6168-36809	4	3329.72		
8	3263.03	II	9585-40223	18	3330.48	I	0-30017
8	3264.44	II	12472-43097	7	3332.40	II	12220-42220
8	3265.58	II	7332-37945	12	3333.13	I	2869-32863
13	3267.00	II	7001-37602	44	3334.61	II	6214-36194
8	3269.48	II	6700-37277	9	3335.06	II	8606-38582
8	3270.83	II	0-30565	44	3337.87	II	1860-31811
8	3272.05	I	0-30553	9	3338.39	II	7332-37277
22	3273.89	II		4	bl 3341.31	ThO	
22	3275.06	II		4	3343.26	II	
22	3280.37	II	8018-38494	9	3343.61	I	
4	3282.96	II		9	3344.87	II	7829-37716
9	3285.75	I		7	bl 3345.89	ThO	
22	3286.58	II	8018-38436	13	3346.55	II	9585-39458
44	3287.79	II	1522-31929	22	3348.77	I	0-29853
9	3290.12			9	3348.96	II	
65	3291.74	II	6214-36584	70	3351.23	II	1522-31353
44	3292.52	II	6700-37063	9	3353.95	II	11117-40924
9	3293.58	II		22	3354.18	II	
17	3293.94	II	9202-39552	14	3354.61	II	8379-38180
9	3294.99	II		9	3355.25	II	
13	3295.32	II	6244-36582	7	3356.82	II	
9	3295.52	II	9061-39397	44	3358.60	II	1860-31626
11	3296.60	II	12902-43228	9	3360.15	II	11576-41328
9	3297.36	II		9	3360.37	II	
17	3297.83	II	9238-39552	22	d 3361.61	II	
4	3298.04				3361.73	II	9720-39458
4	3300.61	II	1522-31811	7	3362.18	II	
17	3301.26	II		9	3362.50	II	9712-39443
	3301.35			5	3362.67		
17	3301.63	II		9	3363.06	II	8379-38105
9	3303.48	II		9	3363.70	II	0-29720
34	3304.24	I	0-30255	18	3364.69	II	
4	3305.30	I		9	3365.33	I	2869-32575
9	3309.14	II	7332-37542	18	3366.52	II	13249-42944
9	3309.36	I	0-30209	28	3367.81	II	4490-34175
13	3310.24	II	6244-36445	18	3371.79	II	
4	3313.06	I		9	3373.49	I	
13	3313.64	II		18	3374.58	II	
17	3314.80	II		18	3374.98	I	
4	3317.73	II	13251-43383	5	3376.84	II	10673-40278
4	3318.97	II	6691-36813	28	3378.58	II	8018-37608
20	3320.29	II	6700-36809	9	3380.86	I	2869-32439
36	3321.44	II	4113-34212	9	3381.35	II	9585-39151
4	3322.09	I	2558-32651	9	3383.14	II	
28	3324.75	II	1860-31929	22	3385.53	II	4490-34019
60	3325.12	II	4147-34212	22	3386.50	II	9061-38582
7	3326.45	II	4490-34544	8	3387.91	I	
9	3327.18	II	12472-42519	8	3388.58	II	

Thorium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
9	3389.46	I	8111-37606	9	3441.36	II	6691-35741
22	3389.65	II	1860-31353	8	3442.58	I	4962-34001
8	3390.36	II		5	3443.11	II	9401-38436
90	3392.03	II	1522-30994	5	3444.00	II	10673-39701
5	3393.23	II		14	3445.21	II	
8	3394.13	II		5	3445.38	II	12472-41488
9	3394.79	II		14	3445.73	II	14791-43804
8	3395.37	II	7001-36445	5	3449.28	II	
9	3396.41	II		12	3449.65	II	10572-39552
14	3396.73	I	3865-33297	8	3450.94	II	13251-42220
16	3397.52	I		9	3451.70	II	9202-38165
18	3398.53	I		19	3452.68	II	6244-35199
14	3401.68	II	7001-36390	8	3453.51	I	
14	3402.02	I	8460-37846	7	3454.20	II	9238-38180
70	3402.70	II		14	3461.02	I	0-28885
14	3403.28	II	9061-38436	19	3461.22	I	4962-33845
12	3404.63	II	10189-39552	24	3462.85	II	9712-38582
14	3405.56	I	3688-33043	19	3463.72	II	13251-42113
9	3406.23	II	6691-36041	5	3465.03		
5	3407.82	I		32	3465.77	II	6700-35546
18	d 3408.63	II		9	3465.92	II	4113-32957
	3408.75	I	2869-32197	19	d 3466.52	I	4962-33801
14	3409.26	II	10572-39895		3466.64	I	4962-33800
12	3411.77	II	7829-37130	28	3468.22	II	
18	3413.01	I		12	3469.34		
9	3414.51	II	9585-38864	95	3469.92	II	4147-32957
5	3415.88	II		12	3471.21	I	3865-32666
14	3418.77	II	4113-33355	5	3471.95	I	7280-36074
14	3418.94	II	4490-33731	9	3473.03	II	9061-37846
19	3419.17	II		7	3473.41	II	9712-38494
28	3421.21	I	2869-32090	12	3476.53	II	6700-35456
14	3422.65	II	4147-33355	5	3477.70		
9	3423.11	II	12472-41677	9	3478.12	II	9202-37945
19	3423.99	I	0-29197	9	3478.46	II	
9	3425.15	II	9202-38389	18	3479.17	II	6691-35426
9	3425.94	II	9401-38582	5	3480.05	I	8111-36838
14	3429.00	I	2558-31713	9	3482.55	II	9585-38292
8	3429.39	II	9238-38389	9	3482.76	II	1860-30565
9	3429.88	II	4490-33637	14	3485.20	II	8379-37063
9	3431.80	II		28	3486.50	II	
					3486.54	I	
70	3434.00	II	1860-30972	5	3490.26	II	
9	3434.74			5	3490.45	II	
55	3435.98	II	0-29095	5	3491.57	II	
19	3436.71	II	9202-38292	19	3493.52	II	7829-36445
9	3437.02	II	8379-37465	9	3495.70	I	
24	3437.31	I	2869-31953	5	3496.81	I	0-28589
24	3438.95	II	13249-42319	5	3497.01	II	
5	3439.40	I		5	3497.26		
38	3439.72	II		14	3498.00	II	
9	3441.01	II					

Thorium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
9	3498.62	I		12	3557.47	II	6168-34270
9	3498.95	I	7502-36074	38	3559.45	II	6244-34330
	3498.99	II	9720-38292	19	3559.95	II	8606-36688
14	3499.98	II	8018-36582	5	3561.78	I	
10	3501.46	II		8	3563.37	I	
5	3501.94	II	7332-35879	5	3564.72	II	
14	3502.77	II	9061-37602	10	3565.39	I	
10	3503.61	II		5	3567.06	II	6700-34727
5	3503.78	I		12	3567.26	I	0-28025
10	3505.48	II		5	3567.69	II	12902-40924
5	3506.85	II	15237-43744	5	3569.62	II	6168-34175
5	3509.09	I		10	3569.82	I	3865-31870
8	3511.16	I		8	3571.57	II	10189-38180
48	d 3511.56	II	4490-32960	24	3572.39	II	8460-36445
	3511.67	II		14	3573.22	II	8606-36584
10	3512.74	II	9720-38180	38	3575.32	II	6700-34662
14	3514.52	II	9401-37846	14	3576.56	II	15145-43097
5	3514.96	II		24	3579.35	II	8460-36390
10	3516.36	II	8379-36809	10	3580.23		
10	3516.83	II	8018-36445	14	3582.01		
10	3518.40	I	2869-31283	10	d 3583.04	II	
5	3518.89	II	7332-35741		3583.11	I	4962-32863
5	3521.06	I		8	3584.18	I	2869-30762
24	3521.92	II		9	3585.06	II	
5	3523.53	II	8018-36390	19	d 3585.76	II	9585-37465
					3585.89	II	
5	3526.64	I	0-28348				
10	3528.82	II		12	3588.22	II	1860-29720
19	3528.95	II		8	3589.15	II	6700-34554
8	3530.52	I		14	3589.36	II	6691-34544
10	3531.44	I	4962-33271	12	3589.75	I	7502-35351
10	3531.92	II					
14	3537.15	II	9202-37465	8	3591.06	II	8606-36445
24	3539.32	II	4490-32736	10	3591.46	I	3688-31524
48	3539.59	II	0-28244	19	3592.78	I	
10	3541.62	II	8460-36688	10	3593.88	II	10572-38389
				5	3595.33	II	12472-40278
5	3542.50	I					
13	3544.02	I	8800-37009	5	3595.61	I	
5	3545.00	I		19	3598.12	I	0-27784
18	d 3545.18	II		28	3601.04	II	
	3545.29	II	1522-29720	24	3603.21	II	9720-37465
				5	3603.36	II	
5	3545.96	I					
10	3547.34	I	3688-31870	5	3604.05	II	
12	3549.60	I	8111-36275	8	3604.68	I	5563-33297
5	3550.29	II		5	3605.20	I	
10	3551.40	I		8	3605.65	II	
				12	3608.38	I	
14	3553.11	II					
5	3553.38	II	9712-37846	14	3609.22	II	
14	d 3555.02	I	2869-30991	70	3609.44	II	4113-31811
	3555.10	II		17	d 3610.04	II	
5	3555.71	I			3610.13	II	
				12	3610.40	II	

## Thorium — All Observed Lines

Intensity and Character	Wave-length in A	Spectrum	Energy Levels in K	Intensity and Character	Wave-length in A	Spectrum	Energy Levels in K
14	3610.79	II	4113-31800	10	3668.14	I	
14	3612.43	I	0-27674	20	3669.96	I	8111-35351
5	3612.87	I	0-27671		3670.06	II	4113-31353
10	3613.78	II	4147-31811	7	3671.54	I	6362-33591
10	3614.01	II		10	3673.26	II	
5	3614.21	I		14	3673.79	II	7332-34544
5	3614.35	I		50	3675.57	II	1522-28721
34	3615.13	II	4147-31800	28	3678.04	II	8018-35199
48	d 3617.02	II	15305-42944	20	3679.72	II	
	3617.12	II		6	3681.88	II	11576-38729
8	3618.36	I	7502-35131	17	3688.76	II	
3	3619.71	II	10673-38292	15	3690.49	II	9720-36809
14	3620.37	II		13	3691.88	I	
19	3621.12	II	10572-38180	12	3692.57	I	3688-30762
10	3622.33	I	5563-33162	20	3693.90	II	
8	3622.80	I	3688-31283	11	3695.98	II	11117-38165
19	3624.90	II	6700-34279	5	3696.65	II	9401-36445
28	3625.63	II	1522-29095	5	3697.03	II	6168-33209
14	3625.89	II		13	3698.11	I	9805-36838
	3625.93	II	9238-36809	4	3698.30	II	11726-38758
8	3632.62	II	9061-36582	8	3700.77	II	15305-42319
10	3632.83	I		3.0	3700.98	I	5563-32575
17	3634.58	I		3.0	3702.87	II	
10	3635.24	II		6	3703.78	I	4962-31953
14	3635.42	II		18	d 3703.92	II	
					3704.00	II	
19	3635.94	I		6	d 3704.87	I	2869-29853
8	3637.57	II	6691-34175		3704.97	II	15237-42220
4	3638.32			24	3706.77	I	8111-35081
5	3638.64	I	8800-36275	3.0	3707.00	I	
24	3639.45	II	6168-33637	3.0	3707.43	II	
22	3642.25	I	0-27448	2.5	3708.76	II	
8	3643.51	I	6362-33801	20	3711.30	II	6700-33637
5	3644.35	II	10673-38105	6	3711.62	I	6362-33297
7	3647.30	II		4	3712.54	II	
	3647.38	II		3.0	3717.83	II	
11	3647.65	II		3.0	3718.17	II	9238-36125
8	3648.17	II	0-27403	42	3719.44	I	0-26878
10	3648.42	II		32	3719.96	II	10189-37063
22	3649.25	II	7332-34727	19	3720.31	II	9712-36584
12	3649.73	I	5563-32955	55	3721.82	II	1860-28721
12	3650.77	II	9061-36445	24	3722.11	II	4113-30972
26	3652.17	II		3.5	3723.29	II	
10	3652.54	II	7829-35199	4	3723.66	II	4147-30994
7	3656.20	II	9720-37063	6	3724.74	II	
30	3658.06	II	7001-34330	5	3725.39	I	
40	3659.51	II		16	3726.72	II	4147-30972
14	3661.62	II		8	3727.90	I	2869-29686
16	3663.20	II	11576-38867	9	3730.37	I	6362-33162
24	3663.70	II	9401-36688	12	3730.75	II	
9	3666.98	I	8800-36063				



Thorium — All Observed Lines

Intensity and Character	Wave-length in A	Spectrum	Energy Levels in K	Intensity and Character	Wave-length in A	Spectrum	Energy Levels in K
1.6	3731.26	I		3.5	3788.35	II	
3.0	3731.42	II		22	3789.11	II	1860-28244
3.5	3732.98	I		6	3790.35	I	
3.5	3733.66	I		14	3790.79	I	
7	3734.59	II	4490-31259	5	3791.29	II	11576-37945
7	3737.51	I		8	3792.38	I	
12	3738.84	II	8460-35199	7	3794.15	II	11117-37465
8	3740.87	II		4	3794.69	I	
90	3741.19	II	1522-28244	6	3795.38	I	
11	3742.92	I		4	3796.72	I	8800-35131
3.0	3743.51	II	10572-37277	3.0	3797.45	II	
4	3744.74	II	8460-35157	4	3798.10	I	4962-31283
3.5	3745.66	I		9	3801.44	I	7502-33801
24	3745.98	II	7332-34019	2.0	3802.14	II	9585-35879
22	3747.54	II	9202-35879	42	3803.07	I	0-26287
3.0	3751.02	I		6	3803.98	I	8800-35081
	3751.12	I		8	3805.81	II	6691-32960
46	3752.57	II	9238-35879	26	3807.87	II	9202-35456
2.5	3753.24	I		4	3808.61	I	
4	3754.03	I		4	3809.83	II	
9	3754.59	II	0-26626	7	3810.99	I	
9	3755.21	I		2.0	3812.40	I	
3.5	3756.29	I		24	3813.07	II	9238-35456
10	3757.70	I		3.0	3815.02	II	
9	3758.46	I	2558-29157	8	3817.47	I	
9	3759.31	I		3.5	3818.68	I	
3.5	3760.28	II		12	3821.42	II	11117-37277
5	3761.11	I		12	3822.15	II	9585-35741
3.5	3761.47	I		6	3823.58	II	13251-39397
36	3762.88	II	6168-32736	2.0	3826.36	I	
	3762.94	I	3688-30255	8	3826.94	II	14349-40472
3.5	3763.32	II		32	3828.38	I	0-26113
8	3765.24	I	8800-35351	11	3829.33	II	
3.5	3766.35	I		4	3830.06	I	
14	3767.90	I		8	3830.77	I	0-26097
13	3770.05	I	5563-32080	19	3831.74	II	
14	3771.37	I	0-26508	3.5	3832.97	II	
7	3772.24	II	7829-34330	9	3836.54	I	
12	3773.74	II	10572-37063		3836.58	I	
3.5	3774.19	II		18	3837.87	I	2869-28918
5	3775.91	II	14349-40826	60	3839.74	II	6700-32736
6	3776.27	I		6	3840.80	I	4962-30991
1.8	3777.41	I		20	3841.96	II	9720-35741
3.5	3780.97	I		6	3842.90	II	
1.8	3781.31	I			3843.02	I	
12	3783.01	II		2.0	3846.25	II	
10	3783.29	II	0-26425	6	3852.14	I	3688-29640
24	3785.60	II	6168-32577	28	3854.50	II	10189-36125
3.5	3785.91	II		10	3859.85	II	8379-34279
5	3786.88	II	7332-33731	32	3863.41	II	6700-32577

Thorium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
24	3872.72	II		14	3932.91	I	
26	3873.82	I		10	d 3935.54	II	
18	3874.86	I	4962-30762		3935.63	II	
15	3875.37	I	2869-28666	10	3937.04	II	10673-36066
2.0	3875.64	I	7502-33297	8	3937.92	II	7828-33216
10	3879.64	I	7502-33271	8	d 3938.69	I	
4	3884.52	II	9720-35456		3938.73	II	12220-37602
10	3884.82	II		8	h 3941.23		
4	3885.77	I	6362-32090	3.5	3942.07	II	
7	3886.91	I	2869-28589	5	3942.64	II	10189-35546
7	3887.01	I		11	3943.39	II	8379-33731
6	3891.05	II	11117-36809	6	3943.69	II	
2.0	3891.72	I		16	3945.51	II	
3.5	3892.30	II	6244-31929	6	3945.82	II	
4	3893.11	II		16	3946.15	II	
2.0	3893.41	II		8	3947.33	I	9805-35131
24	3895.42	I		5	3948.03	I	0-25322
6	3898.43	I			3948.13	I	
	3898.50	I		14	h 3948.96	II	
2.0	3900.12	II	12472-38105	14	3950.39	II	10572-35879
4	3900.57	I		2.0	3951.11	II	
24	3900.88	II	7332-32960	16	3951.52	II	
4	3901.14	II	12220-37846	3.5	3952.76	I	3865-29157
3.5	3902.12	II	14276-39895	8	3955.17	I	9805-35081
	3902.17	I		3.5	3955.89		
8	3903.10	I		28	d 3956.59	II	10189-35456
10	3904.08	II	4113-29720		3956.68	II	0-25267
12	3905.19	II		4	3957.16	ThO	
3.5	3908.74	I		8	3959.30	I	5563-30813
2.0	3909.13	I		5	3960.33	II	13251-38494
6	3911.91	I		4	3962.42	I	3688-28918
8	3912.28	II	10572-36125	3.5	3963.22	II	
7	3913.01	II		2.0	3963.48	II	
	3913.08	I	11601-37149	3.5	d 3964.74	I	
4	3913.82	II	1860-27403		3964.87	II	
3.5	3916.42	I	0-25526	28	3967.39	I	
10	3916.79	II	9202-34727	5	3969.00	II	0-25188
4	3917.26	I		14	3972.15	I	
6	3918.07	I		5	3972.63	I	
4	3918.51	II		11	3973.20	I	6362-31524
8	3919.02	I	3688-29197	4	3974.22	II	
4	3922.22	II	9238-34727	15	3976.42	II	9585-34727
2.0	3923.80	I	2869-28347	4	3979.04		
10	3925.09	I	3688-29158	11	3980.09	I	
2.0	3926.70	II		4	3980.75	II	
8	3927.17	II		14	3981.11	II	
8	3927.42	II		4	3981.82	I	
42	3929.67	II	0-25440	6	3987.22	I	7502-32575
4	3932.00	II		14	3988.01	II	9202-34270
6	3932.23	II	9238-34662	4	3988.60	II	

Thorium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
5	3988.85	II	6691-31754	10	4053.52	I	
8	3990.49	I	3865-28918	10	4059.25	I	6362-30991
8	3991.73	I	8800-33845	18	4063.40	II	11726-36329
4	3992.28	II	9238-34279	4	4064.32	I	
38	3994.55			4	4065.62	I	
					4065.68	II	9585-34175
18	3996.06	II		4	4067.45	I	2869-27448
4	3997.47	II	11117-36125	65	4069.20	II	6691-31259
11	3997.87	II	9720-34727	4	4071.74	I	
4	4000.28			4	4075.50	I	2558-27088
8	4001.06	I					
4	4001.73	II	4113-29095	4	4080.70	I	
8	4003.11	II	10572-35546	8	4081.37	I	
17	4003.31	II	9202-34175	8	4082.26	II	11576-36066
4	4005.09	I	3688-28649	5	4083.47	I	3865-28348
10	4005.53	II	9585-34544	50	4085.04	II	10189-34662
7	4006.38	II		6	4085.43	I	8800-33271
18	4007.02	II	11117-36066	50	4086.52	II	0-24464
16	4008.21	I		3.5	4087.28	I	
16	4009.05	I	7502-32439	5	4088.72	I	6362-30813
4	4009.72	I	8111-33043	4	4089.14	I	2869-27317
	4009.81	I					
4	4011.59	I	6362-31283	3.5	4091.34	II	9202-33637
8	4011.75	I		6	4093.39	II	7332-31754
20	4012.50	I	2869-27784	50	4094.75	II	0-24415
4	4014.51	II	1522-26425	4	4097.33	II	9238-33637
				8	4097.74	I	2869-27266
4	4018.10	I		12	4098.94	II	8460-32850
300	4019.13	II	0-24874	11	4100.34	I	0-24381
8	4019.77	ThO		10	4100.84	II	
15	4022.08			4	4102.62	I	7502-31870
15	4025.66	II	9720-34554	3.5	d 4103.65	II	12220-36582
					4103.68	I	6362-30724
12	4026.16	II	8379-33209	10	4104.38	II	8379-32736
10	4027.01	I		19	4105.34	II	7001-31353
18	4030.84	I	2869-27671	5	4105.91	II	
8	4032.46	II		4	4107.37	II	11117-35456
8	4032.60	II					
10	4034.25	II	6214-30994	4	4107.86	I	3688-28025
5	4034.90			60	4108.42	II	4490-28824
	4034.93	I		4	4109.32	I	8111-32439
18	4036.05	I	0-24770	8	d 4110.51	II	
17	4036.56	II	1860-26626		4110.64	II	6244-30565
8	4039.86	I		6	4110.86	II	
17	4041.20	II		17	4112.75	I	0-24308
5	4043.12	II		20	bl 4115.76	ThO	
8	4043.40	I	4962-29686	75	4116.71	II	6168-30453
3.5	4045.61	II		3.5	4118.48	I	
4	4048.29	II		4	4122.67	II	
4	4048.43	II	9585-34279	8	4123.53	II	8606-32850
6	d 4049.83	II		14	4127.41	I	
	4049.95	I	3688-28373	4	4130.33	I	
8	4050.89	I		8	4131.00	I	

Thorium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
8	4131.42	II	8379-32577	3.5	4189.56	I	
24	4132.75	II		4	4191.82	II	11576-35426
10	h 4133.46			2.0	4192.36	I	6362-30209
14	4134.06	I	0-24182	9	4193.02	I	8111-31953
	4134.11	II		3.5	4194.93	I	
10	d 4136.28	I		5	4195.56	II	
	4136.40	II		6	4195.83	II	
5	b 4139.19	ThO			4195.95	II	
16	4140.23	II		4	4199.02	II	
11	4141.63	II	15305-39443	12	4201.85	II	8018-31811
12	4142.48	II		3.5	4206.66	II	
18	4142.70	II	0-24132	44	4208.89	II	6700-30453
4	4145.84	I		4	4210.77	I	
16	4148.18	II	7829-31929	9	4210.92	II	
3.5	4148.65	I		4	4213.07	I	2558-26287
	4148.72	I	7502-31599				
32	4149.99	II	10572-34662	2.0	4214.54	II	
4	d 4152.20	I		2.0	4214.83	I	
	4152.34	I		4	4217.23	II	
8	4155.30	II		4	4218.19	II	11726-35426
				4	4218.54	II	10572-34270
5	4155.47	II		4	4220.08	II	
9	4156.23	II	10673-34727	4	4224.25	II	1522-25188
24	4156.52	II	9585-33637	4	4227.39	I	7280-30929
4	d 4157.27	I		7	4229.45	II	
	4157.39	I		6	4230.43	I	
8	4158.54	I	9805-33845	4	4233.29	I	
6	4159.66	II		6	4235.46	I	0-23604
4	d 4161.59	II		3.5	4240.59	II	
	4161.74	I	7502-31524	6	4243.93	II	9401-32957
4	4162.51	I		2.0	4247.60	II	
10	4162.68	II	14276-38292	10	4248.00	II	9202-32736
12	4163.64	II	9720-33731	4	4249.68	II	7829-31353
8	4164.25	II	9202-33209	12	4250.31	II	4490-28011
4	4165.07	II		8	4253.53	I	
10	4165.77	I		5	4256.09	II	9720-33209
4	h 4168.05	I		5	4256.25	I	7502-30991
12	4168.63	II		7	4257.50	I	0-23481
16	4170.47	II	9238-33209	8	4260.34	I	9805-33271
	4170.54	I	4962-28933	2.0	4262.61	I	
4	4170.78	II		4	4263.36	II	9401-32850
8	4171.34	II		2.0	4269.94	I	8111-31524
3.5	d 4176.33	II	14791-38729	4	4270.33	II	
	4176.48	I		3.5	4271.09	II	1860-25267
44	4178.06	II	7332-31259	4	4272.86	I	8800-32197
18	4179.71	II	1522-25440	20	4273.36	II	8379-31773
11	4179.96	II	9720-33637	8	4274.02	II	
4	4180.88	I		7	4276.81	II	8379-31754
8	4182.16	II	14276-38180	4	4276.96	II	9202-32577
4	4183.56	II	9061-32957	34	4277.31	II	0-23373
3.5	4184.71	II	14276-38165	5	4278.32	I	

Thorium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
2.0	4280.57	I	5563-28918	6	4352.67	I	
9	4281.07	II	1522-24874	6	4353.39	II	10673-33637
8	4281.41	II	8460-31811	4	4354.48	I	
50	4282.04	II	6168-29515	8	4355.32	II	8018-30972
8	4283.52	II	9238-32577	4	4357.61	II	1522-24464
5	4284.97	II		4	4358.31	I	
3.5	4286.21			6	4359.37	I	
4	4288.05	II	14791-38105	6	4361.30	II	
2.0	4288.48	I		6	4365.93	I	
2.0	4288.66	I	7502-30813	6	4369.30	II	8379-31259
4	4291.81	I		6	4373.90	II	9720-32577
6	4295.04	II		6	4374.13	I	0-22855
4	4297.30	I		9	4374.78		
5	4298.84	II		4	4378.18	I	2869-25703
6	4299.84	I		5	4381.41	I	
4	4306.37	II		90	4381.86	II	6700-29515
7	4307.18	I		2.0	4384.65	II	15145-37945
2.0	4308.12	I		80	4391.11	II	4490-27257
14	4309.99	II		4	4392.98	I	
2.0	4311.58	I		2.0	4393.76	I	7502-30255
2.0	4311.80	I		6	4394.90	II	8606-31353
10	4312.99	I	2869-26049	5	4396.48	II	9061-31800
4	4315.25	I	2869-26036	6	4397.92	II	
8	d 4318.29	II	9585-32736	3.5	4399.10	II	
	4318.42	I		4	4401.58	I	4962-27674
2.0	4319.09			4	4402.93	I	
10	4320.12	II	4490-27631	6	4408.88	I	3688-26363
6	4320.58	II	12902-36041	2.0	4410.47	II	
6	d 4327.14			6	4412.56	I	
4	4328.68	II		15	4412.74	II	6168-28824
4	4329.49	II		4	4414.52	I	
2.0	4330.84	I	8111-31195	6	4416.23	II	10572-33209
4	4331.92	II		2.0	4416.84	I	9805-32439
2.0	4333.93	II		2.0	4418.66	II	
2.0	4335.32	I		3.5	4421.54	II	1522-24132
12	4335.70	II	11117-34175	3.5	4422.06	I	
9	4337.28	I	0-23049	4	4427.64	II	
3.5	4338.10	I		2.0	4432.25	I	6362-28918
4	d 4340.89	I		18	4432.96	II	
	4341.02	II		1.6	4436.06	II	10673-33209
6	4342.26	II		2.0	4436.28	II	9238-31773
5	4342.44	I		3.0	4436.55	II	14276-36809
7	4343.94	II	1860-24874	10	4439.12	II	11117-33637
9	4344.32	II	0-23012	3.0	4440.58		
12	4344.60			10	4440.86	II	8460-30972
5	4346.43	I		3.5	4443.07		
3.5	4347.22	II		2.0	4445.01	I	
4	4348.59	I		2.0	4445.89	II	14791-37277
4	4349.07	I	4962-27949	8	4447.83	II	6244-28721
10	h 4350.82	II		1.8	4452.56	I	2869-25322

Thorium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
1.8	4454.51	II	11576-34019	1.6	4551.49	I	
6	4458.00	I	3688-26113	2.5	4552.16	I	8800-30762
6	d 4461.08	II	9401-31811	5	4555.81	I	3865-25809
	4461.24	I	3688-26097	5	4561.36	I	7280-29197
3.0	4461.51			7	4563.28	II	
3.0	4461.72	II		3.0	4563.66	I	8111-30017
16	4465.34	II	8606-30994	1.6	4564.19	II	10673-32577
4	4469.53	I		2.5	4566.66	II	7829-29720
2.5	4472.25			1.6	4567.25	I	
3.0	4474.07	II		5	4570.97	I	
6	4480.82	II	4113-26425	2.0	4573.71	I	
3.0	4482.17	I	4962-27266	1.6	4575.27	II	1522-23373
3.0	4485.78	II	10673-32960	1.6	4575.43	II	14276-36125
1.8	4486.65	II		1.6	4581.20	I	
1.8	4486.90	I	2558-24839	3.0	4581.58	II	
8	4487.50	II	4147-26425	2.5	4584.37	II	12472-34279
10	4488.68	II	1860-24132	2.5	4588.22	II	
3.0	4492.24	II	12472-34727	4	4588.43	I	
12	4493.33	I	0-22249	3.0	4589.12	II	
3.0	4496.32	II		2.5	4589.66	I	
1.7	4497.92	I		4	4592.67	I	
8	4498.96	I	5563-27784	1.5	4593.65	I	
5	4499.99	I		6	4595.42	I	3688-25443
4	4505.22	I	8800-30991	3.5	4602.90	II	7001-28721
1.7	4506.49	I	7502-29686	2.0	4606.52	II	8018-29720
20	4510.53	II	10572-32736	4	4609.38	II	
3.0	4512.50	II	11576-33731	5	4611.87		
4	4513.69	I	9805-31953	2.0	4612.56	II	9585-31259
3.0	4515.12	I	0-22142	8	4619.51	II	
3.0	4515.98	II		2.5	4623.90	II	
1.6	4517.04	II	6691-28824	2.0	4624.14	II	11117-32736
1.6	4518.64	II		2.0	4625.04	II	
1.6	4519.26	I	3688-25809	11	4631.76	II	10189-31773
1.6	4519.75	I		3.5	4633.77	I	
5	h 4521.22	I	2869-24981	5	4639.71	II	12472-34019
1.6	4522.78	II		5	4640.05	II	
3.0	4524.85	II	7001-29095	2.5	4641.23	I	
2.0	4525.10	II	11117-33209	11	4651.56	II	7332-28824
1.4	4529.50	II	12472-34544	2.5	4651.99	II	1522-23012
1.6	4530.32	I		1.8	4663.20	I	2869-24308
5	4531.71	II		5	4666.01	II	
6	4532.26	II		4	4666.79	I	6362-27784
12	4533.29	II	9720-31773	7	4668.17	I	7502-28918
5	4534.12	II	10572-32621	4	h 4669.98	I	
3.0	4535.25	I		6	4673.66	I	
5	4537.08	II	14276-36310	5	4676.06	II	
4	4540.41	II	14791-36809	2.5	4680.65	I	
5	4544.52	II	4490-26489	1.2	4686.19	I	2869-24203
2.5	4545.84	II		8	4689.20	II	6691-28011
	4545.92	I		1.2	4690.64		

Thorium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
3.0	4691.07	II		0.9	4821.29	II	
1.2	4691.64	I	6362-27671	2.0	4822.86	I	
11	4694.09	II	0-21297	1.8	4823.20	II	4147-24874
4	d 4694.90	II	4147-25440	2.5	4823.61	I	6362-27088
	4695.04	I	3688-24981	3.0	4826.71	I	13088-33801
4	4700.14	II	14276-35546	3.5	4831.12	I	3688-24381
1.2	4702.32	II	9712-30972	1.0	4831.60	I	
4	4703.99	I	0-21253	5	4832.80	II	
10	4705.76	II		3.5	4840.48	II	
3.0	4706.25	II	7001-28244	4	4840.84	I	2869-23521
1.2	4708.10	II	11726-32960	3.5	4844.17	II	11117-31754
5	4712.44	II	9238-30453	1.4	4844.57	II	
2.0	4715.43	II	10572-31773	2.5	4848.36	I	3688-24308
5	4718.61	II		3.0	4849.04	II	
3.0	4719.98	II	14276-35456	6	4850.44	II	
2.5	4722.09	I		1.2	4852.86	I	
7	4723.44	II	12472-33637	0.9	4858.09	II	
9	4723.78	I	7502-28666	3.0	4858.33		
4	4724.76	I		1.0	4861.22	I	
2.5	d 4726.32	II	1860-23012	22	4863.17	II	6700-27257
	4726.47						
2.5	4729.11	I		3.5	4865.48	I	13297-33845
3.5	4729.87	II	8379-29515	0.9	4868.27	II	
1.0	4732.66	II		0.9	4868.87	I	
15	4740.53	II	6168-27257	3.0	4872.91	I	6362-26878
				1.0	4874.37	I	
1.0	4741.31	I	6362-27448	4	4877.00	II	
2.0	4742.26	II	10673-31754	2.0	4878.73	I	2558-23049
3.5	4743.68	II	4113-25188	3.5	4894.95	I	0-20424
2.0	4749.19	I		2.5	4898.45	II	
1.6	4749.95	I	8111-29158	1.0	4898.80	II	
11	4752.41	II		2.0	4899.23	I	
3.5	h 4758.12	I		1.4	4911.39	I	
5	4761.11	II		3.0	4912.52	II	4113-24464
3.0	4764.35	I		1.2	4914.12	II	
1.0	4766.60	I	3865-24839	19	4919.82	II	6168-26489
5	4774.27	II	6691-27631	2.0	4920.53	I	
2.0	4777.19	I		5	4921.62	II	9202-29515
2.0	4778.30	I	0-20922	1.4	4922.94	II	
1.0	4779.60			2.0	4924.42	II	4113-24415
1.8	4782.76	II		1.4	4927.78	I	
1.2	4784.04	I		1.4	4929.98	II	
3.0	4789.39	I	3688-24562	1.4	4933.85	I	
1.0	4800.18	II		3.0	4936.77	I	8800-29051
1.6	4803.49	II		3.5	4939.64	I	
0.9	4803.96	II		1.4	4943.07	I	2869-23094
3.5	4808.13	I		1.4	4945.47	I	0-20215
2.0	d 4813.73	I		1.4	4946.67		
	4813.89	I		5	4947.58	I	
3.5	4818.65	II		4	4950.64	II	
1.4	4820.90	II		8	4954.57	II	11576-31754

Thorium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
1.6	4960.46	I		2.0	5140.77	I	6362-25809
2.0	4963.20	II	11117-31259	8	5143.28	II	1860-21297
4	4964.12	II		2.0	5143.92	I	
2.0	4968.76	I		2.0	5145.04	I	
3.5	4970.06	I		10	5148.22	II	
3.0	4972.18	II		4	5151.62	II	12220-31626
3.0	4973.40	II		2.0	5151.87	II	
3.0	4975.96			4	5154.24	I	
1.6	4976.60			7	5158.60	I	2869-22249
1.6	4980.96	I		6	5160.72	I	
2.0	4985.38	I	3688-23741	2.0	5163.46	I	3688-23049
9	4987.15	II		4	5164.98	I	
1.6	4989.31	I	7280-27317	2.0	5170.23	II	11117-30453
2.0	4997.82			4	5176.96	I	
1.6	4999.95	II	14276-34270	3.0	5182.53	II	
4	5002.10	I		3.0	5183.99	II	
1.6	5008.19	II		1.2	5187.46	I	
4	5015.90	II		1.8	5189.68	II	
22	5017.26	II	7332-27257	4	5190.88	II	4113-23373
3.5	5019.34	II		3.5	5193.84	II	0-19248
1.4	5020.55	II		4	h 5195.82	I	4962-24203
11	5028.66	II	10572-30453	4	5198.81		
1.4	5029.63	II		8	5199.16	I	3865-23094
2.0	5039.24	I	2558-22397	2.0	5205.77	II	
3.5	h 5040.15			5	5206.49	II	
4	d 5040.57	I			5206.65	II	
	5040.69	I	3688-23521	4	5211.23	I	3865-23049
4	5044.73	I	0-19817	2.0	5213.35	I	
1.6	5045.25	I	7502-27317	8	5216.58	II	
1.6	5047.05	I	4962-24770	4	5218.52	II	7332-26489
2.0	5047.43	II		3.0	5219.10	I	8111-27266
20	5049.80	II	6691-26489	9	5231.16	I	2558-21669
2.0	5050.80	I	3688-23481	2.0	5232.02		
7	5055.36	II	1522-21297	7	5233.21	II	9720-28824
6	5058.57	II		3.5	5237.90	II	
2.0	5059.86	I	7502-27260	3.5	5240.18	II	
3.5	5061.23	II	14791-34544	8	5247.65	II	0-19051
1.6	5064.61	I	4962-24701	1.6	5253.45	I	
2.0	5066.79	I		3.0	5258.36	I	3865-22878
9	5067.97	I		1.0	5266.70	I	3688-22670
2.0	5075.47	II		6	5277.50	II	10572-29515
2.0	5090.75	II	8606-28244	1.0	5280.08	II	14276-33209
1.8	5094.12			2.5	5297.74	I	8800-27671
3.5	5095.06	II	9202-28824	3.0	5301.40	II	
4	5098.05			1.0	5303.04	II	12902-31754
1.8	5100.62	I	4962-24562	1.0	5304.63	II	14791-33637
2.0	5107.24	II	7829-27403	1.4	5305.57	II	9401-28244
4	5110.86	II		2.5	5307.46	II	
2.5	5115.04	I		3.5	5310.25	II	
3.5	5131.06	II		3.0	5312.00	I	3688-22508



Thorium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
3.0	5312.53	I	5563-24381	1.0	h 5528.00	II	
5	5325.14	II		1.0	5537.12	II	9202-27257
4	5326.98	I	8111-26878	4	5539.26	I	9805-27853
2.0	5329.38	II		6	5539.90	II	9585-27631
5	5343.58	I	3688-22397	1.6	5542.88	I	
2.5	5345.31	II		0.8	5546.10		
1.2	5347.04	II		3.0	5548.18	I	6362-24381
1.2	5351.13	I		2.0	5551.36	II	
3.5	5375.35	II		2.0	5557.04	I	8800-26790
2.0	5375.77	II		1.0	5557.30	II	
1.0	5378.84	I		4	5558.35	I	8111-26097
3.0	5382.93	II		0.6	5559.88	I	3688-21669
1.0	5384.04	I		5	5564.19	II	
3.0	5386.62	I	4962-23521	3.0	5568.00	II	
6	5390.46	II		3.0	5571.20	I	
4	5392.58	II		1.4	5572.47	I	7502-25443
1.0	5394.76	I	3865-22397	3.5	5573.35	I	8111-26049
2.0	5398.91	I	8800-27318	2.0	d 5575.98	I	
2.0	5407.65	I			5576.21	I	
1.8	5410.76	I	6362-24839	3.0	5579.36	I	5563-23481
6	5415.46	II	14276-32736	1.8	5583.76	II	
2.0	5417.49	I	3688-22142	5	5587.03	I	4962-22855
1.6	5421.84	II	7001-25440	2.0	5587.72	II	
1.8	5424.04	I		2.0	5588.87	I	
5	5425.68	II	9585-28011	2.0	5593.62	II	7001-24874
1.0	5431.11	I	6362-24770	2.0	5595.07	I	
0.8	5433.69	II	11117-29515	0.6	5601.60	I	
1.0	5435.12	II		4	5604.51	II	
4	5435.88	II		0.6	5605.28	I	
2.0	5437.38	II		1.0	5610.25	I	7502-25322
3.0	5443.11	I		1.6	5610.67	I	11601-29419
3.5	5449.47	II	14276-32621	1.0	5612.07	I	
2.5	5452.22	I		3.0	5615.32	I	3865-21669
2.0	5461.74	II		2.0	5615.68	II	
2.5	5462.61	II	14276-32577	0.6	5626.73	II	
1.6	5474.86	II		0.6	5630.30	I	
2.0	5484.12	II		6	5639.75	II	1522-19248
2.0	5488.63	II	0-18214	4	5645.88	II	11117-28824
0.6	5495.82	II		1.0	5652.90	II	
0.8	5496.13	I	5563-23753	1.0	5654.01	II	
2.5	5499.26	I	2558-20737	1.0	5657.93	I	
1.0	5501.93	II	6244-24415	1.4	5665.18	I	
1.6	5504.30	I	7280-25443	2.5	5665.62	II	
3.0	5509.99	I	9805-27949	1.2	5674.98	I	11803-29419
1.0	5510.67	II		0.6	5678.97		
1.6	5514.87	I		2.0	5700.45	II	
1.6	5518.99	I		8	5700.69	II	9720-27257
1.0	5521.75	I			5700.90	II	
2.0	5524.22	II		8	5707.10	II	6214-23731
1.0	5524.58	I		1.6	5719.63	I	7502-24981

Thorium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
4	5720.20	I	3688-21165	1.2	6151.99	I	7502-23753
2.5	5725.39	I		5	6169.82	I	4962-21165
2.5	5732.99	II		4	6182.62	I	2869-19039
0.6	5738.29	II	8018-25440	1.0	6184.77	I	13089-29253
1.6	5741.18	II	7001-24415	1.6	6188.12	I	
2.0	5742.09	I		1.0	6191.89	I	6362-22508
0.8	5745.68	II		2.0	6193.86	II	11117-27257
0.8	5748.76	I	6362-23753	0.8	6198.24	I	3688-19817
2.5	5749.40	II	1860-19248	1.0	6200.43	II	
0.8	5753.04	I	4962-22339	1.0	6203.50	I	
6	5760.55	I	0-17355	1.6	6207.22	I	5563-21669
0.8	5763.54	I	2869-20215	1.0	6224.53	I	2869-18930
0.8	5784.86	II		1.0	6232.98	II	9401-25440
1.8	5796.42	II	11576-28824	2.0	h 6234.85	I	6362-22396
3.0	5804.14	I	0-17224	1.0	h 6258.60	II	
1.4	5806.25	II		1.8	6261.06	II	4113-20081
1.6	5815.43	II	1860-19051	1.8	6261.42	I	
0.8	5838.94	II	0-17122	0.9	6266.17	II	8460-24415
0.6	5852.68	I		4	6274.13	II	4147-20081
1.4	5859.67	II		0.9	6277.23	II	6214-22140
1.4	5870.54	II		2.5	6279.16	II	12902-28824
1.2	5885.70	I	9805-26790	1.4	6285.28	II	11726-27631
0.7	5891.45	I		0.9	h 6289.49	II	
3.5	5914.39	II	9585-26489	0.9	6301.41	I	
1.4	5914.68	I	7280-24182	0.9	h 6304.25	II	8606-24464
1.6	5925.89	II		0.6	6326.37	I	
1.4	5938.83	I	5563-22397	1.8	6327.28	I	
0.8	5944.66	I		3.0	6342.86	I	8800-24562
2.5	5973.67	I	3688-20424	0.9	h 6348.57	II	
2.5	5975.06	I	6362-23094	0.6	6358.61	II	
7	5989.07	II	1522-18214	1.2	6369.13	I	
1.2	5991.03	I	6362-23049	3.5	6376.93	I	
2.0	5994.16	I		3.5	bl 6406.2	ThO	
0.6	6001.22	I	8111-24770	1.6	6408.60	II	1522-17122
1.8	6007.07	I	8800-25443	2.5	6411.90	I	7502-23094
0.9	6010.18	I	2869-19503	2.0	6413.61	I	13297-28885
2.5	6015.43	II		1.4	6416.10	II	9401-24982
1.0	6019.00	II	15145-31754	1.2	6424.80	II	
1.4	6021.04	I		5	6457.28	I	
1.4	6037.70	I	3865-20424	4	6462.62	I	
2.0	6044.42	II		0.7	6471.22	II	
1.0	6066.49	II		1.2	6490.74	I	8800-24203
2.5	6073.09	II		1.0	6503.50	II	11117-26489
1.0	6085.26	II	6214-22642	0.6	h 6511.35	II	9061-24415
2.5	6087.25	II		4	h 6531.34	I	6362-21669
2.0	6099.08	II		0.5	6554.16	I	4962-20215
0.9	6102.60	I		1.2	6560.07	II	14276-29515
2.5	6104.57	II	8606-24982	0.8	6569.61	II	
3.5	6112.83	II	1860-18214	0.4	6572.88	II	
2.5	6120.55	II		1.6	6577.65	II	

Thorium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
2.0	6583.91	I		0.8	7021.27	I	
2.0	6588.54	I	3865-19039	1.2	7036.28	I	11601-25809
1.0	6591.48	I	0-15167	5	7045.80	II	
2.0	6593.94	I		2.5	7053.62	II	
2.0	6605.42	II	4113-19248	1.0	7060.66	II	
0.8	6617.06	II	12902-28011	1.0	7064.45	I	
2.0	6619.95	II	4147-19248	1.0	7072.39	I	
1.8	6644.66	II		4	7075.33	II	
0.7	6646.54	II		5	7084.17	I	
0.5	6648.50	II		4	7089.34	II	
0.3	6648.95	I		1.6	7100.52	II	
0.5	h 6658.68	II	9401-24415	1.8	7124.56	I	0-14032
2.5	6662.27	I	7502-22508	0.6	7130.29	I	
0.3	6678.71	I	7280-22249	0.9	7131.36	I	
1.0	6692.71	II	4113-19051	0.8	7140.45	II	
1.0	6704.04	II	8460-23373	0.8	7148.55	I	
1.0	6713.98	I	6362-21253	0.9	7150.28	I	3865-17847
1.0	6719.19	I		1.6	hw 7154.94	I	7280-21253
2.0	6727.46	I	5563-20424	2.5	hs 7155.38		
1.0	6733.76	I		0.8	7156.94	I	4962-18930
0.8	6742.87	I	12848-27674	1.4	hs 7158.56		
2.5	6756.45	I	2558-17355	3.0	hs 7159.10		
0.8	6765.69	I		0.9	7159.93	I	13297-27260
1.2	6770.10	II		1.2	hs 7164.88		
1.0	6772.17	I	15493-30255	5	7168.90	I	
0.8	6778.31	I	3865-18614	1.2	7173.37	I	
0.9	6780.12	I		0.9	7176.72	II	
1.4	6780.41	I	8111-22855	7	7191.14	II	
0.8	6787.73	I		1.2	7200.04	I	7280-21165
0.8	6788.84	I		0.8	7206.48	I	
0.8	6791.23	I	8800-23521	6	7208.01	I	8800-22670
0.7	6804.73	II		1.8	7212.69	I	
1.0	6810.54	II		1.6	7217.75	II	
0.8	6812.77	II		1.8	7218.05	I	9805-23655
1.0	6824.68	I		0.7	7219.15	I	
1.4	6829.04	I	7502-22142	0.8	7230.86	I	
1.8	6834.92	I		0.8	7244.69	I	
0.9	6854.11	I	13089-27674	1.2	7284.90	I	3688-17411
0.7	6868.45	I	13297-27853	0.8	7285.62		
1.0	6874.75	I	2869-17411	1.2	7287.05	I	
2.5	6889.30			1.8	hs 7288.97		
1.4	bl 6894.5	ThO		1.8	7305.40	II	
2.5	6909.85	II		1.2	7324.81	I	
4	6911.23	I		1.2	7328.28	I	7280-20922
6	6943.61	I	9805-24203	1.2	7335.57	II	
1.0	6952.95	II		1.4	7341.15	I	
9	6989.66	I		0.8	7342.58	I	
4	6993.04	II	7001-21297	0.9	7346.34	II	
3.0	7000.80	I		1.0	h 7358.35	II	
1.6	7018.57	I		1.4	7376.88	I	

Thorium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
1.2	7383.71	I		1.8	7941.73	I	
3.0	7385.50	I	3688-17224	1.2 h	7972.59	I	
0.5	7393.44	I		4	7978.97	I	3688-16218
0.9	7402.24	I		0.8	7981.23	II	
3.5	7428.94	I	7280-20737	0.6	7981.68	II	
1.6	7430.25	I	6362-19817	1.8	7987.98	I	
0.7	7447.84	I		1.8	8032.43	I	7502-19948
1.6	7481.35	I		0.6	8054.52	II	
1.2	7511.34	II		1.8	8062.63	I	
8	7525.51	II		0.9	8075.65	I	11803-24182
0.7	7528.48			0.9	8085.22	I	8800-21165
0.8	7536.41	II		0.8	8093.60	I	3865-16218
1.2	7549.31	I	7280-20523	1.2	8122.73	I	
1.2	7566.53			1.8	8138.46	I	5563-17847
3.0	7567.74	I		0.9 h	8139.92	II	
4	7585.73	I		3.0	8143.16	II	14349-26626
0.6	7598.20	II		0.8	8152.40		
1.2	7625.70	I	8800-21910	2.0	8159.75	I	6362-18614
0.8	7627.16	I		1.6	8163.15	II	
0.7 h	7630.30	I		1.2	8166.47	I	
5	7647.38	I		1.2	8169.81	I	7280-19517
1.2	7653.83			2.5	8186.92	I	
0.6	7658.32	I	8111-21165	2.0	8203.21	I	
1.2	7676.22	II		1.2	8217.23	II	
0.6	7678.12	I	7502-20523	0.8	8252.39	I	
3.5	7685.30	II		0.6	8261.02	I	
0.6	7693.80	II		0.8	8263.93		
1.4 h	7701.11	II		3.0	8275.63	I	
0.9	7709.57	II		2.5	8320.86	I	7502-19517
0.6	7710.27	I		5	8330.47	I	7502-19503
1.6	7731.74	II		0.7	8358.72	I	
0.6	7742.57	I		0.7	8369.34	I	
0.5	7743.95	II		1.0	8387.10	II	
1.2	7782.32	I		3.0	8403.79	II	
2.5	7787.80	II		2.5	8416.72	I	
2.5	7788.93	II		0.9	8418.00	I	
0.9	7798.36	I		2.0	8421.22	II	
3.5	7817.77	I		1.4	8445.49	I	8111-19948
1.4	7834.46	II		3.5	8446.51	I	
1.0 d	7840.31	I		0.9	8450.67	II	
	7840.45	I		3.0	8478.37	I	5563-17355
0.9	7841.79	I		0.9	8500.67	I	
2.5	7847.54	I		1.0 h	8516.55	I	
0.6	7848.45	I	8800-21540	0.7	8543.69	I	
0.7	7849.62	II		0.6	8544.58	I	
2.0	7865.97	I		0.6 h	8556.32	I	
1.6 bl	7868.40			0.7	8568.22	II	
1.0	7886.28	I	6362-19039	1.8	8573.14	I	5563-17224
1.2	7897.99	I		0.8 h	8587.64	II	
1.8	7900.32	II	12220-24874	2.0	8591.85	II	

Thorium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
0.6	8639.44	I		2.5	8758.24	I	8800-20215
0.6	8645.31	I	13962-25526	1.4 h	8775.58	I	8111-19503
1.6	8665.50	I	7502-19039	1.4 h	8784.57	II	1522-12902
0.7	8668.11	I	12848-24381	1.4	8816.16	II	4113-15453
0.7	8686.12	II		1.0	8841.16	I	
0.9	8709.24	I	3688-15167	3.0	8842.08	II	4147-15453
0.8	8719.63	I		2.5	8868.81	I	
0.8	8721.67	I		2.5	8957.97	II	
1.4	8732.42	II		7	8967.61	I	8800-19948
3.0	8748.03	I	7502-18930	2.5 bl	8971.96	ThO	
1.0	8749.16	I					

# THULIUM

$$\text{Tm, } Z=69, M=168.94, \text{ Ratio } \frac{\text{Tm}}{\text{Cu}}=2.659$$

Tm I Normal state of valence electrons  $4f^{13} 6s^2 {}^2F_{3/2}^{\circ}=0$ . I. P.  $\approx 50000$  K  
 Tm II Normal state of valence electrons  $4f^{13} 6s^1 {}^3F_4^{\circ}=0$ .

## References

Wavelengths and Spectrum Assignments:  
 W. F. Meggers, unpublished material (1940).

Classification:

Tm I, Tm II, W. F. Meggers, Rev. Mod. Phys. **14**, 96 (1942), and unpublished material (1961).

## Relative intensity of thulium lines observed in an arc of copper containing 0.1 atomic percent of thulium

### *Strong lines of thulium*

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
800	3462. 20	II	0-28875	$4f^{13}6s^1 {}^3F_4^{\circ} - 28875_5$
750	3848. 02	II	0-25980	$4f^{13}6s^1 {}^3F_4^{\circ} - 25980_3$
750	4094. 19	I	0-24418	$4f^{13}6s^2 {}^2F_{3/2}^{\circ} - 24418_{4\frac{1}{2}}$
700	3131. 26	II	0-31927	$4f^{13}6s^1 {}^3F_4^{\circ} - 31927_5$
700	4105. 84	I	0-24349	$4f^{13}6s^2 {}^2F_{3/2}^{\circ} - 24349_{4\frac{1}{2}}$
650	3717. 92	I	0-26889	$4f^{13}6s^2 {}^2F_{3/2}^{\circ} - 26889_{4\frac{1}{2}}$
650	4187. 62	I	0-23873	$4f^{13}6s^2 {}^2F_{3/2}^{\circ} - 23873_{4\frac{1}{2}}$
600	3425. 08	II	237-29425	$4f^{13}6s^1 {}^3F_3^{\circ} - 29425_3$
600	3795. 76	II	237-26575	$4f^{13}6s^1 {}^3F_3^{\circ} - 26575_4$
500	3761. 33	II	0-26579	$4f^{13}6s^1 {}^3F_4^{\circ} - 26579_3$
500	3883. 13	I	0-25745	$4f^{13}6s^2 {}^2F_{3/2}^{\circ} - 25745_{4\frac{1}{2}}$
460	3441. 50	II	237-29286	$4f^{13}6s^1 {}^3F_3^{\circ} - 29286_2$
460	3453. 67	II	237-29183	$4f^{13}6s^1 {}^3F_3^{\circ} - 29183_4$
440	4203. 73	I	0-23782	$4f^{13}6s^2 {}^2F_{3/2}^{\circ} - 23782_{4\frac{1}{2}}$
420	3744. 07	I	0-26701	$4f^{13}6s^2 {}^2F_{3/2}^{\circ} - 26701_{4\frac{1}{2}}$
400	3700. 26	II	237-27254	$4f^{13}6s^1 {}^3F_3^{\circ} - 27254_4$
400	3761. 91	II	0-26575	$4f^{13}6s^1 {}^3F_4^{\circ} - 26575_4$
400	3887. 35	I	0-25717	$4f^{13}6s^2 {}^2F_{3/2}^{\circ} - 25717_{3\frac{1}{2}}$
380	3362. 62	II	237-29967	$4f^{13}6s^1 {}^3F_3^{\circ} - 29967_2$
320	3701. 36	II	0-27009	$4f^{13}6s^1 {}^3F_4^{\circ} - 27009_4$

Thulium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
6	2284.80	II		10	d 2513.77	I	
3.5	2329.78	II			2513.85	II	
7	2331.78	III		2.5	2518.46	II	
7	2338.36	III		11	2519.80	III	
2.5	2340.93	II		22	2520.87	II	
					2520.94	II	
12	2357.05	III		28	2522.16	II	
5	2361.23	III		20	2524.09	II	237-39843
5	2363.93	III		14	2527.03	I	
2.0	2365.95	II		12	2527.42	II	0-39554
7	2367.11	II	237-42470	4	2527.86	II	
8	2383.68	II		2.0	2531.43	II	
6	2388.95	II		13	2542.66	II	237-39554
4	2408.23	II		3.5	2544.02	II	
32	2409.03	II		3.5	2551.51	II	
7	2412.44	II		13	2552.49	III	
5	2419.37	II		40	2552.75	II	
2.5	2420.21	II		60	2561.65	II	
9	2421.64	II		17	2563.86	II	
2.0	2423.28	II		7	2565.98	II	237-39197
40	2426.16	II		4	2568.26	II	
5	2428.42	II		4	2569.34	II	
3.0	2430.75	II		5	2574.56	III	
5	2434.74	II		4	2583.42	II	
4	2436.19	II		48	2588.27	II	
6	2437.66	II		4	2594.97	II	
9	2440.69	II		19	h 2596.49	I	
14	2445.46	II		12	2601.08	I	
4	2445.94	II		24	2606.01	II	0-38361
7	2447.40	II		90	2607.05	II	237-38583
9	2451.20	II		6	2609.46	II	
4	2454.90	II		8	2613.59	II	
9	2458.57	II		4	2615.99	II	
9	2464.94	II		8	2616.31	II	
2.0	2471.36	II		4	2616.99		
9	2476.96	II		4	2620.93	II	
85	2480.13	II	237-40545	8	2622.21	II	237-38361
17	2481.15	II		75	2624.34	II	0-38094
14	2487.52	II		7	2629.78	II	
4	2490.93	II		4	2632.23	II	
28	2491.59	II		6	2637.23	II	
10	2499.20	II		7	2638.41	II	
11	2499.52	II		22	2640.77	II	237-38094
6	2502.69	II		4	2642.83	II	
7	2504.74	III		4	2643.50	II	
3.0	2505.89	II	0-39894	13	2646.45	II	
3.0	2506.45	II		7	2648.14	II	
14	2507.14	II		16	2650.27	II	237-37958
140	2509.08	II	0-39843	3.5	2653.41	II	
5	2511.82	II		19	2658.48	II	237-37841

Thulium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
26	2660.09	II		11	2780.87	II	
5	2664.46	II		36	2785.07	II	237-36132
14	2668.20	II		10	2786.17	II	
4	2674.98	II		5	2787.96	II	
6	2677.12	II		3.0	2791.43	II	
5	2678.09	II		12	2791.62	II	
32	2679.56	II		18	2792.15	II	237-36041
10	2682.31	III		70	2794.60	II	
10	2684.08	II	237-37483	10	h 2796.09	II	0-35754
3.5	d 2686.20	II		75	2797.26	II	
	2686.32	II					
3.5	2689.99	II		6	2797.98	II	237-35966
3.5	2693.47	II		10	2800.40	II	
17	2697.50	II		7	2803.10	II	
4	h 2698.26	III		4	2806.79	III	
				18	2807.98	II	
4	2699.47	III		17	2808.42	II	237-35834
4	2699.82	III		10	2812.26	II	
5	2700.17	II		4	2813.02	II	
4	2701.95	II		3.0	2813.82	II	
8	2707.01	III		14	2814.42	II	
2.0	2708.19	II	237-37151	14	2814.51	II	
10	2709.72	III		3.0	2814.74	II	237-35754
11	2711.51	II	0-36869	4	2816.55	II	
4	2717.55	III		9	2817.31	II	
20	2719.46	III		11	2818.14	II	
55	2721.19	II		26	2818.47	II	
3.0	2721.90	II		7	2819.08	II	
20	2727.55	III		2.5	2820.22	II	
15	2729.04	II	237-36869	4	2823.54	II	
3.5	2730.72	II		6	2824.77	II	
7	2731.42	III		10	2826.43	II	
5	2735.33	II	0-36548	26	2827.02	II	
10	2742.95	II		8	2827.76	II	
20	2744.08	II		60	2827.92	II	
11	2750.77	II		5	2830.15	II	
11	2753.18	II	237-36548	20	2831.55	II	
15	2756.69	II	8770-45034	7	2833.82	II	8770-44047
9	2758.97	II		5	2836.17	II	
4	2759.56	II		4	2838.63	II	
7	2766.81	II	0-36132	16	2838.93	II	
5	2767.09	II		10	2839.10	II	
11	2771.04	II	8957-45034	7	2839.85	II	
9	2773.80	II	0-36041	12	2841.34	II	
7	2774.78	II		4	2842.42	II	
18	2774.98	II		3.0	2842.76	II	
5	2776.69	II		32	2844.66	II	237-35380
12	2777.04	II		6	2845.35	II	
9	2777.50	II		10	2848.86	II	
5	2778.40	II		3.0	2848.98	II	8957-44047
28	2779.55	II	0-35966	3.0	2852.59	II	



Thulium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
3.0	2853.25	II	237-35274	8	2932.96	I	0-34085
9	2854.02	II					
20	2854.16	I					
6	2854.89	II					
20	2860.12	II					
5	2860.36	II	237-35185	3.0	2936.59	II	
7	2860.55	II					
20	2861.74	II					
10	2863.35	II		0-34914			
15	2863.75	II					
3.0	2864.75	I		3.5	2950.08	II	
16	2868.01	II					
160	2869.22	II					
8	2873.00	II					
4	2878.20	II					
6	2878.36	II	237-34871	5	2955.06	II	
1.8	2883.04	II					
14	2886.46	II					
6	2887.96	II					
10	2889.64	II		8770-43366			
3.0	2889.93	II		5	2961.40	II	
3.5	2890.74	II					
65	2890.93	II					
5	2893.60	II					
17	2894.47	II					
13	2903.08	II	8957-43366	16	2973.39	II	
3.0	2904.09	II					
10	2905.41	II					
7	2907.17	II					
6	2908.69	II					
3.0	2910.36	II	0-34308	55	2981.48	II	8957-42470
5	2911.87	II					
13	2913.96	II					
17	2914.83	I		0-34297			
13	2916.52	II					
22	2918.27	II		16	2973.39	II	237-33666
7	2920.98	II					
6	2921.27	II					
7	2922.09	II					
7	2922.83	II					
28	2925.65	II	237-34404	11	2974.29	II	
7	2925.92	II					
70	2926.74	II					
3.0	2927.31	II					
5	2927.65	II					
11	2928.22	II		3.0	2974.60	II	0-33565
3.0	2928.64	II					
5	2930.56	II					
4	2931.09	I					
7	2932.58	II					
				15	2978.42	II	
				3.5	2979.43	II	
				7	2983.13	II	
				7	2985.08	II	
				13	2985.37	II	
				36	2986.52	II	237-33666
				65	2990.54	II	
				3.5	2992.88	II	
				20	2993.26	II	
				12	2993.90	II	
				3.0	2994.33	II	0-33392
				13	2999.60	II	237-33565
				3.5	3001.16	II	
				3.0	3004.17	II	
				6	3006.36	II	
				12	3008.91	II	
				3.0	3009.20	II	
				7	3013.59	II	
				24	3013.71	II	
				44	3014.65	II	
				150	3015.30	II	

Thulium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
7	d 3016.09	II		7	3150.07	II	8770-40506
	3016.18	II		180	3151.04	II	
3.5	3016.79	II		140	3157.35	II	237-31900
28	3017.10	II		7	3162.44	II	
7	3017.26	II		7	3164.87	II	8957-40545
3.0	3018.27	II		18	3168.19	II	
10	3018.59	II		7	3168.82	II	8957-40506
6	3019.79	II		42	3172.66	I	0-31510
3.5	3022.08	II		220	3172.83	II	237-31745
34	3026.06	II		36	3173.58	II	
5	3028.73	II		12	3177.46	II	8770-40232
7	3031.67	II		7	3178.20	II	
7	3034.08	II		14	3180.56	I	0-31432
8	3035.98	II		14	3185.47	II	
26	3042.35	II	237-33097	22	3195.33	II	8770-40056
32	d 3046.76	II	237-33049	12	3196.54	II	8957-40232
	3046.87	I	0-32811	12	3200.00	II	
16	3048.81	II		30	3210.57	II	
30	3050.73	II		30	3210.83	II	0-31136
7	3053.71	II		30	3212.02	II	8770-39894
14	3054.04	II		12	3214.63	II	8957-40056
32	3056.07	II		7	3216.12	II	
7	3058.35	II		7	3226.81	II	
7	3058.98	II		7	3228.90	II	
7	3061.14	II		22	3231.51	II	8957-39894
7	3062.06	II		7	3233.75	I	0-30915
7	3064.01	II		44	3235.45	II	237-31136
5	3068.11	II		110	3236.81	II	8957-39843
55	3073.08	II		150	3240.23	II	
14	3073.49	II		220	3241.53	II	0-30841
7	3073.84	II		12	3245.86	II	237-31037
34	3081.12	I	0-32446	40	3247.46	II	8770-39554
14	3087.01	II		7	3249.83	II	
17	3093.11	II		7	3251.33	II	
11	3096.96	II		15	3251.63	II	
70	3098.60	II	237-32500	180	3258.05	II	0-30684
7	3099.60	II		38	3261.65	II	
5	3101.85	II		30	3264.09	II	
7	3102.87	II		150	3266.63	II	237-30841
5	3113.31	II		110	3267.40	II	8957-39554
14	3122.53	I		75	3268.99	II	
4	3123.29	II		100	3276.81	II	0-30509
7	3124.90	II		110	3283.40	II	237-30684
7	3125.73	II		8	3284.67	II	
14	3126.01	II		110	3285.61	II	8770-39197
700	3131.26	II	0-31927	220	3291.00	II	0-30377
220	3133.89	II	0-31900	190	3302.45	II	237-30509
22	3144.89	II		20	3306.01	II	8957-39197
22	3146.16	II	8770-40545	20	3306.91	II	8770-39001
7	3149.15	II	0-31745	20	3308.01	II	

Thulium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
110	3309.80	II		13	3458.55	I	
60	3310.60	II		13	3461.16	II	8957-37841
8	3316.17	II		800	3462.20	II	0-28875
38	3316.88	II	237-30377	20	3467.51	I	
15	3323.21	II		32	3476.69	I	
8	3327.58	II	8957-39001	32	3480.98	I	
8	3335.06	II		32	3481.75	II	8770-37483
22	3349.99	I	0-29842	16	3487.08	II	
22	3354.86	II		40	3487.38	I	0-28666
380	3362.62	II	237-29967	12	3489.52	I	
12	3368.33	II		5	3491.72	I	
12	3368.60	I		20	3492.58	II	
15	3369.64	II		8	3495.19	II	
8	3372.78	I		32	3499.95	I	0-28564
46	3374.51	II	8957-38583	12	3503.36	I	
5	3380.04	II		24	3513.02	II	
16	3380.53	I		8	3514.12	I	0-28449
40	d 3384.98	II		8	3514.86	I	
	3385.09	I		24	3517.60	I	0-28420
16	3393.19	I		13	3517.72	I	
160	3397.50	II	0-29425	16	3522.43	II	8770-37151
6	3397.87	I		8	3525.03	I	
16	3398.02	II		6	3525.28	I	
40	3399.95	II	8957-38361	24	3534.85	II	
80	3410.05	I	0-29317	160	3535.52	II	
5	3411.57	II		46	3536.21	II	
32	3412.59	I	0-29295	80	3536.58	II	0-28268
32	3416.59	I	0-29260	40	3537.91	I	
16	3421.80	I		5	3542.08	I	
6	3424.50	I		13	3548.48	II	
600	3425.08	II	237-29425	8	3550.16	II	
90	3425.63	II	0-29183	8	3550.83	II	
16	3428.62	II		8	3551.68	I	
32	3429.33	I	0-29152	20	3555.82	I	
80	3429.97	II		8	3556.58	I	
40	3431.20	II	8957-38094	8	3557.34	I	
5	3434.91	II		40	3557.80	II	8770-36869
18	3435.35	I		32	3560.92	I	
8	3437.64	II		40	3563.88	I	0-28051
13	3438.81	II	8770-37841	46	3565.91	II	
460	3441.50	II	237-29286	120	3566.47	II	237-28268
16	3443.00	I		40	3567.36	I	0-28024
8	3444.16	I		12	3569.80	I	
8	3446.55	I		26	3574.06	II	
16	d 3447.26	II	8957-37958	8	3575.29	I	
	3447.35	I					
16	3449.76	II		8	3583.43	I	
8	h 3453.02	I		26	3586.07	I	
460	3453.67	II	237-29183	12	3590.73	I	
5	3456.36	I		16	3598.62	I	
				8	3599.16	II	

Thulium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
12	3607.35	II		6	3802.07	I	
200	3608.77	II	0-27702	50	3807.72	I	0-26255
24	3609.54	II		32	3810.72	II	8770-35004
6	3611.61	II		46	3817.40	II	
8	3612.39	II		5	3821.62	I	
7	3613.03	II		24	3826.38	I	0-26127
15	3619.97	II		110	3838.20	II	8957-35004
2.5	3623.42	II	8957-36548	24	3840.87	I	
7	3624.20	I	0-27584	750	3848.02	II	0-25980
32	3638.41	I	0-27477	5	3853.10	II	
3.0	3639.89	II	237-27702	10	3857.84	II	8957-34871
7	3642.94	I		500	3883.13	I	0-25745
80	3643.66	II		130	3883.44	II	237-25980
15	3646.70	I	0-27414	400	3887.35	I	0-25717
12	3647.23	II		32	3890.53	II	0-25696
20	3647.73	II		32	3896.62	I	0-25656
50	3653.61	II	8770-36132	50	3900.79	II	8770-34398
7	3660.88	II		260	3916.48	I	8771-34297
42	3665.81	II	8770-36041	9	3928.66	II	8957-34404
90	3668.09	II	0-27254	42	3929.58	II	8957-34398
10	3673.14	II		110	3949.28	I	8771-34085
34	3677.98	II		4	3957.42	II	
38	d 3678.86	II	8957-36132	110	3958.10	II	0-25258
	3678.95	II		7	3976.68	I	
12	3683.20	II		32	3995.59	II	237-25258
34	3694.73	II		130	3996.52	II	
	3694.82	II		16	4024.23	I	
7	3697.57	II		6	4034.76	II	
14	3699.87	II		28	4044.47	I	0-24718
400	3700.26	II	237-27254	6	4055.80	I	
320	3701.36	II	0-27009	6	4090.30	II	8957-33399
28	3704.85	II	8770-35754	6	4091.49	II	8957-33392
650	3717.92	I	0-26889	750	4094.19	I	0-24418
6	3719.71	II	8957-35834	700	4105.84	I	0-24349
75	3725.06	II		5	4107.93	I	
10	3730.81	II	8957-35754	9	4132.69	II	
200	3734.12	II	237-27009	80	4138.34	I	0-24157
420	3744.07	I	0-26701	9	4149.14	I	
140	3751.81	I	0-26646	4	4150.11	I	
26	3756.86	II	8770-35380	9	4158.60	I	8771-32811
500	3761.33	II	0-26579	5	4159.55	II	
400	3761.91	II	0-26575	5	4170.45	I	
6	3765.85	II		650	4187.62	I	0-23873
7	3781.15	I	0-26440	38	4199.92	II	0-23803
22	3783.56	II	8957-35380	440	4203.73	I	0-23782
4	3787.01	I		16	4206.00	I	
32	3795.17	II	237-26579	4	4212.79	II	8770-32500
600	3795.76	II	237-26575	28	4222.67	I	8771-32446
65	3798.54	I		7	4236.94	II	
20	3798.75	II	8957-35274	220	4242.15	II	237-23803

Thulium — All Observed Lines

Intensity and Character	Wave-length in A	Spectrum	Energy Levels in K	Intensity and Character	Wave-length in A	Spectrum	Energy Levels in K
4	4246.40	II	8957-32500	2.5	4644.58	I	
5	4268.56	I		9	4655.09	I	
20	4271.71	I	8771-32174	2.5	4666.70	II	
11	4298.37	I		2.5	4671.99	II	
7	4318.40	I		2.5	4675.10	I	
5	4344.48	I		6	4675.32	I	
5	4346.48	I		3.0	4677.86	II	237-21608
4	4351.00	II		12	4681.92	I	
7	4351.18	II	8770-31745	5	4685.12	I	
200	4359.93	I	0-22930	9	4691.11	I	
7	4363.66	II		8	4724.26	I	0-21161
4	4367.89	II		50	4733.34	I	0-21121
100	4386.43	I	0-22791	2.5	4750.75	II	
15	4394.42	I	0-22750	5	4759.90	I	
9	4395.96	I		2.0	4789.92	II	
10	4396.49	I	8771-31510	2.0	4807.48	I	
4	4399.73	I		2.5	4808.68	I	
4	4437.40	II		2.5	4813.50	I	
6	4442.74	I		2.0	4826.99	II	
3.5	4447.59	I		2.0	4828.97	I	
9	4454.04	I		6	4831.20	II	
6	4459.98	I		2.5	4835.76	I	
3.5	4467.98	II		2.0	4851.75	I	
40	4481.27	II	0-22309		4851.90	II	
6	4489.71	II	8770-31037	1.4	4872.28	II	
11	4519.61	I		2.0	4879.20	I	
19	4522.57	II		2.0	4891.59	I	
13	4529.38	II	237-22309	1.8	4909.74	I	
6	4532.15	I		4	4923.83	I	
8	4548.60	I		10	4957.18	I	
3.0	4556.69	II		3.0	4970.87	II	
3.0	4561.86	II	8770-30684	2.0	4971.26	I	
6	4564.69	I		3.0	4975.12	II	
3.0	4567.11	II		3.5	4978.90	I	
7	4596.63	I		3.0	4980.68	II	
20	4599.02	I	0-21738	4	4989.32	II	
2.5	4601.29	II	8957-30684	2.0	4993.78	II	
4	4603.44	II		1.4	4994.72	II	
3.0	4604.86	I		2.5	5001.03	I	
3.5	4613.98	I		2.0	5001.57	I	
3.0	4614.47	II		12	5009.78	II	
22	4615.95	II		2.5	5014.56	II	
2.5	4619.06	II		2.0	5017.88	II	
3.0	4621.72	I		12	5034.24	II	
6	4626.33	II		2.0	5041.00	II	
7	4626.56	II	0-21608	1.6	5043.51	I	
3.0	4626.97	I		2.5	5045.41	I	
8	4634.26	II		2.0	5060.43	II	
3.0	4642.96	II		11	5060.90	I	0-19754
7	4643.12	I	8771-30302	2.0	5062.26	I	

Thulium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
2.0	5065.87	I		38	5675.85	I	0-17614
6	5066.68	I		1.0	5683.60	I	
2.0	5072.43	I		3.0	5684.77	II	
2.0	5076.37	I		1.0	5696.44	II	
2.0	5077.20	I		2.5	5709.98	II	
2.5	5085.10	I		1.6	5715.79	I	
3.0	5107.54	I		1.0	5733.82	II	
7	5113.99	I	0-19549	0.8	h 5737.22	II	
3.5	5114.55	II		1.0	h 5738.93	II	
1.6	5120.68	I		2.0	5758.02	I	
1.6	5140.28	II		4	5760.21	I	8771-26127
3.0	5149.40	II		14	5764.30	I	0-17343
1.4	5182.68	I		0.4	5778.83	II	
3.0	5185.25	I	8771-28051	1.4	5782.36	II	
1.0	5204.52	II		1.6	5784.44	I	
6	5213.38	I		0.8	5799.98	II	
1.6	5228.24	II		1.0	5811.18	II	
1.0	5260.93	II		1.0	h 5816.48	I	
1.8	5267.34	II		2.5	5838.78	II	
3.0	5291.15	I		18	5895.65	I	0-16957
3.0	5294.32	I		2.5	5899.48	I	8771-25717
2.5	5300.21	I		1.8	5901.58	I	
2.5	5302.70	I		0.6	5912.59	I	
4	5305.88	II		0.8	5931.72	I	
48	5307.12	I	0-18837	2.0	5935.90	I	
1.2	5323.00	II		10	5971.28	I	0-16742
2.5	5338.92	I		2.0	5975.03	I	
	5339.03	I		0.8	5984.87	I	
6	5346.50	II		1.4	6025.45	I	
2.0	5373.01	II		0.8	6067.78	II	
1.0	5391.97	II		1.2	6131.54	I	
2.0	5400.46	II		1.0	6175.30	I	
2.0	5402.24	I		1.0	6181.42	II	
1.0	5405.99	II		1.0	6299.45	II	
1.0	5461.96	II		2.0	6352.66	I	
1.0	5464.15	I		1.6	6401.45	I	
1.0	5465.54	II		0.6	6430.95	II	
1.2	5500.32	II		1.0	6440.55	I	
1.0	5526.82	II		15	6460.27	I	
1.8	5528.32	I		1.0	6490.72	I	
1.0	5539.03	II		1.0	6519.79	I	
2.0	5566.01	I		0.6	6575.54	I	
1.6	5581.36	I		7	6604.97	I	
1.0	5586.66	II		0.6	6627.25	I	
1.0	5589.95	II		2.5	6657.73	I	
1.0	5606.64	I		0.8	6658.64	I	
20	5631.40	I	0-17753	1.2	6692.93	I	
3.0	5642.60	I		3.5	6721.37	I	
2.0	5645.40	I		1.0	6726.35		
5	5658.30	I	8771-26440	1.0	6728.01		

Thulium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
2.0	6739.23			11	7481.09	I	
1.0 h	6767.50			11	7490.22	I	
1.0	6777.94			1.4 h	7507.31		
12	6779.77	I		2.0	7545.78		
1.6 h	6782.01	I		20	7558.35	I	
2.0	6788.52	I		2.5 h	7580.61		
1.4 h	6820.27			3.0 h	7593.74		
1.6	6826.96			2.5	7595.07		
1.6	6829.14			0.7	7629.86		
2.5	6831.11			0.7 h	7648.78		
13	6844.28	I		2.5	7655.01		
9	6845.77	I		0.6	7660.32		
2.0	6854.16			1.0 h	7666.25		
0.9	6898.58			1.2	7676.04		
0.9	6915.87			1.2 h	7701.46		
1.4	6937.40			12	7731.54	I	
0.8	6949.55			0.6 h	7778.29		
0.8 h	6976.71			1.8 h	7782.36		
0.7	7010.81			1.2 h	7785.66		
0.9 h	7014.33			2.5	7803.93	I	
1.4	7017.90			0.6	7829.22		
0.9 h	7029.38			6	7856.11	I	
1.8	7034.32			0.5	7861.76		
1.4	7056.44			0.7	7918.10		
0.7	7060.99	I	8771-22930	8	7927.52		
0.9	7079.80			16	7930.88		
1.4	7106.14			0.9	7971.56		
0.7 h	7231.32			1.6 h	7985.94		
0.8	7233.74			2.0 h	8014.79		
0.6	7257.71			14	8017.92	I	
2.5	7272.62			0.5 h	8021.31		
1.2	7284.31			2.0	8194.20		
1.6 h	7286.15			0.8	8294.53		
2.0	7310.51			1.0	8365.74		
1.6	7336.73			1.0	8460.77		
2.0	7432.19			4	8472.02		
0.8	7434.51			1.0 h	8546.09		
0.7	7439.96			1.6	8565.73		

TIN

Sn, Z=50, M=118.70, Ratio  $\frac{Sn}{Cu}=1.868$

Sn I Normal state of valence electrons  $5s^2 5p^2 \ ^3P_0 = 0$ . I.P.= 59232 K  
 Sn II Normal state of valence electrons  $5s^2 5p^1 \ ^2P_{3/2} = 0$ . I.P.=118017 K

References

Wavelengths and Classification:

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Relative intensity of tin lines observed in an arc of copper containing 0.1 atomic percent of tin

Strong lines of tin

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
1400	2839.99	I	3428-38629	$5s^2 5p^2 \ ^3P_2 - 5s^2 5p^1 6s^1 \ ^3P_{3/2}$
1000	2863.33	I	0-34914	$5s^2 5p^2 \ ^3P_0 - 5s^2 5p^1 6s^1 \ ^3P_1$
850	3034.12	I	1692-34641	$5s^2 5p^2 \ ^3P_1 - 5s^2 5p^1 6s^1 \ ^3P_0$
700	2706.51	I	1692-38629	$5s^2 5p^2 \ ^3P_1 - 5s^2 5p^1 6s^1 \ ^3P_{3/2}$
700	3009.14	I	1692-34914	$5s^2 5p^2 \ ^3P_1 - 5s^2 5p^1 6s^1 \ ^3P_1$

Tin — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
11	1970.80	I	1692-52416	110	2483.39	I	3428-43683
8 h	1983.55	I	3428-53826	110	2495.70	I	8613-48670
8	2040.66	I	3428-52416	15	2523.92	I	8613-48222
7	2073.08	I	0-48222	240	2546.55	I	0-39257
10	2091.58	I	1692-49487	100	2571.58	I	8613-47488
2.5 h	2096.39	I	8613-56299	55	2594.42	I	8613-47146
3.0	2100.93	I	3428-51010	140	2661.24	I	1692-39257
12	2113.93	I	1692-48982	700	2706.51	I	1692-38629
2.0	2148.73	I	1692-48216	11	2761.78	I	3428-39626
5	2151.43	I	3428-49894	100	2779.81	I	8613-44576
9	2194.49	I	3428-48982	32	2785.03	I	8613-44509
13	2199.34	I	1692-47146	12	2812.59	I	17163-52707
22	2209.65	I	3428-48670	60	2813.58	I	8613-44145
2.0	2211.05	I	8613-53826	1400	2839.99	I	3428-38629
4	2231.72	I	3428-48222	170	2850.62	I	8613-43683
42	2246.05	I	0-44509	1000	2863.33	I	0-34914
2.0	2251.17	I	8613-53021	24 h	2913.54	I	17163-51475
6	2267.19	I	8613-52707	700	3009.14	I	1692-34914
42	2268.91	I	3428-47488	40	3032.80	I	17163-50126
10	2286.68	I	3428-47146	850	3034.12	I	1692-34641
50	2317.23	I	8613-51754	4	3141.84	I	17163-48982
38	2334.80	I	1692-44509	550	3175.05	I	3428-34914
190	2354.84	I	1692-44145	550	3262.34	I	8613-39257
2.0	2357.90	I	8613-51010	110	3330.62	I	8613-38629
9	2380.72	I	1692-43683	40	3655.78	I	17163-44509
16	2408.15	I	8613-50126	280	3801.02	I	8613-34914
260	2421.70	I	8613-49894	40	4524.74	I	17163-39257
420	2429.49	I	3428-44576	4	5631.71	I	17163-34914
3.0	2433.47	I	3428-44509	0.8 h	8552.60	I	34914-46603
5	2455.24	I	3428-44145				



# TITANIUM

Ti,  $Z=22$ ,  $M=47.90$ , Ratio  $\frac{\text{Ti}}{\text{Cu}}=0.754$

Ti I Normal state of valence electrons  $3d^2 4s^2 {}^3F_2 = 0$ . I.P. = 55138 K  
 Ti II Normal state of valence electrons  $3d^2 4s^1 {}^4F_{1/2} = 0$ . I.P. = 109506 K

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## Relative intensity of titanium lines observed in an arc of copper containing 0.1 atomic percent of titanium

### *Strong lines of titanium*

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
1000	3349.41	II	393-30241	$3d^2 4s^1 a {}^4F_{4/2} - 3d^2 4p^1 z {}^4G_{5/2}$
650	3998.64	I	387-25388	$3d^2 4s^2 a {}^3F_4 - 3d^2 4s^1 4p^1 y {}^3F_4$
600	3361.21	II	225-29968	$3d^2 4s^1 a {}^4F_{3/2} - 3d^2 4p^1 z {}^4G_{4/2}$
600	3361.26	I	170-29912	$3d^2 4s^2 a {}^3F_3 - 3d^2 4s^1 4p^1 w {}^3D_3$
600	3653.50	I	387-27750	$3d^2 4s^2 a {}^3F_4 - 3d^3 4p^1 y {}^3G_3$
550	3234.52	II	393-31301	$3d^2 4s^1 a {}^4F_{4/2} - 3d^2 4p^1 z {}^4F_{5/2}$
550	3642.68	I	170-27615	$3d^2 4s^2 a {}^3F_3 - 3d^3 4p^1 y {}^3G_4$
550	4981.73	I	6843-26911	$3d^3 4s^1 a {}^5F_5 - 3d^3 4p^1 y {}^5G_3$
500	4305.92	I	6843-30060	$3d^3 4s^1 a {}^5F_5 - 3d^3 4p^1 x {}^5D_4$
500	4533.24	I	6843-28896	$3d^3 4s^1 a {}^5F_5 - 3d^3 4p^1 y {}^5F_3$
480	3341.88	{I	0-29915	$3d^2 4s^2 a {}^3F_2 - 3d^2 4s^1 4p^1 x {}^3G_3$
480	3372.80	II	4629-34543	$3d^2 4s^1 a {}^2F_{3/2} - 3d^2 4p^1 z {}^2G_{3/2}$
480	3372.80	II	94-29734	$3d^2 4s^1 a {}^4F_{3/2} - 3d^2 4p^1 z {}^4G_{3/2}$
480	3383.76	II	0-29544	$3d^2 4s^1 a {}^4F_{1/2} - 3d^2 4p^1 z {}^4G_{1/2}$
480	3989.76	I	170-25227	$3d^2 4s^2 a {}^3F_3 - 3d^2 4s^1 4p^1 y {}^3F_3$
440	3236.57	II	225-31114	$3d^2 4s^1 a {}^4F_{3/2} - 3d^2 4p^1 z {}^4F_{3/2}$
440	3752.86	I	387-27026	$3d^2 4s^2 a {}^3F_4 - 3d^3 4p^1 x {}^3F_4$
440	3958.21	I	387-25644	$3d^2 4s^2 a {}^3F_4 - 3d^2 4s^1 4p^1 y {}^3D_3$
440	4991.07	I	6743-26773	$3d^3 4s^1 a {}^5F_4 - 3d^3 4p^1 y {}^5G_3$
400	3635.46	I	0-27499	$3d^2 4s^2 a {}^3F_2 - 3d^3 4p^1 y {}^3G_3$
400	3981.76	I	0-25107	$3d^2 4s^2 a {}^3F_2 - 3d^2 4s^1 4p^1 y {}^3F_2$
380	3948.67	I	0-25318	$3d^2 4s^2 a {}^3F_2 - 3d^2 4s^1 4p^1 y {}^3D_1$
380	3956.34	I	170-25439	$3d^2 4s^2 a {}^3F_3 - 3d^2 4s^1 4p^1 y {}^3D_2$
380	4999.51	I	6661-26657	$3d^3 4s^1 a {}^5F_3 - 3d^3 4p^1 y {}^5G_4$
360	3349.04	II	4898-34748	$3d^2 4s^1 a {}^2F_{3/2} - 3d^2 4p^1 z {}^2G_{3/2}$
360	3371.45	I	387-30039	$3d^2 4s^2 a {}^3F_4 - 3d^2 4s^1 4p^1 x {}^3G_5$

## Titanium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
2.0	2272.61	I	387-44376	8	2661.97	I	0-37555
2.5	2273.28	I	0-43976	9	2669.60	I	170-37618
2.0	2276.70	I	170-44079	12	2679.93	I	387-37690
3.0	2279.96	I	387-44233	2.5	2684.80	I	
3.0	2299.85	I	0-43468	3.0	2685.14	I	387-37618
3.0	2302.73	I	170 43583	6	2688.82	I	
4	2305.67	I	387-43745	2.5	2716.25	II	8744-45549
3.0	2380.81	I	387-42377	8	2725.07	I	8492-45178
1.6	2384.52	I	387-42311	7	2727.42	I	8437-45091
4	2418.36	I	0-41337	2.0	2731.13	I	8602-45206
6	2421.30	I	170-41458	4	2731.58	I	8492-45091
8	2424.24	I	387-41624	16	2733.26	I	8602-45178
3.0	2428.23	I	0-41170	5	2735.29	I	8492-45041
3.0	2433.22	I	170-41255	4	2735.61	I	7255-43800
1.6	2434.10	I	387-41458	8	2739.81	I	8602-45091
3.0	2440.21	II	12629-53597	24	2742.32	I	7255-43710
6	2440.98	I	387-41342	4	2749.06	I	8492-44858
2.5	2450.44	II	12758-53555	6	2757.40	I	8602-44858
2.5	2504.54	I		9	2758.08	I	12118-48365
8	2517.43	II	1087-40798	1.4	2761.29	II	8710-44915
4	2519.04	I	0-39686	24	2802.50	I	7255-42928
15	2520.54	I	0-39662	5	2805.70	I	8602-44233
8	2524.64	II	984-40582	3.0	2806.50	II	9851-45473
38	2525.60	II	1216-40798	4	2809.17	I	8492-44079
3.0	2527.98	I	170-39716	7	2810.30	II	29734-65307
22	2529.85	I	170-39686	3.0	2812.98	I	8437-43976
20	2531.25	II	1087-40582	3.0	2817.40	I	8492-43976
20	2534.62	II	984-40426	6	2817.84	I	8602-44079
14	2535.87	II	908-40330		2817.87	II	29968-65446
20	2541.92	I	387-39716	6	2828.07	I	6557-41907
					2828.15	II	30241-65589
7	2555.99	II	4629-43741	12	2832.16	II	4629-39927
12	2571.03	II	4898-43781	18	2841.94	II	4898-40075
5	2572.65	II		10	2851.10	II	9851-44915
5	2580.82	I		4	2853.93	II	4898-39927
3.5	2590.26	I	170-38765	9	2862.32	II	9976-44902
20	2593.64	I	0-38544	5	2868.74	II	4629-39477
7	2596.58	I	170-38671	17	2877.44	II	8998-43741
28	2599.92	I	0-38451	26	2884.11	II	9118-43781
36	2605.15	I	170-38544	6	2888.93	II	4629-39233
48	2611.28	I	387-38671	5	2891.07	II	4898-39477
7	2611.48	I	170-38451	5	2905.66	I	
28	2619.94	I	387-38544	3.0	2909.92	II	393-34749
16	2631.54	I	170-38160	42	2912.08	I	7255-41585
16	2632.42	I	0-37977	32	2928.34	I	12118-46258
60	2641.10	I	0-37852	17	2933.55	I	0-34079
75	2644.26	I	170-37977	14	2937.32	I	170-34205
90	2646.64	I	387-38160	100	2942.00	I	0-33981
3.0	2649.30	I		120	2948.26	I	170-34079
1.4	2654.93	I	0-37655	3.0	2954.58		
3.5	2657.19	I	0-37623				

Titanium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
150	2956.13	I	387-34205	130	3168.52	II	1216-32767
16	2956.80	I	170-33981	200	3186.45	I	0-31374
2.5	2959.71	I	8492-42270	85	3190.87	II	8744-40075
3.5	2959.99	I	8602-42377	260	3191.99	I	170-31489
16	2965.71	I	8602-42311	4	3197.52	II	225-31491
18	2967.22	I	387-34079	320	3199.92	I	387-31629
2.5	2968.23	I	0-33680	65	3202.54	II	8710-39927
7	2970.38	I	0-33656	4	3203.44	II	0-31207
3.0	2974.93	I	8602-42207	20	3203.83	I	170-31374
16	2983.31	I	170-33680	4	3204.87	I	8492-39686
3.0	3000.87	I	387-33701	9	3213.14	II	94-31207
10	3017.19	II	12775-45909	22	3214.24	I	387-31489
12	3029.73	II	12677-45674	16	3214.75	II	393-31491
9	3046.68	II	9396-42209	90	3217.06	II	225-31301
11	3056.74	II	9364-42069	9	3217.94	I	15877-46944
11	3057.40	II	0-32698	22	3218.27	II	12677-43741
14	3058.09	II	9518-42209	9	3219.21	I	15976-47030
7	3059.74	II	9396-42069	9	3221.38	I	16106-47140
110	d 3066.22	II	94-32698	110	3222.84	II	94-31114
	3066.35	II	0-32603	18	3223.52	I	16268-47281
6	3071.24	II	9518-42069	20	3224.24	II	12775-43781
50	3072.11	II	225-32767	12	3226.13	I	16459-47447
95	3072.97	II	0-32532	44	3228.60	II	8710-39675
130	3075.22	II	94-32603	65	3229.19	II	0-30959
190	3078.64	II	225-32698	44	3229.42	II	9118-40075
300	3088.02	II	393-32767	9	3231.32	II	1087-32026
15	3089.40	II	15266-47625	20	3232.28	II	8998-39927
15	3097.19	II	9931-42209	550	3234.52	II	393-31301
15	3100.67	I	8602-40844	18	3236.12	II	8710-39603
19	3103.80	II	15258-47467	440	3236.57	II	225-31114
19	3105.08	II	9873-42069	340	3239.04	II	94-30959
22	3106.23	II	10025-42209	18	3239.66	II	8744-39603
6	3106.81	I	8492-40671	220	3241.99	II	0-30837
4	3110.67	II	9931-42069	100	3248.60	II	10025-40798
4	3112.48	I	8437-40556	80	3251.91	II	94-30837
12	3117.67	II	9931-41997	100	3252.91	II	225-30959
60	3119.72	I	12118-44163	100	3254.25	II	393-31114
	3119.80	II	10025-42069	100	3261.60	II	15258-45909
16	3123.07	I	7255-39266	26	3271.65	II	10025-40582
20	3130.80	II	94-32026	26	3272.08	II	9873-40426
12	3141.54	I	7255-39078	17	3278.29	II	9931-40426
8	3141.67	I	17215-49036	22	3278.92	II	8744-39233
18	3143.76	II	225-32026	18	3282.33	II	9873-40330
20	3148.04	II	0-31757	44	3287.66	II	15266-45674
20	3152.25	II	984-32698	24	3292.08	I	7255-37623
20	3154.20	II	908-32603	14	3299.41	I	7255-37555
20	3155.67	II	1087-32767	14	3306.88	I	17215-47447
42	3161.20	II	908-32532	18	3308.39	I	8437-38654
65	3161.77	II	984-32603	18	3308.81	II	1087-31301
85	3162.57	II	1087-32698	22	3309.50	I	8492-38700

Titanium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
5	3309.73	I	17075-47281	75	3444.31	II	1216-30241
9	3312.69	I	16961-47140	5	3452.47	II	16516-45473
70	3314.42	I	8602-38765	15	3456.39	II	16625-45549
	3314.52	I	8492-38654	50	3461.50	II	1087-29968
24	3315.32	II	9873-40027	8	3467.26	I	8492-37325
28	3318.02	II	984-31114	50	3477.18	II	984-29734
46	3321.70	II	9931-40027	5	3478.92	I	8437-37173
240	3322.94	II	1216-31301	20	3480.53	I	8602-37325
32	3326.76	II	908-30959	5	3485.69	I	8492-37173
180	3329.46	II	1087-31114	5	3489.74	II	1087-29734
46	3332.11	II	10025-40027	40	3491.05	II	908-29544
150	3335.20	II	984-30959	5	3495.75	I	8492-37091
95	3340.34	II	908-30837	8	3499.10	I	8602-37173
480	3341.88	I	0-29915	75	3504.89	II	15258-43781
		II	4629-34543	10	3506.64	I	387-28896
10	3342.15	I	0-29912	50	3510.84	II	15266-43741
22	3343.77	II	1216-31114	5	3520.25	II	16516-44915
28	3346.73	II	1087-30959	26	3535.41	II	16625-44902
360	3349.04	II	4898-34748	16	3547.03	I	12118-40303
1000	3349.41	II	393-30241	10	3573.74	II	4629-32603
10	3352.94	I	170-29986	5	3574.24	I	18288-46258
340	3354.64	I	170-29971	5	3587.13	II	4898-32767
24	3358.28	I	0-29769	20	3596.05	II	4898-32698
24	3360.99	I	170-29915	16	3598.72	I	7255-35035
600	3361.21	II	225-29968	50	3610.16	I	7255-34947
	3361.26	I	170-29912	16	3624.82	II	9851-37431
10	3361.84	I	170-29907	8	3635.20	I	387-27888
95	3370.44	I	0-29661	400	3635.46	I	0-27499
360	3371.45	I	387-30039	10	3637.97	I	0-27480
12	3372.21	II	4898-34543	16	3641.33	II	9976-37431
480	3372.80	II	94-29734	550	3642.68	I	170-27615
5	3374.35	II	9976-39603	15	3646.20	I	0-27418
240	d 3377.48	I	387-29986	600	3653.50	I	387-27750
	3377.58	I	170-29769	24	3654.59	I	0-27355
24	3379.22	I	387-29971	55	3658.10	I	170-27499
120	3380.28	II	393-29968	10	3659.76	II	12758-40075
14	3382.31	I	8602-38160	32	3660.63	I	170-27480
480	3383.76	II	0-29544	16	3662.24	II	12629-39927
14	3385.66	I	387-29915	32	3668.97	I	170-27418
120	3385.95	I	387-29912	50	3671.67	I	387-27615
120	3387.84	II	225-29734	260	3685.20	II	4898-32026
5	3388.76	II	9976-39477	10	3685.96	I	11532-38654
12	3390.68	I	8492-37977	8	3687.35	I	387-27499
12	3392.71	I	12118-41585	50	3689.91	I	387-27480
95	3394.58	II	94-29544	12	3694.45	I	11640-38700
5	3398.63	I	8437-37852	2.5	3698.18	I	18145-48178
5	3402.42	II	9851-39233	5	3698.43	I	11640-38671
5	3407.20	II	393-29734	5	3700.08	I	
8	3409.81	II	225-29544	10	3702.29	I	8437-35439
5	3439.30	I	11777-40844	16	3704.30	I	11777-38765

## Titanium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
12	3706.23	II	12629-39603	15	3900.96	I	170-25798
4	3707.53	I	16268-43232	220	3904.78	I	7255-32858
24	3709.96	I	8492-35439	9	h 3911.19	I	16459-42019
2.5	3715.40	I		42	3913.46	II	8998-34543
38	3717.40	I	0-26893	42	3914.34	I	387-25927
12	3721.64	II	4629-31491	2.0	3914.74	I	0-25537
28	3722.57	I	170-27026	3.0	3919.82	I	12118-37623
50	3724.57	I	12118-38960	24	3921.42	I	0-25494
32	3725.16	I	8602-35439	90	3924.53	I	170-25644
240	3729.82	I	0-26803	9	3926.32	I	20796-46258
4	3735.67	I		75	3929.88	I	0-25439
5	3738.90	I	15157-41895	3.0	3932.02	II	9118-34543
280	3741.06	I	170-26893	6	3934.24	I	387-25798
28	3741.64	II	12758-39477	90	3947.78	I	170-25494
13	3748.10	I	15108-41781	380	3948.67	I	0-25318
440	3752.86	I	387-27026	380	3956.34	I	170-25439
50	3753.64	I	170-26803	440	3958.21	I	387-25644
12	3757.69	II	12629-39233	80	3962.85	I	0-25227
280	3759.30	II	4898-31491	80	3964.27	I	170-25388
240	3761.32	II	4629-31207	400	3981.76	I	0-25107
4	3761.89	II	20892-47467	48	3982.48	I	0-25103
5	3766.45	I	8492-35035	5	3984.33	I	16961-42053
50	3771.66	I	387-26893	3.0	3985.25	I	
2.5	3776.06	II	12758-39233	5	3985.59	I	
70	3786.04	I	7255-33661	480	3989.76	I	170-25227
10	3789.30	I	11777-38160	3.0	3994.70	I	16875-41901
6	3795.90	I	11640-37977	650	3998.64	I	387-25388
5	3798.31	I	11532-37852	6	3999.36	I	16961-41959
6	3818.22	I	18193-44376	6	4002.49	I	17075-42053
5	3822.03	I	17075-43232	6	4003.81	I	17215-42185
20	3828.19	I	17215-43330	3.0	4005.97	I	16961-41917
8	3833.68	I		6	4008.06	I	17075-42018
8	3836.78	I		80	4008.93	I	170-25107
5	3846.45	I		16	4009.66	I	170-25103
11	3853.05	I	15877-41823	6	4012.39	II	4629-29544
11	3853.73	I	15976-41917	15	4013.58	I	17215-42124
14	3858.14	I	16106-42018	6	4015.38	I	16817-41714
20	3866.44	I	16268-42124	3.0	4016.28	I	17215-42107
14	3868.40	I	15976-41819	10	h 4017.77	I	16875-41757
10	3873.21	I	16106-41917	12	4021.83	I	16961-41819
22	3875.26	I	0-25798	100	4024.57	I	387-25227
		I	16106-41903	3.5	4025.14	II	4898-29734
14	3882.15	I	16268-42019	16	h 4026.54	I	17075-41903
14	3882.33	I	16268-42018	3.5	4027.48	I	
42	3882.89	I	16459-42206	3.5	4028.34	II	15258-40075
5	h 3888.02	I	16106-41819	16	h 4030.51	I	17215-42019
6	3889.95	I	0-25700	3.5	4033.91	I	17424-42207
17	h 3895.25	I	16459-42124	2.5	4034.91	I	17370-42146
7	3898.49	I	0-25644	9	4035.83	I	17540-42311
44	3900.54	II	9118-34748	3.0	h 4040.32	I	17075-41819

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Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
24	4055.02	I	8437-33091	9	4281.38	I	6557-29907
7	4057.62	I	18594-43232	18	4282.71	I	15108-38451
7	4058.14	I	18695-43330	13	4284.99	I	14028-37359
34	4060.26	I	8492-33114	75	4286.01	I	6661-29986
17	4064.22	I	8492-33091	70	4287.40	I	6743-30060
17	4065.10	I	8492-33085	2.5	4288.16	I	6599-29912
70	4078.47	I	8602-33114			I	8492-31806
3.5	4079.72	I	17424-41929	80	4289.07	I	6599-29907
24	4082.46	I	8602-33091	10	4290.23	II	9396-32698
7	4099.17	I	17540-41929	70	4290.94	I	6557-29855
18	4112.71	I	387-24695	10	4291.14	I	
7	4122.17	I	21470-45722	12	4294.12	II	8744-32026
3.5	4123.31	I	22405-46650	70	4295.76	I	6557-29829
7	4123.57	I	21588-48832	170	4298.66	I	6599-29855
11	4127.54	I	21740-45960	17	4299.23	I	14106-37359
3.5	4129.17	I		17	4299.64	I	6661-29912
3.5	4131.25	I	18525-42724	17	4300.05	II	9518-32767
12	4137.29	I	18695-42859	240	4300.56	I	6661-29907
7	4143.05	I	18594-42724	340	4301.09	I	6743-29986
14	4150.96	I	17540-41624	7	4301.93	II	9364-32603
7	4159.64	I	17424-41458	500	4305.92	I	6843-30060
6	4163.65	II	20892-44902	15	4307.90	II	9396-32603
3.0	4164.14	I	15108-39116	3.0	4308.50	I	8602-31806
3.5	4166.32	I	15157-39152	3.5	4311.65	I	17370-40556
7	4169.35	I	15220-39198	7	4312.87	II	9518-32698
10	4171.03	I	17370-41337	7	4314.35	I	6743-29915
3.5	4171.90	II	20952-44915	100	4314.80	I	6743-29912
3.0	4183.30	I	18062-41959			I	6599-29769
30	4186.12	I	12118-36000	30	4318.64	I	18193-41342
3.5	4188.69	I	18062-41929	15	4321.66	I	18037-41170
6	4200.75	I	18145-41944	16	4325.13	I	18141-41255
7	4203.46	I	18145-41929	13	4326.36	I	6661-29769
3.0	4211.73	I	20063-43800	2.5	4334.84	I	6599-29661
3.5	4224.79	I	22405-46068	13	4337.92	II	8710-31756
3.5	4227.65	I	20063-43710	2.0	4344.29	II	8744-31756
11	4237.89	I	20210-43800	6	4346.11	I	18037-41040
7	4249.12	I	18525-42053	3.0	4354.06	I	17424-40385
11	4256.04	I	18695-42185	8	4360.49	I	17540-40467
6	4258.54	I	18483-41959	2.0	4368.94	I	18288-41170
6	4261.60	I	18594-42053	8	4369.68	I	20796-43674
28	4263.13	I	15220-38671	5	4372.38	I	20063-42928
3.0	4265.71	I	15108-38544	2.5	4388.08	I	18062-40844
3.5	4266.22	I	18525-41959	14	4393.92	I	18288-41040
6	4270.14	I	18695-42107	28	4395.04	II	8744-31491
7	4272.43	I	6661-30060	5	4399.77	II	9976-32698
20	4274.58	I	6599-29986	20	4404.28	I	18145-40844
		I	15157-38544	5	4404.90	I	15157-37852
10	4276.43	I	13982-37359	2.5	4405.68	I	8492-31184
10	4278.23	I	20796-44163	5	4416.54	I	15108-37744
2.5	4278.81	I	18594-41959	18	4417.28	I	15220-37852

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Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
5	4417.72	II	9396-32026	85	4518.03	I	6661-28788
10	4421.76	I	18062-40671	8	4518.70	I	11532-33656
10	4422.82	I	8602-31206	85	4522.80	I	6599-28703
2.0	4424.39	I	18288-40883	65	4527.31	I	6557-28639
2.5	4425.83	I	8602-31191	500	4533.24	I	6843-28896
10	4426.06	I	15157-37744	20	4533.97	II	9976-32026
75	4427.10	I	12118-34700	300	4534.78	I	6743-28788
1.8	4430.02	I	19422-41988	200	4535.58	I	6661-28703
7	4430.37	I	11640-34205	100	4535.92	I	6599-28639
4	4431.28	I	17996-40556	100	4536.05	I	6557-28596
2.5	4432.60	I		2.0	4537.23	I	
2.0	4433.58	I	19323-41872	2.0	4539.10	I	
14	4434.00	I	11532-34079	60	4544.69	I	6599-28596
		I	15108-37655	80	4548.77	I	6661-28639
6	4436.59	I	15157-37690	20	4549.63	II	12775-34748
2.5	4438.23	I	18145-40671	80	4552.46	I	6743-28703
11	4440.35	I	15108-37623	2.0	4555.08	I	19422-41369
4	4441.27	I	15108-37618	60	4555.49	I	6843-28788
19	4443.80	II	8710-31207	1.6	4557.86	I	19938-41872
2.0	4444.27	I	18062-40556	1.6	4558.11	I	18912-40844
70	4449.15	I	15220-37690	5	4559.92	I	11777-33701
2.5	4450.49	II	8744-31207	4	4562.63	I	170-22081
46	4450.90	I	15157-37618	3.0	4563.43	I	19574-41481
70	4453.32	I	11532-33981	9	4563.77	II	9851-31756
24	4453.71	I	15108-37555	3.0	4570.91	I	19323-41194
80	4455.33	I	11640-34079	20	4571.98	II	12677-34543
90	4457.43	I	11777-34205	2.0	4589.95	II	9976-31756
1.8	4462.09	I	0-22405	5	4599.23	I	
6	4463.38	I	15157-37555	1.8	4609.37	I	
8	4463.54	I	15220-37618	80	4617.27	I	14106-35758
24	4465.81	I	14028-36415	2.0	4619.52	I	18826-40467
20	4468.50	II	9118-31491	40	4623.09	I	14028-35653
20	4471.24	I	13982-36341	16	4629.34	I	13982-35577
8	4474.85	I	11640-33981	4	d 4634.87		
8	4479.70	I	13982-36298	5	4637.88	I	18912-40467
4	4480.59	I	14028-36341	20	4639.37	I	14028-35577
44	4481.26	I	14106-36415	18	4639.67	I	14106-35653
8	4482.69	I	11777-34079	16	4639.95	I	13982-35528
1.6	4488.32	II	25193-47467	12	4645.19	I	13982-35503
22	4489.09	I	14028-36298	10	4650.02	I	14028-35528
2.0	4492.55	I	16961-39214	2.0	4656.04	I	14106-35577
3.5	4495.01	I		60	4656.47	I	0-21470
20	4496.15	I	14106-36341	70	4667.59	I	170-21588
2.0	4497.73	I	17075-39302	6	4675.12	I	8602-29986
17	4501.27	II	8998-31207	80	4681.92	I	387-21740
3.5	4503.78	I	17215-39413	1.8	4686.92	I	17370-38700
1.8	4506.36	I		2.0	4690.80	I	8602-29915
4	4511.17	I		16	4691.34	I	8602-29912
65	4512.74	I	6743-28896	3.5	4693.68	I	170-21470
1.6	4515.62	I	17075-39214	2.0	4696.94	I	17370-38654

Titanium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
16	4698.76	I	8492-29769	2.0	4958.25	I	7255-27418
10	4710.19	I	8437-29661	5	4964.75	I	15877-36014
2.0	4715.30	I	387-21588	6	4968.58	I	15976-36096
6	4722.62	I	8492-29661	7	4973.05	I	16106-36209
6	4723.17	I	8602-29769	11	4975.35	I	20210-40303
5	4731.17	I	17540-38671	6	4977.74	I	16268-36351
4	4733.43	I	17424-38544	11	4978.20	I	15877-35959
1.6	4734.68	I	18037-39152	550	4981.73	I	6843-26911
2.0	4742.11	I	17370-38451	14	4989.15	I	15976-36014
15	4742.79	I	18037-39116	440	4991.07	I	6743-26773
2.0	4747.68	I	18141-39198	3.0	4995.08	I	18145-38160
28	4758.12	I	18141-39152	13	4997.10	I	0-20006
28	4759.28	I	18193-39198	380	4999.51	I	6661-26657
4	4766.33	I	18141-39116	22	5001.01	I	16106-36096
2.5	4769.77	I	18193-39152	340	5007.21	I	6599-26564
6	4778.26	I	18037-38960	11	5009.65	I	170-20126
4	4781.72	I	6843-27750	22	5013.30	I	16268-36209
10	4792.49	I	18826-39686	300	d 5014.19	I	0-19938
4	4796.22	I	18818-39662		5014.24	I	6557-26494
3.0	4797.98	I	18826-39662	55	5016.17	I	6843-26773
10	4799.80	I	18288-39116	80	5020.03	I	6743-26657
2.5	4805.10	II	16625-37431	80	5022.87	I	6661-26564
10	4805.43	I	18912-39716	55	5024.84	I	6599-26494
4	4808.53	I	24695-45485	28	5025.58	I	16459-36351
2.0	4811.08	I	15220-36000	110	5035.91	I	11777-31629
3.5	4812.25	I	18912-39686	80	5036.47	I	11640-31489
18	4820.42	I	12118-32858	70	5038.40	I	11532-31374
2.0	4825.46	I	18695-39413	110	5039.95	I	170-20006
3.5	4836.13	I	18288-38960	7	5040.62	I	6661-26494
42	4840.87	I	7255-27907	8	5043.59	I	6743-26564
6	4848.47	I	17540-38160	3.5	5044.27	I	17540-37359
26	4856.01	I	18193-38780	5.0	5045.41	I	6843-26657
3.0	4864.18	I	17424-37977	2.5	5048.21	I	17370-37173
18	4868.26	I	18037-38573	10	5052.87	I	17540-37325
22	4870.14	I	18141-38669	2.0	5054.08	I	21588-41369
2.5	4880.91	I	17370-37852	10	5062.11	I	17424-37173
4	4882.35	I	18193-38669	3.5	5064.07	I	21740-41481
36	4885.08	I	15220-35685	130	5064.66	I	387-20126
36	4899.91	I	15157-35560	9	5065.99	I	11640-31374
30	4913.62	I	15108-35454	3.5	h 5068.33	I	21470-41194
5	4915.24	I	15220-35560	6	5069.35	I	17370-37091
12	4919.87	I	17424-37744	12	5071.48	I	11777-31489
17	4921.77	I	17540-37852	4	5085.34	I	11532-31191
5	4925.41	I	15157-35454	12	5087.07	I	11532-31184
3.0	4926.16	I	6599-26893	2.0	5103.15	I	
14	4928.34	I	17370-37655	5	5109.44	I	11640-31206
3.0	4937.74	I	6557-26803	18	5113.44	I	11640-31191
9	4938.29	I	20796-41040	26	5120.42	I	20796-40320
3.0	4941.58	I	17424-37655	3	5129.15	II	15258-34748
2.0	4948.19	I	17540-37744	26	5145.47	I	11777-31206



## Titanium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
22	5147.48	I	0-19422	2.5	5436.73	I	7255-25644
20	5152.20	I	170-19574	1.6	5438.32	I	11532-29915
2.0 bl	5166.86	TiO		4	5446.64	I	18818-37173
100	5173.75	I	0-19323	1.0 bl	5448.34	TiO	
4	5186.34	I	17075-36351	3.0	5448.90	I	18826-37173
8	5188.70	II	12758-32026	2.0	5449.16	I	11640-29986
120	5192.98	I	170-19422	3.5	5453.65	I	11640-29971
8 h	5194.04	I	16961-36209	5	5460.51	I	387-18695
6	5201.10	I	16875-36096	7	5471.21	I	11640-29912
11	5206.08	I	20063-39266	3.5	5472.70	I	11640-29907
7	5207.87	I	16817-36014	4 h	5473.55	I	18826-37091
130	5210.39	I	387-19574	8	5474.23	I	11777-30039
6	5212.29	I		3.0	5474.46	I	18912-37173
14	5219.71	I	170-19323	11 h	5477.71	I	19574-37825
9	5222.69	I	16817-35959	10	5481.43	I	19422-37660
8	5223.64	I	16875-36014	7	5481.87	I	11532-29769
24	5224.32	I	17215-36351	8 h	5488.20	I	19323-37539
9	5224.56	I	16961-36096	14	5490.15	I	11777-29986
18	5224.95	I	17075-36209	2.5	5490.84	I	387-18594
6	5226.56	II	12629-31756	10	5503.90	I	20796-38960
11	5238.58	I	6843-25927	4	5511.78	I	20063-38201
2.0	5246.15	I	20210-39266	32	5512.53	I	11777-29912
5	5246.57	I	6743-25798	26	5514.35	I	11532-29661
7	5247.31	I	16961-36014	30	5514.54	I	11640-29769
2.0	5250.95	I	6661-25700	2.5	5530.49		
10	5252.11	I	387-19422	10	5565.49	I	18037-36000
7	5255.83	I	17075-36096	1.2	5579.16		
5	5259.99	I	22081-41087	2.0 h	5582.98		
5	5263.50	I	17215-36209	3.0 h	5585.68		
14	5265.98	I	15220-34205	6 bl	5597.85	TiO	
4	5282.39	I	8492-27418	5 bl	5629.28	TiO	
13	5283.45	I	15157-34079	1.6	5635.84		
3.5	5284.39	I	8437-27355	24	5644.14	I	18288-36000
2.5	5288.81			7	5648.58	I	20126-37825
6	5295.79	I	8602-27480	2.5 bl	5661.55	TiO	
11	5297.26	I	15108-33981	18	5662.16	I	18695-36351
6	5298.44	I	20210-39078	7	5662.91	I	20006-37660
2.5	5336.81	II	12758-31491	2.0	5673.42	I	25103-42724
1.6	5341.50	I	34947-53663	12	5675.44	I	18594-36209
7	5351.08	I	22405-41087	3.0 h	5679.94	I	19938-37539
2.5	5366.65	I	6599-25227	9	5689.47	I	18525-36096
5	5369.64	I		7	5702.68	I	18483-36014
4	5389.18	I	6557-25107	3.5	5708.23	I	18695-36209
5	5389.99	I	15108-33656	6	5711.88	I	18594-36096
1.6	5396.60	I	170-18695	4 h	5713.92	I	18463-35959
8	5397.09	I	15157-33680	9	5715.13	I	18193-35685
3.5	5404.02	I	18826-37325	5	5716.48	I	18525-36014
10	5409.61	I	15220-33701	3.5	5720.48	I	18483-35959
4	5426.26	I	170-18594	8	5739.51	I	18141-35560
7	5429.15	I	18912-37325	4	5740.02	I	18037-35454

Titanium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
1.8	5741.22	I	20210-37623	1.0	6419.10	I	17540-33114
2.0	5752.84	I	18062-35439	1.6	6497.69	I	11640-27026
1.8	5756.86	I		1.8	6508.14	I	11532-26893
4	h 5762.27	I	26494-43844	5	6546.28	I	11532-26803
5	h 5766.35	I	26564-43902	6	6554.23	I	11640-26893
7	h 5774.05	I	26657-43972	7	6556.07	I	11777-27026
3.0	5780.78	I	18145-35439	1.8	h 6565.62	I	
7	h 5785.98	I	26773-44051	1.6	h 6575.18	I	20796-36000
6	hl 5804.26	I	26911-44135	4	6599.11	I	7255-22405
2.0	bl 5814.96	TiO		2.0	bl 6651.46	TiO	
4	5823.71	I	18288-35454	2.0	h 6666.55	I	11777-26773
2.0	5852.34			2.0	6677.18	I	20063-35035
38	5866.46	I	8602-25644	2.5	b 6691.21	TiO	
6	5880.31	I	8492-25494	3.0	6716.68	I	20063-34947
2.0	h 5888.68			1.8	bl 6723.95	TiO	
22	5899.32	I	8492-25439	9	6743.12	I	7255-22081
5	5903.33	I	8602-25537	2.0	6844.64		
11	5918.55	I	8602-25494	2.0	6860.39		
14	5922.12	I	8437-25318	4	6861.47	I	18288-32858
7	5937.82	I	8602-25439	1.0	6873.92	I	21588-36132
11	5941.76	I	8492-25318	1.4	6913.19	I	21740-36201
28	5953.17	I	15220-32014	1.6	h 6933.15	I	25107-39527
19	5965.84	I	15157-31914	1.6	h 6943.70	I	25388-39786
26	5978.56	I	15108-31830	3.0	6996.63	I	18826-33114
32	5999.04	I	17540-34205	2.0	7004.66	I	18818-33091
6	5999.68	I	18037-34700	1.8	7008.35	I	18826-33091
2.0	6012.73			1.8	7010.94	I	18826-33085
10	6064.63	I	8437-24921	1.8	h 7035.86	I	25318-39527
11	6085.23	I	8492-24921	5	7038.80	I	18912-33114
11	6091.17	I	18288-34700	1.8	7050.65	I	18912-33091
4	6092.81	I	15220-31629	5	bl 7054.51	TiO	
4	h 6098.67	I	24695-41087	3.0	7069.11	I	25644-39786
3.5	h 6121.01	I	15157-31489	3.0	7072.05		
11	6126.22	I	8602-24921	6	bl 7087.89	TiO	
1.8	6138.38	I	17370-33656	4	b 7124.9	TiO	
3.0	6146.22	I	15108-31374	5	bl 7125.61	TiO	
2.0	6149.74	I	17424-33680	3.5	7138.91	I	11640-25644
3.0	bl 6162.23	TiO		3.5	7167.13		
3.5	6186.15	I	17540-33701	3.0	7171.53		
9	h 6215.28	I	21740-37825	7	7189.89	I	20796-34700
7	h 6220.49	I	21588-37660	3.5	b 7203.64	TiO	
6	h 6221.41	I	21470-37539	34	7209.44	I	11777-25644
36	6258.10	I	11640-27615	8	7216.20	I	11640-25494
36	6258.70	I	11777-27750	17	7244.86	I	11640-25439
28	6261.10	I	11532-27499	17	7251.72	I	11532-25318
6	6303.75	I	11640-27499	2.5	7263.40		
5	6312.24	I	11777-27615	2.5	7266.29	I	13982-27740
2.5	6318.03	I	11532-27355	2.5	b 7269.05	TiO	
3.0	6336.10	I	11640-27418	2.0	7315.56	I	17540-31206
3.5	6366.35	I	11777-27480	3.5	7318.39	I	18145-31806

Titanium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
16	7344.72	I	11777-25388	13	8377.85	I	6661-18594
1.4	7352.16	I	20063-33661	13	8382.54	I	6599-18525
12	7357.74	I	11640-25227	7	8382.82	I	6557-18483
8	7364.11	I	11532-25107	10	8396.87	I	6557-18463
3.5	7440.60	I	18193-31629	16	8412.36	I	6599-18483
1.2	7474.94	I	14106-27480	2.5	8416.98	I	18037-29915
3.5	7489.61	I	18141-31489	2.0	8424.41	I	16961-28829
2.5	7496.12	I	18037-31374	22	8426.52	I	6661-18525
1.6	7580.55	I	17996-31184	65	8434.94	I	6843-18695
1.2 bl	7589.62	TiO		32	8435.70	I	6743-18594
2.0	7614.50	I	18062-31191	5	8438.93	I	18193-30039
3.0	7654.44	I	18145-31206	5	8450.89	I	18141-29971
1.4 bl	7705.21	TiO		1.2 h	8457.10	I	14106-25927
4	7949.17	I	12118-24695	2.5 h	8467.15	I	17075-28882
3.5 h	7961.58	I	26657-39214	6	8468.50	I	15220-27026
8	7978.88	I	15220-27750	2.0	8496.04	I	18145-29912
1.2	7979.07	I	26773-39302	2.5 h	8518.05	I	17215-28952
4	7996.53	I	26911-39413	5	8518.32	I	15157-26893
0.9 h	8003.55			1.8	8539.38	I	18062-29769
7	8024.84	I	15157-27615	5	8548.12	I	15108-26803
4	8068.24	I	15108-27499	1.2	8569.77	I	17996-29661
1.0	8267.62			1.2 h	8598.18	I	18288-29915
1.8 h	8306.31	I	27750-39786	12	8675.39	I	8602-20126
1.2 h	8307.41	I	6661-18695	6	8682.99	I	8492-20006
1.2 h	8311.76	I	27499-39527	3.0	8692.33	I	8437-19938
1.0 h	8312.85	I	27615-39641	2.5	8734.69	I	8492-19938
1.6	8334.37	I	6599-18594	3.0	8766.64	I	8602-20006
1.8	8353.15	I	6557-18525	2.0 h	8778.71	I	14106-25494
10	8364.24	I	6743-18695				

TUNGSTEN

$$W, Z=74, M=183.86, \text{Ratio } \frac{W}{Cu}=2.894$$

W I Normal state of valence electrons  $5d^4 6s^2 {}^5D_0 = 0$ . I.P. = 64400 K  
 W II Normal state of valence electrons  $5d^4 6s^1 {}^6D_{0\frac{1}{2}} = 0$ .

References

Wavelengths:

- G. R. Harrison, Massachusetts Institute of Technology Wavelength Tables (John Wiley & Sons, New York, 1939).  
 C. C. Kiess and W. F. Meggers, Sci. Papers BS **16**, 51 (1920).  
 D. D. Laun, unpublished material.

Classification:

- W I, O. Laporte and J. E. Mack, Phys. Rev. **63**, 246 (1943).  
 D. D. Laun, unpublished material (1955).  
 W II, D. D. Laun, J. Research NBS **21**, 207 (1938) and unpublished material (1955).

Relative intensity of tungsten lines observed in an arc of copper containing 0.1 atomic percent of tungsten

*Strong lines of tungsten*

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
950	4008.75	I	2951-27890	$5d^5 6s^1 a {}^7S_3 - 5d^5$ $6p^1 z^1 P_3^{\frac{1}{2}}$
550	4074.36	I	2951-27488	$5d^5 6s^1 a {}^7S_3 - 5d^5$ $6p^1 z^1 P_3^{\frac{1}{2}}$
450	4294.61	I	2951-26230	$5d^5 6s^1 a {}^7S_3 - 5d^5$ $6p^1 z^1 P_3^{\frac{1}{2}}$
320	2724.35	I	2951-39646	$5d^5 6s^1 a {}^7S_3 -$ $39646\frac{3}{2}$
300	2944.40	I	2951-36904	$5d^5 6s^1 a {}^7S_3 -$ $36904\frac{3}{2}$
300	2946.98	I	2951-36874	$5d^5 6s^1 a {}^7S_3 -$ $36874\frac{3}{2}$
280	2551.35	I	0-39183	$5d^4 6s^2 a {}^5D_0 -$ $39183\frac{1}{2}$
260	2681.41	I	2951-40234	$5d^5 6s^1 a {}^7S_3 -$ $40234\frac{3}{2}$
260	2718.90	I	2951-39720	$5d^5 6s^1 a {}^7S_3 -$ $39720\frac{3}{2}$
240	3617.52	I	2951-30587	$5d^5 6s^1 a {}^7S_3 - 5d^4 6s^1 6p^1 z {}^5P_3^{\frac{1}{2}}$
240	4302.11	I	2951-26189	$5d^5 6s^1 a {}^7S_3 - 5d^4 6s^1 6p^1 z {}^7D_3^{\frac{1}{2}}$
200	2656.54	I	2951-40583	$5d^5 6s^1 a {}^7S_3 -$ $40583\frac{3}{2}$
200	2831.38	I	2951-38259	$5d^5 6s^1 a {}^7S_3 -$ $38259\frac{3}{2}$
200	3867.98	I	2951-28797	$5d^5 6s^1 a {}^7S_3 - 5d^4 6s^1 6p^1 z {}^7D_3^{\frac{1}{2}}$
190	2896.45	I	2951-37466	$5d^5 6s^1 a {}^7S_3 -$ $37466\frac{3}{2}$
160	2435.96	I	4830-45869	$5d^4 6s^2 a {}^5D_3 -$ $45869\frac{3}{2}$
160	2481.44	I	6219-46506	$5d^4 6s^2 a {}^5D_4 -$ $46506\frac{3}{2}$
160	3817.48	I	2951-29139	$5d^5 6s^1 a {}^7S_3 - 5d^4 6s^1 6p^1 z {}^6F_3^{\frac{1}{2}}$
150	4269.39	I	2951-26367	$5d^5 6s^1 a {}^7S_3 -$ $26367\frac{3}{2}$
140	2466.85	I	3326-43851	$5d^4 6s^2 a {}^5D_2 -$ $43851\frac{3}{2}$
130	3215.56	I	6219-37309	$5d^4 6s^2 a {}^5D_4 -$ $37309\frac{3}{2}$
120	2474.15	I	6219-46625	$5d^4 6s^2 a {}^5D_4 -$ $46625\frac{3}{2}$
120	2547.14	I	3326-42573	$5d^4 6s^2 a {}^5D_2 -$ $42573\frac{3}{2}$
120	3768.45	I	1670-28199	$5d^4 6s^2 a {}^5D_1 - 5d^4 6s^1 6p^1 z {}^5P_1^{\frac{1}{2}}$
120	3780.77	I	2951-29393	$5d^5 6s^1 a {}^7S_3 - 5d^4 6s^1 6p^1 z {}^5P_2^{\frac{1}{2}}$
120	3835.05	I	3326-29393	$5d^4 6s^2 a {}^5D_2 - 5d^4 6s^1 6p^1 z {}^5P_2^{\frac{1}{2}}$
110	2459.30	I	3326-43975	$5d^4 6s^2 a {}^5D_2 -$ $43975\frac{3}{2}$
110	4102.70	I	6219-30587	$5d^4 6s^2 a {}^5D_4 - 5d^4 6s^1 6p^1 z {}^5P_3^{\frac{1}{2}}$

Tungsten — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
3.0	2001.71	II	3173-53114	1.4	2328.31	II	1519-44455
8	2008.07	II	4716-54499	4	2331.30	I	12162-55043
3.0	2009.98	II	1518-51254	1.6	2331.92	I	
2.5	2010.23	II	3173-52902	1.6	2332.76		
2.5	2014.23	II		3.0	2333.77	II	1519-44355
5	2026.08	II	4716-54057	5	2341.37	I	1670-44367
10	2029.98	II	6147-55393	1.6	2343.13	I	17008-59673
2.0	2035.03	II		1.8	2347.97	I	3326-45902
5	2049.63	II	1519-50292	1.8	2349.26	II	
2.5	2065.57	II	4716-53114		2349.32	I	13307-55859
4	2071.21	II	3173-51438	3.5	d 2350.37	II	
2.5	2075.59	II	8711-56875		2350.46	I	4830-47362
12	2079.11	II	6147-54229	9	2354.61	I	6219-48676
5	2088.19			1.8	2358.07	I	12162-54557
3.0	2089.14	II	4716-52567	1.8	2358.81	II	3173-45554
2.5	2090.48			18	2360.43	I	3326-45678
9	2094.75	II	1519-49242	26	2363.06	I	1670-43975
4	2098.60			1.8	2364.22	II	
3.5	2100.67	II	0-47589	3.5	2365.45	I	0-42262
2.5	2101.54			3.5	2365.85	I	17008-59264
2.5	2106.18	II	1519-48983	3.5	2366.18	I	4830-47079
2.5	2110.34	II	8711-56084	3.0	2366.95	I	9528-51763
4	2118.87	II	0-47180	5	2367.68	I	1670-43893
5	2121.59	II	3173-50292	3.5	2370.88	I	2951-45117
2.5	2153.56	II	6147-52567	1.2	2371.39	I	17107-59264
2.5	2157.80	II	4716-51045	1.8	2374.14	I	6219-48326
5	2166.32	II	4716-50863	18	2374.46	I	4830-46932
2.0	2182.90	I	6219-52015	3.0	2374.76	I	3326-45422
2.0	2194.52	II	0-45554	3.5	2376.07	I	15070-57143
7	2204.48	II	6147-51495	1.8	2376.56	I	17107-59172
4	2248.75	II	0-44455	1.8	2377.03	I	
4	2249.84	I	1670-46105	8	2382.99	I	6219-48171
2.0	2270.24	II	1519-45554	26	2384.82	I	6219-48138
1.0	2271.37	I	3326-47338	3.5	2386.17	I	17008-58904
6	2277.58	I	0-43893	10	2389.07	I	1670-43515
2.0	2284.90	I	1670-45422	5	2390.37	II	7421-49242
4	2285.17	I	6219-49966	5	2392.93	II	4716-46493
8	d 2294.49	I	6219-49789	5	2395.47	I	
	2294.54	II	4716-48285	34	2397.09	II	3173-44877
4	2298.28	I	4830-48326	26	2397.72	I	3326-45019
4	2303.83	II	1519-44912	26	2397.98	I	3326-45015
4	2306.60	I	2951-46292	3.0	2399.04	I	17107-58778
6	2309.04	I	6219-49514	1.6	2401.29	I	6219-47851
8	2313.19	I	0-43217	5	2402.44	I	13778-55389
4	2314.18	I	6219-49418	3.5	2404.24	II	8711-50292
3.5	2315.02	II	3173-46355	2.5	2405.26	I	13349-54912
2.0	2318.94	I	15070-58179	85	d 2405.58	I	1670-43228
9	2321.63	I	3326-46385		2405.69	I	4830-46385
6	2326.09	II	6147-49125	5	2409.03	I	4830-46328
8	d 2326.56	I	6219-49188	3.0	2410.63	I	6219-47689
	2326.71	I	3326-46292				

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Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
3.5	2411.54	II	17437-58892	120	2474.15	I	6219-46625
17	2414.04	I	3326-44737	30	2477.80	II	6147-46493
34	2415.68	I	1670-43054	90	2480.13	I	1670-41979
3.0	2416.23	I	6219-47593	4	2480.65	I	2951-43251
3.0	2419.34	II	20040-61361	40	2480.95	I	1670-41965
3.5	2420.20	I	13778-55084	160	2481.44	I	6219-46506
3.0	2421.01	II	13412-54705	50	d 2482.10	I	2951-43228
8	2422.28	I	3326-44596		2482.21	I	12162-52436
2.5	2422.66	I	6219-47484	3.0	2484.40	II	20040-60279
70	2424.22	I	4830-46068	60	2484.74	I	12162-52395
16	d 2425.98	I	13349-54557	13	2486.30	I	
	2426.07	I	19535-60741	40	2487.49	I	4830-45019
10	2427.29	I	15070-56256	28	2488.77	II	7420-47589
15	2427.49	II	3173-44355	12	2488.91	I	6219-46385
14	2429.39	II		40	2489.23	II	4716-44877
13	2429.84	I	6219-47362	7	2489.72	I	3326-43479
10	2430.44	I	14976-56109	8	2490.84	I	17008-57143
50	2431.08	I	3326-44447	8	2492.93	II	14857-54959
55	2433.98	I	4830-45902	7	2493.39	I	12162-52256
5	2435.01	II	20534-61590	65	2495.26	I	1670-41734
160	2435.96	I	4830-45869	24	2496.64	II	4716-44758
2.5	2436.26	I	2951-43985	5	2496.97	I	17107-57143
22	2436.62	I	3326-44353	10	2497.48	II	6147-46175
2.5	2437.96	I	9528-50534	10	2499.44	I	13349-53346
6	2442.97	I		14	2499.69	II	7420-47413
2.5	2443.33	I	19826-60741	4	d 2500.11	II	
10	2443.62	I	17008-57919	16	2501.78	I	2951-42911
55	2444.06	I	1670-42573		2501.90	II	13412-53370
15	2446.39	II	7421-48285	1.4	2503.04	I	15070-55009
28	2448.39	I	12162-52993	4	2503.96	I	
28	2451.34	I	12162-52943	7	2504.53	I	9528-49444
80	2451.48	II	1519-42298	70	2504.70	I	1670-41583
90	2452.00	I	0-40771	4	2505.38	I	3326-43228
44	2454.71	I	15070-55796	10	2505.65	I	12162-52060
65	2454.97	I	4830-45551	28	2506.03	I	3326-43217
80	2455.50	I	6219-46932	2.5	2508.00	II	
80	2456.53	I	3326-44020	10	2508.44	I	12162-52015
110	2459.30	I	3326-43975	20	2508.74	I	6219-46068
28	2460.16	I	6219-46855	26	2510.16	I	15070-54896
20	2461.57	I	12162-52774	8	2510.47	II	19071-58892
50	2462.79	I	1670-42262	3.0	2512.93		
28	2464.31	I	3326-43893	14	2513.93	I	4830-44596
10	2465.20	I	17008-57561	9	2516.58	I	17107-56832
24	2466.52	II	1519-42049	6	2518.14	II	10593-50292
140	2466.85	I	3326-43851	3.0	2518.50	I	12162-51856
8	2470.80	II	20781-61241	10	2519.88	I	
8	2471.21	I	17107-57561	32	2520.45	I	15070-54733
50	2472.51	I	4830-45263	6	2520.98	I	
10	d 2473.69	I	14976-55389	80	2521.32	I	2951-42601
	2473.82	I	0-40411	28	2522.04	II	4716-44355

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Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
80	2523.41	I	4830-44447	55	2571.44	II	3173-42049
6	2523.59	I		18	d 2572.24	II	20534-59399
8	2524.81	I	13349-52943		2572.35	II	13412-52276
14	2525.68	I		20	2573.53	I	13307-52153
10	2526.42	I	6219-45790	8	2573.95	II	16553-55393
44	2527.77	I		5	2575.46	I	19828-58644
20	2529.72	I	17008-56527	14	2577.02	I	15070-53863
2.5	2530.99	I	2951-42450	20	2579.26	II	
80	2533.63	I	1670-41127	20	2579.40	I	13307-52064
3.0	2533.98	I	15460-54912		2579.54	II	7420-46175
5	2534.68	I		30	2580.33	I	2951-41694
5	2534.82	II	20781-60219	90	2580.49	I	1670-40411
9	2535.10	I	1670-41104	14	2581.06	I	12162-50894
7	2539.31	I	19535-58904	4	2581.20	II	6147-44877
8	2541.69	I	6219-45551	8	2583.22	I	
12	2543.44	I		40	2584.38	I	17008-55691
3.0	2544.17	I		4	2585.22	I	
60	2545.34	I	3326-42601	11	2585.43	I	13349-52015
120	2547.14	I	3326-42573	4	2586.34	I	3326-41979
3.5	2548.15	I	6219-45452	5	2586.64	I	4830-43479
3.5	2548.57	I		12	2586.94	I	12162-50806
5	2549.09	II	3173-42390	10	2587.76	I	2951-41583
4	2550.10	II		40	2589.17	II	6147-44758
80	2550.37	I	1670-40868	18	2591.49	II	0-38576
14	2551.00	I	3326-42514	7	2593.38	I	2951-41499
280	2551.35	I	0-39183	5	2596.34		
3.0	2551.98	I	17107-56280	7	2596.67	I	15460-53959
18	2553.16	I	4830-43985	8	2597.73	I	17008-55492
46	2553.82	I	4830-43975	7	2598.42	I	17701-56175
42	2554.86	II	0-39129	11	2598.74	II	8711-47180
60	2555.09	II	3173-42298	8	2600.74	I	17107-55546
	2555.20	I	3326-42450	38	2601.96	I	4830-43251
4	2556.27	I		8	2602.51	II	
32	2556.74	I	1670-40771	13	2602.80	I	3326-41734
8	2557.56	I	13349-52436	8	2603.02	II	16553-54959
3.0	2558.48	I		28	2603.54	I	4830-43228
30	2560.12	I	15070-54119	15	2604.38	I	17107-55492
3.0	2560.75	I		18	2605.51	I	3326-41694
9	2561.51	I	2951-41979	70	2606.39	I	0-38356
75	2561.96	I	4830-43851	8	2606.90	I	17107-55455
					2606.98	II	8833-47180
24	2563.16	II	17437-56440	33	2607.38	I	1670-40011
11	2563.91	II	11301-50292	38	2608.32	I	6219-44547
15	2564.68	I	17008-55988	5	2610.74	I	
14	2567.50	I	3326-42262	19	2612.19	I	19648-57919
13	2568.21	I	3326-42251				
10	2568.56	I	2951-41872	100	2613.07	I	3326-41583
8	2568.98	I	19648-58563	50	2613.82	I	2951-41198
20	2569.25	I	12162-51072	24	2615.12	I	6219-44447
	2569.30	II	15147-54057	7	2615.44	II	15147-55370
16	2570.09	I	6219-45117	20	2618.81	I	3326-41499

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Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
26	2619.18	I	15070-53238	20	d 2677.79	II	4716-42049
50	2620.23	I	2951-41104		2677.91	I	17701-55033
50	2622.21	I	15070-53194	5	2678.52	I	19826-57149
50	2625.22	I	4830-42911	50	2678.88	I	2951-40269
10	2626.24	I	14976-53042	16	2680.04	I	17008-54310
26	2628.25	I	1670-39707	260	2681.41	I	2951-40234
20	d 2628.89	I		36	2683.34	I	12162-49418
	2629.00	II	13412-51438	10	2687.37	I	18974-56175
50	2632.49	I	12162-50137	26	2691.09	I	4830-41979
50	2632.70	I	2951-40924	5	2692.16	I	18974-56108
100	2633.13	I	1670-39637	80	2695.67	I	3326-40411
36	2636.55	I	2951-40868	16	2697.51	I	2951-40011
50	d 2638.61	I	19256-57143	26	2697.71	II	1519-38576
	2638.75	I	15460-53346	20	2698.84	I	4830-41872
20	2643.12	I	13778-51600	80	2699.59	I	6219-43251
10	2644.60	I	6219-44020	50	2700.01	I	12162-49188
26	2645.69	I	15070-52856	5	2701.48	II	14857-51863
80	2646.19	I	3326-41104	20	2702.11	II	13434-50431
50	2646.74	I	4830-42601	26	2702.52	I	19535-56527
20	2647.10	I	6219-43985	10	2706.01	I	3326-40269
9	2647.74	II		50	2706.58	I	13349-50285
10	2649.98	I	17008-54733	5	2707.02		
20	2652.61	I	16431-54119	8	2707.88	I	19256-56175
5	2653.42	II	16553-54229	5	2708.18	I	16431-53346
10	2653.57	II	4716-42390	50	2708.58	I	15070-51979
16	2654.67	I	15460-53118	50	d 2708.79	I	1670-38576
10	d 2655.55				2708.92	I	4830-41734
	2655.67	II	8711-46355	10	2709.58	II	14968-51863
200	2656.54	I	2951-40583	5	2710.78	II	16235-53114
50	2657.38	I	4830-42450	50	2715.50	I	6219-43034
50	d 2658.04	II	1519-39129	10	2716.32	II	14634-51438
	2658.19	I	19535-57143	10	2717.53	I	14976-51763
10	2660.52	I	19256-56832		2717.61	I	15070-51856
10	2661.56	I	13349-50909	10	2718.04	II	16590-53370
100	2662.84	I	3326-40868	260	2718.90	I	2951-39720
10	2663.94	I	14976-52503	40	2719.33	I	16431-53194
20	2664.32	I	6219-43741	26	2719.86	I	2951-39707
	2664.34	II	17437-54959	20	d 2722.68	I	14976-51694
32	2664.96	I	1670-39183		2722.81	II	15147-51863
20	2665.77	I	6219-43721	320	2724.35	I	2951-39646
9	2666.49	II	7421-44912	26	2724.63	I	6219-42911
26	2669.30	I	13349-50800	50	2725.03	I	3326-40011
5	2669.77	I	3326-40771		2725.06	I	1670-38356
100	2671.47	I	4830-42251	16	2727.95	I	6219-42866
10	2673.59	II		10	2729.62	II	8833-45457
8	2674.70	I		10	2733.18	I	9528-46105
5	2675.13	I	13349-50719	5	2735.97	I	19256-55796
5	2675.40	I	15070-52436	5	2738.00	I	16431-52943
16	2675.87	I	1670-39030	9	2740.79	II	23804-60279
80	2677.28	I	3326-40666	20	2743.42	I	13349-49789



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Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
10	2744.34	I	19828-56256	16	d 2827.15	I	19648-55009
5	2746.21	I			2827.28	I	
10	2746.74	I	15460-51856	32	2829.82	I	13349-48676
80	2748.85	I	4830-41198	5	2830.29	I	12162-47484
20	2753.05			200	2831.38	I	2951-38259
10	2754.92	I	13349-49637	100	2833.63	I	6219-41499
5	2755.26	I	17107-53390	26	2835.64	I	2951-38206
10	2755.94	I	4830-41104	10	2836.25	I	19648-54896
5	2760.03	I	15070-51291	14	2837.34	I	1670-36904
5	d 2760.74	II	19277-55488	5	2837.76	I	18117-53345
	2760.84	I	13307-49517				
10	2761.59	II	8711-44912	5	2838.89	I	15070-50285
50	2762.34	I	0-36190	16	2839.34	I	9528-44737
50	2764.27	II	0-36165	50	2841.57	I	4830-40011
26	2768.98	I	1670-37774	5	2842.56	I	16431-51600
				10	2843.78	I	
50	2769.74	I	4830-40924	20	2847.82	I	3326-38430
100	2770.88	I	2951-39030	100	2848.03	I	2951-38053
26	2773.70	I		20	d 2849.46	I	19828-54912
100	2774.00	I	4830-40868		2849.56	I	13307-48390
100	2774.48	I	6219-42251	16	2850.80	I	15070-50138
20	2776.50	II	14857-50863	5	2852.91	I	
5	2778.69	II	16590-52567	10	2853.49	I	15460-50495
20	2779.72	I	16431-52395	5	2853.84	I	3326-38356
10	2780.28	I	19535-55492	10	2855.35	I	13307-48319
20	2783.12	I	19535-55455	80	2856.03	I	1670-36674
5	2785.88	I	18974-54859	10	2857.13	I	14976-49966
26	2787.98	I	3326-39183	20	2858.04	I	6219-41198
16	2789.07	I	19648-55492	16	2863.01	I	1670-36588
5	2789.68	I	4830-40666	16	2863.88	I	19826-54733
42	2791.95	I	12162-47969	80	2866.06	I	3326-38206
100	2792.70	I	2951-38748	5	2866.37	I	4830-39707
10	2796.15	I	4830-40583	5	2870.90	I	13349-48171
5	2797.20	I	13778-49517	16	2871.37	I	4830-39646
10	2799.03	II	15147-50863	16	2875.21	I	12162-46932
50	2799.92	I	3326-39030	28	2878.72	I	3326-38053
20	d 2801.05	II	13434-49125	75	2879.11	I	2951-37674
	2801.17	I	12162-47851	75	2879.39	I	0-34719
10	2802.95	I	13778-49444	5	2880.63	I	6219-40924
10	2804.01	I	6219-41872	11	2884.18	I	19648-54310
16	2804.24	I	16431-52081	11	2887.66	I	13349-47969
10	2804.67	I	17701-53346	5	2893.12	I	17701-52256
16	2805.63	I	18117-53749	5	2894.25	I	13778-48319
16	2805.92	II	16235-51863	55	2896.01	I	1670-36190
10	2807.72	I	19254-54859	190	2896.45	I	2951-37466
8	2808.57	I		6	2900.52	I	13778-48244
5	2812.25	II	13434-48983	6	2901.78	I	17701-52153
5	2813.13	I	17701-53238	6	2907.26	I	18117-52503
10	2815.45	I	19535-55043	11	d 2908.26	I	16431-50806
100	2818.06	I	6219-41694		2908.40	I	
20	2822.57	II	13412-48831	11	2909.12	I	9528-43893

Tungsten — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
28	2910.48	I	3326-37674	24	3009.08	I	4830-38053
34	2911.00	I	0-34342	44	3013.79	I	4830-38001
11	2915.11	I	14976-49270	65	3016.47	I	6219-39361
11	2915.59	I		95	3017.44	I	2951-36082
6	2917.67	I	18974-53238	13	3024.50	II	11301-44355
44	2918.25	I	6219-40476	26	3024.92	I	1670-34719
6	2918.63	II	11301-45554	38	d 3026.68	I	19826-52856
44	2923.10	I	4830-39030		3026.78	I	13778-46806
28	2923.54	I	2951-37146	20	3033.58	I	12162-45117
28	2925.12	I	15460-49637	20	3034.20	I	19826-52774
11	2926.98	I	17701-51856	20	3039.31	I	
6	2927.93	I	18974-53118	55	d 3041.74	I	15460-48326
11	2928.19	I	3326-37466		3041.87	I	3326-36190
6	2928.66	I	13349-47484	34	3043.81	I	4830-37674
10	2930.15	I	15070-49188	55	3046.45	I	1670-34486
85	2934.99	I	1670-35732	14	3048.66	I	18280-51072
6	2935.62	I	15460-49514	10	3049.00	I	
12	2936.00	I	6219-40269	100	3049.69	I	2951-35732
6	2936.67			7	3054.01	I	9528-42262
12	2937.14	I	19826-53863	14	3064.94	I	3326-35943
17	2939.04	I	6219-40234	22	3073.28	I	6219-38748
6	2941.24	I	13349-47338	14	3077.52	II	
300	2944.40	I	2951-36904	22	d 3084.82	I	17107-49514
300	2946.98	I	2951-36874		3084.91	I	3326-35732
60	2947.38	I	4830-38748		3089.06	I	
26	2952.29	II	14968-48831	12	c 3089.18	I	14976-47338
12	2954.90	I			3089.31	I	2951-35311
12	2960.14	I	13307-47079	8	3090.58	I	19254-51600
55	2964.52	I	2951-36674	46	3093.51	I	4830-37146
12	2966.57	I	17107-50806	8	3105.88	I	19828-52015
6	2967.07	I	17107-50800	30	3107.23	I	3326-35499
6	2967.55	I	15460-49148	30	3108.02	I	2951-35117
10	2969.62	I	13778-47443	8	3111.12	I	15460-47593
18	2971.67	I	1670-35311	28	3117.58	I	13307-45374
18	2972.92	I	12162-45790	32	3120.18	I	6219-38259
12	2976.79	I	13349-46932	20	3133.89	I	13778-45678
60	2977.10	I	19648-53228	16	3141.42	I	12162-43985
	2977.21	I	3326-36904	8	3149.85	II	13173-44912
90	d 2979.72	I		8	3152.96	I	16431-48138
	2979.86	I	3326-36874	8	3155.10	I	18280-49966
18	2982.61	I	19256-52774	12	3159.18	I	13778-45422
12	2984.14	I	6219-39720	36	3163.42	I	15070-46672
19	2990.51	I	4830-38259	16	3164.44	I	13349-44940
6	2990.71	I	6219-39646	16	3165.38	I	18117-49700
50	2993.61	I	6219-39614	8	3167.58	I	
30	2995.26	I	4830-38206	12	3170.20	I	2951-34486
24	2997.79	I	3326-36674	40	3176.59	I	1670-33141
6	3000.24	I	19535-52856	16	3179.06	I	17701-49148
10	3001.98	I	13778-47079	8	3180.74	I	13307-44737
6	3002.82	I	19826-53118	24	3181.81	I	16431-47851

Tungsten — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
16	3184.04	I	18117-49514	20	3477.95	I	
16	3184.42	I	3326-34719	10	3481.82	I	19256-47969
8	3189.24	II	15147-46493	50	3495.25	I	19648-48251
48	3191.57	I	0-31323	20	3508.74	I	3326-31818
48	3198.84	I	4830-36082	20	3510.03	I	2951-31433
65	3207.25	I	2951-34122	10	3521.91	I	13349-41734
17	3208.28	I	3326-34486	20	3526.85	I	13349-41694
130	3215.56	I	6219-37309	20	3535.55	I	13307-41583
17	3221.21	I	18117-49152	20	3537.45	I	15070-43331
17	3221.91	I	3326-34354	80	3545.23	I	0-28199
24	3232.49	I	6219-37146	10	3554.21	I	4830-32958
10	3232.65	I	15460-46385	20	3568.04	I	15460-43479
17	3237.09	I	9528-40411	30	3570.66	I	3326-31323
17	3242.02	I	21449-52285	10	3572.48	II	10593-38576
17	3252.29	I		20	3575.23	I	17008-44971
26	3254.36	I	15070-45789	10	3575.98	I	13778-41734
17	3259.44	I	18117-48788	10	3590.83	I	15070-42911
26	3259.66	I	4830-35499	10	3592.42	II	11301-39129
26	d 3266.62	I		30	3606.07	I	1670-29393
	3266.76	I	19535-50138	10	3607.07	I	19826-47541
18	3281.94	I		10	3613.79	II	14634-42298
18	3293.71	I	12162-42514	240	3617.52	I	2951-30587
90	3300.82	I	4830-35117	20	3622.34	I	19256-46855
55	3311.38	I	2951-33141	16	3627.24	I	13307-40868
9	3316.09	I	1670-31818	40	3631.95	I	1670-29196
9	3320.37	I	9528-39637	30	3641.41	II	8711-36165
55	3326.19	I	6219-36275	10	3646.52	II	14634-42049
55	3331.67	I	2951-32958	10	3651.00	I	17008-44390
9	3345.09	I		10	3657.59	II	8833-36165
9	3345.86	I	13349-43228	12	3663.36	I	16431-43721
18	3354.45	I	4830-34633	10	3667.72	I	18117-45374
9	3363.34	I	6219-35943	10	3668.66	I	19256-46506
19	3371.05	I	4830-34486	12	3674.58	I	19648-46855
10	3371.35	I	1670-31323	20	3675.56	I	12162-39361
48	3373.75	I	3326-32958	10	3679.61	I	15070-42239
10	3388.83	I	21449-50949	80	3682.09	I	6219-33370
10	3391.10	I	15460-44940	50	3683.31	I	18280-45422
10	3391.53	I	15070-44547		3683.39	I	15460-42601
10	3398.10	I	19256-48676	20	3683.94	I	19535-46672
10	h 3408.38	I		10	3684.66	I	19254-46385
19	3412.96	I	4830-34122	70	3688.07	I	19648-46755
19	3413.54	I	2951-32238	10	3699.42	I	19648-46672
19	3422.43	I		10	3702.32	I	14976-41979
19	3427.72	I	13349-42514	10	3703.36	I	
28	3429.60	I	19535-48685	95	3707.93	I	2951-29913
30	3443.01	I	12162-41198	7	3714.24	I	17008-43924
10	3448.83	I	15460-44447	7	3714.86	I	
10	3463.25	I	2951-31818	7	3715.05	I	20428-47338
10	3468.40	I	13778-42601	7	3716.08	II	15147-42049
10	3475.84	I	12162-40924	10	3717.10	I	17701-44596

Tungsten — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
12	3719.40	I	17107-43985	16	3859.29	I	18117-44020
10	3722.25	I	19648-46506	8	3861.06	I	14976-40868
10	3730.43	I	19826-46625	4	3861.24	I	12162-38053
6	3736.22	II	18001-44758	20	3864.34	I	3326-29196
3.5	3739.48	I	18280-45015	7	3866.05	I	13778-39637
14	3741.71	I	14976-41694	200	3867.98	I	2951-28797
9	3742.68	I	22477-49188	28	3872.83	I	3326-29139
8	3749.66			12	3874.41	I	19648-45452
4	3751.43	I	19254-45902	8	3875.68	I	14976-40771
4	3757.09	I	6219-32828	80	3881.39	I	4830-30587
60	3757.92	I	4830-31433	4	3883.83	I	18280-44020
80	3760.13	I	3326-29913	4	3890.74	I	18280-43975
3.0	3761.61	I	18974-45551	12	3892.72	I	13349-39030
8	3764.31	I	19828-46385	15	h 3897.91	I	
8	3767.85	I	19256-45790	4	3901.83	I	18974-44596
120	3768.45	I	1670-28199	4	3903.98	I	29773-55381
14	3769.21	I	14976-41499	8	3905.97	I	19828-45422
14	3769.87	I	15460-41979	8	3918.60	I	12162-37674
8	3772.42	I	20983-47484	4	3924.37	I	20428-45902
40	3773.70	I	13778-40269	4	3924.70	I	18974-44447
9	3778.59	I	19648-46106	4	3926.03	I	15460-40924
9	3778.68	I	18280-44737	7	3930.25	I	19826-45263
120	3780.77	I	2951-29393	9	3930.48	I	14976-40411
6	3783.73	I	19256-45678	4	3930.97	I	18083-43515
4	3786.38	I	17008-43411	16	3935.04	I	13778-39183
20	3792.77	I	13349-39707	4	3936.23	I	18117-43515
10	3794.34	I	15070-41417	13	3936.98	I	18974-44367
4	3796.28	I	19535-45869	4	3937.63	I	19535-44924
8	3801.52	I	13349-39646	4	3939.44		
10	3801.92	I	19256-45551	13	3947.98	I	19648-44971
3.0	3804.08	I	19826-46106	13	3952.52	I	14976-40269
34	3809.23	I	2951-29196	13	3952.90	I	19256-44547
22	3810.38	I	18117-44353	18	3953.16	I	19828-45117
30	3810.80	I	13778-40011	22	3955.31	I	19648-44924
4	3815.78	I		8	3958.88	I	13778-39030
8	3816.39	I	19256-45452	9	3962.33	I	17008-42239
160	3817.48	I	2951-29139	9	3964.99	I	6219-31433
4	3820.11	I	16431-42601	18	3965.14	I	22477-47689
4	3824.15	I	18974-45117	14	3968.59	I	19256-44447
11	3824.39	I	19648-45790	9	3969.20	I	19828-45015
11	3826.19	I	15070-41198	17	h 3970.80	I	
12	3829.13	I	1670-27778	9	3975.46	I	12162-37309
4	3834.04	I	19828-45902	5	3975.89	I	17107-42251
120	3835.05	I	3326-29393	14	3979.29	I	13307-38430
32	3838.50	I	12162-38206	14	3980.64	I	19826-44940
10	3842.30	I	6219-32238	4	3982.87	I	18117-43217
80	3846.21	I	1670-27662	10	3982.96	I	19254-44353
28	3847.49	I	0-25984	28	3983.29	I	19826-44924
3.0	3851.57	II	13173-39129	9	3991.22	I	21449-46497
16	3855.54	I	13778-39707	8	3992.75	I	

Tungsten — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
5	3993.90	I	23047-48078	11	4125.18	I	16431-40666
5	3997.13	I	18974-43985	17	4126.80	I	19254-43479
5	3998.16	I	21454-46458	6	4132.21	I	19828-44020
8	3998.76	I	18974-43975	11	4133.48	I	19535-43721
9	h 4000.69	I		6	4136.35	I	18280-42450
9	4001.37	I	12162-37146	60	4137.46	I	3326-27488
8	4005.40	I	1670-26630	17	4138.02	I	13307-37466
950	4008.75	I	2951-27890	10	4138.30	I	19828-43985
5	4010.38	I	23047-47975	6	4139.32	I	16431-40583
60	4015.22	I	19648-44547	12	4142.26	I	18117-42251
19	h 4016.53	I		15	4145.16	I	13349-37466
24	4019.23	I	3326-28199	12	4145.95	I	12162-36275
14	4022.12	I	19535-44390	6	4149.44	I	19648-43741
20	4028.79	I	9528-34342	18	4154.68	I	19389-43452
5	4035.36	I	15460-40234	6	4160.04	I	20983-45015
20	4036.86	I	19256-44020	5	4160.35	I	22477-46506
15	4039.86	I	18974-43721	10	4168.66	I	18280-42262
5	4040.59	I	19648-44390	18	4170.54	I	18280-42251
5	4043.89	I	19254-43975	50	4171.18	I	4830-28797
15	h 4044.29	I	26230-50949	6	4180.24	I	19826-43741
100	4045.60	I	2951-27662	6	4183.67	I	18083-41979
10	4046.70	I	13349-38053	10	4183.83	I	19826-43721
5	4047.94	I	1670-26367	5	4186.02	I	17701-41583
10	4053.94	I	14976-39637	5	4199.63	I	17107-40912
5	4060.71	I	19828-44447	6	4200.03	I	16431-40234
20	4064.79	I	19256-43851	10	4203.82	I	12162-35943
16	4069.80	I	19826-44390	18	4204.41	I	19256-43034
80	4069.95	I	4830-29393	24	4207.05	I	19648-43411
38	4070.61	I	1670-26230	12	4215.38	I	19535-43251
11	4071.93	I	15460-40011	6	4218.56	I	18280-41979
9	4073.15	I	15070-39614	28	4219.38	I	6219-29913
550	4074.36	I	2951-27488	12	4222.06	I	15070-38748
16	4082.97	I	19256-43741	6	4224.76	I	23930-47593
14	4088.33	I	3326-27778	5	4226.34	I	19256-42911
5	4088.77	I	19535-43985	6	4226.92	I	18083-41734
11	4095.70	I	17008-41417	6	4233.00	I	18117-41734
5	4097.67	I	18117-42514	16	4234.35	I	19256-42866
4	4099.03	I	19535-43924	32	4241.45	I	15460-39030
5	4101.85	I		6	4243.64	I	
110	4102.70	I	6219-30587	60	4244.37	I	6219-29773
6	4108.53	I	18117-42450	6	4249.46	I	13349-36874
16	4109.76	I	13349-37674	6	4258.53	I	17107-40583
6	4110.57	I	18280-42601	32	4259.36	I	21449-44920
11	4111.81	I	1670-25984	6	4259.94	I	17008-40476
6	4115.59	I	15070-39361	22	4260.29	I	18117-41583
17	4118.05	I	18974-43251	22	4263.32	I	23047-46497
11	4118.18	I	13778-38053	6	4266.54	I	23930-47362
11	4120.86	I	15460-39720	150	4269.39	I	2951-26367
6	4122.02	I	18974-43228	12	4269.78	I	18280-41694
6	4123.06	I	15460-39707	6	4273.69	I	22477-45869

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Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
24	4274.55	I	20064-43452	15	4466.35	I	13349-35732
18	4275.49	I	18117-41499	15	4466.73	I	
18	4276.75	I	19535-42911	5	4474.04	I	
12	4282.34	I	19256-42601	5	4481.28	I	
5	4284.96	I	19535-42866	70	4484.19	I	1670-23965
12	4286.01	I	13349-36674	5	4489.02	I	
12	4294.10	I	13307-36588	5	4492.33	I	17107-39361
450	4294.61	I	2951-26230	8	4493.97	I	19254-41499
240	4302.11	I	2951-26189	9	4494.51	I	19256-41499
18	4306.88	I	24763-47975	5	4495.30	I	15070-37309
12	4307.64	I	19826-43034	3.5	4498.47	I	18974-41198
6	4316.81	I		4	4504.17	I	
6	4327.41	I		18	4504.86	I	12162-34354
9	4330.66	I	19826-42911	14	4512.91	I	18117-40269
9	4330.97	I	19828-42911	13	4513.30	I	13349-35499
12	4332.13	I	14976-38053	4	4519.17	I	
5	4345.84	I	18974-41979	4	4529.76	I	22477-44547
11	4347.00	I	19254-42251	4	4530.47	I	12162-34229
5	4347.51	I	19256-42251	7	4534.71	I	19826-41872
6	4348.12	I	20983-43975	9	4535.05	I	19828-41872
17	4355.16	I	12162-35117	7	4536.66	I	21856-43893
11	4361.82	I	6219-29139	4	4542.89	I	15460-37466
17	4364.79	I	3326-26230	17	4543.51	I	21449-43452
11	d 4365.96	I	28393-51291	17	4546.49	I	18280-40269
	4366.07	I	18974-41872	16	4551.85	I	13349-35311
17	4372.53	I	3326-26189	4	4556.87	I	23930-45869
22	4378.49	I	4830-27662	4	4558.97	I	18083-40011
20	4384.86	I	15460-38259	4	4559.11	I	14976-36904
6	4389.84	I	19828-42601	8	4563.59	I	19828-41734
9	4394.08	I	18117-40868	4	4565.32	I	14976-36874
11	4403.95	I		15	4570.66	I	23047-44920
22	4408.28	I	26676-49355	4	4578.34	I	
14	4412.20	I	3326-25984	4	4579.70	I	
5	4415.08	I	18280-40924	7	4586.85	I	9528-31323
5	4418.45	I	20428-43054	19	4588.75	I	26189-47975
10	4420.47	I	19256-41872	8	4592.42	I	19648-41417
9	4423.78	I	22853-45452	6	4592.58	I	13349-35117
5	4425.91	I	18280-40868	15	4599.96	I	24763-46497
18	4436.90	I	20983-43515	3.5	4600.44	I	18280-40011
5	4438.30	I	18974-41499	15	4609.92	I	15460-37146
8	4441.81	I	17107-39614	18	4613.32	I	6219-27890
10	4445.15	I	14976-37466	2.5	4614.86	I	19535-41198
10	4449.01	I	12162-34633	3.5	4620.55	I	19535-41171
5	4450.36	I	22477-44940	3.0	4623.69	I	16431-38053
4	4455.46	I	19256-41694	6	4634.81	I	16431-38001
4	4456.11	I		3.5	4641.80	I	4830-26367
5	4458.09	I	13307-35732	10	4642.56	I	13778-35311
4	4458.30	I	19828-42251	3.5	4643.15	I	20983-42514
15	4460.50	I	13778-36190	3.5	4646.15	I	19254-40771
8	4463.50	I	23930-46328	13	4657.44	I	27890-49355

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Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
65	4659.87	I	0-21454	1.6	4902.97	I	19256-39646
2.5	4661.23	I	22477-43924	2.5	4910.74	I	19256-39614
3.5	4661.97	I	15460-36904	3.0	4916.18	I	14976-35311
4	4668.46	I	15460-36874	4	4931.56	I	15460-35732
5	4676.63	I	19535-40912	3.0	4953.09	I	19828-40011
6	4677.69	I	19826-41198	3.5	4957.37	I	13778-33944
3.0	4679.04	I	18280-39646	1.4	4972.57	I	19256-39361
65	4680.52	I	4830-26189	5	4979.85	I	18280-38356
4	4683.54	I	19826-41171	20	4982.60	I	0-20064
10	4693.73	I	26676-47975	3.0	4983.54	I	
3.0	4698.63	I	19828-41104	2.0	4984.72	I	18974-39030
5	4700.41	I	6219-27488	6	4986.94	I	15070-35117
3.0	4702.47	I	18974-40234	2.0	4989.09	I	
2.0	4706.17	I	16431-37674	1.4	4994.10	I	
2.5	4710.34	I		1.4	4995.32	I	22853-42866
2.5	4711.19	I	19256-40476	1.4	5002.80	I	20428-40411
4	4712.49	I	14976-36190	30	5006.16	I	6219-26189
2.5	4716.86	I	17008-38203	20	5015.32	I	4830-24763
2.5	4718.63	I	23930-45117	5	5040.36	I	13307-33141
2.5	4720.40	I	13307-34486	2.0	5052.23	I	20983-40771
5	4725.14	I	19254-40411	75	5053.30	I	1670-21454
8	4729.65	I	13349-34486	19	5054.61	I	1670-21449
2.0	4745.57	I	18117-39183	2.5	5055.53	I	22477-42251
3.0	4752.21	I	18974-40011	19	5069.15	I	3326-23047
3.0	4752.58	I	13307-34342	11	5071.73	I	
2.0	4753.39	I		3.5	5110.36	I	15070-34633
14	4757.55	I	2951-23965	3.5	5124.24	I	14976-34486
2.5	4757.78	I	15070-36082	3.0	5130.11	I	23965-43452
2.0	4758.21	I	23930-44940	3.5	5138.40	I	28233-47689
1.8	4767.78	I		4	5145.77	I	20983-40411
3.5	4773.91	I	13778-34719	1.6	5153.53	I	
1.6	4780.52	I		3.0	5183.97	I	18974-38259
2.5	4787.94	I	13349-34229	4	5192.72	I	14976-34229
2.0	4788.43	I	16431-37309	2.0	5195.63	I	25984-45225
2.5	4797.55	I	19828-40666	4	5203.26	I	19535-38748
8	4799.92	I	19648-40476	5	5204.51	I	20428-39637
5	4807.37	I	12162-32958	5	5206.19	I	19828-39030
2.0	4816.11	I	19254-40011	4	5212.79	I	28797-47975
2.0	4816.82	I	28600-49355	70	5224.67	I	4830-23965
2.5	4835.02	I	20428-41104	3.0	5233.54	I	19254-38356
80	4843.83	I	3326-23965	7	5242.99	I	16431-35499
4	4854.09	I	13349-33944	3.0	5254.54	I	15460-34486
2.5	4863.08	I	22477-43034	4	5255.42	I	22477-41499
2.5	4878.28	I	18083-38576	6	5259.36	I	27488-46497
38	4886.91	I	6219-26676	1.2	5263.21	I	
1.6	4888.39	I	13778-34229	4	5275.55	I	19256-38206
1.6	4890.29	I	16431-36874	2.5	5318.87	I	27662-46458
1.6	4890.89	I	20428-40868	2.5	5337.37	I	26189-44920
3.0	4892.44	I	22477-42911	4	5348.95	I	26230-44920
3.0	4902.32	I	19254-39646	3.0	5350.44	I	29393-48078

Tungsten — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
2.0	5351.90	I	27778-46458	1.4	5676.93	I	17701-35311
2.0	5354.46	I	9528-28199	1.4	5697.82	I	13778-31323
1.2	5355.26	I	19535-38203	0.6	5723.06	I	25984-43452
1.2	5357.12	I	15460-34122	5	5735.09	I	27488-44920
1.2	5368.70	I	28233-46855	0.5	5739.60	I	32238-49656
2.0	5374.16	I	20428-39030	0.6	5747.26	I	30683-48078
2.0	5388.02	I	19648-38203	1.2	5749.22	I	30587-47975
1.4	5397.97	I	19254-37774	0.5	5754.57		
1.0	5419.40	I	22477-40924	1.0	5756.09	I	15460-32828
0.6	5422.89	I	22477-40912	0.6	5759.65	I	29139-46497
0.6	5423.93	I	19828-38259	1.2	5793.07	I	27662-44920
5	5435.06	I	1670-20064	1.2	5796.51	I	17107-34354
1.0	5435.61	I	17107-35499	0.4	5799.53	I	13349-30587
0.8	5440.08	I	19826-38203	4	5804.87	I	26230-43452
2.0	5456.59	I	23930-42251	1.2	d 5806.07	I	18280-35499
					5806.27	I	28233-45452
0.6	5457.94			0.6	5822.60	I	22477-39646
1.0	5475.11	I	28199-46458	1.2	5833.59	I	22477-39614
3.5	5477.80	I	9528-27778	1.2	5838.99	I	17107-34229
1.4	5486.01	I	31433-49656	1.6	5845.26	I	29393-46497
0.9	5487.78	I	4830-23047				
6	5492.32	I	29773-47975	2.6	5851.56	I	26367-43452
0.9	5496.24	I	22477-40666	1.0	5856.62	I	20983-38053
2.5	5500.51	I	19826-38001	2.0	5864.63	I	19828-36874
2.5	5503.45	I	14976-33141	1.0	5874.23	I	19256-36275
0.9	5508.63	I	20428-38576	0.8	5875.66	I	17107-34122
20	5514.70	I	3326-21454	1.2	5880.22	I	34122-51123
0.8	5521.01	I	18083-36190	1.2	5891.61	I	18974-35943
1.4	5531.38	I	18117-36190	1.2	5901.23		
1.4	5537.74	I	19256-37309	3.5	5902.66	I	19254-36190
0.8	5539.49	I	20983-39030	1.2	5928.58		
1.2	5568.07			5	5947.58	I	13778-30587
0.6	5576.34	I	20428-38356	1.2	5953.97	I	20983-37774
1.2	5604.33	I	31818-49656	1.2	5956.18	I	17701-34486
0.8	5616.19			2.5	5960.82		
0.8	5617.08	I	17701-35499	5	5965.86	I	18974-35732
0.5	5624.58	I	19535-37309	2.5	5972.52	I	3326-20064
0.8	5629.65	I	15070-32828	1.8	5978.89	I	28199-44920
1.0	5631.26	I	33370-51123	1.8	5983.84	I	28233-44940
2.5	5631.97	I	12162-29913	1.2	6009.04	I	18083-34719
0.5	5635.50			5	6012.81	I	19648-36275
0.7	5642.04	I	1670-19389	3.5	6021.54	I	18117-34719
0.4	5644.48			1.8	6028.35	I	29913-46497
6	5648.38	I	18974-36674	1.8	6043.33	I	31433-47975
0.7	5660.07	I	18280-35943	1.2	6049.92	I	18974-35499
3	5660.75	I	19648-37309	1.2	6065.09	I	20983-37466
0.7	5664.34	I	18083-35732	2.0	6081.48	I	18280-34719
0.7	5673.56	I	19254-36874	1.2	6111.68	I	15460-31818
2.5	5674.42	I	19256-36874	1.2	6115.55	I	14976-31323
0.6	5675.38	I	18117-35732	2.0	6128.27	I	28233-44547
1.2	5676.61	I	12162-29773	1.2	6143.94	I	22477-38748



Tungsten — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
1.8	6153.73	I	19254-35499	1.4	7296.58	I	19256-32958
1.8	6154.86	I	17701-33944	0.3	7298.23		
1.8	6203.51	I	19828-35943	0.6	7385.08	I	18280-31818
1.8	6254.29	I	33370-49355	0.4	7451.40		
2.5	6285.90	I	19828-35732	0.3	7456.34		
4	6292.03	I	13307-29196	0.7	7483.35	I	20983-34342
1.8	6303.24	I	19256-35117	0.6	7504.16	I	13307-26630
1.2	6386.47			0.9	7508.99	I	19828-33141
3.0	6404.20	I	14976-30587	0.3	7520.66	I	19535-32828
3.5	6445.13	I	18974-34486	0.8	7537.43	I	18974-32238
1.0	6508.02	I	13778-29139	0.8	7550.46	I	18083-31323
1.4	6532.42	I	20428-35732	1.6	7569.91	I	18117-31323
1.2	6538.14	I	19826-35117	0.5	7582.88	I	28233-41417
1.2	6563.22	I	19254-34486	0.3	7612.13		
1.8	6573.95	I	20983-36190	1.6	7614.11	I	19828-32958
1.0	6607.15	I	17107-32238	0.3	7631.29		
1.0	6609.04	I	15460-30587	0.3	7654.78		
1.6	6611.64	I	32958-48078	1.2	7688.94	I	19826-32828
1.0	6621.68	I	19256-34354	0.4	7701.00	I	19256-32238
1.2	6678.41	I	18974-33944	0.5	7761.14	I	13349-26230
1.4	6693.12	I	14976-29913	0.3	7776.71		
0.5	6746.56	I	23930-38748	1.0	7784.12	I	18974-31818
0.5	6764.43	I		0.6	7808.94	I	14976-27778
0.6	6805.28	I	19254-33944	0.2	7823.78		
0.8	6814.95	I	22477-37146	0.4	7863.46	I	20428-33141
0.8	6820.28	I	19828-34486	0.2	7867.03	I	16431-29139
0.7	6828.42	I	31818-46458	0.4	7880.34	I	14976-27662
0.4	6853.73	I	19535-34122	0.5	7886.47	I	13307-25984
0.4	6876.02	I	35117-49656	0.8	7940.93	I	13778-26367
0.5	6908.29	I	13307-27778	0.3	7957.06	I	19254-31818
0.8	6934.27	I	14976-29393	2.0	8017.18	I	18117-30587
0.7	6964.12	I	13307-27662	0.6	8054.86	I	13778-26189
1.2	6984.30	I	13349-27662	2.0	8055.60	I	19828-32238
0.7	6993.26	I	19826-34122	0.5	8060.36	I	18280-30683
0.4	6994.08	I	19828-34122	1.2	8123.79	I	18280-30587
0.7	7017.91			0.5	8143.12		
0.3	7028.68			0.3	8165.70	I	28233-40476
0.3	7098.22	I	44547-58631	0.5	8210.20	I	19256-31433
0.4	h 7111.18	I	20428-34486	0.4	8322.00	I	23930-35943
1.4	7140.54	I	13778-27778	0.9	8338.01	I	19828-31818
0.8	7162.66	I	18280-32238	0.4	8348.76	I	20983-32958
0.5	h 7191.37	I	31323-45225	0.6	8358.67		
0.5	7198.62	I	19254-33141	0.3	8382.87	I	9528-21454
1.0	7200.18	I	13778-27662	0.4	8402.55	I	19535-31433
0.5	7216.31	I	18974-32828	0.4	8475.16	I	18117-29913
0.4	7226.05	I	19535-33370	2.5	8585.06	I	22477-34122
0.7	7237.08	I	37309-51123	0.9	8594.37	I	18280-29913
0.5	7274.49			0.7	8613.26	I	19826-31433
0.9	7278.23	I	15460-29196	0.3	8614.48	I	19828-31433
1.4	7285.80	I	19648-33370	1.2	8865.50	I	18117-29393

# URANIUM

$$U, Z=92, M=238.07, \text{Ratio } \frac{U}{Cu}=3.747$$

U I Normal state of valence electrons  $5f^3 6d^1 7s^2 {}^5L_6^{\circ}=0$ . I.P.  $\approx 50000$  K  
 U II Normal state of valence electrons  $5f^3 7s^2 {}^4I_{4\frac{1}{2}}^{\circ}=0$  (assumed)

## References

Wavelengths:

G. R. Harrison, Massachusetts Institute of Technology Wavelength Tables (John Wiley & Sons, New York, 1939).

C. C. Kiess, C. J. Humphreys, and D. D. Laun, unpublished material.

Classification:

U I, C. C. Kiess, C. J. Humphreys, and D. D. Laun, J. Research NBS **37**, 1 (1946).

U II, J. C. van den Bosch, Physica **15**, 503 (1949). In using this reference, we have assumed that the energy levels of "group B" start at the ground state of the atom.

## Relative intensity of uranium lines observed in an arc of copper containing 0.1 atomic percent of uranium

### Strong lines of uranium

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
360	3859. 58	II	289-26191	$5f^3 6d^1 7s^1 L_{5\frac{1}{2}} - 261_{6\frac{1}{2}}$
180	3854. 66	II		
160	3670. 07	II	915-28154	$5f^3 6d^1 7s^1 K_{4\frac{1}{2}} - 281_{5\frac{1}{2}}$
160	3890. 36	II	289-25986	$5f^3 6d^1 7s^1 L_{5\frac{1}{2}} - 260_{6\frac{1}{2}}$
160	4090. 14	II	1749-26191	$5f^3 6d^1 7s^1 L_{6\frac{1}{2}} - 261_{6\frac{1}{2}}$
150	3831. 46	II		
140	3782. 84	II	289-26717	$5f^3 6d^1 7s^1 L_{5\frac{1}{2}} - 267_{6\frac{1}{2}}$
140	3812. 00	I	0-26226	$5f^3 6d^1 7s^2 {}^5L_7^{\circ} - 262_6$
140	3865. 92	II	2295-28154	$5f^3 6d^1 7s^1 K_{5\frac{1}{2}} - 281_{5\frac{1}{2}}$
130	3584. 88	I	0-27887	$5f^3 6d^1 7s^2 {}^5L_6^{\circ} - 278_7$
120	4050. 04	II	0-24684	$5f^3 7s^2 {}^4I_{4\frac{1}{2}} - 247_{4\frac{1}{2}}$
110	3871. 04	I	0-25826	$5f^3 6d^1 7s^2 {}^5L_6^{\circ} - 258_6$
100	4171. 59	II	1749-25714	$5f^3 6d^1 7s^1 L_{6\frac{1}{2}} - 257_{6\frac{1}{2}}$
95	3566. 60	I	620-28650	$5f^3 6d^1 7s^2 {}^5K_3^{\circ} - 287_5$
90	3839. 62	I	3801-29838	$5f^3 6d^1 7s^2 {}^5L_7^{\circ} - 299_7$
90	3943. 82	I	0-25349	$5f^3 6d^1 7s^2 {}^5L_6^{\circ} - 253_6$
85	3985. 80	II	5260-30342	$5f^3 6d^1 7s^1 L_{7\frac{1}{2}} - 303_{7\frac{1}{2}}$
80	3701. 52	II	5527-32535	$5f^3 6d^1 7s^1 K_{6\frac{1}{2}} - 325_{6\frac{1}{2}}$
75	3881. 46	II	4585-30342	$5f^3 6d^2 {}^6M_{6\frac{1}{2}} - 303_{7\frac{1}{2}}$
75	4042. 76	I	620-25349	$5f^3 6d^1 7s^2 {}^5K_3^{\circ} - 253_6$
75	4241. 67	II	4585-28154	$5f^3 6d^2 {}^6M_{6\frac{1}{2}} - 281_{5\frac{1}{2}}$
70	3748. 68	II		
65	3489. 37	I	0-28650	$5f^3 6d^1 7s^2 {}^5L_6^{\circ} - 287_5$
65	3514. 61	I	0-28444	$5f^3 6d^1 7s^2 {}^5L_6^{\circ} - 284_5$
65	4062. 55	II	0-24608	$5f^3 7s^2 {}^4I_{4\frac{1}{2}} - 246_{5\frac{1}{2}}$
65	4153. 97	I	0-24067	$5f^3 6d^1 7s^2 {}^5L_6^{\circ} - 240_7$
60	4116. 10	II	0-24288	$5f^3 7s^2 {}^4I_{4\frac{1}{2}} - 243_{5\frac{1}{2}}$
55	2941. 92	II	5527-39508	$5f^3 6d^1 7s^1 K_{6\frac{1}{2}} - 395_{6\frac{1}{2}}, 7\frac{1}{2}$
55	3659. 16	I	620-27941	$5f^3 6d^1 7s^2 {}^5K_3^{\circ} - 278_6$
55	3826. 51	II	289-26415	$5f^3 6d^1 7s^1 L_{5\frac{1}{2}} - 264_{6\frac{1}{2}}$
50	2889. 63	II	289-34886	$5f^3 6d^1 7s^1 L_{5\frac{1}{2}} - 349_{5\frac{1}{2}}$
50	3746. 41	II	5527-32211	$5f^3 6d^1 7s^1 K_{6\frac{1}{2}} - 322_{6\frac{1}{2}}$
50	4341. 69	II	289-23315	$5f^3 6d^1 7s^1 L_{5\frac{1}{2}} - 233_{4\frac{1}{2}}$
48	3550. 82	II	0-28154	$5f^3 7s^2 {}^4I_{4\frac{1}{2}} - 281_{5\frac{1}{2}}$
48	3561. 80			
48	3638. 20	I	3801-31279	$5f^3 6d^1 7s^2 {}^5L_7^{\circ} - 312_8$
46	3854. 22	I	0-25938	$5f^3 6d^1 7s^2 {}^5L_6^{\circ} - 259_6$
46	3874. 04			
46	3878. 09			
46	3892. 68	II	5260-30942	$5f^3 6d^1 7s^1 L_{7\frac{1}{2}} - 309_{7\frac{1}{2}}$
46	3899. 78	II	2295-27930	$5f^3 6d^1 7s^1 K_{5\frac{1}{2}} - 279_{5\frac{1}{2}}$
46	4543. 63	II	915-22917	$5f^3 6d^1 7s^1 K_{4\frac{1}{2}} - 229_{5\frac{1}{2}}$

Uranium — All Observed Lines

Intensity and Character	Wave-length in A	Spectrum	Energy Levels in K	Intensity and Character	Wave-length in A	Spectrum	Energy Levels in K
6	2419.57			9	2593.57		
3.0	2423.70			14	2597.69		
4	2427.45			7	2598.86		
2.5	2432.4			11	2601.54		
4	2448.93			1.6	2603.55	II	
4	2450.44			5	2604.31		
3.5	2454.37			8	2606.52		
2.0	2455.68			8	2606.73		
3.0	2468.26			8	2608.20		
5	2470.64			4	2609.26		
2.5	2477.18			5	2612.46		
3.0	2484.01			9	2613.95		
1.2	2490.93			3.0	2615.95		
1.6	2498.83			6	2616.07		
10	2500.86			4	2621.81		
1.2	2503.9			5	2623.54		
5	2514.77			8	2624.92		
5	2518.97			8	2625.26		
2.5	2528.10			4	2625.86		
3.0	2533.23			5	2628.50		
3.0	2534.95			12	2628.93		
5	2537.30			2.0	2629.15		
9	2538.43			5	2631.26		
2.5	2538.73			10	2632.66		
2.5	2541.37			14	2632.98		
2.0	2544.36			36	2635.53		
5	2549.30			3.0	2636.25		
16	2556.19	II	0-39109	6	2637.70		
3.0	2559.49			1.6	2638.6		
12	2562.94			3.0	2639.01		
26	2565.41			8	2639.84		
1.8	2567.11			4	2639.89		
5	2567.96			4	2641.55		
5	2568.87			6	2641.93		
1.8	2568.98			1.4	2643.24		
20	2569.71			1.4	2643.54		
9	2570.67			8	2644.12		
8	2577.32			2.5	2644.48		
5	2579.16			28	2645.47		
5	2579.44			2.0	2647.02		
5	2579.57			1.4	2647.53		
2.5	2582.11			4	2648.79		
2.5	2583.48			15	2649.07	II	
8	2584.42			12	2652.83		
5	2584.90			6	2654.58		
5	2586.20			4	d 2656.46		
6	d 2587.07			1.4	d 2657.86		
3.0	2589.59			1.4	d 2658.36		
20	2591.25			4	2659.02		
8	2592.57			5	2659.46		

Uranium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
8	2660.14			4	2713.91		
4	2661.17			6	2714.58		
10	2664.15			6	2715.54	II	2295-39109
6	2665.70			5	2716.39		
6	2665.87			3.0	2717.56		
8	2666.54			8	2719.33		
3.0	2668.02			12	2723.03		
20	2669.17			2.0	2725.07		
8	2670.52			6	2725.52		
3.0	2670.89			8	2725.94		
6	2672.21			6	2727.34		
3.0	2672.69			7	2728.55		
1.4	2673.58			7	2728.7		
8	2675.12			3.0	2729.26		
8	2675.88	II	1749-39109	10	2730.31		
13	2676.41			6	2731.27		
2.0	2676.69			3.0	d 2732.95		
1.4	2678.86			3.0	2733.77		
2.0	d 2681.73			22	2733.97		
28	2683.28			7	2734.96		
9	2684.04			5	2735.58		
1.4	2684.29			5	d 2737.07		
4	2685.61			6	2738.13		
16	2685.98			3.0	2738.41		
1.4	2689.13			6	2738.98		
8	2690.51			10	2739.39	II	289-36783
19	2691.04			4	2740.86		
6	2691.80			2.0	2741.06		
12	2692.36			8	2741.75		
10	2693.77			5	d 2742.60		
3.0	2694.22			6	2743.22		
12	2695.49			6	2743.66		
3.0	2695.91			2.0	2744.27		
2.5	2696.30			10	2744.40		
6	2697.40			8	2746.16		
16	2698.06			3.5	2746.3		
6	2698.45			3.0	2747.15		
1.4	2699.37			6	2747.36		
4	2700.96			10	2748.45		
5	2701.55			6	2749.96		
2.0	2704.80			3.0	2750.13		
12	d 2705.19			28	2754.16		
1.6	2705.77			8	2755.13		
22	2706.95			3.5	2757.55		
1.6	2708.50			4	d 2757.92		
3.0	d 2709.03				2758.18		
6	2709.51			8	2758.50		
4	2711.10			9	2758.96		
4	2711.76			8	2759.79		
8	2712.06			2.0	2760.33		

## Uranium — All Observed Lines

Intensity and Character	Wave-length in A	Spectrum	Energy Levels in K	Intensity and Character	Wave-length in A	Spectrum	Energy Levels in K
1.6	2761.18			5	2818.98		
20	2762.85			9	2819.84		
6	2764.25			8	2820.27		
12	2765.40			36	2821.12	II	
8	2766.88			16	2824.37	II	289-35685
16	2770.04			5	2824.86		
4 d	2772.18			8	2825.35		
8	2772.59			9	2826.19		
6	2773.61			4	2827.00		
5	2774.74			28	2828.90		
5	2775.02			8	2829.37		
3.5	2775.22			38	2832.06		
3.5	2775.78			9	2833.82		
3.5 d	2776.29			4	2834.55		
3.0	2778.45			6	2835.80		
7	2779.41			15	2837.19		
8	2780.04			9	2837.33		
9	2780.77			4	2837.73		
9	2781.04			3.0	2838.62	II	915-36133
8	2781.62			19	2839.89	II	
5	2782.07			4	2840.47		
7 d	2783.29			8 d	2840.62		
17	2784.45	II		15	2842.09		
7	2784.67			4	2842.24		
3.0	2784.92			4	2842.48		
2.5	2785.17			6	2844.99		
7 d	2787.33			8	2845.60		
6	2788.13			6	2845.96		
7	2790.66			4	2846.09		
5	2791.07			4	2847.34		
3.0	2791.26			2.0	2847.72		
34	2793.94	II		2.5	2848.05		
8	2795.23			15	2849.48		
12	2797.14			6	2849.7		
3.5	2797.30			4	2849.98		
3.5	2797.77			8	2850.49		
5	2799.12			4	2850.82		
36	2802.56			5	2851.81		
5	2803.83			6	2852.09		
7	2805.24			8	2852.75		
26	2807.05	II		2.0	2852.94		
18	2808.98			8	2853.42		
9	2809.95			8	2853.57	II	1749-36783
5 d	2810.35			4	2854.92		
12	2811.34			6	2855.96		
7	2813.04			4	2857.47		
5	2815.76			12	2858.90	II	
7	2815.98	II	289-35790	5	2859.74		
2.5	2816.74			16	2860.47		
26	2817.96	II		7	2860.80		

## Uranium — All Observed Lines

Intensity and Character	Wave-length in A	Spectrum	Energy Levels in K	Intensity and Character	Wave-length in A	Spectrum	Energy Levels in K
7	2861.13			4	2898.56		
5	2862.41			6	2898.71	II	2295-36783
4	2862.62	II	4585-39508	8	2901.22		
3.0	2862.80			6	2902.41		
4	2863.44			4	2902.81	II	0-34439
4	2863.54			4	2903.05		
6	2864.10			6	2903.55		
6	2864.28			5	2904.02		
12	2865.14			6	2904.41		
40	2865.68	II	0-34886	10	2904.51	II	289-34708
6	2866.16			32	2906.80		
4	2867.80			8	2906.91		
8	2868.19			32	2908.28		
8	d 2869.37			8	2908.41		
14	2870.97			8	2909.25		
4	2873.00			7	2910.82		
9	2874.08			4	2911.55		
9	2875.20	II	915-35685	6	2912.58		
8	d 2876.43			4	2912.75		
4	2877.05			6	2913.44		
2.0	2877.83			13	2914.25	II	289-34593
4	2878.87			15	2914.63	II	
10	d 2879.59			4	2914.84		
8	2880.59			9	d 2915.54		
4	2882.34			9	2916.46		
20	2882.74			4	2918.37		
10	2882.93	II		4	2918.68		
3.5	h 2883.75			7	2918.97	II	5260-39508
6	d 2884.92			18	d 2921.68		
4	2885.19				2921.72		
4	2886.05			4	2922.06		
8	d 2886.45	II	289-34924	4	2923.17	II	0-34199
19	2887.25			11	2923.50		
6	2887.59			7	2924.58		
4	2887.91			4	2925.22		
17	2888.26			11	2925.57		
8	2888.74			7	2925.98		
50	2889.63	II	289-34886	4	2926.10		
6	d 2891.80			4	2926.39		
4	2893.76			9	2926.59		
13	2894.14			13	2927.38	II	289-34439
17	2894.51			20	2928.60		
4	2894.84			7	2929.12		
4	2894.89			9	2929.64		
8	d 2895.54			7	2929.78		
10	2896.68			8	2930.43		
3.5	2896.96			5	2930.59		
6	2898.01			24	2931.41		
6	2898.1			9	2931.89		
4	2898.37			5	2932.18		

Uranium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
18	2932.61			10	2978.14		
14	2933.86			5	2980.28		
7	2935.62			5	2980.69		
11	2936.45			5	2981.04		
4	2936.78	II	1749-35790	13	2982.74	II	
5	2937.35			22	2984.61	II	2295-35790
9	2939.04			4	2985.08		
5	2939.49			7	d 2985.80		
4	2940.04			7	2987.80	II	289-33749
22	d 2940.37			4	2987.95		
9	2941.34			12	2988.42		
55	2941.92	II	5527-39508	10	2988.71		
9	2942.12	II	289-34268	12	2989.88		
11	2942.85	II	915-34886	4	2990.21		
5	2943.18			17	2992.72		
5	2943.40			7	2993.70		
34	2943.90			5	2994.45		
7	2944.19			5	2996.10		
9	2945.89	II	1749-35685	5	2996.39		
11	2947.43			5	2998.36		
14	2948.09	II	289-34199	7	2999.03		
4	2948.44			7	2999.22		
12	2948.94			7	3000.09		
9	2949.61			5	3001.21		
4	2949.97			5	3002.64		
5	2951.92			10	3003.07		
9	2954.39	II	2295-36133	12	3003.32		
16	2954.77			5	3003.85		
10	2955.65			10	3004.15		
24	2956.06			9	3005.10		
7	2956.78			8	3005.52		
7	d 2957.74			15	3007.91		
5	2958.10			12	3009.42		
10	2959.85			5	3010.37		
10	d 2962.78			7	3010.75		
10	2964.25			5	3011.48		
19	2965.03			4	3012.45	II	289-33475
7	2966.12			7	3012.71		
10	2966.66	II	1749-35447	10	3013.37		
24	2967.89	II		7	3013.44		
7	2968.40	II	915-34593	5	3014.88		
5	2970.48			5	3015.68		
24	2971.06			4	3016.05		
10	2973.08			12	3016.96	II	1749-34886
12	2973.26			7	3017.35		
10	2975.22			6	3018.10		
7	2975.64			5	3018.59		
12	2975.88			5	3020.24		
17	2976.31			5	3020.57		
12	2977.27			5	3020.92		

Uranium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
13	3021.22			4	3072.34		
26	3022.21	II		3.5	3072.45		
7	3024.38			24	3072.78		
13	3024.51			8	3073.50		
8	3026.15			11	3075.04		
5	3026.43			5	3075.45		
8	3026.70			5	3077.33		
10	3027.66	I	620-33640	11	3079.95		
13	3028.19			12	3080.74	II	1749-34199
9	3029.13			7	3081.19		
5	3029.42			11	3082.02		
5	3030.83			8	3083.61		
26	3031.99	II		5	3084.24	II	2295-34708
20	3033.19	II	1749-34708	8	3086.73		
9	3035.51			5	3087.11		
5	3035.96			10	3088.99		
8	3036.45			8	3090.36		
5	3036.61			4	3090.55		
8	3038.05			5	3091.25		
8	3039.14			24	3093.01		
10	3039.26			5	3094.83		
4	3039.93			12	3095.04	II	1749-34049
5	3040.5			8	3095.23	II	2295-34593
5	3041.25			13	3095.75		
4	3041.86			5	3096.88		
4	3041.9			13	3098.01	II	915-33184
4	3042.73			24	3102.39		
8	3043.79			6	3102.61		
20	3044.16			3.5	3102.90		
4	3045.46			5	3103.77		
8	3046.46	II	289-33104	19	3104.16		
8	3046.57			6	3105.10		
8	3046.84			5	3105.65		
10	3047.57			4	3110.52		
12	3048.64	I	620-33412	6	3110.83		
4	3049.84			40	3111.62		
24	3050.20			10	3112.25		
10	3051.14			7	3114.54	I	0-32098
10	3052.91				3114.59		
5	3054.73			6	3115.93		
10	3055.59	II	0-32717	6	3119.24		
8	3056.72			22	3119.35	II	5260-37308
26	3057.91			6	3120.87		
5	3060.06			5	3121.09		
19	3061.62			6	3121.33		
26	3062.54			8	3124.43		
4	3063.88	II	2295-34924	28	3124.90	II	
4	3064.18			6	3126.17		
5	3066.87			7	3126.70	II	2295-34268
11	3068.65			8	3129.73		



Uranium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
4	3130.73			3.0	3190.89		
8	3131.99			3.0	3191.76		
4	3133.42	II	2295-34199	9	3193.23		
4	3133.63			5	3196.74		
6	3133.92			10	3200.14		
6	3136.89			14	3206.05		
5	3138.51			6	3206.23	II	2295-33475
5	3138.83			3.0	3211.77		
22	3139.56	II	4706-36549	3.0	3213.09	II	8394-39508
6	3141.95			3.0	3214.70		
17	3144.96			9	3218.34		
20	3145.56	II	5527-37308	6	3219.17		
8	3146.26			10	3224.26		
6	3146.75			10	3226.17		
11	3147.09			30	3229.50		
6	3148.56			28	3232.16	II	289-31219
28	3149.21			6	3233.34		
4	3150.36			3.0	3235.23		
6	h 3151.08	II	1749-33475	3.0	3238.42		
6	3152.31			3.0	3240.35		
22	3153.12			9	3241.99	II	
4	3155.26			18	3244.17		
6	3155.41	II	1749-33432	6	3244.79	II	2295-33104
11	3155.86			9	3246.11		
8	3156.07			9	3246.39	II	289-31084
6	3157.45			3.0	3247.49		
8	3157.86			4	3248.07		
6	3159.82			4	3249.14		
8	3160.77			6	3250.28		
4	3163.73			6	3253.80		
4	3165.28			9	3254.84		
9	3165.50			3.0	3257.26		
9	3167.10			12	3261.72		
6	3170.86			5	3263.12	I	0-30637
6	3171.37	II	5260-36783	14	3265.81		
4	3173.71			3.0	3269.78	II	289-30863
6	3175.36			18	3270.12	II	289-30860
14	3176.21			3.0	3271.45		
14	3177.33			3.0	3279.55		
9	3179.04			6	3280.00		
9	3179.83			6	3282.54		
9	3180.20			8	3283.10		
3.0	3182.55			12	3285.22		
3.0	3182.83			9	3287.45		
5	3185.14			18	3288.21		
11	3185.71			30	3291.34		
9	3188.34	II	1749-33104	3.0	3293.59		
6	3189.02			5	3294.44		
3.0	3189.42			4	3297.89		
6	3190.70			11	3299.06		

## Uranium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
9	3299.70			12	3395.32		
12	3303.60	II	289-30550	12 d	3395.58		
44	3305.93	II	0-30240	3.0	3397.20		
3.0	3307.55			6	3398.26		
3.0	3310.50			3.0	3399.00		
12	3311.72	II	5260-35447	12	3401.01		
12	3313.94			6	3401.21		
3.0	3318.85	II		3.0	3401.87		
6	3319.21	II		12	3403.55		
6	3319.32			4	3405.75		
9	3322.12	II		9	3406.28	II	915-30264
3.0	3322.46			6 d	3407.91		
6	3325.66	II	0-30061	12	3411.53		
6	3327.50			12	3412.10		
12	3329.92			6	3412.36		
3.0	3332.42	II	5791-35790	5	3413.81		
6	3336.68			3.0	3414.36		
16	3337.79	II	289-30240	3.0	3416.12		
6	3338.48	II	915-30860	3.0	3418.39	I	620-29866
18	3341.66	II	2295-32211	9	3421.69		
12	3342.68			3.0	3422.35		
6	3344.87			9	3423.05		
4	3345.54			24	3424.56	II	1749-30942
6	3345.89	I	620-30499	6	3424.81		
11	3354.50			7	3426.39		
3.0	3355.11	II	289-30086	2.0	3430.18		
11	3357.93	II	289-30061	3.0	3430.48		
6	3360.08			6	3431.14	I	4276-33412
6	3361.73			6	3431.54	II	5791-34924
6	3367.56			3.0	3433.71	II	289-29404
5	3367.90			6	3433.90	II	289-29402
9	3368.83			11	3434.15	II	1749-30860
3.0	3368.98	I	620-30294	5	3434.61		
5	3370.13	II	5260-34924	6	3435.20		
12	3371.29			24	3435.49	I	620-29720
9	3372.01	II	289-29936	6	3436.78		
9	3375.78			3.0	3437.93		
5	3376.55			6	3440.98		
6	3377.39	II		11	3442.95		
3.0	3378.20			3.0	3447.32		
6	3380.70			6	3448.78		
6	3381.95			6	3451.21	II	1749-30716
3.0	3382.68	II	915-30469	15	3453.57		
9	3384.45	II	289-29828	6	3453.78		
9	3386.13			13	3454.23		
30	3390.39			10	3455.74		
5	3390.97			13	3457.05	II	
3.0	3392.99	II	4585-34049	13	3457.71		
12	d 3393.91			10	3458.17		
14	3394.78	II	5260-34708	3.0	3458.68		

Uranium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
15	3459.92			6	3516.3		
13	3462.21	I	0-28875	6	3516.85		
19	3463.54			6	3517.05	II	6283-34708
26	3466.30	I	3801-32642	16	3519.96		
6	3469.49			8	3520.79		
5	3469.78	II		5	3521.48		
16	3472.51			6	3522.58		
6	3472.56	II	2295-31084	6	3522.67		
13	3473.43			3.0	3523.35		
6	3474.54			10	3523.57		
6	3474.99			10	3525.14		
6	3476.44			10	3525.65		
3.0	3477.50			3.0	3525.73		
11	3477.84			10	3526.60		
5	3479.16			10	3528.69		
15	3480.36			3.0	3529.77		
28	3482.54			16	3531.11	II	1749-30061
5	3486.30			10	3531.64		
6	3488.82			26	3533.57	II	915-29207
65	3489.37	I	0-28650	13	3534.33	I	0-28286
9	3489.57	II	5791-34439	3.0	3535.84		
12	3490.24			3.0	3537.06		
5	3491.34			10	3537.28		
16	3493.33			6	3537.44		
14	3493.99	I	620-29233	5	3538.23	I	620-28875
13	3494.84			10	3539.65		
3.0	3495.60	II		22	3540.46	II	
3.0	3495.75			3.0	3541.89		
22	3496.42	II	1749-30342	13	3542.57	I	4276-32496
6	3497.26			10	3543.16	II	5260-33475
6	3497.62			5	3543.73		
10	3499.33	II	2295-30863	6	3544.21		
26	3500.07	I	0-28563	6	3544.99		
3.0	3500.33			10	3545.44		
3.0	3501.00			10	3545.67		
10	d 3502.24			10	3546.13		
13	3504.00			10	3546.68	II	1749-29936
6	3504.93			16	3547.19	II	1749-29932
13	3505.07			6	3548.62	II	5260-33432
6	3505.45			13	3549.20	I	3801-31968
10	3507.05	I	620-29126	6	3550.17		
32	3507.34	I	0-28504	48	3550.82	II	0-28154
13	3508.85	II	1749-30240	6	3551.04		
16	3509.67			13	3552.17		
10	3511.44	I	0-28470	6	3552.67		
6	3511.58	II	289-28758	3.0	3552.92		
6	3513.37			6	3553.44		
13	3513.68			28	3555.32	I	0-28119
65	3514.61	I	0-28444	16	3557.84	I	0-28099
5	3515.24			6	3560.31		

## Uranium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
6	3560.44	II	1749-29828	19	3605.28		
13	3561.41			5	3605.48	II	1749-29477
48	3561.80			15	3606.32	II	
16	3563.66	I	0-28053	6	3608.96		
5	3564.18			10	3609.68		
10	3564.59			6	3610.49		
6	3564.88			6	3610.69		
6	3565.05	I	4276-32318	3.0	3611.24		
95	3566.60	I	620-28650	3.0	3611.40	I	0-27682
6	3568.82			8	3612.67	II	915-28587
22	3569.06			6	3615.54		
3.0	3570.65			13	3616.33	I	3801-31445
3.0	3570.93	II	4421-32417	13	3616.76	II	
6	3571.18			3.0	3616.89		
5	3571.56			3.0	3617.49		
6	3571.69	II		3.0	3617.62		
8	3574.11			6	3618.49		
13	3574.76	I	0-27966	3.0	3619.13	II	289-27912
10	3576.22			13	3920.08	I	0-27616
6	3577.08			3.0	3622.04		
15	3577.92	I	0-27941	13	3622.70		
10	3578.33	II		16	3623.06	II	915-28508
26	3578.72			5	3625.98		
8	3580.25	I	620-28543	3.0	3628.38		
15	3581.84			19	3630.73		
12	3582.02			3.0	3632.95		
8	3582.62			8	3633.29		
130	3584.88	I	0-27887	5	3634.56		
10	3585.84			6	3635.30	I	3801-31301
5	d 3587.78	I	4453-32318	6	3635.40	II	0-27499
	3587.84						
10	3589.66	I	620-28470	7	3637.51		
10	3589.79	II	5667-33516	48	3638.20	I	3801-31279
12	3590.32	II	5260-33104	7	3638.65		
13	3590.50	II	915-28758	18	3640.76		
				14	3640.95	II	1749-29207
6	3591.56			9	3642.44		
16	3591.74	I	620-28454	24	3644.24	I	620-28053
5	3592.97	I	620-28444	3.0	3644.85		
10	3593.20	I	4276-32098	18	3645.03		
19	3593.52			10	d 3649.41		
					3649.58		
5	3593.68						
12	3594.95			38	3651.53		
6	d 3596.76			28	3652.07		
	3596.88			8	3653.21	I	3801-31166
6	3599.84			8	3654.89	I	3868-31221
6	3600.29			7	3657.32		
3.0	3601.19			10	3659.01		
6	3602.48	I	3801-31552	55	3659.16	I	620-27941
6	3603.36	I	0-27744	10	3659.59		
5	3603.74	I	4276-32017	9	3662.33		

Uranium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
10	d 3666.10			17	h 3720.39		
	3666.21			17	3722.68		
6	3667.13			8	3724.23		
6	3667.98			26	d 3724.99	II	1749-28587
7	3669.15				3725.07		
160	3670.07	II	915-28154	9	3725.65		
14	3670.53			26	3729.82		
11	3672.58			9	3730.13		
10	3673.06			7	3731.45	I	0-26792
11	3673.39			17	d 3731.58		
					3731.77		
11	d 3674.13			17	3732.26	I	3801-30587
11	d 3674.99			26	3732.62		
	3675.08	II		26	3733.07		
15	3676.56	II	6283-33475	17	3733.58		
15	3677.39	I	3801-30986				
11	3677.67			17	3737.25		
22	3678.75			44	3738.05	II	5791-32535
14	3679.38	I	620-27791	14	3742.35		
16	3679.81			22	3744.24		
14	3680.88			50	3746.41	II	5527-32211
13	3682.04			26	3747.12		
8	3682.46	II	6283-33432	70	3748.68	II	
13	3683.59			44	3751.18	I	3801-30451
13	3684.62			18	3751.72		
11	3685.78	I	620-27744	26	3752.66		
40	3691.92			14	3754.31		
24	3693.70			26	3755.48		
14	3697.13			18	3756.66		
16	3697.93			18	3756.92		
40	3700.58	II	915-27930	36	3758.36	I	4276-30876
80	3701.52	II	5527-32535	26	3759.23		
17	3702.62	I	4276-31276	9	3759.88		
17	3703.27	I	620-27616	18	3760.88		
17	3704.10			12	3761.96		
13	3705.04			12	3762.11		
8	3705.98			24	3763.27	I	7006-33571
17	d 3707.29			36	3764.57		
	3707.39			20	3765.35	I	0-26550
8	3707.65			32	3766.89	I	4453-30993
8	3707.95	I	7104-34065	18	3768.80		
8	3709.88			24	3769.54		
26	d 3713.56	I	0-26921	14	3772.82		
	3713.65			40	3773.44	I	3801-30294
17	3714.76	II	2295-29207	18	3775.99	II	915-27390
17	3715.47			22	3776.48		
8	3716.14			9	3779.05		
22	3717.42			28	3780.72	II	915-27357
26	3718.11			9	3781.75	I	3868-30304
12	3718.61			140	3782.84	II	289-26717
8	3719.29	I	620-27499	32	3783.84	II	5791-32211

## Uranium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
9	3786.57			90	3839.62	I	3801-29838
18	3786.84			9	3842.99		
14	3787.23			9	3844.00		
14	3788.16			9	3844.23		
9	3790.22			9	h 3845.12		
9	3790.33			28	3845.32		
9	3792.41	II		9	3846.24		
42	3793.10	II	4585-30942	18	3846.55	I	3801-29791
28	3793.28			15	3847.84		
28	3793.57			36	d 3848.62	II	4585-30562
					3848.72		
16	3795.13			9	3849.71		
18	3796.20			15	3849.85	II	0-25968
18	3796.54			9	3851.72	I	5991-31946
18	3796.84			46	3854.22	I	0-25938
14	3797.77						
18	3798.84			180	3854.66	II	
18	3799.20	II	8394-34708	360	3859.58	II	289-26191
18	3799.55			36	3861.16		
18	3801.15	I	620-26921	9	3863.09		
18	3802.27			18	3864.30		
9	3803.35			18	3864.48		
28	3808.93	I	6249-32496	140	3865.92	II	2295-28154
28	3809.22	II		28	3866.80		
7	3810.10			18	3867.17	I	3868-29720
140	3812.00	I	0-26226	9	3868.42	II	4421-30264
9	3812.58			18	3870.05		
28	3813.79	II	2295-28508	110	3871.04	I	0-25826
28	3814.07	II	915-27126	7	3871.88		
9	3816.61			46	3874.04		
9	3817.16			18	3876.13	I	0-25792
12	3818.06			9	3876.59		
9	3818.48	II	1749-27930	46	3878.09		
9	3818.76	II		18	3879.53	I	4453-30222
9	3819.25	I	4276-30451	18	3879.71		
9	3821.22			75	3881.46	II	4585-30342
18	3821.95	I	3801-29958	36	3882.36	II	1749-27499
9	3822.35			18	3883.10		
9	3822.56			28	3883.33		
55	3826.51	II	289-26415	18	3884.68		
18	3829.03			13	3887.45		
14	3829.39			13	3887.70		
9	3829.79	I	0-26104	160	3890.36	II	289-25986
150	3831.46	II		9	3891.68		
18	3831.86			18	3891.82		
15	3833.02			18	3892.41		
18	3835.14			46	3892.68	II	5260-30942
9	3835.22			36	3894.12	I	0-25672
15	h 3835.92			15	3895.27	II	4421-30086
9	3837.27			36	3896.78	II	8394-34049
15	3838.15			18	3897.06		

## Uranium — All Observed Lines

Intensity and Character	Wave-length in A	Spectrum	Energy Levels in K	Intensity and Character	Wave-length in A	Spectrum	Energy Levels in K
14	3897.26			12	3964.96		
9	3897.71			18	3966.40	II	2295-27499
14	3899.10	II	4421-30061	44	3966.57	II	
18	3899.27			9	3967.48		
18	3899.42			9	3969.02		
46	3899.78	II	2295-27930	9	h 3974.98		
30	3902.49	II	2295-27912	14	3978.80		
34	3904.30	II		9	h 3980.80	I	5762-30876
18	3904.56	II	5260-30863	17	3983.91	II	
9	3904.85			7	3984.18		
28	3906.46			85	3985.80	II	5260-30342
9	3908.33			6	3988.64		
9	3908.47			14	3988.89	II	2295-27357
9	3909.06			34	3990.42	II	915-25968
18	3910.89			28	3992.54	II	
24	3911.67			9	3994.29		
14	3914.20			17	3994.98		
14	3914.27			14	3995.97	II	
28	3915.88	II		9	3997.09	I	7008-32017
9	3916.53			26	3998.24		
18	3917.25	I	8119-33640	9	3999.18	I	3801-28799
9	3917.82			9	d 4001.25		
6	3918.06	II	4421-29936	9	4002.34		
14	3921.55			9	4003.20		
9	3923.05			26	4004.06	II	1749-26717
14	3924.27	II	4585-30061	32	4005.21	I	4453-29414
24	3926.22	I	0-25463	14	4005.70		
24	3926.73	I	5762-31221	9	4009.17	II	6283-31219
18	3927.76			8	4011.45		
9	3928.83			6	4014.16		
12	3930.43			42	4017.72	II	
32	3930.98			22	4018.99	II	289-25164
15	3932.03	II	289-25714	6	4026.02	II	2295-27126
9	3933.03	II	0-25419	12	4031.31		
36	3935.38			12	4033.43	II	4421-29207
24	3940.49			14	4033.73		
14	3942.55	II	0-25357	16	4034.50	I	4453-29233
18	3942.83			16	4039.78		
90	3943.82	I	0-25349	75	4042.76	I	620-25349
18	3944.13	II	4585-29932	38	4044.42		
22	3948.45	I	0-25319	30	4047.62	I	620-25319
7	3951.48			120	4050.04	II	0-24684
7	3951.55	II		40	4051.91	II	5260-29932
22	3953.58	II	4421-29707	13	4053.03	II	1749-26415
40	3954.66	II		22	4054.31	II	6283-30942
18	3955.38			32	4058.16		
9	3959.20			6	4060.10		
14	3962.79	II	4706-29934	6	4061.35		
26	3964.22	I	6249-31469	8	4061.74		
18	3964.67			65	4062.55	II	0-24608

## Uranium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
8	4064.16			100	4171.59	II	1749-25714
8	4066.80			10	4172.97	II	6283-30240
38	4067.76	II	6283-30860	16	4174.19	II	5527-29477
30	4071.11			10	4179.00	II	4585-28508
22	4074.49	II		6	h 4184.89		
24	4076.72			14	4186.96	I	4276-28153
16	4077.79			14	4188.07	II	289-24160
24	4080.61			22	4189.28	II	289-24153
14	h 4084.93	II	5791-30264	4	4191.94	I	0-23849
20	4088.25	II	0-24453	13	4197.52	II	8394-32211
160	4090.14	II	1749-26191	10	4198.22	I	620-24433
16	4091.52			4	4200.10	II	6283-30086
8	4091.64	I	0-24433	7	4201.13		
6	4094.62			13	4204.37	II	0-23778
6	4094.89			6	4210.45		
16	4095.75			18	4211.68	II	
16	4096.35			10	4212.26	II	4421-28154
34	4098.03	II	289-24684	10	4213.88		
15	4101.91	I	8119-32491	6	4214.28		
14	4103.12			6	4214.42	II	289-24010
28	4106.28			5	4219.98		
15	4106.93	II	0-24342	26	4222.36	I	3801-27478
5	4108.36	I	0-24334	5	4227.33	II	6283-29932
8	4113.11	II	0-24306	6	4228.76		
60	4116.10	II	0-24288	16	4231.67	I	7646-31270
4	4116.89			5	4232.04	II	289-23912
30	4124.73	II	1749-25986	12	4236.04		
30	4128.34			4	4240.59	II	6283-29858
10	4132.02			75	4241.67	II	4585-28154
10	4133.20			38	4244.37	II	0-23554
15	4133.50	I	0-24186	19	4246.26	I	0-23544
7	4135.76	II	4585-28758	12	4252.43		
10	4136.81	II	4421-28587	4	4266.32	I	0-23433
7	4138.66			10	4267.30	II	915-24342
14	4139.14	II	0-24153	4	4267.94		
34	4141.23	II	8394-32535	6	4268.85		
5	4141.86	I	620-24757	12	4269.61	II	1749-25164
11	4144.70	II	2295-26415	6	4273.98	II	915-24306
4	4145.39	II	6445-30562	6	4276.47		
4	4146.61			15	4282.03	II	289-23636
65	4153.97	I	0-24067	12	4282.45	II	4585-27930
20	4155.41	II	6283-30342	15	4287.87	II	0-23315
28	4156.66	I	620-24671	15	4288.84	I	6249-29559
5	4160.95	I	0-24026	11	4297.11	II	289-23554
18	4162.43	I	3801-27818	9	4301.47	II	0-23241
26	4163.68	II	0-24010	4	4306.78		
5	4164.79			4	4310.39	II	6283-29477
20	4165.68	II	289-24288	11	4313.13	I	3801-26979
5	4166.64			9	4313.88		
12	4169.06	I	8119-32098	3	4319.78		



## Uranium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
5	4325.90			3.0	4611.44		
9	4335.73	I	0-23058	22	4620.23	I	6249-27887
50	4341.69	II	289-23315	3.0	4622.43	II	5260-26887
11	4347.19	II	915-23912	19	4627.08	II	4585-26191
10	4354.55			17	4631.62	I	0-21585
32	h 4355.75	I	620-23572	5	4641.66	II	8394-29931
32	4362.05	I	0-22919	18	4646.60	II	915-22430
14	4362.26	II	0-22917	4	4663.75	I	620-22056
5	4362.93	II	4585-27499	11	4666.86	II	289-21711
7	4371.76	I	8119-30986	8	4671.41	II	4585-25986
12	4372.57	II	915-23778	14	4689.07	II	0-21320
5	4372.76	I	0-22862	3.5	4700.98		
8	4373.41	II	1749-24608	4	4702.05	II	4706-25968
4	4383.27	I	3801-26608	8	4702.52	II	2295-23554
24	4393.60	I	0-22754	3.5	4715.68	I	4453-25653
5	d 4402.30			13	4722.73	II	1749-22917
	4402.44			10	4731.60	II	4585-25714
10	4415.24	II	0-22642	3.0	4743.53	I	6249-27324
5	4426.68	II	4706-27290	8	4755.73	II	0-21021
5	4426.94	I	0-22583	12	4756.80	I	620-21637
8	4427.65	II	289-22868	3.0	4768.66	I	620-21585
5	4433.89	II	8394-30942	6	4769.26	II	0-20962
8	4434.53	II		8	4772.70	II	2295-23241
3.0	4440.74	I	3801-26313	3.0	4778.10		
11	4462.97	II	915-23315	4	4779.63	II	6445-27361
5	4465.13	II	2295-24684	3.0	4780.19	II	
4	4469.32	I	0-22368	3.0	4785.91		
44	4472.34	II	289-22642	3.5	4790.06	I	3801-24671
5	4477.71	II	915-23241	3.0	4810.90	I	3801-24581
8	4490.84	II	1749-24010	4	4819.54	II	4421-25164
5	4510.32	II	0-22165	4	4842.48	I	620-21265
18	4515.28	II	289-22430	6	4847.66	II	2295-22917
5	4516.73	I	620-22754	7	4858.08	II	4585-25164
14	4538.19	II	1749-23778	6	4859.68	II	0-20572
46	4543.63	II	915-22917	8	4861.02	II	5402-25968
11	4545.58	II	2295-24288	3.0	4868.86	I	3801-24334
3.5	4551.98	I	620-22583	3.5	4883.78		
3.0	4553.86	II	915-22868	3.5	4885.15	I	0-20464
6	4555.10	II	8394-30342	2.5	4886.33	II	5527-25986
4	4563.96			8	4899.29	II	915-21320
7	4567.69	II	1749-23636	4	4910.35	I	6249-26608
10	4569.91	II	289-22165	6	4913.16	II	2295-22642
3.0	4570.99	II	6283-28154	3.5	4924.64	II	5667-25968
12	4573.69	II	2295-24153	3.5	4928.44	I	4276-24560
4	4576.64	I	620-22464	2.0	4933.06	I	3801-24067
4	4584.85	II	1749-23554	2.5	4933.66	II	4421-24684
4	4601.13	II	915-22642	2.5	4950.17	II	5791-25986
10	4603.66	II	2295-24010	3.5	4955.78	I	7646-27818
4	4605.15	II	5791-27499	3.5	4967.33	I	3801-23927
3.0	4609.86			3.5	4972.10	II	915-21021

## Uranium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
3.5	4986.90	II	915-20962	1.6	5449.86		
10	5008.22	II	1749-21711		5449.93		
2.0	5011.42	I	620-20569	1.6	5459.27	I	620-18933
15	5027.38	I	0-19885	3.0	5465.69		
2.0	5047.42	II	2295-22101	7	5475.72		
3.0	5063.77	I	3801-23544	6	5480.28	II	
2.0	5077.82			6	5481.22	II	6445-24684
3.0	5085.86	II	915-20572	4	5482.55	II	
1.8	5088.29	I	0-19648	1.0	5484.52		
6	5117.25			3.0	5487.02	II	5791-24010
1.6	5137.05			2.5	5488.91		
2.0	5145.10	II	6283-25714	3.0	5491.24		
2.5	5154.04			14	5492.97	II	0-18200
7	5160.33	II	5791-25164	2.5	5494.67		
5	5164.14	I	8119-27478	3.0	5496.43	I	4276-22464
5	5184.59	II	5402-24684	1.4	5500.69	I	11545-29720
4	5204.32			1.4	5501.49		
2.0	5225.12	II	4421-23554	3.5	5504.15	II	6445-24608
1.6	5238.61			3.0	5510.44		
1.6	5247.35	II	5402-24453	4	5511.49	I	620-18759
4	5247.75	II	4585-23636	1.4	5513.39		
4	5257.04	II	5667-24684	6	5527.85	II	
1.4	5272.00	I	7646-26608	1.4	5531.26	I	8119-26192
2.0	5278.18	II	5402-24342	1.4	5535.80		
6	5280.38	I	0-18933	2.0	5538.53		
1.6	5288.40	II	5402-24306	2.5	5544.82		
3.5	5308.54	I	3801-22633	1.4	5548.06		
1.8	5310.04			2.5	5551.44	II	6445-24453
3.5	5311.88	II	4421-23241	1.6	5552.62	II	6283-24288
1.4	5312.73	II	5791-24608	1.4	h 5555.77		
1.6	5315.27	I	7646-26454	2.0	5557.90	II	5791-23778
1.8	5319.38			6	5564.17	I	3801-21768
1.4	5321.60	II	5667-24453	3.5	5570.68		
3.0	5327.71			1.2	5573.07	I	10347-28286
3.5	5329.26	I	0-18759	1.0	5573.59	I	6249-24186
1.8	5349.92			1.8	5580.82	II	5402-23315
1.6	5362.40			2.5	5581.23		
1.6	5363.82	II	5667-24306	4	5581.61	II	289-18200
2.5	5368.43			1.0	5587.19		
1.0	5373.45			2.5	5597.38	II	6445-24306
1.0	5382.94	I	620-19192	2.0	5602.91	II	6445-24288
1.0	5385.54	I	7646-26209	1.2	5603.99		
5	5386.21	II		1.2	5608.86		
1.6	5389.80			5	5610.89	I	6249-24067
3.0	5400.95	II	5402-23912	1.2	5616.58	I	8119-25918
2.0	5403.20			5	5620.78	I	620-18406
2.0	5406.00	II	8394-26887	2.5	5621.51	I	3801-21585
1.2	5410.24	I	4276-22754	1.2	5628.02	II	5791-23554
1.0	5423.35			1.2	5629.46		
3.0	5444.48	II	5791-24153	1.2	5632.47		

Uranium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
2.5	5634.38	I	7646-25389	1.6	5828.02		
0.8	5636.80			1.6	5832.39		
1.2	h 5638.00			4	5836.08	I	10347-27478
1.2	5640.33			5	5837.71	II	4585-21711
0.8	5644.25			1.0	5839.05		
0.8	5648.38			1.6	5841.84		
2.0	5653.79			2.0	5843.29	II	6445-23554
2.0	5654.41	II	4421-22101	1.0	5843.92		
1.6	5658.26	I	5762-23430	3.0	5845.27		
1.2	h 5664.86			1.0	5852.03		
2.5	5669.42	I	620-18254	2.5	5853.93		
0.8	5674.88			1.0	5859.19		
1.2	5680.37	I	6249-23849	0.6	5863.43		
1.6	5683.33			3.0	5870.95	II	5402-22430
1.2	5685.19	I	4453-22038	1.0	5886.95		
3.5	5691.39	II	6445-24010	2.0	5895.33		
2.0	5704.07			1.8	5898.78	I	6249-23197
1.0	5705.66			2.0	5902.50		
1.8	5706.99			20	5915.40	I	0-16900
1.0	5709.49			2.0	h 5925.47	I	7646-24517
1.8	5716.87	I	4453-21941	1.8	5929.33	I	3801-20662
1.0	5722.23			1.4	5932.44	II	5791-22642
3.5	5723.63	II	6445-23912	1.4	5933.85	I	620-17468
2.0	5733.26			0.9	5934.46		
2.0	5736.38	I	7006-24433	0.9	5942.77	I	5762-22584
2.0	5737.27	I	5762-23187	1.2	5948.57	I	7646-24452
1.8	5748.13			1.8	5952.05	II	6445-23241
1.0	5748.47			1.8	5956.86	I	5991-22774
1.8	5750.54			5	5971.50	I	620-17362
2.0	5758.14	I	0-17362	9	5976.32	I	3801-20529
1.0	5758.35	I	4276-21637	2.5	5986.10	I	3868-20569
0.8	5761.88			4	5997.31	I	6249-22919
1.0	h 5763.63	I	7326-24671	1.4	5997.96	I	4276-20943
1.0	h 5765.41			2.0	5999.41	I	3801-20464
1.0	5767.43	I	5991-23325	1.8	6000.20		
1.0	5771.05	I	6249-23572	1.8	6004.83		
1.0	5776.90			1.8	6008.87		
1.0	5777.81			1.8	6010.86	I	10347-26979
6	5780.59	I	6249-23544	1.8	6014.07		
2.0	5788.59	II	6283-23554	0.9	6016.73	I	5762-22378
2.0	5791.77			2.5	6017.39	II	4706-21320
1.0	5796.54			1.8	6017.57	I	6249-22862
6	5798.55			1.4	6019.19	I	4453-21062
3.5	5802.11	I	8119-25349	2.0	6028.13		
1.0	5805.20			0.6	6035.54		
1.8	5811.29			1.8	6039.60	I	8119-24671
1.0	5813.83	I	5991-23187	0.8	6050.48	I	3868-20392
0.8	5814.41	I	3868-21062	0.8	6050.67	I	7326-23849
1.0	5816.79			5	6051.74		
0.8	5819.01	I	7006-24186	1.4	6056.80	I	0-16506

## Uranium — All Observed Lines

Intensity and Character	Wave-length in A	Spectrum	Energy Levels in K	Intensity and Character	Wave-length in A	Spectrum	Energy Levels in K
1.4	6057.07	I	6249-22754	1.0	6424.89	II	5402-20962
1.6	6059.73	II	5667-22165	0.7	6430.93		
1.6	6062.30	I	4276-20766	0.4	6448.04		
4	6067.23			10	6449.17	I	620-16122
8	6077.29	I	620-17070	3.0	6465.00	I	7326-22790
2.5	6087.34	II	6445-22868	0.4	6470.55		
1.4	6089.19	I	3801-20219	0.4	6481.72		
1.6	6101.77	I	6249-22633	0.4	6485.38		
0.8	6110.91			0.8	6488.35		
1.4	6127.77	I	8119-24433	0.4	6495.35		
2.5	6129.72	I	620-16930	1.4	6503.62	I	4276-19648
1.8	6132.61			0.4	6506.32		
0.8	6138.54			1.4	6518.94	I	6249-21585
0.8	6152.25	I	10347-26597	0.4	6520.98		
0.7	6164.50	I	7326-23544	0.6	6526.08		
1.4	6164.77			0.4	6527.04	I	5762-21079
3.5	6171.85	I	7646-23844	0.4	6534.60		
3.0	6175.38	I	4276-20464	1.0	6535.46		
0.7	6181.37	II		0.6	6536.58	II	5667-20962
1.4	6215.37	I	3801-19885	0.8	6542.97	I	7104-22383
1.4	6234.30	I	4276-20312	0.6	6549.88		
1.4	6246.53	I	5762-21766	0.3	6552.75	I	7326-22583
1.4	6254.22	II	6445-22430	1.2	6555.01		
1.2	6268.66	I	8119-24067	0.6	6557.58		
1.0	6279.64	II	5791-21711	0.3	6582.78		
2.5	6280.20	II	5402-21320	0.6	6587.83		
0.6	6291.48			0.9	6590.05	II	5402-20572
1.2	6292.03			0.4	6601.46	I	7646-22790
1.8	6293.32	I	620-16506	0.2	6602.68		
1.6	6298.53	I	3868-19741	0.5	6603.34		
1.2	6322.37			0.9	6603.98	I	7326-22464
0.8	6330.77			2.5	6620.52	I	620-15721
0.6	6336.55			2.5	6621.77		
0.6	6346.27			1.0	6622.82		
2.5	6359.28	I	0-15721	1.0	6625.29	I	5762-20852
5	6372.47	I	3801-19489	0.6	6628.65		
0.5	6373.01			0.8	6647.79		
1.0	6374.78			0.8	6656.81	I	620-15638
0.5	6375.98			0.4	6671.29		
2.5	6378.56			1.4	6676.92		
2.0	6379.64			0.4	6681.15		
0.7	6383.59	I	4453-20114	1.8	6683.38	I	3801-18759
1.0	6386.8			0.4	6691.21	I	10686-25627
2.0	6389.80	I	5991-21637	0.4	6700.83		
0.5	6391.32			0.6	6701.68		
2.5	6392.78	I	0-15638	0.8	6707.59		
8	6395.45	I	0-15632	0.8	6710.57		
1.6	6397.18	I	7006-22633	1.2	6717.51		
0.7	6400.36	II	5402-21021	0.8	6720.84	II	6445-21320
0.8	6411.59	I	7326-22919	0.8	6726.89		

## Uranium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
0.4	6727.96	I	5762-20621	1.0	7371.95	I	5991-19552
1.4	6736.80			3.0	7379.70	II	
0.4	6742.47			1.0	7390.99		
0.6	6754.93	I	8119-22919	1.0	7392.11		
0.4	6768.64			3.0	7396.99	I	4453-17969
0.6	6771.03			1.0	7416.57		
0.8	6776.89			5	7425.50	I	0-13463
0.4	6780.62			2.5	7454.03		
0.4	6782.70			1.0	7510.08		
0.4	6782.85	I	4453-19192	1.0	7517.41		
2.0	6790.30	I	7646-22368	2.0	7528.70		
0.4	6796.46			10	7533.91	I	3801-17070
0.4	d 6808.76			2.5	7550.23		
0.2	6812.98	I	4453-19127	1.6	7580.91		
0.4	d 6813.75			0.7	7587.55		
	6813.81						
1.0	6818.29	I	3868-18531	1.0	7590.54	I	5762-18933
3.5	6820.76	I	4276-18933	1.0	7595.07	I	10686-23849
1.2	6824.56			0.8	7600.27		
14	6826.93	I	0-14644	2.0	7609.16	I	7326-20464
				3.5	7619.35	I	7646-20766
0.6	6832.71	I	7006-21637	1.6	7621.95		
1.0	6846.25	I	6249-20852	2.5	7631.71	I	3801-16900
2.5	h 6869.07			1.6	7634.73	I	7326-20420
5	6876.75			3.0	7639.54	I	4276-17362
1.2	6887.74	I	8119-22633	0.8	7653.61		
1.0	6902.55	I	4276-18759	0.8	7668.73		
1.2	6915.31	I	5762-20219	0.8	7669.69		
2.5	6917.05	I	3801-18254	1.6	7748.19	I	11545-24448
2.5	6948.58	II		1.6	7754.19	I	7326-20219
1.2	6987.72			1.6	7759.87	I	7646-20529
1.2	7015.72	I	8119-22368	2.5	7761.86	I	7006-19885
3.0	7020.71			3.0	7784.13	I	620-13463
1.2	7030.69			1.6	h 7802.40		
2.5	7033.84	I	10347-24560	1.6	7816.32	I	13128-25918
1.2	7073.61			0.7	7832.05		
5	7074.81	I	4276-18406	0.5	7835.71		
2.5	7082.11			2.0	7837.71		
6	7101.63	I	4453-18531	2.0	7844.71		
7	7128.91	I	620-14644	3.0	7868.75	I	3801-16506
1.0	h 7130.09	I	5762-19783	3.0	7875.38		
3.5	7147.89	I	10347-24334	11	7881.94	I	6249-18933
2.0	7164.87	I	4453-18406	2.0	7900.43	I	4276-16930
1.0	7172.10	I	7326-21265	1.4	7904.29	I	8119-20766
2.0	7183.47			1.4	h 7908.00	I	7006-19648
2.0	7194.63			2.0	7918.80	I	4276-16900
1.0	7196.66			1.4	7959.96	I	7326-19885
1.0	7205.45	I	10686-24560	3.0	7963.97		
1.6	7210.29	I	6249-20114	4	7970.46	I	8119-20662
1.6	7218.04			0.7	7974.66		
3.5	7254.47			2.0	7975.09	I	5991-18527

Uranium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
0.7	7975.47			1.4	8357.07		
2.0	7976.88	II		4	8381.86	I	7006-18933
1.4	7991.30	I	6249-18759	1.6	8387.16		
2.0	7998.60	I	13128-25627	2.5	8389.17	I	5991-17908
0.7	8012.96	I	4453-16930	1.6	8396.76		
1.2	8019.38	I	7006-19472	0.8	8402.58		
2.0	8034.79	I	10347-22790	3.5	8441.20	I	7646-19489
0.7	8040.10			8	8445.35	I	3801-15638
1.4	8055.60	I	8119-20529	4	8450.03	I	3801-15632
2.0	8065.47			1.6	8496.09	I	8119-19885
0.7	8065.84			1.6	8504.70	II	6445-18200
2.0	8074.03			2.5	8540.20	I	5762-17468
2.0	8097.62			0.8	8542.32		
1.2	8126.23			1.6	8557.34	I	10686-22368
1.4	8137.21	I	10347-22633	1.6	8567.73	I	4453-16122
1.4	8153.71	I	13128-25389	3.5	8570.51	I	8119-19783
3.5	8174.30	I	4276-16506	1.6	8574.61	I	6249-17908
1.4	8175.85	I	0-12228	17	8607.94	I	0-11614
2.0	8188.20			0.8	8618.96		
1.4	8210.27			2.0	8641.12		
1.4	8230.83	I	5762-17908	1.6	8659.52		
0.7	8240.51	I	5762-17894	5	8691.28		
4	8262.05	I	8119-20219	1.0	8702.08		
0.8	8307.56			4	8710.77	I	5991-17468
1.6	8310.61			4	8753.69	I	10347-21768
3.5	8318.34			7	8757.75		
1.4	8329.73			1.8	8787.37		
3.5	8337.46			2.0	8816.56		
2.5	8346.74	I	5991-17969				

# VANADIUM

$$V, Z=23, M=50.95, \text{Ratio } \frac{V}{Cu}=0.802$$

V I Normal state of valence electrons  $3d^3 4s^2 {}^4F_{1/2}=0$ . I.P. = 54361 K  
 V II Normal state of valence electrons  $3d^4 {}^5D_0=0$ . I.P. = 118200 K

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## Relative intensity of vanadium lines observed in an arc of copper containing 0.1 atomic percent vanadium

### Strong lines of vanadium

Intensity	Wavelength Å	Spectrum	Energy levels K	Term combination
950	4379. 24	I	2425-25254	$3d^4 4s^1 a {}^6D_{4/2} - 3d^4 4p^1 y {}^6F_{5/2}$
700	3183. 98	{I	323-31722	$3d^3 4s^2 a {}^4F_{3/2} - 3d^3 4s^1 4p^1 x {}^4G_{3/2}$
700	4111. 78	I	0-31398	$3d^3 4s^2 a {}^4F_{1/2} - 3d^3 4s^1 4p^1 x {}^4G_{5/2}$
550	4384. 72	I	2425-26738	$3d^4 4s^1 a {}^6D_{4/2} - 3d^4 4p^1 y {}^6D_{3/2}$
500	3093. 11	II	2311-25112	$3d^4 4s^1 a {}^6D_{3/2} - 3d^4 4p^1 y {}^6F_{1/2}$
500	3185. 40	I	3163-35483	$3d^3 4s^1 a {}^5F_5 - 3d^3 4p^1 z {}^5G_6$
420	3183. 41	I	553-31937	$3d^3 4s^2 a {}^4F_{4/2} - 3d^3 4s^1 4p^1 x {}^4G_{5/2}$
400	3102. 30	II	137-31541	$3d^3 4s^2 a {}^4F_{2/2} - 3d^3 4s^1 4p^1 x {}^4G_{3/2}$
400	3703. 58	I	2968-35193	$3d^3 4s^1 a {}^5F_4 - 3d^3 4p^1 z {}^5G_5$
380	4389. 97	I	2425-29418	$3d^4 4s^1 a {}^6D_{4/2} - 3d^4 4p^1 y {}^6P_{3/2}$
360	4408. 51	{I	2220-24993	$3d^4 4s^1 a {}^6D_{2/2} - 3d^4 4p^1 y {}^6F_{3/2}$
340	3110. 71	II	2153-24830	$3d^4 4s^1 a {}^6D_{1/2} - 3d^4 4p^1 y {}^6F_{1/2}$
340	4115. 18	I	2112-24789	$3d^4 4s^1 a {}^6D_{0/2} - 3d^4 4p^1 y {}^6F_{0/2}$
320	2908. 82	II	2809-34947	$3d^3 4s^1 a {}^5F_3 - 3d^3 4p^1 z {}^5G_4$
320	2924. 02	II	2311-26605	$3d^4 4s^1 a {}^6D_{3/2} - 3d^4 4p^1 y {}^6D_{3/2}$
320	3066. 38	I	3163-37531	$3d^3 4s^1 a {}^5F_5 - 3d^3 4p^1 z {}^5D_4$
320	3855. 84	I	3163-37352	$3d^3 4s^1 a {}^5F_5 - 3d^3 4p^1 z {}^5F_5$
280	3840. 75	I	553-33155	$3d^3 4s^2 a {}^4F_{4/2} - 3d^3 4s^1 4p^1 w {}^4F_{4/2}$
280	4395. 23	I	553-26480	$3d^3 4s^2 a {}^4F_{4/2} - 3d^4 4p^1 y {}^4D_{3/2}$
280	4408. 20	I	323-26353	$3d^3 4s^2 a {}^4F_{3/2} - 3d^4 4p^1 y {}^4D_{5/2}$
260	3118. 38	II	2153-24899	$3d^4 4s^1 a {}^6D_{1/2} - 3d^4 4p^1 y {}^6F_{2/2}$
240	4128. 07	I	2220-24899	$3d^4 4s^1 a {}^6D_{2/2} - 3d^4 4p^1 y {}^6F_{2/2}$
240	4132. 02	I	2687-34746	$3d^3 4s^1 a {}^5F_2 - 3d^3 4p^1 z {}^5G_3$
220	2924. 64	II	2220-26438	$3d^4 4s^1 a {}^6D_{2/2} - 3d^4 4p^1 y {}^6D_{1/2}$
220	4099. 80	I	2311-26506	$3d^4 4s^1 a {}^6D_{3/2} - 3d^4 4p^1 y {}^6D_{2/2}$
220	4105. 17	I	2968-37151	$3d^3 4s^1 a {}^5F_4 - 3d^3 4p^1 z {}^5F_4$
220	4407. 64	I	2220-26605	$3d^4 4s^1 a {}^6D_{2/2} - 3d^4 4p^1 y {}^6D_{3/2}$
220	4407. 64	I	2153-26506	$3d^4 4s^1 a {}^6D_{1/2} - 3d^4 4p^1 y {}^6D_{2/2}$
220	4407. 64	I	2311-24993	$3d^4 4s^1 a {}^6D_{3/2} - 3d^4 4p^1 y {}^6F_{3/2}$

Vanadium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
5	2092.44	I	553-48329	14	2549.28	II	11908-51123
2.5	2384.00	II	8842-50775	16	2552.65	I	137-39300
2.5	2384.28	I	0-41928	12	2552.96	II	13609-52767
4	2386.96	I	10892-52774	5	2553.67	II	11515-50662
4	2388.92	I	11101-52948	7	2554.86	I	137-39267
5	2390.87	I	137-41950	5	2558.90	I	323-39391
5	2391.26	I	2220-44026	28	2562.13	I	323-39342
6	2392.90	I	2425-44203	10	h 2564.23	I	15265-54251
5	2397.78	I	553-42246	15	2564.82	I	323-39300
5	2398.27	I	553-42237	5	2568.39	I	
5	2399.96	I	0-41655	30	2574.02	I	553-39391
10	2406.75	I	323-41861	6	2577.29	I	553-39342
9	2407.90	I	137-41655	12	2620.29	I	8716-46868
8	2412.69	I	323-41758	19	2630.67	II	14656-52658
6	2413.03	I	0-41429	5	2640.69	I	9825-47683
11	2415.33	I	0-41389	17	2642.21	II	14556-52392
11	2416.75	I	553-41918	6	2643.16	I	137-37960
8	2417.35	I	137-41492	6	2644.36	II	34746-72551
9	2420.12	I	553-41861	20	2645.26	I	323-38116
9	2421.06	I	137-41429	11	2645.84	II	14462-52246
9	2421.98	I	323-41599	12	2647.71	I	0-37757
4	2423.38	I	137-41389	19	2651.90	I	137-37835
11	2428.28	I	323-41492	6	2652.92	I	15265-52948
8	2432.02	I	323-41429	6	2653.83	I	15104-52774
12	2435.52	I	553-41599	7	2655.68	II	35193-72837
6	2439.10	I	553-41539	20	2656.22	I	323-37960
4	2441.89	I	553-41492	4	2658.98	II	14656-52253
9	2479.05	II	13543-53869	4	2659.61	II	17911-55499
6	2479.52	II	13609-53927	24	2661.42	I	553-38116
6	2482.31	II	11908-52181	4	2665.96	I	0-37499
18	2501.61	I	0-39962	4	2671.67	I	137-37556
8	2503.02	II	8640-48580	38	2672.00	II	107-37521
10	2503.30	I	0-39935	5	2673.23	II	
9	2506.22	II	8842-48731	50	2677.80	II	36-37369
20	2506.90	I	0-39878	36	2678.57	II	209-37531
32	2507.78	I	137-40001	50	2679.32	II	209-37521
24	2511.65	I	323-40126	24	2682.87	II	107-37369
24	2511.95	I	137-39935	24	2683.09	II	0-37259
10	2514.64	II	9098-48853	6	2685.14	I	9637-46868
9	2515.15	I	137-39884	9	2685.69	II	36-37259
24	2517.14	I	323-40039	6	2686.36	I	9637-46851
32	2519.62	I	323-40000		2686.51	I	553-37765
55	2526.22	I	553-40126	140	2687.96	II	339-37531
28	2527.90	II	12706-52253	22	2688.72	II	339-37521
16	2528.47	II	12545-52083	20	2689.88	II	36-37201
20	2528.84	II	12622-52154	30	2690.24	II	209-37369
32	2530.18	I	553-40064	32	2690.79	II	107-37259
4	2534.52	II	11296-50739	16	2696.99	I	10893-47960
8	2545.98	I	0-39267	16	2697.74	I	11101-48158
8	2548.69	II	11515-50739	6	2698.73	I	9825-46868



Vanadium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
4	2699.11	I	9825-46863	14	2847.57	II	20242-55350
90	2700.94	II	339-37352	9	2848.77	I	0-35092
50	2702.19	II	209-37205	4	2849.05	II	13491-48580
6	2705.22	II	0-36955	9	2849.18	I	137-35225
70	2706.17	II	209-37151	10	2850.69	II	22274-57343
					2850.77	II	14656-49724
20	2706.70	II	107-37041				
14	2707.86	II	36-36955	18	2852.87	I	13802-48845
22	2711.74	II	339-37205	18	2854.34	II	20280-55304
8	2713.05	II	107-36955	26	2855.22	I	0-35013
16	2714.20	II	209-37041	8	h 2857.94	I	9637-44617
85	2715.69	II	107-36919	24	2859.97	I	137-35092
20	2722.56	I	10893-47612	32	2864.36	I	323-35225
4	2723.22	II	209-36919	10	2866.42	I	9825-44701
32	2728.64	II	36-36674	22	2866.59	I	15104-49978
24	2731.35	I	11101-47702	28	2868.10	I	15265-50121
5	2733.90	II	107-36674	18	2869.13	II	20363-55207
13	2739.71	II	0-36489	4	2869.96	II	2687-37521
12	2742.41	II	36-36489	28	2870.55	I	553-35379
4	2742.67	II	3163-39613	14	2877.69	II	14462-49202
8	2747.48	II	19113-55499	14	2879.16	II	2809-37531
19	2753.40	II	19192-55499	46	2880.03	II	2809-37521
8	2760.12	II	13512-49731	50	2882.50	II	2687-37369
12	2760.70	II	19192-55403	50	2884.78	II	2605-37259
18	2765.67	II	12706-48853	19	2888.25	II	14656-49269
8	2766.46	II	13595-49731	50	2889.62	II	2605-37201
11	2768.56	II	12622-48731	120	2891.64	II	2687-37259
6	2773.68	I	11101-47143	70	2892.44	II	2968-37531
12	2774.28	II	12545-48580	120	2892.66	II	2809-37369
6	2774.72	II	19113-55142	190	2893.32	II	2968-37521
6	2775.76	II	19192-55207	8	2894.58	I	0-34537
18	2777.73	II	13742-49731	48	2896.21	II	2687-37205
7	2783.78	I	13811-49723	12	2899.20	I	137-34620
3.5	2785.54	I	14515-50404	15	2899.60	I	0-34477
7	2785.69	I	13802-49689	48	2903.08	II	2605-37041
9	2797.02	II	16341-52083	8	2903.70	I	0-34429
10	2797.80	II	16422-52154	11	2904.13	I	323-34747
11	2798.76	II	16533-52253	20	2906.13	I	137-34537
12	2799.45	II	13491-49202	120	2906.46	II	2809-37205
12	2802.80	II	13543-49211	65	2907.47	II	2968-37352
16	2803.47	II	13609-49269	6	2908.44	II	20343-54716
4	2805.54	II	18294-53927	320	2908.82	II	3163-37531
12	2810.16	II	18294-53869	95	2910.02	II	2687-37041
12	2810.27	II	18354-53927	70	2910.39	II	2605-36955
8	2817.50	II	18269-53751	75	2911.06	II	2809-37151
8	2836.52	II	13609-48853	7	2914.30	I	16573-50876
4	2838.06	I	0-35225	50	2914.93	I	323-34620
8	2841.04	II	13543-48731			I	16729-51026
4	2844.93	I	14549-49689	8	2915.33	I	137-34429
6	2845.24	II	20363-55499	6	h 2916.02	I	10893-45176
16	2846.57	I		16	2917.37	II	2687-36955

Vanadium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
8	2917.93	I	11101-45361	9	3031.01	I	10893-43875
28	2919.99	II	2968-37205	36	3033.45	II	20363-53320
50	2920.38	II	2687-36919	38	3033.82	II	14656-47608
95	2923.62	I	553-34747	6	3041.42	II	16341-49211
320	2924.02	II	3163-37352	12	3042.26	II	16341-49202
220	2924.64	II	2968-37151	30	3043.12	I	137-32989
8	2926.26	I	323-34487	30	3043.56	I	0-32847
7	2930.13	II	14462-48580	30	3044.94	I	323-33155
95	2930.81	II	2809-36919	30	3048.22	II	20280-53077
9	2932.32	II	20623-54716	12	3048.89	II	16422-49211
28	2934.40	II	2605-36674	6	3050.40	I	11101-43874
15	2935.87	I	323-34375	22	3050.89	I	0-32768
12	2937.69	I	137-34168	9	3052.19	I	137-32891
4	2938.25	II	14556-48580	24	3053.39	II	14556-47297
120	2941.37	II	3163-37151	60	3053.65	I	0-32738
60	2941.49	II	2687-36674	9	3053.89	II	16533-49269
30	2942.33	I	553-34530	160	3056.33	I	137-32847
	2942.35	I	0-33976	190	3060.46	I	323-32989
30	2943.20	I	0-33967	19	3063.25	II	20242-52878
140	2944.57	II	2968-36919	320	3066.38	I	553-33155
15	2946.53	I	137-34066	26	3067.12	II	14462-47056
8	2949.17	II	22274-56171	18	3069.64	I	323-32891
30	2949.63	I	137-34030	22	3073.82	I	323-32847
40	2950.35	II	2605-36489	13	3075.27	I	15104-47612
85	2952.08	II	2809-36674	20	3082.11	I	553-32989
16	2954.33	I	137-33976	6	3087.06	I	9545-41928
12	2955.80	I	553-34375	12	3088.11	I	9637-42010
11	2957.33	I	323-34128	6	3089.13	I	9637-41999
34	2957.52	II	2687-36489	500	3093.11	II	3163-35483
55	2962.77	I	323-34066	26	3094.20	II	16422-48731
80	2968.38	II	13742-47420	7	3094.69	I	9545-41848
16	2972.25	II	19133-52767	24	3100.94	II	16341-48580
6	2974.22	I	9637-43249	400	3102.30	II	2968-35193
12	2975.65	II	13512-47108	340	3110.71	II	2809-34947
16	2976.20	II	13512-47102	12	3113.57	II	23391-55499
50	2976.52	II	13595-47181	260	3118.38	II	2687-34746
32	2977.54	I	553-34128	10	3120.73	II	20623-52658
8	2981.20	II	19166-52700	50	3121.14	II	3163-35193
12	2988.02	II	13595-47052	20	3122.90	II	23391-55403
6	2989.60	II	13742-47181	200	3125.28	II	2605-34593
10	2994.54	II	30673-64057	34	3126.22	II	2968-34947
10	2996.00	II	13512-46880	70	3130.27	II	2809-34746
6	2999.24	I	9637-42969	55	3133.33	II	2687-34593
34	3001.20	II	13742-47052	28	3134.93	II	20363-52253
12	3003.46	II	13595-46880	20	3136.51	II	20280-52154
6	3008.61	II	13512-46740	20	3139.74	II	20242-52083
12	3013.10	II	13512-46690	26	3142.48	II	17911-49724
18	3014.82	II	13595-46755	20	3145.34	II	3163-34947
10	3016.16	I	9825-42969	7	3145.97	II	2968-34746
24	3016.78	II	13742-46880	6	3146.23	II	20617-52392

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Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
5	3151.32	II	20522-52246	14	3377.62	I	9825-39423
5	3164.83	II	8842-40430	22	3400.40	I	8716-38116
7	3168.14	II	8640-40196	7	3402.57	I	8579-37960
420	3183.41	I	137-31541	7	3417.06	I	8579-37835
700	3183.98	I	323-31722	6	3418.52	I	8716-37960
		I	0-31398				
500	3185.40	I	553-31937	15	3425.07	I	
55	3187.71	II	8640-40002	15	3485.92	II	8842-37521
70	3188.51	II	8842-40196	6	3489.47	I	17242-45892
100	3190.68	II	9098-40430	7	3493.17	II	8640-37259
				12	3497.03	II	20981-49568
7	3193.92	I	15063-46363	5	3500.82	I	19145-47702
70	3198.01	I	137-31398	28	3504.44	II	8842-37369
7	3199.82	I	15001-46244	7	3505.69	I	13802-42318
100	3202.38	I	323-31541	75	3517.30	II	9098-37521
60	3205.58	I	10893-42079	20	3520.02	II	8640-37041
60	3207.41	I	553-31722	15	3524.72	II	8842-37205
10	3208.35	II	8842-40002	30	3529.74	I	9637-37960
55	3212.43	I	11101-42221	30	3530.77	II	8640-36955
10	3214.75	II	9098-40196	75	3533.68	I	9825-38116
28	3217.11	II	16533-47608	15	3543.50	I	9545-37757
		I	323-31398				
5	3218.87	I	10893-41950	75	3545.20	II	8842-37041
7	3233.19	I	11101-42021	15	3553.27	I	9825-37960
20	3237.87	II	16422-47297	7	3556.25	I	17242-45354
7	3249.57	I	553-31318	75	3556.80	II	9098-37205
				7	3560.60	II	8842-36919
7	3250.78	II	23391-54144	15	3566.18	I	8579-36612
5	3251.87	II	20343-51086			II	8640-36674
18	3254.77	II	16340-47056	7	3568.94	I	17055-45067
5	3255.65	I	8716-39423	7	3571.04	I	17242-45237
18	3263.24	I	0-30636	12	3571.65	I	17117-45107
140	3267.70	II	8640-39234	12	3573.52	I	17182-45158
120	3271.12	II	8842-39404	7	3577.87	I	17117-45059
12	3271.64	I	137-30694	7	3582.81	I	17242-45145
10	3273.03	I	10893-41437	75	3589.76	II	8640-36489
100	3276.12	II	9098-39613	65	3592.02	II	8842-36674
14	3279.84	II	19113-49593	75	3592.53	I	
7	3282.53	II	19113-49568	36	3593.33	II	9098-36919
12	3283.31	I	323-30771	6	3605.59	I	
7	3284.36	I	11101-41539	15	3606.69	I	10893-38611
12	3289.39	II	8842-39234	7	3616.72	I	
19	3298.14	I	553-30864	6	3637.76	I	
12	3298.74	II	9098-39404	15	3639.02	I	14549-42021
7	3309.18	I	9637-39847	7	3643.86	I	14515-41950
7	d 3321.54	II	19113-49211	15	3644.71	I	11101-38530
	3321.68	I	15265-45361	12	3648.97	I	16450-43847
14	3329.86	I	9825-39847	12	3656.71	I	16573-43912
12	3356.35	I	9637-39423	26	3663.59	I	16361-43649
14	3365.55	I	9545-39249	8	3665.14	I	16729-44005
7	3376.06	I	9637-39249	26	3667.74	I	16450-43707
7	3377.39	I	9637-39237	12	3669.41	II	20363-47608

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Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
18	3671.20	I	10893-38124	4	3781.39	I	15572-42010
10	3672.40	I	16917-44140	7	3787.14	I	15104-41501
30	3673.40	I	16573-43788	55	3790.32	I	2220-28596
30	3675.70	I	2220-29418	10	3793.61	I	0-26353
18	3676.68	I	17136-44327	120	3794.96	I	2425-28768
32	3680.11	I	16729-43894	60	3799.91	I	2153-28462
60	3683.13	I	2153-29296	60	3803.47	I	2311-28596
20	3686.26	I	11101-38221	9	d 3803.78	I	10893-37175
50	3687.47	I	16917-44028		3803.90	I	323-26605
140	3688.07	I	2311-29418	20	3806.80	I	11101-37362
110	3690.28	I	2112-29203	32	3807.50	I	2112-28369
160	3692.22	I	2220-29296	55	3808.52	I	0-26249
48	3695.34	I	17136-44190	24	3809.60	I	2220-28462
110	3695.86	I	2153-29203	110	3813.49	I	137-26353
400	3703.58	I	2425-29418	10	3815.51	I	2112-28314
190	3704.70	I	2311-29296	15	d 3817.84	I	553-26738
60	3705.04	I	2220-29203		3817.98	I	11101-37285
10	3706.04	I	15104-42079	140	3818.24	I	0-26183
14	3708.72	I	15265-42221	24	3819.96	I	2425-28596
4	3713.96	I	553-27471	24	3821.49	I	2153-28314
34	3715.47	II	12706-39613	60	3822.01	I	323-26480
5	3718.91	I		48	3822.89	I	2311-28462
5	3722.00	I	15001-41861	32	3823.21	I	2220-28369
5	3722.20	I	18198-45057	7	3823.99	I	8476-34620
26	3727.34	II	13609-40430	5	3826.77	I	8413-34537
5	3728.34	II	20242-47056	180	3828.56	I	137-26249
6	3729.04	I	14949-41758	5	3830.27	I	
30	3732.76	II	12622-39404	3.0	3832.84	I	13802-39884
16	3734.43	I	15078-41848	30	3834.22	I	13811-39884
5	3737.99	I	14910-41655	8	3835.56	I	8413-34477
9	3738.76	I	15270-42010	8	3836.05	I	8476-34537
4	3740.24	I	15270-41999	17	3839.00	I	8579-34620
10	3741.50	I	18438-45158	12	3839.38	I	14549-40587
24	3745.80	II	12545-39234	8	3840.14	I	10893-36926
4	3747.98	I	15572-42246	60	3840.44	I	8716-34747
22	3750.87	II	13543-40196	280	3840.75	I	323-26353
4	3751.78	I	8579-35225	12	3841.89	I	323-26345
4	3753.27	I	13802-40437	40	3844.44	I	0-26004
4	3755.70	I	18302-44921	34	3847.33	I	137-26122
4	3759.32	I	20830-47423	12	3849.32	I	
5	3761.44	I	15270-41848	8	3851.17	I	8579-34537
9	3763.14	I	15572-42138	4	3852.10	I	8476-34429
4	3769.07	I	13802-40326	130	3855.37	I	0-25931
22	3770.97	II	13491-40002	320	3855.84	I	553-26480
4	3774.11	I	13811-40300	7	3858.68	I	8579-34487
4	3775.19	I	15270-41752	8	3859.34	I	8716-34620
4	3775.72	I	18680-45158	16	3862.22	I	137-26022
4	3776.16	I	15771-42246	14	3863.87	I	10893-36766
28	3778.68	I	2311-28768	140	3864.86	I	137-26004
5	3779.65	I	10893-37343	24	3867.60	I	323-26172

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Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
4	3870.58	I	15771-41599	8	3973.64	II	11515-36674
18	3871.08	I	11101-36926	4	3979.14	I	20768-45892
7	3873.64	I	10893-36701	4	3979.42	I	19023-44146
160	3875.08	I	323-26122	4	3980.52	I	
44	3875.90	I	137-25931	4	3984.34	I	14910-40001
60	3876.09	I	553-26345	7	3984.60	I	14949-40039
14	3878.71	II	14656-40430	7	3988.83	I	15001-40064
3.0	3883.89	I	15689-41429	42	3990.57	I	14949-40001
7	3886.59	I	11101-36823	20	3992.80	I	15001-40038
55	3890.18	I	323-26022	4	3997.12	II	11908-36919
7	h 3891.12	I		34	3998.73	I	15063-40064
36	3892.86	I	323-26004	13	4005.71	II	14656-39613
7	3894.04	I	18174-43847	4	4023.17	I	15270-40119
7	3896.16	I	8716-34375	9	4023.39	II	14556-39404
7	3897.08	I	18259-43912	9	4031.83	I	19078-43874
22	h 3898.02	I	18680-44327	12	4035.63	II	14462-39234
11	3899.13	II	14556-40196	9	4042.64	I	15270-40000
11	h 3900.18	I	18372-44005	4	4048.62	I	137-24830
11	h 3901.15	I	18513-44140	28	4050.96	I	17182-41861
190	3902.25	I	553-26172	28	4051.35	I	17242-41918
4	3903.26	II	11908-37521	4	4053.26	I	15270-39935
4	3904.47	I	14515-40119	22	4057.07	I	17117-41758
8	3906.75	I	8579-34168	10	4057.82	I	15689-40326
55	3909.89	I	553-26122	18	4063.93	I	17055-41655
8	3910.79	I	8413-33976	18	4071.54	I	15572-40126
17	3912.21	I	8413-33967	5	4082.93	I	9545-34030
4	3912.89	I	8579-34128	90	4090.58	I	8716-33155
11	3914.33	II	14462-40002	4	4091.94	I	9545-33976
8	3916.41	II	11515-37041	14	4092.41	I	9637-34066
8	3920.49	I	8476-33976	140	4092.69	I	2311-26738
8	3921.90	I	8476-33967	9	4093.50	I	9545-33967
18	3922.43	I	8579-34066	5	4094.28	I	17242-41660
19	3924.66	I	15063-40536	70	4095.49	I	8579-32989
12	3925.24	I	19026-44495	220	4099.80	I	2220-26605
16	3927.93	I	15001-40452	46	4102.16	I	8476-32847
20	3930.02	I	11101-36539	18	4104.40	I	17242-41599
12	3931.34	I	14949-40379	20	4104.78	I	15771-40126
20	3934.01	I	8716-34128	220	4105.17	I	2153-26506
12	3935.14	I	14910-40315	5	4107.49	I	9637-33976
8	3936.28	I	8579-33976	9	4108.22	I	17055-41389
4	3937.53	I	15063-40452	180	4109.79	I	2112-26438
4	3938.20	I	19078-44463	700	4111.78	I	2425-26738
4	3939.33	I	15001-40379	9	4112.33	I	17182-41492
3.0	3941.25	I	14949-40315	18	4113.52	I	9825-34128
7	3942.01	I	11101-36461	5	4114.53	I	15665-39962
12	3943.66	I	8716-34066	340	4115.18	I	2311-26605
8	3950.23	I		140	4116.47	I	2220-26506
11	3951.97	II	11908-37205	14	4118.18	I	15724-40000
7	3963.63	I		14	4118.64	I	8716-32989
4	3968.09	II	11296-36489	18	4119.46	I	8579-32847

Vanadium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
14	4120.54	I	8476-32738	13	4297.68	I	17117-40379
14	4123.19	I	15689-39935	13	4298.03	I	17055-40315
160	4123.57	I	2153-26397	13	4306.21	I	137-23353
9	4124.07	I	9825-34066	11	4307.18	I	0-23211
240	4128.07	I	2220-26438	13	4309.80	I	323-23520
9	4128.86	I	15665-39878	3.0	4313.89	I	14949-38124
240	4132.02	I	2311-26506	36	4330.02	I	0-23088
180	4134.49	I	2425-26605	40	4332.82	I	137-23211
5	4136.11	I	15078-39249	3.0	4334.09	I	9825-32891
5	4139.26	I	15270-39423	60	4341.01	I	323-23353
3.5	4150.67	I		4	4342.83	I	15104-38124
3.5	4152.66	I		80	4352.87	I	553-23520
12	4159.69	I	2311-26345	10	4354.98	I	15265-38221
5	4171.30	I	15270-39237	12	4355.94	I	137-23088
8	4174.01	I	13802-37753	4	4363.52	I	2220-25131
18	4179.42	I	2425-26345	4	4364.22	I	17055-39962
12	4182.59	I	2220-26122	12	4368.04	I	323-23211
14	4189.84	I	2311-26172	4	4368.60	I	17117-40001
14	4191.56	I	2153-26004	11	d 4373.23	I	21603-44463
5	4197.60	I	15265-39081	6	4373.83	I	17182-40039
5	4198.61	I	2311-26122	8	4375.30	I	21646-44495
4	4200.19	I	2220-26022	950	4379.24	I	2425-25254
18	4209.86	I	2425-26172	8	4380.55	I	17242-40064
5	4218.71	I	2425-26122	550	4384.72	I	2311-25112
5	4224.14	I	15724-39391	380	4389.97	I	2220-24993
9	4226.62	I	15689-39342	7	4392.07	I	2153-24915
4	4227.74	I	13811-37458	3.5	4393.09	I	15078-37835
4	4229.69	I	15665-39300	3.5	4393.84	I	8476-31229
28	4232.46	I	15771-39391	280	4395.23	I	2153-24899
14	4232.95	I	15724-39342	110	4400.58	I	2112-24830
14	4234.00	I	15689-39300	6	4403.67	I	15063-37765
4	4234.52	I	0-23609	7	h 4406.15	I	8579-31268
9	4235.76	I	15665-39267	180	4406.64	I	2425-25112
4	4240.36	I	15724-39300	220	4407.64	I	2311-24993
8	4257.37	I	15001-38483	280	4408.20	I	2220-24899
9	4259.31	I	137-23609	360	4408.51	I	2153-24830
9	4262.16	I	14949-38405			I	2112-24789
4	h 4265.17	I		11	4412.14	I	2112-24771
44	4268.64	I	15063-38483	3.5	4415.06	I	15001-37644
4	4269.76	I	14910-38324	50	4416.47	I	2153-24789
4	4270.32	I	14549-37960	9	4419.94	I	2220-24839
36	4271.55	I	15001-38405	50	4421.57	I	2220-24830
36	4276.96	I	14949-38324	7	4423.21	I	8716-31318
3.5	4282.91	I	15063-38405	2.5	4423.91	I	20813-43411
34	4284.06	I	14910-38246	3.5	4424.56	I	11101-33695
4	4286.42	I	15001-38324	7	4425.71	I	14910-37499
3.5	4287.81	I		36	4426.00	I	2311-24899
3.0	4291.30	I	14949-38246	9	4427.31	I	21603-44184
26	4291.82	I	17242-40536	24	4428.52	I	2153-24728
17	4296.11	I	17182-40452	18	4429.80	I	2425-24993

Vanadium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
2.5	4430.50	I	15270-37835	16	4571.78	I	15689-37556
7	4434.60	I	15572-38116	40	4577.17	I	0-21841
34	4436.14	I	2112-24648	11	4578.73	I	15665-37499
50	4437.84	I	2311-24839	2.5	4579.19	I	15724-37556
65	4441.68	I	2220-24728	50	4580.40	I	137-21964
7	4443.34	I	21646-44146	4	4583.78	I	15689-37499
50	4444.21	I	2153-24648	65	4586.36	I	323-22121
5	4449.57	I	10893-33360	13	4591.22	I	19145-40920
5	4450.90	I	19078-41539	100	4594.11	I	553-22314
48	4452.01	I	15063-37518	8	4606.15	I	137-21841
2.0	4452.70	I	14910-37362	2.5	4609.65	I	11101-32788
3.0	h 4456.50	I		2.0	4611.74	I	15665-37343
32	4457.48	I	2220-24648	18	4619.77	I	323-21964
9	4457.76	I	15104-37530	5	4624.41	I	8476-30095
80	4459.76	I	2311-24728	4	4626.48	I	8413-30022
160	4460.29	I	2425-24839	8	4635.18	I	553-22121
6	4460.99	I	19026-41437	5	4640.07	I	8476-30022
48	4462.36	I	15001-37404	5	4640.74	I	8579-30121
3.0	4464.27	I	19145-41539	10	4646.40	I	8579-30095
3.0	4464.75	I	15724-38116	2.5	4648.89	I	19189-40694
3.0	4465.50	I	15572-37960	2.5	4666.14	I	15270-36695
9	4468.01	I	14910-37285	12	4670.49	I	8716-30121
3.0	4468.76	I	15104-37475	1.8	4684.45	I	15270-36612
30	4469.71	I	14949-37316	2.5	4686.92	I	15078-36408
9	4474.04	I	15771-38116	4	4706.16	I	15572-36815
16	4474.71	I	15265-37606	6	4706.57	I	17242-38483
2.0	4475.89	I	14949-37285	6	4710.56	I	17182-38405
6	4480.04	I	15001 37316	5	4714.12	I	17117-38324
30	4488.89	I	14910-37181	2.5	4715.89	I	19026-40225
6	4490.80	I	14949-37211	4	4717.69	I	17055-38246
8	4496.06	I	15724-37960	3.0	4721.51	I	15724-36898
5	4496.85	I	14949-37181	3.0	4722.86	I	15771-36938
3.0	4497.40	I	21646-43875	3.0	4729.53	I	15270-36408
9	4501.95	I	11101-33307	2.0	4730.38	I	15689-36823
6	4514.19	I	15689-37835	2.0	4742.63	I	18805-39884
11	4524.22	I	15265-37362	1.8	4746.63	I	16361-37423
3.0	4525.16	I	15665-37757	3.0	4748.52	I	16450-37503
3.0	4527.99	I		3.5	4750.98	I	16573-37615
3.0	4529.30	I	15270-37343	2.5	4751.56	I	15572-36612
6	4529.59	I	15104-37175	3.0	4753.93	I	16729-37758
3.0	4530.79	I		5	4757.48	I	16361-37375
3.0	4533.92	I		4	4766.63	I	16450-37423
3.0	4537.66	I	14549-36580	10	4776.36	I	16573-37503
3.0	4540.01	I	15265-37285		4776.52	I	19189-40119
28	4545.39	I	15771-37765	8	4786.51	I	16729-37615
8	4549.65	I		10	4796.92	I	16917-37758
2.0	4551.84	I	14515-36478	1.4	4799.77	I	0-20828
7	4553.05	I	19023-40981	10	4807.53	I	17136-37931
22	4560.71	I	15724-37644	10	4827.45	I	323-21033
5	4570.42	I	15771-37644	11	4831.64	I	137-20828

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Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
9	4832.43	I	0-20688	2.0	5418.09	I	19023-37475
1.4	4833.02	I	13802-34487	3.5	5424.08	I	19026-37458
1.4	4848.81	I	21603-42221	3.0	5434.18	I	19078-37475
24	4851.48	I	0-20606	0.8	5437.66	I	19145-37530
2.5	4862.61	I	20830-41389	1.2	5458.12	I	19026-37343
36	4864.74	I	137-20688	0.9	5471.33		
1.6	4871.26	I	17242-37765	1.8	5487.22	I	14549-32768
46	4875.48	I	323-20828	6	5487.92	I	19145-37362
4	4880.56	I	9637-30121	1.8	5489.94	I	14515-32725
55	4881.56	I	553-21033	2.0	5504.87	I	13802-31962
2.0	4891.60	I		5	5507.75	I	19023-37175
1.6	4894.21	I	17055-37481	1.0	5511.18	I	19145-37285
4	4900.62	I	17117-37517	1.6	5545.93	I	8579-26605
7	d 4904.29	I	9637-30022	5	5547.07	I	8716-26738
	4904.34	I	17242-37626	2.5	5558.75	I	13802-31786
6	4925.65	I	9825-30121	2.0	5561.66	I	13811-31786
2.5	4932.03	I	9825-30095	10	5584.50	I	8579-26480
1.6	4966.12	I	23935-44066	1.6	5586.00	I	15001-32898
5	5002.33	I	19023-39009	7	5592.42	I	8476-26353
6	5014.62	I	19145-39081	2.0	5601.38	I	19078-36926
2.0	5051.63	I	21646-41437	5	5604.94	I	8413-26249
2.5	5064.12	I		0.9	5624.20	I	18805-36580
2.5	5105.14	I		14	5624.60	I	8579-26353
8	5128.53	I	18438-37931	5	5624.89	I	8476-26249
8	5138.42	I	18302-37758	4	5626.01	I	8413-26183
1.8	5139.53	I	19078-38530	28	5627.64	I	8716-26480
5	5148.72	I	18198-37615	0.9	5632.46	I	553-18302
3.0	5159.35	I	18126-37503	0.7	5633.90	I	19078-36823
1.6	5169.94	I	18086-37423	0.9	5635.51	I	19026-36766
5	5176.77	I		6	5646.11	I	8476-26183
1.4	5192.01	I	18120-37375	8	5657.44	I	8579-26249
8	5192.99	I	18680-37931	8	5668.36	I	8716-26353
1.6	5193.62	I	18174-37423	22	5670.85	I	8716-26345
8	5194.83	I	18259-37503	1.4	5683.22	I	
4	5195.36	I	18372-37615	85	5698.52	I	8579-26122
1.4	5206.61	I	18174-37375	65	5703.56	I	8476-26004
3.0	5216.59	I	18259-37423	40	5706.98	I	8413-25931
2.5	5225.77	I	18372-37503	0.8	5708.95	I	19189-36701
2.5	5233.75	I	18513-37615	0.8	h 5716.21	I	
8	5234.07	I	19023-38124	5	5725.64	I	19078-36539
1.4	5240.20	I	18680-37758	60	5727.03	I	8716-26172
8	5240.87	I	19145-38221	12	5727.66	I	8476-25931
1.2	5260.98	I	18438-37441	16	5731.25	I	8579-26022
3.0	5353.41	I	19078-37753	3.0	5734.01	I	19026-36461
2.5	5383.43	I	20828-39399	16	5737.06	I	8579-26004
3.0	5385.14	I	21033-39597	8	5743.45	I	8716-26122
1.0	5388.30	I	20688-39241	1.2	5747.70	I	19145-36539
0.8	5397.87	I	20606-39127	3.0	5748.87	I	15270-32660
7	5401.93	I	19023-37530	1.2	5752.74	I	15078-32456
10	5415.26	I	19145-37606	1.2	5761.41	I	8579-25931



Vanadium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
5	5772.42	I	15572-32891	1.2 h	6282.33	I	17242-33155
2.5	5776.64	I	8716-26022	14	6285.16	I	2220-18126
0.8	5782.61	I	8716-26004	14	6292.83	I	2311-18198
0.8	5783.50	I	21841-39127	12	6296.49	I	2425-18302
3.0 h	5784.38	I	22314-39597	2.0 h	6311.50	I	26738-42578
4 h	5786.16	I	21964-39241	1.0	6324.66	I	17182-32989
1.6	5788.56	I	15078-32349	5	6326.84	I	15063-30864
2.5 h	5807.14	I	24899-42114	4	6339.09	I	15001-30771
1.6	5817.06	I	15270-32456	3.5	6349.48	I	14949-30694
2.5 h	5817.53	I	24993-42177	1.0	6355.58	I	17117-32847
4 h	5830.72	I	25112-42257	3.5	6357.30	I	14910-30636
6 h	5846.30	I	25254-42353	1.8	6358.82	I	17242-32964
0.8	5850.32	I	15572-32660	2.5	6361.27	I	17182-32898
3.0	5924.57	I	15063-31937	1.6	6379.36	I	17117-32788
2.0	5978.91	I	15001-31722	1.0	6393.28	I	17055-32692
1.4	5980.78	I	9637-26353	2.5	6430.47	I	15771-31318
2.0	6002.31	I	9825-26480	1.6	6431.63	I	15724-31268
4	6002.63	I	8476-25131	1.0	6433.18	I	15689-31229
2.0	6016.12	I	21603-38221	0.8	6435.16	I	15665-31200
1.4	6025.41	I	14949-31541	5	6452.34	I	9637-25131
32	6039.73	I	8579-25131	0.8	6488.05	I	19078-34487
7	6058.14	I	8413-24915	4	6504.17	I	9545-24915
1.4	6067.26	I	21646-38124	8	6531.43	I	9825-25131
34	6081.44	I	8476-24915	2.0	6543.51	I	9637-24915
90	6090.22	I	8716-25131	1.2	6558.02	I	11101-26345
2.0	6106.98	I	11101-27471	0.8	6565.88	I	9545-24771
20	6111.67	I	8413-24771	4	6605.97	I	9637-24771
42	6119.52	I	8579-24915	1.2	6607.83	I	10892-26022
1.4	6128.34	I	8476-24789	0.8	6623.54	I	15771-30864
20	6135.38	I	8476-24771	4	6624.85	I	9825-24915
13	6150.15	I	2425-18680	1.0	6633.26	I	11101-26172
6	6170.36	I	2311-18513	1.0	6643.79	I	15724-30771
1.6	6189.35	I	2220-18372	0.6	6693.66	I	21603-36539
32	6199.19	I	2311-18438	0.6	6708.07	I	9825-24728
9	6213.87	I	2425-18513	5 c	6753.00	I	8716-23520
32	6216.37	I	2220-18302	0.8	6760.12	I	
2.0 h	6218.31	I	23520-39597	4 c	6766.49	I	8579-23353
9	6224.50	I	2311-18372	3.0	6784.98	I	8476-23211
30	6230.74	I	2153-18198	1.2	6786.32	I	
7	6233.20	I	2220-18259	2.0	6812.40	I	8413-23088
4	6240.13	I	2153-18174	0.7 c	6829.94	I	8716-23353
12	6242.81	I	2112-18126	1.2	6832.44	I	8579-23211
50	6243.10	I	2425-18438	0.9	6839.58	I	19023-33640
20	6251.82	I	2311-18302	0.9	6841.90	I	8476-23088
6	6256.90	I	2220-18198	0.8 c	6870.88	I	19145-33695
6	6258.57	I	2112-18086	0.7	6871.56	I	15572-30121
4	6261.22	I	2153-18120	0.6	6894.00	I	19026-33528
6	6266.32	I	2220-18174	1.0	6974.50	I	19026-33360
9	6268.82	I	2425-18372	1.8	7026.07	I	19078-33307
12	6274.65	I	2153-18086	0.6	7063.69	I	11101-25254

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Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
0.9 h	7092.08	I		1.2 h	8045.71		
0.5	7102.58	I	17242-31318	1.0	8051.89		
2.0	7148.15	I		1.2	8093.48	I	8476-20828
0.6	7151.36	I	20768-34747	0.7	8102.44	I	
0.6	7182.08	I	18805-32725	1.0	8108.59	I	25112-37441
1.2	7264.29	I	20768-34530	0.8 h	8109.07	I	24899-37227
0.7	7321.44	I	17117-30771	10 cw	8116.80	I	8716-21033
3.5	7338.92	I	17242-30864	0.9 h	8136.79	I	24830-37117
3.0	7356.54	I	17182-30771	2.5	8144.59	I	8413-20688
0.9	7358.66	I	20789-34375	0.8	8154.55	I	24899-37158
2.0	7361.39	I	17054-30636	6 c	8161.07	I	8579-20828
1.0	7362.49	I	19189-32768	1.2	8171.35	I	24993-37227
2.0	7363.16	I	17117-30694	0.6	8180.21	I	20768-32989
0.8	7385.95	I	19189-32725	3.0	8186.71	I	8476-20688
0.5 h	7393.49			2.0	8187.33	I	25112-37322
1.0 h	7485.90	I	20813-34168	2.5	8198.87	I	8413-20606
1.0 h	7488.08	I	15270-28621	3.0	8203.07	I	25254-37441
1.0 h	7492.44			2.0	8241.61	I	8476-20606
1.0 h	7578.75	I	24915-38106	2.5 c	8253.51	I	8716-20828
0.8 h	7591.24	I	24771-37940	2.5	8255.88	I	8579-20688
1.2 h	7596.92	I	19189-32349	0.4 h	8280.39	I	25931-38004
1.0 h	7598.28	I	18805-31962	1.6	8282.37	I	26172-38242
2.0	7624.81	I	25131-38242	0.7	8324.42	I	25931-37940
0.4	7701.37	I	18805-31786	1.2 h	8331.23	I	26004-38004
0.7	7704.81	I	25131-38106	1.2	8342.03	I	26122-38106
0.7 h	7851.18			0.6	8402.81	I	
1.2 bl	7865.51	VO		1.0	8499.52	I	26480-38242
1.0	7896.40			0.5	8534.49	I	21646-33360
1.2 h	7898.81			0.5 bl	8624.86	VO	
2.0	7937.92	I	24728-37322	5 c	8919.85	I	9824-21033
2.5 c	8027.39	I	8579-21033	2.5 c	8932.93	I	9637-20828
1.2	8028.13	I		1.0	8971.62	I	9545-20688
1.2 h	8035.38						

# YTTERBIUM

Yb,  $Z=70$ ,  $M=173.04$ , Ratio  $\frac{Yb}{Cu}=2.723$

Yb I Normal state of valence electrons  $6s^2 \ ^1S_0 = 0$ . I.P.=50000 K  
 Yb II Normal state of valence electrons  $6s^1 \ ^2S_{0\frac{1}{2}}=0$ . I.P.=97000 K

## References

### Wavelengths:

W. F. Meggers and B. F. Scribner, J. Research NBS **19**, 651 (1937).  
 W. F. Meggers, unpublished material (1961).

### Classification and Spectrum Assignments:

Yb I, W. F. Meggers, unpublished material (1961).  
 Yb II, W. F. Meggers and G. Racah, unpublished material (1953).  
 Yb III, W. F. Meggers and B. F. Scribner, J. Research NBS **19**, 651 (1937).

## Relative intensity of ytterbium lines observed in an arc of copper containing 0.1 atomic percent of ytterbium

### Strong lines of ytterbium

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
3200	3694. 19	II	0-27062	$4f^{14}6s^1 \ ^2S_{0\frac{1}{2}} - 4f^{14}6p^1 \ ^2P_{0\frac{1}{2}}$
2600	3289. 37	II	0-30392	$4f^{14}6s^1 \ ^2S_{0\frac{1}{2}} - 4f^{14}6p^1 \ ^2P_{1\frac{1}{2}}$
1900	3987. 98	I	0-25068	$4f^{14}6s^2 \ ^1S_0 - 4f^{14}6s^16p^1 \ ^1P_1$
500	2891. 38	II	0-34575	$4f^{14}6s^1 \ ^2S_{0\frac{1}{2}} - 4f^{13}5d^16s^1 \ 34575_{1\frac{1}{2}}$
340	3464. 36	I	0-28857	$4f^{14}6s^2 \ ^1S_0 - 4f^{13}5d^16s^2 \ 28857_1$
280	2970. 56	II	0-33654	$4f^{14}6s^1 \ ^2S_{0\frac{1}{2}} - 4f^{13}5d^16s^1 \ 33654_{0\frac{1}{2}}$
180	2750. 48	II	21418-57765	$4f^{13}6s^2 \ ^2F_{3\frac{1}{2}} - 4f^{13}6s^16p^1 \ 57765_{4\frac{1}{2}}$
140	2653. 74	II	21418-59090	$4f^{13}6s^2 \ ^2F_{3\frac{1}{2}} - 4f^{13}6s^16p^1 \ 59090_{3\frac{1}{2}}$
140	5556. 48	I	0-17992	$4f^{14}6s^2 \ ^1S_0 - 4f^{14}6s^16p^1 \ ^3P_1$
130	3031. 11	II	0-32982	$4f^{14}6s^1 \ ^2S_{0\frac{1}{2}} - 4f^{13}5d^16s^1 \ 32982_{1\frac{1}{2}}$
75	7699. 49	I	19710-32695	$4f^{14}6s^16p^1 \ ^3P_2 - 4f^{14}6s^17s^1 \ ^3S_1$
70	3454. 07	II	26759-55702	$4f^{13}5d^16s^1 \ 26759_{2\frac{1}{2}} - 4f^{13}5d^16p^1 \ 55702_{1\frac{1}{2}}$
70	3476. 31	II	0-28758	$4f^{14}6s^1 \ ^2S_{0\frac{1}{2}} - 4f^{13}5d^16s^1 \ 28758_{1\frac{1}{2}}$
70	3478. 84	II	30224-58961	$4f^{13}5d^16s^1 \ 30224_{1\frac{1}{2}} - 4f^{13}5d^16p^1 \ 58961_{5\frac{1}{2}}$
65	2464. 49	I	0-40564	$4f^{14}6s^2 \ ^1S_0 - 4f^{14}6s^17p^1 \ 40564_1$

Ytterbium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
8	2116.65	II		55	2672.65	II	21418-58823
11	2126.72	II	0-47006	3.0	2680.40	II	26759-64056
2.0	2161.60	II		2.0	2683.42	II	44438-81693
6	2185.70	II	0-45737	10	2684.75	II	32371-69608
7	2224.45	II	0-44941	3.5	2687.96	II	30224-67416
5	2320.81	II		4	2695.43	II	31632-68720
2.5	2362.88	II	21418-63727	2.0	2696.62	II	32371-69444
12	2390.73	II	21418-63234	2.5	2700.80	II	
1.4	2398.01	II	0-41688	3.0	2708.84	II	33052-69957
3.0	2421.36	II	32371-73658	9	2710.54	II	31568-68450
3.5	2447.25	II	28758-69608	3.5	2711.79	II	21418-58284
4	2460.24	II	30224-70858	8	2712.66	II	30563-67416
65	2464.49	I	0-40564	24	2718.35	II	31980-68756
2.0	2484.87	II	30563-70794	3.0	2722.19	II	34390-71114
10	2502.00	II	21418-61374	16	2732.72	II	31568-68150
4	2505.46	II	31568-71469	3.0	2734.08	II	34390-70954
1.6	2508.04	II		8	2741.71	II	33494-69957
20	2512.05	II	21418-61215	8	2747.58	II	32371-68756
2.5	2516.36	II	33052-72780	2.5	2748.03	II	34575-70954
7	2522.42	II	21418-61051	32	2748.66	II	31568-67939
9	2537.64	II	30563-69957	180	2750.48	II	21418-57765
38	2538.67	II	0-39379	12	2751.45	II	30224-66558
2.0	2550.04	II		3.0	2759.00	II	37516-73751
10	2552.14	II	30224-69395	9	2760.78	II	35059-71270
8	2552.69	II	31632-70794	9	2761.38	II	35019-71222
3.0	2565.56	II	34785-73751	5	2764.42	II	35059-71222
4	2571.35	II	31980-70858	12	2771.33	II	34785-70858
1.8	2573.13	II	32371-71222	24	2776.28	II	34785-70794
2.5	2596.14	II		14	2784.66	II	33494-69395
4	2596.29	II	31632-70136	2.5	2787.96	II	30224-66082
3.0	2615.26	II	30224-68450	6	2793.28	II	33654-69444
14	2617.00	II	21418-59619	3.5	2794.44	II	35019-70794
8	2634.31	II		3.0	2795.08	II	37516-73283
6	2639.44	II	31568-69444	2.5	2795.31	II	
12	2641.90	II	21418-59259	5	2797.79	II	
11	2642.55	III	34656-72487	14	2798.21	II	30224-65951
16	2644.30	II	33052-70858	6	2799.38	II	
4	2646.44	II	33494-71270	12	2800.05	II	28758-64461
4	2647.46	II	35019-72780	2.0	2810.72	II	32371-67939
4	2648.80	II	33052-70794	9	2814.53	II	30563-66082
7	2649.79	II	33494-71222	4	2816.35	II	30392-65888
4	2650.73	II	30224-67939	20	2821.15	II	31980-67416
140	2653.74	II	21418-59090	14	2824.97	II	30563-65951
5	2656.11	II	28758-66396	26	2830.98	II	30563-65876
3.0	2659.26	II	28758-66351	2.5	2832.20	II	28758-64056
28	2665.02	II	31568-69080	4	2834.98	II	37516-72780
12	2666.11	III	34991-72486	2.0	2842.58	II	32982-68150
12	2666.98	III	34656-72140	32	h 2847.17	II	27062-62174
8	2668.74	II	33494-70954	14	2848.44	II	33052-68149
55	2671.98	I	0-37415	3.0	2849.33	II	44498-79583

Ytterbium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
50	2851.12	II	26759-61822	9	2962.52	II	34390-68135
8	2851.86	II	33494-68549	3.0	2963.21	II	
3.0	2853.41	II	46170-81205	6	2963.45	II	
2.5	2853.68	II	34575-69608	18	2964.75	II	30224-63944
8	2854.13	II	35832-70858	280	2970.56	II	0-33654
6	2854.49	II	40036-75058	6	2982.49	II	33052-66571
6	2858.33	II	30224-65200	3.0	2982.66	II	32371-65888
6	2858.46	II	32982-67955	4	2983.70	II	33052-66558
14	2859.38	II	35832-70794	28	2983.98	II	30224-63727
60	2859.80	II	21418-56376	13	2985.08	II	35059-68549
8	2860.40	II		5	2985.87	II	32982-66463
20	2861.21	II	31632-66571	6	2990.36	II	35019-68450
14	2861.33	II	35019-69957	9	2991.87	II	32982-66396
28	2867.05	II	30224-65093	4	2993.93	II	35059-68450
3.5	2870.06	II		24	2994.80	II	30563-63944
6	2873.50	I		4	2995.86	II	32982-66351
4	2885.97	II	33494-68135	10	3000.46	II	
10	2886.26	II	30563-65200	3.5	3002.61	II	41679-74973
28	2888.03	II	26759-61374	44	3005.76	II	31632-64891
500	2891.38	II	0-34575	14	3009.39	II	31980-65200
6	2893.63	II	35059-69608	9	3010.62	II	32371-65577
4	2896.90	II	46170-80679	8	3014.43	II	30563-63727
12	2899.71	II	28758-63234	22	3017.55	II	35019-68149
2.5	2902.40	II	33494-67939	22	3026.67	II	33052-66082
3.0	2902.92	II	38342-72780	130	3031.11	II	0-32982
3.0	2906.88	II	37078-71469	8	3034.64	II	31980-64923
4	2908.32	II	30224-64598	3.5	3037.99	II	32982-65888
5	2909.19	II	33052-67416	8	3039.67	II	35832-68720
8	2909.47	II	30563-64923	11	3042.65	II	33494-66351
12	2911.52	II	35059-69395	3.0	3044.01	II	30392-63234
2.5	2912.86	II	31568-65888	6	3046.48	II	34390-67205
24	2914.21	II	35832-70136	5	3047.06	II	33654-66463
20	2915.27	II	26759-61051	6	3063.13	II	30224-62861
2.5	2916.43	II	39379-73658	3.0	3063.67	II	34785-67416
40	2919.34	II	31632-65876	16	3065.04	II	28758-61374
8	2921.12	II	32982-67205	2.5	3076.02	II	26759-59259
6	2924.23	II	32371-66558	14	3089.10	II	28758-61120
3.5	2927.85	II	37078-71222	10	3093.87	II	31632-63944
5	2934.35	I		4	3100.71	I	
8	2935.10	II	34390-68450	6	3101.36	II	33654-65888
3.0	2937.18	II	37078-71114	4	3102.07	II	32371-64598
6	2939.52	II	31568-65577	8	3107.76	II	34390-66558
6	2940.51	II		24	3107.90	II	40036-72202
4	2942.04	II	32371-66351	12	3115.33	II	32371-64461
20	2945.90	II	34785-68720	8	3116.70	II	31980-64056
6	2946.30	II	40036-73967	26	3117.80	II	26759-58823
2.5	2946.76	II	43956-77882	7	3136.75	II	33052-64923
4	2950.32	II	35059-68944	32	3140.92	II	28758-60586
6	2955.31	II	26759-60586	11	3141.72	II	34575-66396
2.5	2957.63	II		11	3145.06	II	34785-66571

Ytterbium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
4	3145.55	II		7	3438.71	II	34575-63648
4	3153.17	II	33494-65200	14	3438.85	II	31980-61051
13	3153.86	II		5	3443.59	II	
7	3155.17	II	32371-64056	5	3446.89	II	32371-61374
4	3162.31	I		12	3452.41	I	
10	3163.79	II	33494-65093	70	3454.07	II	26759-55702
7	3165.20	II	35832-67416	26	d 3458.28	II	40036-68944
17	3169.06	II	33052-64598		3458.36	I	
17	3180.92	II	33494-64923	50	3460.27	I	
55	3192.88	II	30563-61874	5	3462.36	II	
10	3198.65	II	31980-63234	340	3464.36	I	0-28857
34	3201.16	II	31632-62861	70	3476.31	II	0-28758
11	3217.18	II	32982-64056	70	3478.84	II	30224-58961
7	3218.33	II	35019-66082	7	3482.57	II	
7	3225.86	II	30224-61215	12	3485.76	II	32371-61051
6	3239.20	II	32371-63234	12	3488.42	II	
5	3239.60	I		14	hw 3495.92	II	
5	3246.06	II		12	3507.82	II	37078-65577
18	3261.50	II	30563-61215	7	3517.02	I	19710-48136
2600	3289.37	II	0-30392	32	3520.29	II	30563-58961
18	3305.27	I		7	3545.71	II	
20	3305.73	II	31632-61874	14	3549.82	II	33052-61215
7	3315.11	II		5	3559.00	I	
11	3319.43	I		28	3560.33	II	21418-49498
7	3333.06	II	33654-63648	24	3560.71	II	34785-62861
34	3337.18	II		7	h 3563.94	II	31568-59619
40	h 3342.94	II		12	3570.56	II	33052-61051
11	3346.50	II		7	3572.50	II	
7	3347.53	II	35059-64923	7	3574.54	II	
5	3351.08	II		50	3585.47	II	21418-49301
7	3351.24	II		13	3606.48	II	33494-61215
14	3352.49	II		5	3610.24	II	31568-59259
14	3362.43	II		7	3611.30	II	37516-65200
7	3363.64	II		20	3619.82	II	28758-56376
34	3375.48	II	26759-56376	11	3634.54	II	
7	3376.62	II		24	3637.76	II	21418-48900
4	3382.58	II		7	3648.13	I	
20	3387.51	I		9	3655.73	I	17992-45339
7	3390.24	II		24	3669.70	II	27062-54304
4	3390.32	II		5	3670.69	II	38342-65577
7	3391.10	II	37078-66558	14	3675.08	II	30563-57765
7	h 3394.44	II	32371-61822	5	3690.56	II	34785-61874
7	3401.02	II	30224-59619	3200	3694.19	II	0-27062
5	3404.11	II	35832-65200	7	3698.59	II	35832-62861
7	3412.45	I		7	3700.57	I	
20	3418.40	I		5	3710.33	II	28758-55702
50	3426.06	I		6	3724.22	II	31980-58823
11	3428.47	II	34785-63944	18	3734.70	I	17992-44760
34	3431.14	I		55	3770.10	I	17288-43805
6	3434.62	II		8	3774.32	I	

Ytterbium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
6 h	3791.74	I		1.4	5009.52	II	32982-52938
10	3839.92	I		1.0	5067.31	II	34575-54304
20	3872.85	I	17992-43805	1.8	5067.80	I	
20	3900.86	I	19710-45339	4	5069.15	I	
3.0	3904.82	II	38342-63944	13	5074.33	I	24752-44453
8	3911.28	I		3.0	5076.75	I	25068-44760
1900	3987.98	I	0-25068	1.2	5135.99	II	33052-52517
55	3990.89	I	19710-44760	0.8	5147.03	II	38342-57765
3.0	4007.36	I		1.2	5184.18	II	33654-52938
4	4052.28	I		3.5	5196.09	I	
5	4077.28	II	38342-62861	5	5211.59	I	25271-44453
26	4089.69	I		2.0	5240.52	II	30224-49301
7 h	4119.26	II		6	5244.11	I	24752-43816
4	4135.09	II	34785-58961	2.5	5257.51	II	34390-53405
28	4149.07	I	19710-43805	9 h	5277.08	I	24489-43434
7	4174.57	I		2.0	5279.56	II	34785-53721
20	4180.82	II	30392-54304	1.0	5300.95	II	37516-56376
9 d	4218.56	II	37516-61215	10	5335.15	II	30563-49301
	4218.64	I	24752-48449	1.8 d	5345.67	II	35019-53721
7	4231.99	I	17992-41615		5345.85	II	40918-59619
4	4277.73	I		3.5	5347.22	II	35019-53715
7	4305.96	I		1.8 h	5351.33	I	24752-43434
4	4316.96	II	30563-53721	9	5352.96	II	30224-48900
3.5 h	4393.76	I	25068-47822	1.8	5358.66	II	35059-53715
3.5 h	4430.22	I	24489-47055	1.8	5363.66	I	
26	4439.21	I	17288-39809	1.0	5389.87	II	34390-52938
5 h	4482.44	I	24752-47055	0.8	5432.74	II	47680-66082
5	4515.17	II	26759-48900	2.5	5449.30	II	35059-53405
2.0	4553.59	II	30563-52517	0.8	5478.52	II	40036-58284
5 h	4564.00	I	19710-41615	3.5	5481.94	I	24489-42726
38	4576.21	I	17992-39838	2.5	5505.50	I	24489-42648
12	4582.36	I	17992-39809	1.0	5524.55	I	
4	4589.22	I	25271-47055	5 h	5539.09	I	
8	4590.84	I		140	5556.48	I	0-17992
2.5	4598.37	II	31980-53721	2.0	5562.07	I	24752-42726
2.0	4683.83	II	32371-53715	1.2	5568.11	I	
2.5	4684.28	I		1.2	5586.35	I	24752-42648
11	4726.08	II	26759-47912	2.5	5588.47	II	35832-53721
10 h	4781.89	I		3.5	5652.00	II	30224-47912
10	4786.61	II	31632-52517	0.4	5686.53	II	
2.0	4816.40	I		13	5720.01	I	27678-45155
2.5	4820.25	II	28758-49498	0.6	5749.92	II	49009-66396
2.0	4836.95	II	33052-53721	0.6 h	5755.90	I	
2.5	4837.47	I	24489-45155	1.6	5771.67	II	31980-49301
1.0	4851.16	II	24333-44941	0.6	5803.45	I	
2.5 h	4894.63	I		0.6	5819.43	II	46548-63727
1.6	4912.38	I	19710-40062	2.0	5834.00	II	
42	4935.51	I	19710-39966	2.0	5837.15	II	32371-49498
1.4	4937.23	II	37516-57765	1.6	5854.52	I	
8	4966.91	I	19710-39838	0.5	5897.23	II	48923-65876

Ytterbium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
1.2	5908.38	II	31980-48900	1.2	6678.17	I	27678-42648
1.0	5989.32	I		2.0	6727.61	II	33052-47912
2.5	5991.51	II	35832-52517	2.0	6768.70	I	25068-39838
0.6	6052.90	II	32982-49498	55	6799.61	I	17992-32695
0.6	6054.56	I		1.4	6934.04	II	33494-47912
3.5	6152.58	II	33052-49301	2.0	6999.87	II	
1.8	6246.97	II	33494-49498	1.0	7043.80	II	47680-61873
3.5	6274.80	II	31980-47912	0.9 h	7244.47	I	24752-38552
0.8	6308.15	II	33052-48900	0.8 h	7305.25	I	24489-38174
2.0 h	6400.40	I	27678-43298	1.0 h	7313.10	I	24752-38422
2.0 h	6417.97	I	27678-43255	1.6 h	7350.09	I	
1.2	6432.73	II	32371-47912	2.5	7448.33	I	24752-38174
1.0 h	6463.15	II		3.0 h	7527.56	I	25271-38552
20	6489.10	I	17288-32695	75	7699.49	I	19710-32695
1.6	6643.54	I	27678-42726	0.7	7895.12	I	24752-37415
14	6667.85	I	25068-40062	7 h	8922.62	II	44498-55702



# YTTRIUM

$$Y, Z=39, M=88.91, \text{Ratio } \frac{Y}{Cu}=1.399$$

Y I Normal state of valence electrons  $5s^2 4d^1 {}^2D_{1/2}=0$ . I.P.= 52650 K

Y II Normal state of valence electrons  $5s^2 {}^1S_0=0$ . I.P.= 100000 K

## References

### Wavelengths:

A. Gatterer and J. Junkes, Spektren der Seltenen Erden (Specola Vaticana, Vatican, 1945), below 7350 A.

G. R. Harrison, Massachusetts Institute of Technology Wavelength Tables (John Wiley & Sons, New York (1939), above 7350 A.

### Classification:

Y I, Y II, and Y III, W. F. Meggers and H. N. Russell, J. Research NBS **2**, 733 (1929).

### Molecular Spectra:

YO, W. F. Meggers and J. A. Wheeler, J. Research NBS **6**, 239 (1931).

## Relative intensity of yttrium lines observed in an arc of copper containing 0.1 atomic percent of yttrium

### *Strong lines of yttrium*

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
1500	3710. 30	II	1450-28394	$4d^1 5s^1 a {}^3D_3 - 4d^1 5p^1 z {}^3F_4^o$
1300	3600. 73	II	1450-29214	$4d^1 5s^1 a {}^3D_3 - 4d^1 5p^1 z {}^3D_3^o$
1200	3774. 33	II	1045-27532	$4d^1 5s^1 a {}^3D_2 - 4d^1 5p^1 z {}^3F_3^o$
1200	4374. 94	II	3296-26147	$4d^1 5s^1 a {}^1D_2 - 4d^1 5p^1 z {}^1D_2^o$
1000	3611. 05	II	1045-28730	$4d^1 5s^1 a {}^3D_2 - 4d^1 5p^1 z {}^3D_2^o$
1000	3633. 12	II	0-27517	$5s^2 a {}^1S_0 - 4d^1 5p^1 z {}^1P_1^o$
1000	4102. 38	I	530-24900	$4d^1 5s^2 a {}^2D_{3/2} - 4d^1 5s^1 5p^1 y {}^2F_{1/2}^o$
950	4077. 38	I	0-24519	$4d^1 5s^2 a {}^2D_{1/2} - 4d^1 5s^1 5p^1 y {}^2F_{3/2}^o$
900	4128. 31	I	530-24747	$4d^1 5s^2 a {}^2D_{3/2} - 4d^1 5s^1 5p^1 y {}^2D_{3/2}^o$
850	3788. 70	II	840-27227	$4d^1 5s^1 a {}^3D_1 - 4d^1 5p^1 z {}^3F_2^o$
800	3242. 28	II	1450-32284	$4d^1 5s^1 a {}^3D_3 - 4d^1 5p^1 y {}^3P_2^o$
800	3601. 92	II	840-28595	$4d^1 5s^1 a {}^3D_1 - 4d^1 5p^1 z {}^3D_1^o$
800	4177. 54	II	3296-27227	$4d^1 5s^1 a {}^1D_2 - 4d^1 5p^1 z {}^3F_2^o$
750	4142. 85	I	0-24131	$4d^1 5s^2 a {}^2D_{1/2} - 4d^1 5s^1 5p^1 y {}^2D_{1/2}^o$
600	3327. 89	II	3296-33337	$4d^1 5s^1 a {}^1D_2 - 4d^1 5p^1 z {}^1F_3^o$
550	3620. 94	I	530-28140	$4d^1 5s^2 a {}^2D_{3/2} - 4d^1 5s^1 5p^1 x {}^2P_{1/2}^o$
500	3216. 69	II	1045-32124	$4d^1 5s^1 a {}^3D_2 - 4d^1 5p^1 y {}^3P_1^o$
500	3549. 01	II	1045-29214	$4d^1 5s^1 a {}^3D_2 - 4d^1 5p^1 z {}^3D_3^o$

Yttrium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
3.5	2243.06	II	0-44568	15	3021.73	I	530-33614
1.6	2354.20	I	530-42995	10	3022.28	I	530-33608
8	2367.25	III	725-42955	3.0	3026.49	II	26147-59179
1.4	2373.83			3.5	3036.59	II	28730-61650
2.5	2385.24			5	3044.84	I	
1.6	2413.93	II	23776-65189	22	3045.37	I	530-33358
16	2414.68	III	0-41401	2.5	3047.11	I	
38	2422.20	II	3296-44568	7	3055.22	II	29214-61934
6	2460.61	II	24647-65275	7	3086.85	II	26147-58533
2.5	2490.42	I	530-40672	6	h 3091.70	I	
1.2	2540.28			2.5	3093.76	II	32284-64597
1.4	2547.57			11	3095.88	II	1045-33337
1.0	2550.17			5	3111.81	I	10529-42656
2.0	2681.65	I	0-37279	6	3112.04	II	0-32124
7	2694.21			2.5	3114.28	I	
3.0	2695.39	I	530-37620	7	3128.77	II	27227-59179
11	2723.00	I	530-37244	10	3129.93	II	27532-59472
2.5	2730.08	I	0-36618	12	3135.17	II	1450-33337
2.5	2734.85	II	24647-61200	14	3173.06	II	28394-59900
8	2742.53	I	0-36452	28	3179.41	II	840-32284
16	2760.10	I	530-36751	9	3191.31	I	11360-42686
3.5	2785.21	II	23776-59670	300	3195.62	II	840-32124
1.4	2785.59	II	24647-60535	280	3200.27	II	1045-32284
1.4	2791.20	I	0-35817	280	3203.32	II	840-32049
3.5	2800.11	II	23445-59147	500	3216.69	II	1045-32124
3.0	2813.64	I	530-36061	800	3242.28	II	1450-32284
44	2817.01	III	7466-42955	40	3280.91	II	14098-44568
2.0	2818.86	I	10529-45994	2.5	3308.47	II	28730-58947
5	2822.56	I	10529-45948	600	3327.89	II	3296-33337
2.5	2825.37	II	29214-64597	7	3340.38	I	16066-45994
5	2826.38	II	23776-59147	20	3362.00	II	14833-44568
8	2854.43	II	24647-59670	11	3388.59	I	15246-44748
3.0	2856.30	II	23776-58776	6	3397.04	I	16234-45664
1.2	2857.87			11	3412.47	I	15712-45008
11	2886.48	I	11360-45994	26	3448.82	II	3296-32284
2.0	2897.69	II	24647-59147	9	3450.95	I	16234-45204
1.6	2898.82	II	23776-58262	14	3467.88	II	3296-32124
18	2919.05	I	0-34248	22	3485.73	I	17116-45796
2.0	h 2930.03	II	27532-61650	220	3496.09	II	0-28595
32	h 2945.94	III	7466-41401	10	3521.53	I	14949-43338
44	2948.40	I	0-33907	6	3546.01	II	
40	2964.96	I	530-34248	500	3549.01	II	1045-29214
2.0	2973.91	II	24647-58262	17	3551.80	I	14949-43096
55	2974.59	I	0-33608	70	3552.69	I	0-28140
3.5	2980.55	II	28394-61934	22	3558.76	I	15246-43338
85	2984.26	I	530-34030	24	3571.43	I	15712-43704
8	2995.26	I	530-33907	34	3576.05	I	16234-44190
16	2996.94	I	0-33358	420	3584.52	II	840-28730
8	3005.26	I	0-33265	38	3587.75	I	
6	3018.95	I	10529-43644	13	3589.69	I	15246-43096

Yttrium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
360	3592.92	I	0-27824	38	4204.70	II	0-23776
1300	3600.73	II	1450-29214	8	4213.02	I	16234-39964
800	3601.92	II	840-28595	4	4213.54	I	14949-38675
1000	3611.05	II	1045-28730	16	4217.80	I	10529-34231
550	3620.94	I	530-28140	28	h 4220.63	I	14949-38636
240	3628.71	II	1045-28595	8	4224.25	I	
1000	3633.12	II	0-27517	60	4235.73	II	1045-24647
350	3664.61	II	1450-28730	220	4235.94	I	530-24131
5	3668.49	II	28394-55645	30	4251.20	I	15246-38762
20	3692.53	I	17116-44190	36	h 4302.30	I	15712-38949
1500	3710.30	II	1450-28394	280	4309.63	II	1450-24647
7	3718.12	I	16817-43704	5	4316.30	I	11360-34521
7	3738.61	I	16597-43338	11	4330.78	I	10529-33613
140	3747.55	II	840-27517	3.0	4337.29	I	15712-38762
6	3749.89	I	16436-43096	6	4344.65	I	16436-39446
1200	3774.33	II	1045-27532	44	h 4348.79	I	16234-39223
160	3776.56	II	1045-27517	6	4352.33	I	11278-34248
6	3782.30	II	29214-55645	6	4352.70	I	16597-39565
850	3788.70	II	840-27227	12	4357.73	I	16817-39758
150	3818.35	II	1045-27227	80	4358.73	II	840-23776
460	3832.88	II	1450-27532	12	4366.03	I	11360-34257
7	3847.87	II		1200	4374.94	II	3296-26147
8	3876.82			15	h 4375.61	I	17116-39964
48	3878.28	II	1450-27227	8	4379.33	I	11079-33907
3.0	3887.77	I	11360-37074	3.0	4385.48	I	11360-34156
6	h 3904.59	I		10	4387.74	I	
5	h 3918.25	I	10937-36452	3.0	4394.01	I	11278-34030
6	h 3930.11	I		3.0	4394.67	I	16817-39565
24	3930.66	II	3296-28730	180	4398.02	II	1045-23776
440	3950.36	II	840-26147	90	4422.59	II	840-23445
15	3951.60	II	3296-28595	8	4437.34	I	11079-33608
6	h 3955.09	I		10	4443.66	I	11532-34030
360	3982.60	II	1045-26147	13	4446.63	I	11360-33842
4	3987.50	I	11360-36431	2.0	4465.27	I	
95	4039.83	I	0-24747	4	4473.89	I	
240	4047.64	I	0-24699	17	4475.72	I	11278-33614
950	4077.38	I	0-24519	18	4476.96	I	11278-33608
9	h 4081.22	I	18499-42995	16	4477.45	I	10937-33265
200	4083.71	I	0-24481	11	4487.28	I	11079-33358
1000	4102.38	I	530-24900	30	4487.47	I	10937-33215
6	h 4106.39	I	18512-42858	3.0	4491.75	I	11532-33789
8	4110.81	I	15246-39565	2.5	4492.42	I	11360-33613
32	4124.92	II	3296-27532	50	4505.95	I	11079-33265
900	4128.31	I	530-24747	5	4513.58	I	15327-37476
750	4142.85	I	0-24131	8	4514.01	I	15329-37476
10	h 4157.63	I	15712-39758	4	h 4522.05	I	16436-38544
240	4167.52	I	530-24519	90	4527.25	I	11532-33614
200	4174.14	I	530-24481	44	4527.80	I	11278-33358
800	4177.54	II	3296-27227	10	4544.32	I	15477-37476
12	4199.28	II	840-24647	10	4559.37	I	15222-37148

Yttrium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
3.0	4564.39	I		7	4906.11	I	11532-31909
6	h 4573.56	I	16817-38675	3.0	4909.00	I	16066-36431
3.5	4581.32	I	15327-37148	10	4921.87	I	11360-31672
3.0	4581.77	I	15329-37148	2.5	4930.93	I	16146-36420
11	4596.55	I	17116-38866	3.0	4950.66	I	
8	4604.80	I	15329-37040	8	4974.30	I	18499-38597
3.5	4613.00	I	15477-37148	8	4982.13	II	8328-28394
170	4643.70	I	0-21529	7	5006.97	I	18512-38479
17	h 4658.32	I	16159-37620	5	5070.21	I	19148-38866
6	4658.89	I		5	5072.19	I	
7	4667.47	I	15994-37413	75	5087.42	II	8743-28394
5	4670.82	I		2.0	5088.18	I	19028-38675
170	4674.84	I	530-21915	14	5119.11	II	8003-27532
5	4678.35	I	19148-40517	30	5123.21	II	8003-27517
22	4682.32	II	3296-24647	12	5135.20	I	18499-37967
7	4689.77	I	16159-37476	8	5196.43	II	14098-33337
15	4696.81	I	15994-37279	65	5200.41	II	8003-27227
3.0	4708.85	I	15222-36452	100	5205.72	II	8328-27532
5	4725.85	I	15994-37148	12	5240.81	I	18512-37588
14	4728.53	I	10529-31672	4	5289.82	II	8328-27227
5	h 4732.37	I	15327-36452	3.0	5320.78	II	8743-27532
7	4741.40	I	16159-37244	5	5380.62	I	15327-33907
13	4752.79	I	15327-36361	15	5402.78	II	14833-33337
34	4760.98	I	530-21529	1.6	5417.03	I	16066-34521
1.4	4780.18	I	15222-36136	6	5424.37	I	15477-33907
10	4781.04	I	11278-32188	13	5438.24	I	15864-34248
13	4786.58	II	8328-29214	48	5466.46	I	11532-29820
14	4786.89	I	15477-36361	7	5468.47	I	15327-33608
15	4799.30	I	11079-31909	6	5473.39	II	14018-32284
4	4804.31	I	15327-36136	6	5480.74	II	13883-32124
6	4804.81	I	15329-36136	4	5493.17	I	14949-33148
7	bl 4817.38	YO		2.5	5495.59	I	16066-34257
12	bl 4818.20	YO		16	5497.41	II	14098-32284
12	4819.64	I	10937-31680	20	5503.45	I	15864-34030
10	4822.13	I	15329-36061	17	5509.90	II	8003-26147
16	4823.31	II	8003-28730	4	5513.64	I	15477-33608
5	4839.15	I	15477-36136	8	5521.63	I	15327-33432
65	4839.87	I	11532-32188		5521.70	II	14018-32124
46	4845.68	I	11278-31909	1.6	5526.76	I	16159-34248
34	4852.69	I	11079-31680	50	5527.54	I	11278-29364
10	4854.25	I	15222-35817	2.5	5541.63	I	15712-33753
75	4854.87	II	8003-28595	8	5544.61	I	15327-33358
4	4856.70	I	15477-36061			II	14018-32049
28	4859.84	I	10937-31508	6	5546.02	II	14098-32124
4	4879.65	I	15329-35817	5	5556.43	I	15246-33238
160	4883.69	II	8743-29214	4	5567.75	I	15477-33432
4	4886.28	I	16159-36618	12	5577.42	I	15864-33789
3.5	4886.65	I	15994-36452	1.6	5581.08	I	15994-33907
8	4893.44	I	11079-31508	42	5581.87	I	11079-28989
95	4900.12	II	8328-28730	1.4	5590.96	I	15477-33358

Yttrium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
1.4	5594.12	I	16159-34030	3.5	6088.00	I	16817-33238
8	5606.33	I	11532-29364	14 bl	6089.35	YO	
1.0	5623.91	I	16066-33842	11 bl	6096.78	YO	
38	5630.13	I	10937-28694	9 bl	6107.82	YO	
1.6	5632.25	I	15864-33614	9 bl	6114.73	YO	
1.4	5632.89	I	16159-33907	5 bl	6127.38	YO	
8	5644.69	I	11278-28989	95 bl	6132.06	YO	
8	5648.47	I	15712-33412	8	6135.04	I	17116-33412
50	5662.94	II	15683-33337	10	6138.43	I	530-16817
6	5675.27	I	11079-28694	75 bl	6148.36	YO	
1.2	5693.63	I	16597-34156	8	6151.72	YO	
11	5706.73	I	16234-33753	55 bl	6165.08	YO	
1.6	5720.61	I	16436-33912	38 bl	6182.23	YO	
5	5728.89	II	14833-32284	80	6191.73	I	0-16146
10 bl	5730.12	YO		40 bl	6199.82	YO	
1.4	5732.09	I	16817-34257	30 bl	6217.96	YO	
6	5743.85	I	17116-34521	20	6222.59	I	0-16066
1.2 bl	5746.93	YO		18 bl	6236.72	YO	
1.6 bl	5764.22	YO		3	6251.05	I	
5	5765.64	I	16817-34156	8 bl	6275.01	YO	
2.5	5773.86	I	16597-33912	4 b	6295.46	YO	
7	5781.69	II	14833-32124	1.6 b	6316.20	YO	
1.0 bl	5800.00	YO		1.6 b	6338.10	YO	
1.0 bl	5818.58	YO		1.0 b	6359.48	YO	
2.0	5821.87	I	16066-33238	1.0	6369.87	YO	
1.4	5832.27	I	17116-34257	5	6402.01	I	530-16146
0.6 b	5838.07	YO		70	6435.00	I	530-16066
1.0	5858.83	YO		1.6	6437.18	I	18499-34030
1.0	5871.83	I	16817-33842	1.2 h	6501.23	YO	
1.6	5876.14	YO		1.2 h	6518.33	YO	
1.6	5879.96	I	16146-33148	1.2 h	6535.84	YO	
1.6 b	5893.94	YO		6	6538.60	I	18499-33789
2.5	5902.96	I	16817-33753	0.8 h	6553.84	YO	
1.6 b	5912.19	YO		6	6557.39	I	0-15246
1.6 b	5931.10	YO		1.0 h	6572.58		
6 bl	5939.08	YO		3.0	6576.85	I	19238-34438
3.0	5945.72	I	16597-33412	2.0	6584.87	I	530-15712
1.6	5950.02	I	16436-33238	8	6613.75	II	14098-29214
5 b	5956.41	YO		1.2	6622.49	I	18512-33608
85 bl	5972.04	YO		1.6 h	6636.49	I	28989-44053
3.5	5981.86	I	16436-33148	3.5	6650.61	I	19406-34438
70 bl	5987.64	YO		1.8	6664.40	I	29364-44366
50 bl	6003.60	YO		13	6687.58	I	0-14949
8	6004.65			1.2 h	6691.83	I	29820-44760
8	6009.19	I	17116-33753	0.6	6694.75	I	18499-33432
42 bl	6019.87	YO		1.4 h	6699.26	I	
8	6023.41	I	0-16597	6	6700.71	I	18512-33432
34 bl	6036.60	YO		3.0	6713.20	I	21529-36420
28 bl	6053.81	YO		3.5	6735.99	I	19406-34248
9 bl	6072.78	YO		16	6793.71	I	530-15246

Yttrium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
6	h		14018-28730	5			16234-29843
1.0	h		19148-33842	1.2	h		15477-28989
1.8			19238-33907	3.0			14098-27517
1.2			14098-28730	1.8			19028-32366
4			19148-33753	0.7	h		
1.2			14018-28595	3.5			19148-32366
2.5			21915-36431	0.8	h		
1.8			14098-28595	2.0	h		18976-32091
0.8			14949-29420	0.7			19028-32091
1.2			530-14949	0.5			18976-31978
2.5	h		19028-33412	0.8	h		
1.0			14833-29214	2.0			19028-31978
1.0			15246-29614	2.0			19148-32091
2.5			14949-29272	1.4			16436-29272
1.4	h		19148-33412	1.4			16597-29420
1.0			18976-33238	0.6			15327-28140
2.0	h		19028-33238	1.8			16817-29614
3.0			15246-29420	3.0			17116-29843
1.4	h		18976-33148	11			14833-27517
0.9			15712-29843	1.0	h		17116-29614
1.2			15246-29272	0.9			32188-44190
3.5			15712-29614	2.5			16159-28140
1.0	h		36361-50254	0.8	h		24481-36431
3.5			14833-28595	1.8			15994-27824
0.9	h		15712-29420	0.8	h		24699-36420
0.9	h		7330.62	10			0-11360
0.5			13883-27517	2.0	h		14833-26147

## ZINC

$$\text{Zn, } Z=30, M=65.38, \text{ Ratio } \frac{Z_{\text{Zn}}}{Z_{\text{Cu}}}=1.029$$

Zn I Normal state of valence electrons  $3d^{10} 4s^2 {}^1S_0 = 0$ . I.P. = 75767 K  
 Zn II Normal state of valence electrons  $3d^{10} 4s^1 {}^2S_{0\frac{1}{2}} = 0$ . I.P. = 144891 K

### References

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A. Filippov, Phys. Z. Sowjetunion **1**, 289 (1932).

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### Relative intensity of zinc lines observed in an arc of copper containing 0.1 atomic percent of zinc

#### *Strong lines of zinc*

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
1000	2138.56	I	0-46745	$3d^{10}4s^2 {}^1S_0 - 3d^{10}4s^14p^1 {}^1P_1^o$
140	3345.02	I	32890-62777	$3d^{10}4s^14p^1 {}^3P_{\frac{3}{2}} - 3d^{10}4s^14d^1 {}^3D_3$
140	4810.53	I	32890-53672	$3d^{10}4s^14p^1 {}^3P_{\frac{3}{2}} - 3d^{10}4s^15s^1 {}^3S_1$

### Zinc — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
2.5	2025.51	II	0-49354	20	3282.33	I	32311-62769
13	2061.91	II	0-48481	90	3302.59	I	32501-62772
1000	2138.56	I	0-46745	28	3302.94	I	32501-62769
3.5	h 2756.45	I	32311-68579	140	3345.02	I	32890-62777
6	d 2770.86	I	32501-68581	30	3345.57	I	32890-62772
	2770.98	I	32501-68579	6	3345.93	I	32890-62769
9	d 2800.87	I	32890-68583	40	4680.14	I	32311-53672
	2801.06	I	32890-68581	100	4722.16	I	32501-53672
10	h 3072.06	I	32890-65432	140	4810.53	I	32890-53672
26	3075.90	I	0-32502	12	hl 6362.35	I	46745-62458

# ZIRCONIUM

Zr,  $Z=40$ ,  $M=91.22$ , Ratio  $\frac{Zr}{Cu}=1.436$

Zr I, Normal state of valence electrons  $4d^2 5s^2 {}^3F_2 = 0$ . I.P. = 56077 K  
 Zr II, Normal state of valence electrons  $4d^2 5s^1 {}^4F_{1/2} = 0$ . I.P. = 113175 K

## References

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### Classification:

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### Molecular Spectra:

ZrO, C. C. Kiess, Sci. Papers BS **22**, 47 (1927).

## Relative intensity of zirconium lines observed in an arc of copper containing 0.1 atomic percent of zirconium

### *Strong lines of zirconium*

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
900	3391. 98	II	1323-30796	$4d^2 5s^1 a {}^4F_{4/2} - 4d^2 5p^1 z {}^4G_{3/2}$
750	3438. 23	II	763-29840	$4d^2 5s^1 a {}^4F_{3/2} - 4d^2 5p^1 z {}^4G_{1/2}$
650	3496. 21	II	315-28909	$4d^2 5s^1 a {}^4F_{2/2} - 4d^2 5p^1 z {}^4G_{3/2}$
550	3601. 19	I	1241-29002	$4d^2 5s^2 a {}^3F_4 - 4d^2 5s^1 5p^1 x {}^3G_3^o$
340	3556. 60	II	3758-31866	$4d^3 b {}^4F_{4/2} - 4d^2 5p^1 z {}^4F_{4/2}$
340	3572. 47	II	0-27984	$4d^2 5s^1 a {}^4F_{1/2} - 4d^2 5p^1 z {}^4G_{3/2}$
320	3519. 60	I	0-28404	$4d^2 5s^2 a {}^3F_2 - 4d^2 5s^1 5p^1 x {}^3G_3^o$
280	3547. 68	I	570-28750	$4d^2 5s^2 a {}^3F_3 - 4d^2 5s^1 5p^1 x {}^3G_1^o$
280	3551. 95	II	763-28909	$4d^2 5s^1 a {}^4F_{3/2} - 4d^2 5p^1 z {}^4G_{3/2}$
280	3835. 96	I	0-26062	$4d^2 5s^2 a {}^3F_2 - 4d^2 5s^1 5p^1 x {}^3F_2^o$
260	3863. 87	I	570-26444	$4d^2 5s^2 a {}^3F_3 - 4d^2 5s^1 5p^1 x {}^3F_3^o$
260	3890. 32	I	1241-26938	$4d^2 5s^2 a {}^3F_4 - 4d^2 5s^1 5p^1 x {}^3F_1^o$
200	2678. 63	II	1323-38644	$4d^2 5s^1 a {}^4F_{4/2} - 4d^1 5s^1 5p^1 y {}^4F_{4/2}$
200	3279. 26	II	763-31249	$4d^2 5s^1 a {}^4F_{3/2} - 4d^2 5p^1 z {}^4F_{3/2}$
200	3481. 15	II	6468-35186	$4d^2 5s^1 a {}^2F_{3/2} - 4d^2 5p^1 z {}^2G_{4/2}$
200	3576. 85	II	3300-31249	$4d^3 b {}^4F_{3/2} - 4d^2 5p^1 z {}^4F_{3/2}$
200	4687. 80	I	5889-27215	$4d^3 5s^1 a {}^5F_5 - 4d^3 5p^1 y {}^5G_3^o$
190	3479. 39	II	5753-34485	$4d^2 5s^1 a {}^2F_{2/2} - 4d^2 5p^1 z {}^2G_{3/2}$
180	3613. 10	II	315-27984	$4d^2 5s^1 a {}^4F_{2/2} - 4d^2 5p^1 z {}^4G_{3/2}$
180	3614. 77	II	2895-30551	$4d^3 b {}^4F_{2/2} - 4d^2 5p^1 z {}^4F_{2/2}$
180	3623. 86	I	570-28157	$4d^2 5s^2 a {}^3F_3 - 4d^2 5s^1 5p^1 w {}^3F_3^o$
180	3891. 38	I	1241-26931	$4d^2 5s^2 a {}^3F_4 - 4d^2 5s^1 5p^1 z {}^1G_4^o$
180	4072. 70	I	5541-30087	$4d^3 5s^1 a {}^5F_4 - 4d^3 5p^1 x {}^5D_3^o$
180	4081. 22	I	5889-30385	$4d^3 5s^1 a {}^5F_5 - 4d^3 5p^1 x {}^5D_3^o$
180	4227. 76	I	5889-29535	$4d^3 5s^1 a {}^5F_5 - 4d^3 5p^1 y {}^5F_5^o$
180	4239. 31	I	5541-29123	$4d^3 5s^1 a {}^5F_4 - 4d^3 5p^1 y {}^5F_4^o$



Zirconium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
1.8	2374.42	I	0-42103	1.4	2717.48	I	4186-40974
1.8	2384.17	I		150	2722.61	II	1323-38041
1.8	2388.01	I	570-42434	16	2725.47	I	1241-37921
1.8	2389.21	I		90	2726.49	II	763-37430
1.8	2405.52	I	1241-42799	7	2727.02	I	570-37230
3.0	2419.41	II	4248-45568	55	2732.72	II	763-37346
10	2449.85	II	4248-45055	160	2734.86	II	315-36869
1.4	2457.44	II	4506-45186	4	2737.89	I	
5	2487.29	II	8153-48345	8	2740.35	II	3758-40239
3.0	2496.48	II	7838-47882	12	2740.51	II	4248-40727
12	2532.46	II	763-40239	16	2741.55	II	1323-37788
6	2539.65	I	570-39934	120	2742.56	II	0-36452
15	2542.10	II	315-39640	75	2745.86	II	763-37171
3.0	2550.51	I	570-39766	75	2752.21	II	315-36639
15	2550.74	II	0-39192	60	2758.81	II	0-36237
3.0	2556.43	I	1241-40346	1.4	2759.48	I	1241-37469
4	2567.45	I	1241-40178	8	2761.91	II	0-36197
38	2567.64	II	0-38934	10	2763.03	I	4376-40558
110	2568.87	II	1323-40239	22	d 2768.73	II	1323-37430
140	2571.39	II	763-39640		2768.85	II	763-36869
5	2583.40	II	4506-43202	19	d 2774.04	I	570-36608
9	2589.07	II	4248-42861		2774.16	II	6468-42504
1.5	2589.65	I	570-39174	9	2786.86	I	5102-40974
5	2609.43	I	570-38882	22	2790.14	I	5102-40932
17	2630.91	II	4506-42504	14	2792.04	I	0-35806
9	2635.42	I	1241-39174	10	2793.39	I	
24	2639.09	II	763-38644	3.5	2795.13	I	570-36336
8	2643.40	II	315-38134	18	2796.90	II	5724-41468
6	2647.78	I	570-38327	12	2799.15	II	5753-41468
12	2650.38	II	763-38483	10	2806.78	I	4186-39804
8	2658.69	I	4186-41788	4	2808.16	II	315-35915
20	2667.80	II	315-37788	20	2810.91	II	6112-41677
6	2669.49	II	5753-43202	70	2814.90	I	0-35515
		II	7736-45186	44	2818.74	II	7736-43202
13	2670.96	II	4248-41677	8	2819.56	I	5102-40558
200	2678.63	II	1323-38644	6	2821.56	I	570-36001
4	2681.76	II	763-38041	60	2825.56	II	7513-42894
10	2687.75	I	1241-38436	10	2827.50	II	6112-41468
10	2692.60	II	8058-45186		2827.54	I	1241-36597
2.5	2692.92	I	0-37123	7	2829.81	I	4376-39704
18	2693.53	II	315-37430	12	2833.91	II	7513-42789
20	2694.06	II	5753-42861	9	2834.40	II	6468-41738
8	2695.43	II	4248-41337	4	2836.49	I	5102-40346
11	2699.60	II	315-37346	80	2837.23	I	570-35806
85	2700.13	II	763-37788	6	2838.02	II	6112-41337
10	2706.17	I	0-36942	14	2839.34	II	6468-41677
8	2709.33	I	570-37469	15	2843.52	II	7736-42894
32	2711.51	II	0-36869	75	2844.58	II	8058-43202
16	2712.42	II	315-37171	24	2848.19	II	5753-40853
16	2714.26	II	4506-41337	40	2848.52	I	1241-36336

Zirconium — All Observed Lines

Intensity and Character	Wave-length in A	Spectrum	Energy Levels in K	Intensity and Character	Wave-length in A	Spectrum	Energy Levels in K
40	2851.97	II	7736-42789	26	3005.50	I	8057-41320
8	2854.43	II	7838-42861	130	3011.75	I	570-33764
3.0	2856.06	II	5724-40727	16	3013.32	II	4506-37682
11	2860.85	I	570-35515	10	3014.44	I	0-33164
6	2865.10	II	2895-37788	26	3019.84	II	315-33419
10	2865.60	II	3758-38644	55	3020.47	II	4248-37346
38	2869.81	II	8058-42894	80	3028.04	II	7838-40853
4	2872.53	II	8058-42861	140	3029.52	I	1241-34240
55	2875.98	I	1241-36001	28	3030.92	II	0-32984
10	2877.55	II	3300-38041	55	d 3036.39	II	4506-37430
4	2880.83	I	5102-39804		3036.50	II	4248-37171
4	2882.09	II	4248-38934	5	3043.25	I	570-33420
6	2883.80	II	7838-42504	16	3045.83	I	4186-37008
10	2888.04	II	6112-40727	11	3049.33	I	4186-36971
5	2889.43	II	2572-37171	110	3054.84	II	8153-40878
14	2892.26	I	1241-35806	11	3057.22	II	8153-40853
10	2898.71	II	3300-37788	16	3060.11	II	315-32984
7	2901.62	II	13428-47882	14	3061.35	II	763-33419
6	2901.82	II	2895-37346	11	3063.57	I	4376-37008
18	2905.23	II	6468-40878	16	3064.63	II	4248-36869
8	2907.38	II	6468-40853	8	3065.21	II	0-32615
10	2910.25	II	8153-42504	17	3085.34	I	570-32972
34	2915.99	II	3758-38041	9	3090.44	I	5102-37450
3.0	2916.25	I	570-34851	17	3094.80	I	4186-36489
12	2916.64	II	2895-37171	40	3095.07	II	315-32615
30	2918.24	II	8153-42410	17	3095.82	I	4197-36489
8	2923.85	I	570-34762	44	3099.23	II	0-32257
5	2924.64	II	14163-48345	110	3106.58	II	8058-40239
36	2926.99	II	14190-48345	18	3108.37	I	4376-36538
18	2934.61	II	2572-36639	34	3110.88	II	763-32899
18	2936.31	II	3300-37346	55	3120.74	I	4186-36220
10	2945.46	II	7736-41677	11	3125.19	II	4248-36237
36	2948.94	II	7838-41738	50	3125.92	II	0-31981
24	2951.48	II	3300-37171	80	3129.18	II	4248-36197
11	2952.24	II	1323-35186	80	3129.76	II	315-32257
36	2955.78	II	14060-47882	22	3131.11	I	4197-36125
50	2960.87	I	0-33764	55	3132.07	I	4376-36295
50	2962.68	II	2895-36639	17	3133.23	I	5102-37008
50	2968.96	II	3758-37430	55	3133.48	II	7736-39640
19	2969.19	I	570-34240	28	3136.96	I	5102-36971
36	2969.63	II	2572-36237	110	3138.68	II	763-32615
20	2976.61	II	8153-41738	22	3139.80	I	5102-36942
50	2978.05	II	3300-36869	28	3148.82	I	4376-36125
36	2979.18	II	2895-36452	46	3155.67	II	7513-39192
26	2981.02	II	4506-38041	24	3157.00	II	4248-35915
130	2985.39	I	0-33487	50	3157.82	I	4376-36035
4	2987.80	II	9743-43202			I	5102-36760
8	2991.41	II	0-33419	85	3164.31	II	5753-37346
50	3003.74	II	4506-37788	24	3165.45	II	8058-39640
16	3005.37	I	4186-37450	140	3165.97	II	1323-32899

Zirconium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
24	3166.26	II	6468-38041	60	3334.25	II	8058-38041
30	3178.09	II	7736-39192	34	3334.62	II	4506-34485
30	3181.58	II	7513-38934	30	3338.41	II	7736-37682
24	3181.92	II	5753-37171	120	3340.56	II	1323-31249
140	3182.86	II	4506-35915	60	3344.79	II	8153-38041
85	3191.21	I	0-31327	20	3353.66	I	1241-31050
34	3191.90	II	6468-37788	28	3354.39	II	6112-35915
12	3197.04	I	4186-35456	120	3356.09	II	763-30551
4	3204.35	II	7736-38934	85	3357.26	II	0-29778
15	3204.90	I	5102-36295	28	3359.96	II	11984-41738
85	3212.01	I	570-31695	24	3360.46	I	5102-34851
7	3212.58	I	5102-36220	15	3362.68	II	8058-37788
12	3212.85	II	5753-36869	24	3363.82	II	2895-32615
120	3214.19	II	763-31866	24	3367.82	II	2572-32257
17	3222.47	II	14163-45186	4	3368.64	I	0-29677
32	3228.81	II	6468-37430	6	3369.26	II	9969-39640
100	3231.69	II	315-31249	24	3370.59	I	5102-34762
100	3234.12	I	1241-32152	28	3373.42	II	8153-37788
17	3236.58	II	14299-45186	60	3374.73	II	8058-37682
120	3241.05	II	315-31160	17	3376.27	II	7736-37346
50	3250.39	I	570-31327	24	3377.46	II	3300-32899
	3250.46	II	14299-45055	9	3378.30	II	7838-37430
32	3254.28	I	16978-47698	9	3379.92	I	17556-47135
32	3260.11	I	4186-34851	90	3387.87	II	7838-37346
6	3264.81	II	7513-38134	120	3388.30	II	0-29505
30	3269.66	I	4186-34762	900	3391.98	II	1323-30796
24	3271.13	II	4248-34810	90	3393.12	II	315-29778
85	3272.22	II	0-30551	26	3396.33	II	7736-37171
160	3273.05	II	1323-31866	6	3396.66	II	13429-42861
200	3279.26	II	763-31249	6	3397.92	I	18277-47698
50	d 3282.73	I	1241-31695	60	3399.35	II	2572-31981
	3282.83	II	14733-45186	24	3402.87	II	12360-41738
140	3284.71	II	0-30435	30	3403.68	II	8058-37430
22	3285.88	II	8058-38483	90	3404.83	II	2895-32257
24	3288.80	II	763-31160	30	3408.08	II	7838-37171
		II	7736-38134	6	3408.78		
12	3296.40	II	7736-38063	120	3410.25	II	3300-32615
12	3302.67	II	9969-40239	6	h 3411.79	I	17833-47135
		II	17614-47882	60	3414.66	I	570-29847
85	3305.15	II	315-30562			II	8153-37430
140	3306.28	II	315-30551	12	3419.11	II	1323-30562
6	3309.89	II	7838-38041	18	3419.66	I	4186-33420
6	3311.34	II	5724-35915	25	3424.82	II	315-29505
24	3313.70	II	7513-37682	4	3426.93	I	8057-37230
34	3314.50	II	5753-35915	10	3430.29	I	1241-30385
12	3318.51	II	6112-36237	160	3430.53	II	3758-32899
24	3319.02	II	315-30435	18	3431.57	II	7736-36869
60	3322.99	II	6112-36197	22	3432.41	II	7513-36639
6	3326.41	I	4186-34240	18	3433.91	II	8058-37171
60	3326.80	II	12360-42410	60	3437.14	II	5724-34810

Zirconium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
750	3438.23	II	763-29840	100	3550.46	I	0-28157
28	3440.45	I	0-29058	280	3551.95	II	763-28909
19	3443.57	II	7838-36869	20	3554.07	II	9553-37682
30	3446.61	I	4186-33192	340	3556.60	II	3758-31866
95	3447.36	I	0-28999	24	3558.96	I	5102-33192
32	3455.91	I	4186-33114	170	3566.10	I	1241-29275
18	3457.18	I	4197-33114	14	3568.14	II	6468-34485
65	3457.56	II	4506-33419	34	3568.88	I	5102-33114
32	3458.93	II	7736-36639	340	3572.47	II	0-27984
26	3461.09	I	8057-36942	34	3573.08	II	2572-30551
130	3463.02	II	11984-40853	170	3575.79	I	570-28528
15	3465.63	I	1241-30087	200	3576.85	II	3300-31249
6	3469.94	II	8058-36869	28	3577.55	I	8057-36001
95	3471.19	I	0-28801	24	3578.23	II	9743-37682
4	3472.90	I	4186-32972	140	3586.29	I	0-27876
20	3478.30	II	763-29505	70	3587.98	II	2572-30435
10	3478.50	II	9743-38483	28	3588.32	II	3300-31160
32	3478.79	I	4376-33114	11	3591.72	I	570-28404
28	3479.02	II	4248-32984	7	h 3593.13	I	17060-44882
190	3479.39	II	5753-34485	14	3599.90	II	14733-42504
24	3480.41	II	7513-36237	550	3601.19	I	1241-29002
200	3481.15	II	6468-35186	26	3607.38	II	9969-37682
30	3482.81	I	570-29275	110	3611.89	II	14060-41738
30	3483.01	I	8057-36760	180	3613.10	II	315-27984
120	3483.54	II	6112-34810	22	3613.70	I	4186-31851
20	3485.32	II	7513-36197	180	3614.77	II	2895-30551
7	3495.37	I	11956-40558	180	3623.86	I	570-28157
650	3496.21	II	315-28909	28	3630.02	II	2895-30435
30	3499.58	II	3300-31866	22	3633.49	II	14163-41677
20	3501.35	I	570-29123	50	3634.15	I	1241-28750
13	3501.49	I	8057-36608	28	3636.45	II	3758-31249
55	3505.48	II	12360-40878	5	3638.72	I	4376-31851
130	3505.67	II	1323-29840	5	3655.56	II	7838-35186
13	3506.05	II	9969-38483	32	3661.20	I	570-27876
7	3507.67	II	7736-36237	12	3662.14	II	13429-40727
160	3509.32	I	570-29058	140	3663.65	I	1241-28528
32	3510.46	II	4506-32984	20	3668.45	II	3300-30551
320	3519.60	I	0-28404	48	3671.27	II	5753-32984
20	3520.87	II	4506-32899	100	3674.72	II	2572-29778
70	3525.81	II	2895-31249	18	3678.90	II	14163-41337
14	3530.22	I	5102-33420	7	3680.37	I	1241-28404
11	3530.85	II	14190-42504	48	3697.46	II	3758-30796
70	3533.22	I	1241-29535	120	3698.17	II	8153-35186
34	3535.16	I	8057-36336	11	3706.63	I	1241-28212
18	3536.94	II	2895-31160	90	3709.26	II	6468-33419
7	3539.01	II	13429-41677	24	3714.13	I	1241-28157
100	3542.62	II	14190-42410	24	3714.78	II	4248-31160
280	3547.68	I	570-28750	8	3718.84	II	2895-29778
20	3549.51	II	9969-38134	34	3731.26	II	14060-40853
34	3549.74	I	8057-36220	6	3737.39	I	5102-31851

## Zirconium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
6	3738.11	II	4506-31249	9	3941.62	I	8057-33420
70	3745.98	II	14190-40878	3.5	3951.33	I	11641-36942
10	3750.64	II	4506-31160	3.5	3956.79		
110	3751.60	II	7838-34485	85	3958.22	II	4248-29505
6	3754.79	I	14349-40974	7	h 3963.80	I	16317-41538
12	3757.79	II	14733-41337	44	3966.66	I	1241-26444
60	3764.39	I	0-26557	90	3968.26	I	1241-26434
60	3766.72	I	12342-38882	3.5	3972.30	I	15720-40888
42	3766.82	II	3300-29840	10	3973.39	I	12761-37921
3	3767.88	II	5724-32257	60	3973.50	I	570-25730
90	3780.54	I	0-26444	18	3975.29	I	12773-37921
6	3782.22	II	6468-32899	6	3977.34	I	5249-30385
12	3786.61			14	3977.48	I	8057-33192
70	3791.40	I	570-26938	3.5	3978.25	I	
11	3792.40	I	570-26931	9	3978.74	I	12342-37469
16	3796.48	II	8153-34485	18	h 3981.60	I	11017-36125
12	3808.20					I	16978-42087
26	3817.58	II	4248-30435	9	3982.16	I	10885-35990
70	3822.41	I	0-26154	14	3984.75	I	4186-29275
		I	5541-31695	6	3986.80	I	570-25646
7	3827.27	II		9	3988.68	I	5023-30087
280	3835.96	I	0-26062	7	3989.29	I	570-25630
160	3836.76	II	4506-30562	14	3989.50	I	15120-40178
14	3838.28	II	4506-30551	70	3991.13	II	6112-31160
50	3843.02	II	2895-28909	70	3998.97	II	4506-29505
50	3847.01	I	570-26557	3.5	4001.09	I	1241-26227
50	3849.25	I	0-25972	7	4002.55	I	4871-29847
10	3855.43	II	4506-30435	13	4003.10	I	11017-35990
260	3863.87	I	570-26444	7	4004.40	I	12503-37469
70	3864.34	I	1241-27111	7	h 4004.87	I	16978-41941
90	3877.60	I	8057-33839	18	4007.60	I	14989-39934
18	3879.05	I	570-26343	18	4012.25	I	15720-40637
140	3885.42	I	0-25730	14	4016.98	I	12342-37230
260	3890.32	I	1241-26938	11	4018.38	II	7736-32615
180	3891.38	I	1241-26931	36	4023.98	I	5541-30385
9	h 3892.03	I	15201-40888	11	4024.44	II	8058-32899
7	h 3893.84	I	12761-38436	70	4024.92	I	5249-30087
14	3896.53	I	570-26227	90	4027.20	I	5023-29847
		I	17143-42799	22	4028.95	I	4186-28999
7	3897.66	I	14697-40346	36	4029.68	II	5753-30562
36	3900.52	I	0-25630	44	4030.04	I	4871-29677
3.5	3914.34	II	19515-45055	3.5	4034.09	II	6468-31249
28	3915.94	II	4248-29778	36	4035.89	I	1241-26012
14	3916.64	I	1241-26766	3.5	4040.24	II	7513-32257
55	3921.79	I	570-26062	9	4041.64	I	15201-39937
7	h 3926.78	I	15720-41179	22	4042.22	I	11258-35990
110	3929.53	I	570-26012	55	4043.58	I	4186-28910
18	3934.12	II	2572-27984	44	4044.56	I	4871-29588
18	3934.79	II	5753-31160	36	4045.61	II	5724-30435
6	3936.06	II	6468-31866	55	4048.67	II	6468-31160

Zirconium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
18	4050.33	II	5753-30435	36	4194.76	I	11258-35091
18	4050.48	I	4376-29058	7	4196.13	I	12773-36597
11	4054.43	I	1241-25898	55	4199.09	I	5102-28910
70	4055.03	I	5023-29677	55	4201.46	I	5023-28818
54	4055.71	I	12773-37422	55	4208.98	II	5753-29505
30	4061.53	I	4186-28801	7	4211.34	I	14697-38436
140	4064.16	I	5249-29847	18	4211.88	II	4248-27984
7	4068.72	I	10885-35456	7	4212.62	I	10885-34617
180	4072.70	I	5541-30087	36	4213.86	I	4871-28595
28	4074.93	I	4376-28910	11	4218.45	I	5102-28801
18	4076.53	I	4186-28710	3.5	4220.65	I	5023-28710
22	4078.31	I	4197-28710	6	4225.46	I	12342-36001
180	4081.22	I	5889-30385	180	4227.76	I	5889-29535
6	4082.30	I	1241-25730	3.5	4231.63	II	14163-37788
11	4083.08	I	11641-36125	14	4234.63	I	5102-28710
14	4084.30	I	14697-39174	18	4236.06	I	11017-34617
14	4085.66	I	12761-37230	6	4236.55	I	0-23597
7	4087.69	I	12773-37230	9	4237.43	I	11258-34851
14	4090.51	II	6112-30551	180	4239.31	I	5541-29123
14	4090.79	I	12503-36942	70	4240.34	I	4871-28447
5	4093.16	I	4376-28801	70	4241.20	I	5023-28595
11	4094.27	I	12342-36760	110	4241.69	I	5249-28818
6	4096.63	II	4506-28909	7	4253.57	I	11258-34762
10	4099.31	I	0-24388	7	4256.44	I	4186-27673
14	4107.50	I	11956-36295	16	4258.04	II	4506-27984
18	4108.40	I	4376-28710	7	4261.21	I	5541-29002
10	4119.83	I	12342-36608	7	4261.42	I	12761-36220
36	4121.46	I	4376-28633	28	4268.02	I	5023-28447
7	h 4127.96	I	4186-28404	7	4273.52	II	6112-29506
		I	4376-28595	8	4274.77	I	4186-27573
7	4134.31	I	12761-36942	11	4276.72	I	4197-27573
14	4135.68	I	5102-29275	7	4282.03	I	17833-41179
3.5	4140.01	I	14123-38271	50	4282.20	I	5249-28595
6	4147.37	I	12503-36608	3.5	4286.51	II	7838-31160
110	4149.20	II	6468-30562	10	4291.20	I	4376-27673
14	4150.97	II	6468-30551	10	4291.35	I	4186-27482
18	4152.64	I	11017-35091	50	4294.79	I	5541-28818
7	4153.75	I	12773-36841	3.5	4296.74	II	14163-37430
26	4156.24	II	5724-29778	28	4302.89	I	5889-29123
36	4161.21	II	5753-29778	17	4304.68	I	14697-37921
36	4166.36	I	5541-29535	3.5	4309.82	I	4376-27573
7	4169.36	I	14349-38327	7	4317.31	II	5753-28909
11	4171.48	I	10885-34851	7	4319.05	I	1241-24388
7	4179.81	II	13429-37346	7	4321.17	I	1241-24376
18	4183.32	I	5102-28999	10	4324.03	I	14349-37469
9	4186.69	II	14163-38041	16	4325.44	I	5889-29002
60	4187.56	I	11641-35515	3.5	4329.56	I	570-23661
11	4191.79	I	11956-35806	3.5	4333.26	II	19433-42504
3.5	4192.10	I	12761-36608	50	4341.13	I	11258-34287
3.5	4194.01	I	12761-36597	3.5	4343.04	I	0-23019

Zirconium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
6	4346.52	I	14123-37123	7	4539.98	I	5102-27122
3.0	4347.22	I	570-23567	44	4542.22	I	5102-27111
95	4347.89	I	8057-31050	18	4553.01	I	4197-26154
3.0	4348.93	I	5541-28528	4	4553.97	II	19515-41468
6	4358.74	I	4186-27122	18	4555.13	I	12503-34451
26	4359.74	II	9969-32899	13	4555.52	I	12760-34706
28	4360.81	I	4186-27111	4	4558.04	I	11258-33192
32	4366.45	I	11017-33912			I	12773-34706
12	4370.95	II	9743-32615	2.0	4562.12	I	
3	4373.07	I	5889-28750	4	4565.47	I	12342-34240
22	4379.78	II	12360-35186	1.8	4574.50	II	19614-41468
3	4394.50	I	570-23320	44	4575.52	I	0-21849
12	4394.94	I	10885-33632	3.5	4576.20	I	11641-33487
9	4395.21	I	4376-27122	9	4582.29	I	14791-36608
8	4400.24	I	5889-28609	7	4584.24	I	11956-33764
6	4402.95	I	4197-26902	1.8	4590.16	I	11641-33420
6	4403.34	II	9553-32257	13	4590.55	I	4376-26154
17	4413.04	I	11258-33912	32	4602.57	I	15120-36841
3.0	4414.14	I	1241-23889	13	4604.42	I	4186-25898
6	4414.54	II	9969-32615	2.0	4609.15	I	12761-34451
22	4420.46	I	11017-33632	2.0	4609.29	I	5249-26938
11	4427.24	I	18739-41320	2.0	4609.83	I	4871-26557
5	4429.11	I	5102-27673	2.0	4610.11	I	4376-26062
14	4431.49	I	10885-33445	2.0	4619.85	ZrO	
8	4438.05	I	4376-26902	19	4626.41	I	14989-36597
7	4440.46	II	9743-32257	2.0	4627.72	I	11956-33559
13	4443.00	II	11984-34485	3.5	4629.07	II	20080-41677
2.5	4444.33	I	11956-34451	60	4633.98	I	570-22144
2.5	4448.95	I	5102-27573	2.0	4634.64	I	5541-27111
8	4450.28	I	10885-33350	2.0	4637.78	ZrO	
5	4455.43	I	14791-37230	6	4640.13	I	14791-36336
5	4456.30	I	14989-37422	18	4644.83	I	14697-36220
10	4457.43	I	11017-33445			I	11641-33164
		II	9553-31981	3.0	4654.38	I	12761-34240
2.5	4460.34	I	5102-27515	8	4657.64	I	11956-33420
8	4461.22	II	8153-30562	3.0	4659.49	I	5102-26557
10	4466.91	I	5102-27482	6	4667.14	I	5023-26444
2.5	4468.22	I	11258-33632	22	4683.42	I	12342-33688
4	4468.79	I	4186-26557	6	4684.25	I	5102-26444
10	4470.31	I	12342-34706	2.0	4685.19	II	19515-40853
17	4470.56	I	12773-35135	2.0	4686.57	I	11641-32972
3	4480.77	I	14697-37008	200	4687.80	I	5889-27215
4	4482.50	I	15120-37422	44	4688.45	I	1241-22564
2.5	4491.56	I	4186-26444	2.0	4691.73	I	5249-26557
5	4494.42	II	19433-41677	2.0	4695.04	I	17143-38436
2.5	4494.94	I	14989-37230	4	h 4700.11	I	
18	4496.97	II	5753-27984		4700.18	I	4376-25646
50	4507.12	I	4376-26557	9	4707.79	I	11956-33192
2.5	4523.13	I	17753-39855	160	4710.08	I	5541-26766
55	4535.75	I	4186-26227	14	4711.92	I	12342-33559

Zirconium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
6	4713.43	I	14791-36001	38	5078.25	I	11641-31327
10	4717.62	I	4871-26062	7	5085.26	I	14791-34451
18	4719.12	I	14989-36173	4	5112.27	II	13428-32984
2.0	4731.14	I	5023-26154	11	5115.24	I	16317-35861
26	4732.33	I	5102-26227	4	5120.42	I	15932-35456
3.0	4734.36	I	18739-39855	7	5133.40	I	4186-23661
120	4739.48	I	5249-26343	24	5155.45	I	12761-32152
3.0	4742.94	I	12342-33420	16	5158.00	I	16978-36360
3.5	4751.91	I	5023-26062	3.0	5158.67	I	12773-32152
5	4753.05	I	15120-36153	6	5160.99	I	11956-31327
16	4762.78	I	14791-35782	7	5165.96	I	12342-31695
75	4772.31	I	5023-25972	1.4	5178.99	I	4186-23489
18	4784.92	I	5541-26434	8	5183.70	I	5102-24388
14	4788.67	I	5889-26766	2.5	5187.03	I	15932-35206
3.5	4789.11	I	5023-25898	8	5191.60	II	14163-33419
3.0	4793.28	I	14349-35206	8	5201.15	I	4376-23597
2.5	4794.96	I	12342-33192	7	5209.30	I	12503-31695
22	4805.87	I	5541-26343	7	5224.93	I	4186-23320
3.0	4806.68	I	12761-33559	2.5	5243.47	I	17060-36125
12	4809.47	I	12773-33559	10	5277.41	I	4376-23320
16	4815.04	I	5249-26012	6	5280.05	I	12761-31695
60	4815.63	I	4871-25630	5	5294.82	I	8057-26938
24	4824.29	I	5249-25972	10	5296.79	I	8057-26931
16	4828.04	I	5023-25730	5	5301.97	I	17753-36608
9	4838.78	I	12503-33164	9	5311.40	I	4197-23019
5	4838.98	I	12761-33420	2.0	5321.26	I	5102-23889
1.6	4841.45	I	5249-25898	1.8	5330.84	I	570-19324
1.6	4846.35	I	5102-25730	1.0	5338.43	I	4871-23597
18	4851.36	I	5023-25630	2.5	5350.09	II	14299-32984
14	4866.06	I	5889-26434	2.5	5350.35	II	14733-33419
		I	17556-38101	2.0	5350.90	I	18739-37422
9	4881.24	I	5249-25730	2.0	5351.92	I	
9	4883.60	I	5541-26012	6	5362.56	I	4376-23019
4	4893.12	I	12761-33192	1.0	5363.35	I	5249-23889
1.6	4905.08	I	5249-25630	1.4	5369.39	I	4871-23489
2.5	4930.87	I	15201-35476	1.6	5382.37	I	5023-23597
6	4933.64	I	14784-35047	22	5385.14	I	4186-22751
4	4948.76	I	4186-24388	2.5	5386.65	I	5102-23661
2.5	4962.30	I	14989-35135	1.4	5391.18	I	5023-23567
3.0	4963.72	I	15720-35861	1.4	5395.88	I	17833-36360
1.8	4987.82	I	16317-36360	2.0	5405.13	I	5102-23597
8	4994.76	I	15120-35135	7	5407.62	I	5889-24376
7	4996.33	I	15201-35210	1.4	5413.93	I	5541-24006
2.5	5011.46	I	17060-37008	1.6	5421.86	I	17422-35861
20	5046.58	I	12342-32152	1.2	5426.36	I	16787-35210
7	5060.39	I	15720-35476	2.0	5428.42	I	17060-35476
29	5064.91	I	11956-31695	2.0	5437.76	I	1241-19626
9	5065.22	I	18739-38476	1.2	5440.41	I	4871-23246
8	5070.26	I	14989-34706	3.0	5448.57	I	5541-23889
6	5073.98	I	4186-23889	0.8	5474.92	I	16787-35047



Zirconium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
0.8	5477.40	I	4871-23122	14	6121.91	I	8057-24388
3.0	5478.33	I	17753-36001	7	6124.84	I	4197-20519
3.0	5480.83	I	5249-23489	55	6127.44	I	1241-17556
0.8	5481.16	I		28	6134.55	I	0-16297
2.5	5486.09	I	5023-23246	8	6140.46	I	4186-20467
11	5502.12	I	8057-26227	36	6143.20	I	570-16844
2.0	5507.87	I	17060-35210	2.5	6155.61	I	12761-29002
2.5	5517.11	I	5541-23661	6	6157.71	I	19626-35861
0.8	5518.05	I	5889-24006	2.0	6160.20	I	12773-29002
6	5528.41	I	18277-36360	3.0	6189.40	I	19324-35476
1.6	5532.30	I	5249-23320	5	6192.96	I	4376-20519
3.5	5537.46	I	17422-35476	7	6213.05	I	4376-20467
4.0	5545.32	I	17833-35861	8	6214.69	I	17753-33839
1.8 bl	5551.75	ZrO		14 bl	6226.51	ZrO	
2.0 bl	5553.17	ZrO		8	6257.26	I	12773-28750
1.0	5612.11	I	0-17814	4 b	6261.05	ZrO	
10	5620.14	I	4186-21974	3.0	6267.06	I	11956-27908
3.0	5623.53	I	4197-21974	3.5 bl	6292.84	ZrO	
2.0 bl	5629.02	ZrO		10	6299.66	I	12342-28212
2.0 bl	5629.58	ZrO		1.2	6304.34	I	4376-20234
13	5664.51	I	5102-22751	24	6313.02	I	12773-28609
1.6	5666.28	I	17833-35476	2.5	6314.71	I	8057-23889
10	5680.90	I	4376-21974	4	6321.35	I	12342-28157
1.2	5685.42	I	18277-35861	1.8	6340.36	I	12761-28528
2.5	5708.89	I	0-17512	4 bl	6345.10	ZrO	
6 bl	5718.21	ZrO		6	6345.22	I	12773-28528
10	5735.70	I	0-17430	6 bl	6378.56	ZrO	
3.0 bl	5748.17	ZrO		3.0	6407.00	I	1241-16844
1.4 bl	5778.57	ZrO		4 b	6412.39	ZrO	
13	5797.74	I	570-17814	1.0	6426.17	I	22144-37701
2.5	5847.32	I	17143-34240	3.0	6434.33	I	22564-38101
4	5868.27	I	1241-18277	5	6445.74	I	8057-23567
9	5869.50	I	15120-32152	1.6	6451.62	I	5023-20519
28	5879.80	I	1241-18244	1.6	6457.63	I	11641-27122
7	5885.62	I	570-17556	9	6470.21	I	12761-28212
4	5901.09	I	570-17512	5 bl	6473.79	ZrO	
2.5 bl	5908.61	ZrO		0.9	6484.35	I	5102-20519
11	5925.13	I	5102-21974	9	6489.64	I	12503-27908
8	5935.20	I	0-16844	1.8	6493.10	I	12761-28157
9	5955.35	I	0-16787	4	6503.26	I	12503-27876
2.5 bl	5977.80	ZrO		4	6506.36	I	5102-20467
8	5984.23	I	14989-31695	4 bl	6508.15	ZrO	
1.4	5995.37	I	5889-22564	2.5 bl	6542.90	ZrO	
4	6001.05	I	12342-29002	3.0	6550.54	I	11641-26902
2.5	6025.36	I	1241-17833	2.5	6569.43	I	5249-20467
7	6032.61	I	11956-28528	1.6	6576.56	I	0-15201
14	6045.85	I	14791-31327	2.5 b	6578.06	ZrO	
8	6049.24	I	19834-36360	4	6591.99	I	11956-27122
11	6062.84	I	570-17060	0.8	6596.71	I	11956-27111
4	6120.83	I	4186-20519	0.8	6598.84	I	570-15720

Zirconium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
4	6603.27	I	12342-27482	4	7112.82	I	11956-26012
1.2	6620.56	I	18739-33839	1.8	7113.52	I	12503-26557
1.0	6678.01	II	19515-34485	1.2	7132.95	I	11956-25972
2.0	6688.18	I	4376-19324	0.8	7138.28	I	12761-26766
1.0	6702.12	I	11641-26557	1.6	7140.74	I	12342-26343
1.6	6709.61	I	4197-19097	1.2	7144.47	I	12773-26766
2.5	6717.88	I	11017-25898	60	7169.09	I	5889-19834
3.5	6752.73	I	8057-22862	5	7201.62	I	15120-29002
7	6762.38	I	0-14784	1.2	7258.17	I	11956-25730
8	6769.16	I	12342-27111	3.5	7264.76	I	14989-28750
2.5	6772.89	I	10885-25646	0.8	7284.69	I	12503-26227
1.4	6787.15	II	20080-34810	2.0	7306.21	I	12761-26444
3.0	6790.85	I	12761-27482	0.6	h 7307.32	I	
0.7	6796.68	I	14349-29058	2.5	7311.62	I	12761-26434
4	6828.78	I	11258-25898	3.5	7313.72	I	12342-26012
4	6832.89	I	570-15201	9	7318.08	I	12773-26434
0.6	6833.67	I	11017-25646	1.0	7327.82	I	
1.2	6845.33	I	10885-25490	5	7335.97	I	4186-17814
1.6	6846.34	I	5023-19626	5	7343.96	I	14791-28404
9	6846.97	I	11956-26557	2.0	7373.50	I	12503-26062
2.5	6849.26	I	12342-26938	0.8	7374.80	I	12342-25898
1.2	6852.56	I	12342-26931	2.5	7383.63	I	14989-28528
0.8	6854.63	I	5249-19834	0.8	h 7399.30	I	
0.4	6857.90	I	14697-29275	1.4	7400.90	I	12503-26012
0.6	6883.23	I	5102-19626	1.0	7411.39	I	15120-28609
12	6888.29	I	11641-26154	0.8	h 7417.89	I	14123-27600
3.0	6900.59	I	11956-26444	1.0	7422.75	I	12503-25972
2.0	6904.36	I	1241-15720	1.0	7433.10	I	14123-27573
3.0	6907.37	I	11017-25490	11	7439.86	I	4376-17814
2.0	6916.87	I	4871-19324	1.8	7467.57	I	12342-25730
0.6	6922.23	I	12773-27215	1.6	7479.58	I	14791-28157
1.6	6932.38	I	11641-26062	0.9	7502.92	I	14349-27673
3.0	6948.46	I	11258-25646	0.9	7506.51	I	
15	6953.84	I	5249-19626	1.4	h 7515.70	I	15700-29002
6	6966.44	I	12761-27111	1.2	7517.95	I	17753-31050
1.0	6975.91	I	11641-25972	0.9	h 7521.03	I	15457-28750
15	6990.84	I	5023-19324	2.0	h 7540.62	I	15146-28404
8	6994.32	I	5541-19834	2.0	7544.59	I	12761-26012
1.0	7005.46	I	11956-26227	3.0	7551.46	I	12773-26012
10	7027.40	I	4871-19097	0.7	h 7553.00	I	4186-17422
2.5	7057.36	I	12773-26938	4	7554.70	I	4197-17430
1.4	7057.96	I		2.5	7558.45	I	12503-25730
14	7087.30	I	4871-18976	1.2	7560.09	I	14349-27573
2.5	7089.43	I	12342-26444	0.7	7560.31	I	14989-28212
3.5	7094.46	I	12342-26434	1.2	7562.12	I	5023-18244
5	7095.59	I	11641-25730	8	7607.15	I	5102-18244
55	7097.70	I	5541-19626	0.8	7610.83	I	4376-17512
28	7102.91	I	5249-19324	1.4	7612.08	I	14349-27482
17	7103.72	I	5023-19097	2.0	7621.17	I	11258-24376
14	7111.68	I	4186-18244	0.5	7621.61	I	14791-27908

## Zirconium — All Observed Lines

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K	Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
3.0	7658.60	I	4376-17430	40	8132.99	I	5541-17833
1.8	7690.83	I	14123-27122	2.0	8152.58	I	5249-17512
1.4	7704.27	I	14697-27673	1.2	8188.77	I	14349-26557
1.0	7708.42	I	12761-25730	4	8194.73	I	10885-23085
0.6	7722.48	I	22145-35091	6	8201.73	I	4871-17060
0.9	7723.95	I	4871-17814	28	8212.53	I	5249-17422
0.8	7765.70	I	4186-17060	2.0	8240.37	I	17143-29275
1.0	7766.55	I	11017-23889	4	8283.81	I	11017-23085
0.6	7800.74	I	21801-34617	0.7	8299.81	I	12342-24388
1.2	7816.32	I	5023-17814	14	8305.90	I	5023-17060
11	7819.35	I	14697-27482	0.7	8309.50	I	14123-26154
3.5	7822.94	I	14123-26902	0.7	8320.16	I	5541-17556
4	7826.72	I	14349-27122	1.4	8332.44	I	17060-29058
9	7849.35	I	5541-18277	5	8370.23	I	5889-17833
3.5	7869.99	I	5541-18244	12	8389.41	I	4871-16787
1.4	7876.25	I	22398-35091	7	8414.00	I	5541-17422
1.6	7882.18	I	4376-17060	5	8453.17	I	11258-23085
1.0	7897.98	I	4186-16844	0.6	8457.48	I	5023-16844
1.6	7908.46	I	4871-17512	5	8464.65	I	5249-17060
0.6	7924.20	I	22145-34762	0.9	8495.98	I	17143-28910
2.0	7940.47	I	4197-16787	4	8498.44	I	5023-16787
16	7944.61	I	5249-17833	0.5	8513.78	I	5102-16844
8	7956.66	I	5249-17814	0.5	8515.06	I	17060-28801
8	7959.98	I	4871-17430	0.8	8568.54	I	5889-17556
2.0	7963.63	I	14349-26902	0.7	8571.05	I	12342-24006
16	8005.27	I	5023-17512	1.8	8584.21	I	15120-26766
0.7	8015.26	I	11017-23489	0.7	8587.84	I	11956-23597
0.4	h 8040.10	I	14123-26557	0.5	8610.24	I	11956-23567
2.5	8046.05	I	14697-27122	0.5	8641.01	I	
1.6	8053.06	I	14697-27111	1.0	8734.86	I	14989-26434
2.0	8055.29	I	4376-16787	1.2	8749.48	I	4871-16297
2.0	8055.76	I	5102-17512	0.6	8762.93	I	
6	8058.08	I	5023-17430	1.0	8786.23	I	11641-23019
15	8063.09	I	5023-17422	1.6	8804.98	I	14989-26343
80	8070.08	I	5889-18277	7	8836.09	I	15120-26434
1.0	8114.28	I	5102-17422	6	8899.52	I	12773-24006
2.0	8120.17	I	18739-31050				

### Selected Publications of the National Bureau of Standards

Table of Wavenumbers, C. D. Coleman, W. R. Bozman, and

W. F. Meggers:

Monograph 3, Volume I. 2000 A to 7000 A. 508 p. (1960)	\$6.00
Monograph 3, Volume II. 7000 A to 1000 $\mu$ . 542 p. (1960)	\$6.00

New Description of Thorium Spectra, Romuald Zalubas,

Monograph 17, 106 p. (1960)	\$0.65
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Atomic Energy Levels, C. E. Moore:

Circular 467, Volume I. H to V (Z=1 to 23) 206 spectra. 309 p. (1949)	\$5.50
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Circular 467, Volume II. Cr to Nb (Z=24 to 41) 152 spectra. 227 p. (1952)	\$4.00
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Circular 467, Volume III. $\left. \begin{array}{l} \text{Mo to La (Z=42 to 57)} \\ \text{Hf to Ac (Z=72 to 89)} \end{array} \right\}$ 124 spectra. 245 p. (1958)	\$2.50
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An Ultraviolet Multiplet Table, C. E. Moore:

Circular 488, Section 1. H to V (Z=1 to 23); Selected Multiplets of 79 Spectra. 78 p. (1950).	\$0.55
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Circular 488, Section 2. Cr to Nb (Z=24 to 41); Selected Multiplets of 46 Spectra. 115 p. (1952).	\$0.70
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The above publications may be purchased from the Superintendent of Documents, U.S. Government  
Printing Office, Washington 25, D.C.

A Multiplet Table of Astrophysical Interest, C. E. Moore. A Reprinting of the 1945 Multiplet Table (Princeton Univ., Obs. Contr. No. 20):

Technical Note 36 (PB151395), Part I. Table of Multiplets and Part II. Finding List, $\lambda\lambda 2951\text{\AA}-13164\text{\AA}$ . 242 p. (1959).	\$4.00
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The above Technical Note may be purchased by the PB number from the Department of Commerce,  
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