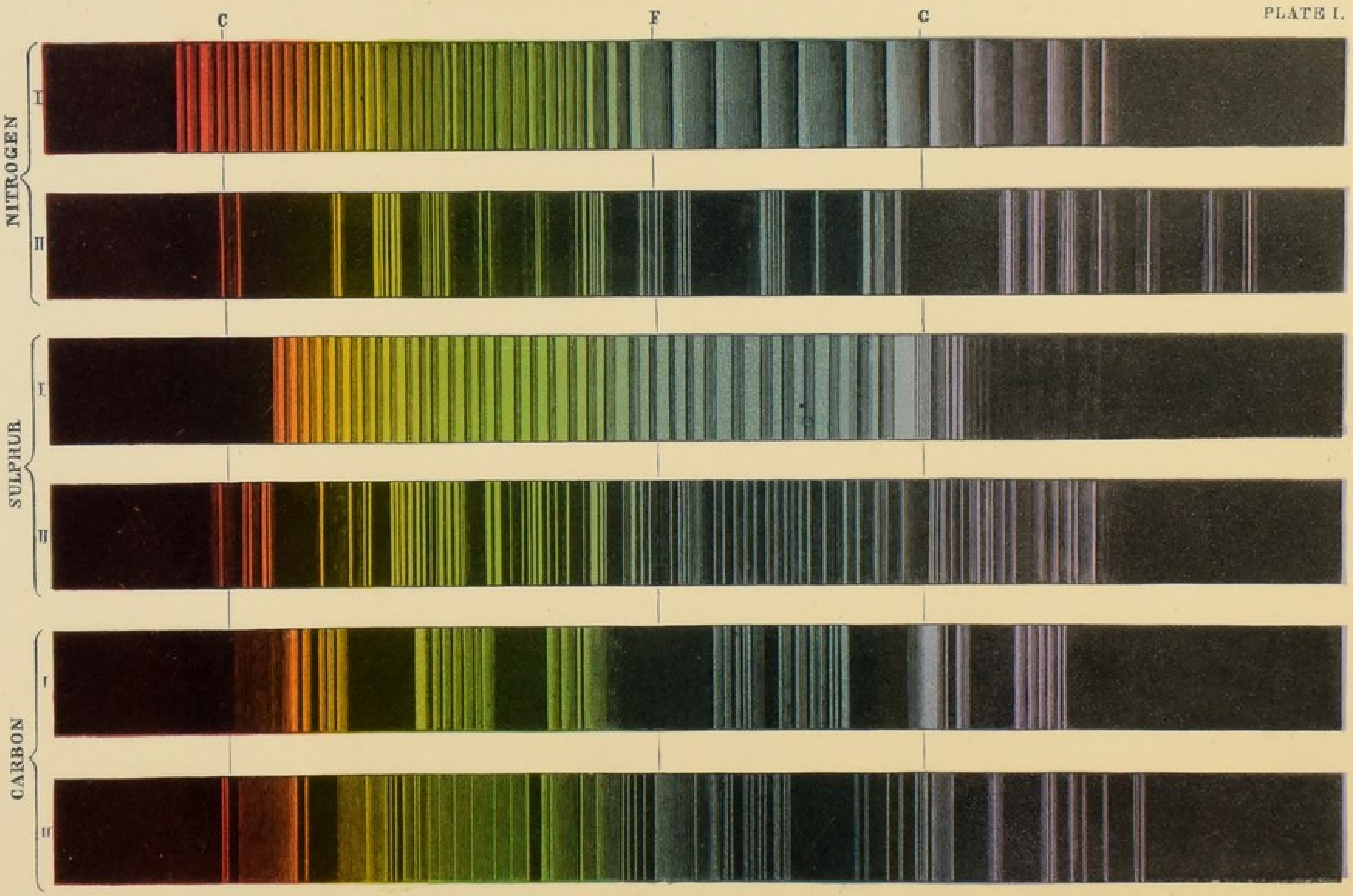
INDEX OF SPECTRA

DR. W. M. WATTS

PLATE I.



DOUBLE SPECTRA OF NITROGEN, SULPHUR, AND CARBON.

INDEX OF SPECTRA.

BY

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PREFACE.

ALL workers with the Spectroscope must have experienced the inconvenience arising from the employment of different scales in the mapping of spectra. The object of this book is to facilitate spectroscopic research by collecting all existing measurements of the spectra of the elements, and presenting them on a uniform scale of wave-lengths, and the attention which the author has bestowed on the work is a sufficient guarantee that the numbers are to be relied upon. This scale of wave-lengths, whilst adequate to the representation of very exact measurements obtained with the largest spectroscopes, is equally convenient for use with instruments of only one or two prisms, and it is therefore much to be desired that its employment should become universal.

I have every reason to hope that Dr. WATTS'S "INDEX OF SPECTRA" may contribute to the adoption of such a uniform scale.

H. E. ROSCOE.

MANCHESTER, *Jan.* 22, 1872.

INTRODUCTION.

ANY method of measurement which is to be applicable to observations made with different spectroscopes must be independent of the peculiar construction of the instruments, the number, position, and refracting angle of the prisms, the dispersive power of the material of which they are made, of variations in the temperature, and of all other disturbing causes. It is clear that in such a method each line can be mapped only by means of its colour, that is to say, by the length of the wave of light by which it is produced; and a spectrum so represented must be such a one as is produced by *diffraction*, and not by *dispersion*.

Dispersion spectra obtained by the use of prisms of different materials vary greatly in the relative breadth of the colours, so that in mapping a spectrum it is by no means sufficient to give the positions of only two or three lines as points of reference. Many otherwise valuable observations of spectra are entirely useless, from the insufficient number of reference lines observed.

In a *diffraction* spectrum the position of the lines is dependent solely on their colour, and is precisely the same by whatever method the spectrum is obtained.

The following table shows the relative positions occupied by the Fraunhofer lines B, D, E, F, and G, in dispersion spectra, produced by prisms of 60°, of crown-glass, of flint-glass, and of carbon disulphide, with which are compared the positions of the same lines in a spectrum obtained by diffraction. The interval between B and G is, in each case, divided into 1000 equal parts.

It will be noticed that the blue end of the spectrum is much more compressed in the diffraction spectrum than in any of the dispersion spectra, and the red end is correspondingly lengthened out.

	Dispersion.			Diffraction.
	Crown-glass.	Flint-glass.	Carbon Disulphide.	
B.	0	0	0	0
D.	236	220	194	381
E.	451	434	400	624
F.	644	626	590	784
G.	1000	1000	1000	1000

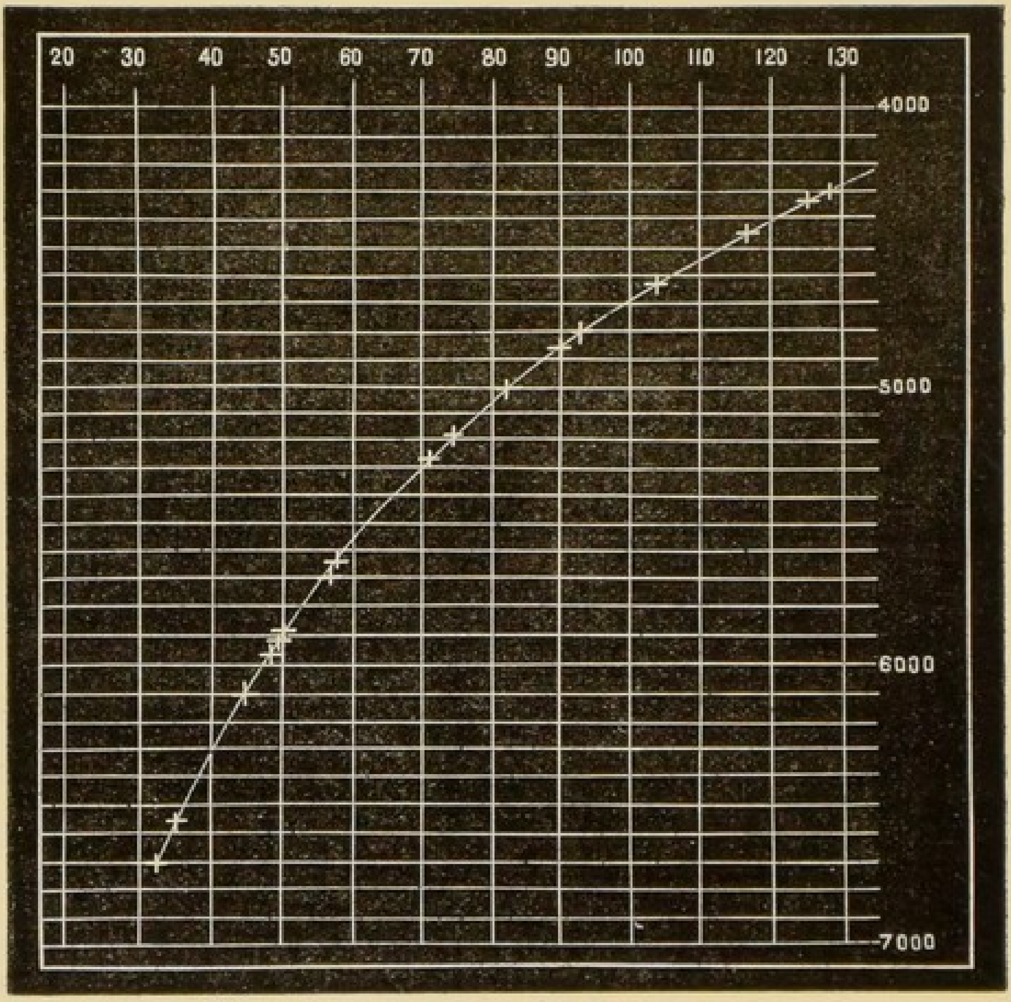
In order that the results obtained by different observers may be comparable, either the spectra must be obtained directly by the method of diffraction, or the results obtained with the prism must be *reduced to wave-lengths*. For this purpose we must possess an accurate table of the wave-lengths of the spectral lines of the elements, we can then very easily determine the wave-lengths of the lines of any new spectrum with as much accuracy as the dispersive power of the spectroscope employed will permit. It is always possible to find two known lines between which the line to be measured falls, and from their wave-lengths to calculate the wave-length of the new line, for which purpose the best method is that of *graphical interpolation*. A scale of wave-lengths is marked off along one edge of paper ruled into squares, and the edge at right angles to that has a scale marked on it corresponding to the scale of the instrument. The positions of as many lines as possible are then mapped on the paper, and through these points a curve is drawn as uniformly as possible. Then the position of the line to be measured, being found on the curve, will have opposite to it the wave-length required on the scale of wave-lengths.

Thus, in using a single prism spectroscope provided with a photograph-millimetre scale, it is necessary first of all to obtain as accurate an interpolation curve as possible, for which purpose the position of as many reference lines as possible should be read off. I take as an example the scale of my own spectroscope, on which I have read off the positions of the principal Fraunhofer lines, of the brightest lines in the *air* spectrum, and of two lines of lithium. We thus obtain the following table:—

	Scale Reading.	Wave-length.
C.	34·6	6562
D.	50·0	5892
E.	70·7	5269
b.	74·5	5174
F.	90·0	4861
G.	128·2	4307
Air	{48·7	5942
	{49·0	5932
—	{56·2	5678
—	{56·6	5666
—	82·5	5003
—	92·8	4803
—	103·9	4630
—	116·5	4447
—	125·1	4348
Lithium	32·0	6705
—	44·6	6101

The figure is a reduction of the curve drawn from these numbers, the actual scale being eight or ten times that of the figure. Paper suitable for this purpose, ruled into inches and tenths, is sold by Messrs. Letts and Co.

If the spectroscope is constructed, like those made by Mr. Browning, with a scale of angular deviations, or with a micrometer-screw, the process is exactly the same, the readings of the micrometer-screw or the angles observed being substituted for the readings of the illuminated scale. For a



small spectroscope, and for most purposes, the illuminated scale is decidedly to be preferred, but with larger spectroscopes the best plan is to employ a *micrometer eye-piece*. This has two very fine spider-lines, one of which is fixed, and the other is moved by means of a micrometer-screw. The interval between the bright line to be measured and each of two known lines between which it falls can thus be determined with great precision.

Instead of employing the method of graphical interpolation, the wave-length may be calculated by means of the following interpolation formula (W. Gibbs, *Silliman's Journal*, July, 1870; *Phil. Mag.* [4]* xl., 177):—

$$\lambda_2^2 = \frac{n_3 - n_1}{\frac{n_2 - n_1}{\lambda_3^2} + \frac{n_3 - n_2}{\lambda_1^2}}$$

where n_3 and n_1 are the readings on the scale of the spectroscope of the two known lines, λ_3 and λ_1 their wave-lengths, n_2 the reading of the line to be measured, and λ_2 its wave-length. The following example will render the use of the formula clear:—One of the brightest lines in the spectrum of the Bessemer flame falls between two bright lines produced by cadmium. Reference to the table shows that these lines have wave-lengths 5378 and 5337 respectively. When the cross wires of the telescope were made to coincide with the lines, the micrometer-screw of the instrument gave the readings 14·38 and 15·27, while, when the wires were brought on the Bessemer line, the reading was 14·81. Putting, then, $n_3 = 15{\cdot}27$, $\lambda_3 = 5327$, $n_1 = 14{\cdot}38$, $\lambda_1 = 5378$, and $n_2 = 14{\cdot}81$, we find for λ_2 the value 5358.

If the line to be determined lies near to the two reference lines, but *not between* them, the *interpolation* formula given above must be replaced by one of the two following *extrapolation* formulæ.

$$\lambda_1^2 = \frac{n_3 - n_2}{\frac{n_3 - n_1}{\lambda_2^2} - \frac{n_2 - n_1}{\lambda_3^2}}$$

$$\lambda_2^2 = \frac{n_2 - n_1}{\frac{n_3 - n_1}{\lambda_2^2} - \frac{n_3 - n_2}{\lambda_1^2}}$$

* In the formulæ 1 and 3, on p. 178, there is a misprint of + for − in the denominator.

I have adopted as the basis of this work Angström's measurements of the wave-lengths of the principal Fraunhofer lines, which appear to me to exceed in accuracy all similar measurements at present at our disposal. They are given in the following table expressed in *tenth-metres*.*

A.	7600·9
a.	7185·0
B.	6866·8
C.	6561·8
D_2.	5895·0
D_1.	5889·0
E.	5269·0
b_1.	5183·0
b_2.	5172·0
b_3.	5168·3
b_4.	5166·7
F.	4860·6
G.	4307·2
h.	4101·2
H_1.	3968·0
H_2.	3932·8

Angström has applied slight corrections to these numbers, and finally adopts the following definitive values (*Recherches sur le Spectre Solaire*, pp. 25 and 34):†—

A.	7604·00
B.	6867·00
C.	6562·01
D.	5892·12
E.	5269·13
F.	4860·72
G.	4307·25
H_1.	3968·01
H_2.	3933·00

* A tenth-metre is $1\text{-}10^{10}$ of a metre.

† These are the values in air at 760 m.m. pressure and 16° C. In order to obtain the wave-lengths *in vacuo*, these numbers must be multiplied by the respective refractive indices of the rays for air at 16° C. When thus corrected the wave-length of C becomes 6563·9 and that of F 4862·1.

These numbers are unquestionably very exact, and it is scarcely likely that any corrections which may be rendered necessary by new and more exact measurements will affect them, except in the decimal place. The wave-lengths of the spectral lines of the elements are given in this work only to the ten-millionth part of a millimetre; a greater degree of exactitude for any except the brightest lines seems scarcely possible at present.

I have collected, in the following table, all the previous measurements of wave-lengths which I have been able to find. The numbers obtained by Fraunhofer (Gilbert's *Annalen der Physik und der physikalischen Chemie*, xiv., 559) are headed F_1, F_2, F_3. The first and second series of measurements were made with wire gratings, and the third with a glass grating. A gives the numbers of Angström (*Recherches sur le Spectre Solaire*, Upsala, 1868), D_2 those of Ditscheiner (*Wien. Ber.*, lii., 289), and V W those of Van der Willigen (*Archives du Musée Teyler*, t. 1, p. 1). These measurements are absolute; the rest are relative only, assuming usually Fraünhofer's number for D, *viz.* 5888. D_1 gives the measurements of Ditscheiner (*Wien. Ber.*, l., 256), B those of Bernard (*Compt. Rend.*, lviii., 1153, and lix., 32), M those of Mascart (*Compt. Rend.*, lviii., 1111), and E those of Esselbach (*Pog. Ann.*, xcviii., 513), who assumes Fraunhofer's numbers for C and H. S gives a series of measurements by Stefan (*Pog. Ann.*, cxxii., 631).

	F_1.	F_2.	F_3.	A.	D_2.	D_1.	B.	M.	E.	V W.	S.
A.	—	—	—	7600·9	—	—	7602	—	—	7633·6	7598
B.	6878	6881	—	6866·8	6883·3	6870·6	6865	6867	6874	6874·8	6872
C.	6564	6567	6556	6561·8	6571·1	6559·5	6557	6561	6564	6565·6	6558
D_2.	5888	5896	5888	5895·0	5905·3	5892·4	5888	5888	5886	5898·6	5894
D_1.				5889·0	5898·9	5888				5892·6	
E.	5260	5271	5265	5269·0	5278·3	5268·6	5266	5268	5260	5272·4	5252
F.	4843	4856	4856	4860·6	4868·7	4859·7	4858	4860	4845	4863·9	4843
G.	4291	4293	4296	4307·2	4317·0	4308·8	4305	4307	4287	4311·2	4302
H_1.	3928	3944	3963	3968·0	3974·2	3966·8	3967	3967	3929	3971·3	—
H_2.	—	—	—	3932·8	3940·5	3935·2	—	—	—	3937·6	—

The spectra of most of the elements have been mapped by Thalén, Huggins, and (as far as the brighter lines are concerned) by Kirchhoff. The numbers in Thalén's memoir (*Nova Acta Reg. Soc. Sc. Upsal* [iii.] vi.) are already given in wave-lengths; they were obtained by interpolation from Angström's fundamental numbers. The instrument employed was a spectroscope of six prisms of flint-glass, or of one or two prisms of carbon disulphide, according to the intensity of the spectrum.

The numbers of Huggins (*Phil. Trans.*, 1864, p. 139) were obtained by observations with a spectroscope of six glass prisms, and are referred to an arbitrary scale, in which the air-lines are taken as starting points. I have reduced these numbers to wave-lengths by means of an interpolation curve, in which Huggins's numbers are represented as abscissæ, and the wave-lengths as ordinates. The curve is drawn by means of 138 lines, spread over the whole spectrum, whose wave-lengths were taken from Angström's normal map of the solar spectrum. The curve so obtained is very regular, and is drawn on a scale so large that the error in determining the wave-length corresponding to any number of Huggins's scale is many times less than the probable error of the original measurements of the lines. Thus it is impossible to draw a smooth curve through all the 138 points of reference, and the curve actually adopted while it passes *through* a large number of these points also leaves a considerable number slightly on the one side or the other. The source of this irregularity may be either in the measurements of Huggins or in those of Angström, or in both; but as the curve drawn from Kirchhoff's numbers and Angström's wave-length determinations is much less irregular, I conclude that Huggins's determinations are not equal in accuracy to those of Angström or of Kirchhoff. The interpolation curve for Kirchhoff's number was drawn by means of 149 solar lines, which could be certainly identified on Angström's map. These points of reference agree better amongst themselves than those used for Huggins's scale, although the curve is not so regular a one. It is made up, indeed, of a number of nearly straight lines, each break in direction corresponding, no doubt, to the re-adjustment of the prisms. I believe that the error arising from such re-adjustments of the apparatus is entirely got rid of by adopting so large a number of reference-lines, and that Kirchhoff's measurements of the wave-lengths of the bright lines of the metals, so far as they extend, are second in value to none.

A comparison of the numbers given in the tables confirms this conclusion, inasmuch as those given by Thalén and Kirchhoff always agree more closely than those of Huggins do either with Kirchhoff's or Thalén's. We may take for example the numbers given on page 61, representing the spectrum of Strontium.

Huggins.	Thalén.	Kirchhoff.
5531	5534	5534
5519	5522	5521
5500	5503	5503
5487	5485	5485
5480	5480	5480
5254	5256	5256
5238	5238	5238
5228	5228	5228
5224	5225	5225
5221	5223	5222
4604	4607	4607

I had completed the reduction of both Huggins's and Kirchhoff's numbers before I became acquainted with two papers by Dr. Wolcott Gibbs, in the "American Journal of Science," for January, 1867, and March, 1869, in which very careful reductions of the numbers of both Kirchhoff and Huggins are given, effected by means of interpolation formulæ.

Dr. Gibbs has employed partly the wave-lengths of Ditscheiner, partly an older series of measurements by Angström,* so that his results are not directly comparable either with my own or with Thalén's numbers. If, however, we make the necessary correction of the fundamental wave-lengths, Dr. Gibbs's numbers agree with mine as closely as can be expected. This will be seen from the following table, which contains a few numbers selected at random. Column A_1 gives the older determinations of Angström, A_2 the more recent ones, D their difference, G the numbers obtained by Dr. Gibbs by reduction of Huggins's observations, G—D the corrected numbers, and W the numbers given in this work.

A_1.	A_2.	D.	G.	G—D.	W.
6566·5	6561·8	4·7	6553·2	6548·5	6547
6520·7	6515·5	5·2	6519·2	6514·0	6513
5900·7	5895·0	5·7	5830·2	5824·5	5824
5607·0	5601·7	5·3	5490·7	5485·4	5487
5273·2	5268·5	4·7	5273·6	5268·9	5269
4386·3	4382·8	3·5	4379·7	4376·2	4376
4310·3	4307·2	3·1	4319·4	4316·3	4318

I have throughout compared Dr. Gibbs's results with my own, in order, as far as possible, to avoid errors in the tables. This means of control is, of course, confined to the 28 elements examined by Dr. Huggins.

The reductions of Kirchhoff's numbers, given by the Astronomer Royal in the "Philosophical Transactions" for 1868, are, as he himself admits, to be trusted only in the close neighbourhood of the six Fraunhofer lines employed as starting points.

* Pog. Ann., cxxiii., 489.

I have not thought it necessary to give the intensities of the lines noted by different observers, but have given a mean estimate on a scale from 1 to 12, 12 being the brightest.

In the case of the elements whose spectra have not been examined by Thalén, Huggins, or Kirchhoff, I have given the best results which exist, and have given references to the original memoirs (the papers of Huggins, Kirchhoff, and Thalén, are not referred to again under the different elements).

The degree of accuracy which these numbers represent is very different. Plücker's measurements for chlorine, bromine, iodine, phosphorus, sulphur, selenium, nitrogen, and oxygen, given in the "Philosophical Transactions" for 1865, seem to be tolerably exact. They have been reduced to wave-lengths by means of an interpolation-curve drawn from the lines of oxygen and nitrogen.

The numbers given from Mascart, Ketteler, and Müller, were obtained by direct observation of the diffraction spectra; they all assume *Fraunhofer's* number for D, *viz.*, 5888.

In the lithographic plates a drawing of the spectrum of each element is given on the plan proposed by Bunsen, in which the intensity of a bright line is indicated by the height of the line representing it. These drawings represent the *dispersion* spectra as obtained with one flint-glass prism; the scale is almost exactly that upon which Bunsen's first drawings of the spectra of the alkalies and alkaline earths were given. The column headed "No." in the tables refers to these drawings, and in all cases where a spectrum has been completely mapped by more than one observer, those lines only are drawn which are recorded by two observers.

The chromo-lithograph gives representations of different spectra produced by the same element, in the case of nitrogen, sulphur, and carbon; oxygen, hydrogen, and aluminium also appear to give more than one spectrum each.

Spectra of hydrogen and aluminium are represented in Plate II., which is a copy of the drawing accompanying Wüllner's paper on the Different Spectra of Hydrogen (*Festchrift der niederrheinischen Gesellschaft für Natur-und Heilkunde, zur 50-jährigen, Jubelfeier der Universität Bonn*); the reference-lines given are too few to render a satisfactory reduction of the drawings to any other scale possible.

It should be remarked that Angström* denies the possibility of an element giving different spectra.

* Comptes Rendus, August 7, 1871.

INDEX OF SPECTRA.

Air.

PLÜCKER and HITTORF. *Phil. Trans.*, 1865, I.

No.	Thalén.	Huggins.	Plücker.	Intensity.
34·0	6602	6602 N	6602 N	6
34·6	6562	6562 H	6562 H	10
36·0	6480	6482 N	6480 N	6
—	—	—	6452 O	8
—	—	—	6376 N	2
—	—	—	6358 N	2
—	—	—	6341 N	2
—	—	—	6288 N	2
—	—	—	6249 N	2
42·9	6171	6171 NO	6170 O	6
—	—	—	{6165, 6152} N	band
—	—	—	6118 O	8
48·5	5949	5950 N	5949 N	4
48·7	5942	5942 N	5942 N	10
49·0	5932	5930 N	5932 N	9
49·1	5929	5925 N	5929 N	4

No.	Thalén.	Huggins.	Plücker.	Intensity.
53·6	5767	5768 N	5767 N	4
—	—	—	5754 N	8
54·1	5745	5746 N	—	4
—	—	5726 N	—	1
55·3	5711	5709 N	5711 N	6
56·0	5686	5686 N	5686 N	5
56·2	5678	5680 N	5681 N	12
56·3	5675	5675 N	5676 N	5
56·6	5666	5668 N	5666 N	10
—	—	—	5560 N	8
60·4	5549	5550 N	5549 N	4
60·8	5541	5541 N	5541 N	5
60·9	5534	5534 N	—	8
61·0	5530	5528 N	5530 N	5
61·2	—	5524 N	5524 N	1
62·2	5495	5495 N	5495 N	7
62·7	5479	5479 N	5479 N	5
63·3	5462	5462 N	5462 N	4
63·5	5453	5453 N	5453 N	4
67·6	5351	5350 N	—	1
68·0	5339	5338 N	5341 N	2
—	—	—	5340 O	10
—	—	—	5330 N	8
68·8	5320	5319 N	—	1
—	—	—	5315 O	10
—	—	—	5309 N	8
—	—	5205 O	—	1
74·2	5190	5190 O	5190 O	4
74·6	5184	5179 N	—	2
74·7	5178	5176 N	5178 O	4
74·8	5172	5172 N	—	2
—	—	—	5164 N	10
75·2	—	5163 O	5161 O	4
—	—	—	{5160 / 5152} N	band
—	—	—	5144 O	10
—	—	—	5120 N	2

No.	Thalén.	Huggins.	Plücker.	Intensity.
—	—	—	5098 N	2
79·4	—	5071 N	5071 N	2
80·6	5045	5045 N	5045 N	10
81·4	5025	5024 N	5025 N	7
81·9	5016	5016 N	5016 N	5
82·2	5010	5010 N	5010 N	5
82·3	5007	5007 N	—	3
82·4	5005	5003 N	5005 N	12
82·7	5002	4999 N	5002 N	12
83·1	4993	4993 N	4992 N	5
83·4	4987	4986 N	4986 N	5
85·0	—	4953 O	4954 O	3
85·7	4941	4943 O	4941 O	4
—	—	4931 N	—	1
86·4	4924	4925 O	4925 O	4
87·4	4906	4907 O	4900 O	4
87·9	4895	4895 N	4894 N	4
88·3	—	4892 O	4884 O	4
88·8	—	4880 N	4876 N	1
89·3	—	4872 O	4866 O	3
—	—	4866 N	—	1
—	—	—	4862 O	2
89·8	—	4858 N	4859 N	4
—	—	—	4856 O	2
90·4	—	4853 O	4850 O	2
—	—	—	4848 O	6
90·5	—	4849 N	4846 N	4
92·8	4803	4804 N	4804 N	8
93·6	4788	4788 N	—	8
94·1	4779	4781 N	—	8
—	—	—	4754 O	4
—	—	—	4744 O	2
—	—	—	4743 N	4
—	—	—	4732 N	4
98·4	4712	—	4711 O	4
98·8	4706	4705 O	4706 O	7
99·1	4698	4699 O	4698 O	7

No.	Thalén.	Huggins.	Plücker.	Intensity.
—	—	—	4690 O	2
100·9	4675	4677 O	4675 O	7
101·7	4662	4662 O	4662 O	7
102·5	4649	4648 O	4649 O	8
—	—	—	4644 N	10
103·1	4642	—	4640 O	6
103·2	4640	4640 NO	4639 O	6
103·9	4630	4629 N	4630 N	10
104·5	4621	4621 N	4621 N	7
105·0	4613	4613 N	4613 N	7
105·3	4607	4608 N	4609 N	7
105·8	4601	4600 N	4601 N	7
106·0	4596	4596 O	4600 O	6
106·4	4590	4588 O	4593 O	6
108·8	—	4553 N	{4551, 4544} N	band
{110·2, 110·9}	—	{4533, 4506} N	{4532, 4523} N	band
—	—	—	{4506, 4500} N	band
—	—	4496 N	—	1
—	—	4490 N	—	1
—	—	4477 N	—	—
—	—	—	4474 O	10
115·0	—	4467 O	4468 O	10
—	—	—	4457 O	4
—	—	—	4450 O	4
116·5	4447	4448 N	4447 N	10
—	—	—	4443 O	4
{117·3, 118·8}	4432	{4437, 4422} N	{4438, 4421} N	band
119·0	4418	4416 O	4418 O	8
119·9	4414	4414 O	4414 O	8
120·4	—	4398 N	4398 O	6
123·4	4368	4364 O	4367 O	4
—	4351	—	—	6
125·1	4348	4347 ON	4348 O	10

No.	Thalén.	Huggins.	Plücker.	Intensity.
—	—	—	4347 O	10
125·4	4346	—	4341 O	6
126·3	4333	—	4334 O	2
—	—	—	4327 O	2
127·3	4319	—	4320 O	8
127·5	4317	4318 O	4317 O	6
—	—	4278 O	—	—
—	—	—	4262 O	10
—	—	—	4243 O	6
133·5 135·5	4230	4238 N	{4247 4227} N	band
137·0 138·6	—	4206 N	{4214 4199} N	band
—	—	—	4196	10
139·9	4190	4190 O	4190 O	5
140·9	4184	4183 O	—	5
141·3 142·8	—	4170 N	{4184 4170} N	band
—	—	—	4171 O	2
144·3	4155	—	4158 O	4
145·0	4149	4149 O	4147 O	2
—	—	—	{4151 4147} N	band
146·1 147·1	4137 —	4142 N 4130 N	4141 4130} N	4
—	—	—	4136 O	2
147·9	4123	—	4126 O	6
148·6	—	4117 O	4117 O	2
—	—	—	4104 O	2
150·9	—	4101 N	4094 O	2
151·7	—	4094 N	{4097 4080} N	band
153·9	4076	—	4086 O	2
—	—	—	4085 O	4
155·0	4074	4073 O	4072 O	3
—	4072	—	—	6

No.	Thalén.	Huggins.	Plücker.	Intensity.
155·5	4069	4069 O	4069 O	3
160·0	4040	4038 N	—	4
165·4	3995	4000 N	—	4

Aluminium.

WÜLLNER. *Festschrift Bonn.*, 1868.

No.	Thalén.	Kirchhoff.	Intensity.
38·2	6371	—	6
38·7	6345	—	6
41·2	6244	6245 6243	9
41·4	6234	6235 6233	9
54·8	5722	5722	10
55·8	5695	5695	10
58·9	5592	—	4
80·2	5056	—	10
101·7	4662	4662 4661	10
110·5	4529	—	7
111·6	4511	—	7
114·2	4478	—	4
171·3	3961	—	8
174·2	3943	—	8

Antimony.

No.	Huggins.	Thalén.	Kirchhoff.	Intensity.
—	7020	—	—	5
—	6840	—	—	2
—	6803	—	—	5
—	6780	—	—	5
—	6742	—	—	1

No.	Huggins.	Thalén.	Kirchhoff.	Intensity.
—	6712	—	—	2
—	6645	—	—	2
—	6513	—	—	2
—	6500	—	—	2
—	6461	—	—	2
—	6392	—	—	4
—	6320	—	—	2
39·9	6301	6301	6301	8
—	6283	—	—	4
41·2	6243	6244	6244	5
42·0	6204	6209	—	4
42·3	6189	6193	—	4
43·3	6153	6155	—	5
43·9	6125	6129	{6130 6128}	10
45·2	6076	6078	{6080 6076}	10
46·0	6050	6051	{6052 6048}	5
47·2	6002	6003	{6006 6003}	12
47·8	5982	5979	5979	4
—	5920	—	—	—
49·5	5912	5909	{5910 5905}	9
50·0	5895	5894	{5896 5891}	9
—	5840	—	—	1
—	5822	—	—	1
52·5	5790	5791	—	4
—	5714	—	—	—
—	5700	—	—	1
—	5663	—	—	1
—	5644	—	—	1
57·5	5635	5638	{5641 5639}	9

No.	Huggins.	Thalén.	Kirchhoff.	Intensity.
—	5629	—	—	1
—	—	5607	—	2
59·7	5556	5567	{5569 5566}	9
63·2	5460	5463	{5465 5462}	8
—	5392	—	—	—
66·4	5379	5379	—	7
—	—	5371	—	2
67·5	5352	5352	—	2
72·0	5238	5241	—	7
73·2	5219	5208	—	1
74·7	5177	5177	—	7
76·2	5139	5141	—	7
77·5	5112	5112	—	5
—	5080	—	—	1
—	5044	—	—	2
81·1	5031	5036	—	2
85·3	4948	4948	—	9
88·9	4878	4878	—	7
91·3	4832	4835	—	5
93·7	4787	4786	—	5
—	4768	—	—	2
—	4757	—	—	2
96·8	4735	4735	—	4
98·4	4712	4711	{4712 4711}	10
99·7	4693	4691	—	7
—	4622	—	—	1
—	4600	—	—	1
106·5	4588	4591	—	7
—	4506	—	—	2
—	4457	—	—	1
—	4376	—	—	1
124·9	4349	4352	—	9
131·8	4264	4265	—	7
—	4249	—	—	1
—	4193	—	—	1

Arsenic.

No.	Huggins.	Thalén.	Kirchhoff.	Intensity.
—	6404	—	—	1
—	6342	—	—	1
—	6252	—	—	1
42·9	6164	6169	{6171, 6167}	10
—	6131	—	—	1
44·3	6108	6110	{6112, 6109}	10
—	6078	—	—	2
46·8	6020	6021	6022	5
—	5839	—	—	1
—	5781	—	—	1
57·1	5647	5651	{5652, 5650}	10
—	5616	—	—	1
—	5590	—	—	1
60·1	5554	5558	{5558, 5556}	10
62·1	5495	5498	{5498, 5496}	8
—	5404	—	—	1
—	5384	—	—	1
68·3	5324	5532	{5333, 5330}	8
—	5287	—	—	1
—	5229	—	—	5
—	5162	—	—	1
—	5104	—	—	5
—	4983	—	—	2
—	4888	—	—	1
—	4732	—	—	1
—	4551	—	—	1
—	4537	—	—	1
—	4497	—	—	2

No.	Huggins.	Thalén.	Kirchhoff.	Intensity.
—	4464	—	—	3
—	4369	—	—	1
—	4335	—	—	1

Barium.

Bunsen and Kirchhoff. *Pogg. Ann.*, cx., 161.

No.	Huggins.	Thalén.	Kirchhoff.	Intensity.
—	6889	—	—	1
—	6780	—	—	1
—	6697	—	—	1
—	6677	—	—	1
—	6589	—	—	1
35·2	6523	6526	—	6
35·8	6499	6496	6497	10
—	—	6483	—	6
36·6	6452	6449	—	6
38·7	6344	6343	—	6
43·7	—	6141	6141	10
44·2	6113	6110	6111	6
45·6	6064	6062	6063	6
46·8	6021	6018	6018	6
47·3	5998	5992	—	6
48·0	5973	5971	5971	6
49·7	5904	5904	—	2
—	5889	—	—	1
51·2	5850	5853	5853	10
51·9	5823	5827	5827	6
—	—	5808	—	2
—	—	5803	—	2
53·2	5774	5780	5780	6
—	5744	—	—	1
60·9	5538	5534	5534	10
61·4	5518	5518	5518	3
—	5490	—	—	1

No.	Huggins.	Thalén.	Kirchhoff.	Intensity.
64·7	—	5425	5424	6
86·0	4934	4933	4933	12
87·7	4898	4899	4899	9
—	4727	—	—	1
—	4690	—	—	1
108·8	4553	4553	{4554 4553}	12
110·8	4524	4524	4524	6
—	4174	—	—	2
—	—	4165	—	8
147·1	4130	4130	—	10

Bismuth.

MASCART. *Annales Scientifiques de l'Ecole Normale Supérieure,* t. iv.

No.	Huggins.	Thalén.	Mascart.	Intensity.
—	6808	—	—	4
34·0	6590	6599	—	4
—	6571	—	—	1
35·8	6499	6493	—	6
44·0	6125	6129	—	8
45·9	6057	6057	—	8
46·0	6055	6050	—	4
46·5	6034	6038	—	4
—	5980	—	—	1
—	5972	—	—	1
50·9	5862	5862	—	8
52·2	5819	5816	—	6
55·0	5717	5717	—	6
56·9	5656	5655	—	4
60·3	5552	5553	—	4
—	5538	—	—	1
63·6	5449	5450	—	8
65·9	5394	5396	—	4

No.	Huggins.	Thalén.	Mascart.	Intensity.
—	5357	—	—	1
70·7	5271	5270	—	10
73·5	5208	5208	—	10
73·9	5199	5201	—	4
76·0	5144	5144	—	12
76·8	5124	5124	—	10
78·5	5089	5090	—	2
79·0	5078	5078	—	5
83·2	4991	4993	—	8
84·2	4970	4970	—	2
—	4915	—	—	1
87·4	4907	4905	—	4
93·1	4798	4797	—	4
95·7	4752	4752	—	2
97·2	4729	4730	—	2
97·8	4723	4722	4721	10
98·8	4705	4705	—	2
—	—	4691	—	4
108·3	4560	4560	—	8
—	4476	—	—	1
—	4389	—	—	2
125·9	4338	4339	—	4
126·6	4329	4328	—	4
128·8	4301	4302	—	8
132·3	4259	4259	—	9
148·2	4120	4119	—	5
154·0	4080	4084	—	4

Boron.

No observations of the spectrum of this element exist. Drawings of the flame-spectrum of Boracic Acid are given by MITSCHERLICH, *Phil. Mag.* [4], xxviii., 169; and by THALEN "Om Spektralanalys." See also SIMMLER, *Pogg. Ann.*, cxv., 242.

Bromine.

PLÜCKER. *Pogg. Ann.*, cvii., 497.
PLÜCKER and HITTORF. *Phil. Trans.*, 1861, I.

No.	Plücker and Hittorf.	Int.	No.	Plücker and Hittorf.	Int.
29·3	6862	6	66·8	5383	1
33·5	6628	6	68·6	5326	10
34·3	6576	6	69·7	5299	1
34·8	6555	6	69·9	5292	10
38·5	6357	10	71·0	5263	8
43·2	6158	10	71·5	5250	8
43·4	6151	2	72·7	5225	10
43·9	6131	2	73·0	5220	1
43·9	6128	2	73·2	5216	2
50·8	5868	6	74·3	5187	1
51·9	5827	10	74·6	5180	2
52·0	5824	2	75·0	5168	10
53·0	5792	1	75·7	5150	8
54·3	5739	2	77·0	5122	2
54·8	5722	6	77·8	5106	2
55·2	5712	2	78·4	5092	4
55·8	5696	6	80·2	5054	6
56·7	5662	2	81·0	5035	6
57·8	5626	2	82·2	5010	6
57·9	5622	2	83·2	4990	6
58·8	5598	10	83·6	4982	1
59·8	5566	1	84·7	4960	2
60·3	5552	1	85·4	4945	2
61·4	5515	8	86·1	4932	8
61·9	5502	8	86·5	4924	2
62·3	5492	8	89·4	4868	1
63·8	5446	10	90·3	4852	2
64·2	5436	10	90·6	4847	1
64·5	5428	1	92·1	4818	8
64·8	5422	8	92·6	4807	2
66·0	5391	1	93·7	4787	10

No.	Plücker and Hittorf.	Int.	No.	Plücker and Hittorf.	Int.
94·2	4778	2	102·9	4644	1
94·6	4771	6	104·2	4625	10
96·1	4746	1	109·6	4543	4
96·8	4736	1	123·5	4365	10
97·2	4730	1	129·8	4288	2
97·9	4721	4	134·0	4241	1
98·7	4706	10	135·4	4228	2
99·5	4695	2	138·8	4198	1
100·7	4680	10	141·3	4181	1
100·9	4676	1	145·9	4142	1

Cadmium.

MASCART. *Annales de l'Ecole Normale.*

No.	Huggins.	Thalén.	Kirchhoff.	Mascart.	Int.
31·3	6740	—	6742	—	4
—	—	—	6726	—	—
36·3	6462	6466	{6468, 6462}	—	7
36·9	6433	6438	6438	6437	10
46·0	6050	6056	—	—	2
47·2	6004	6004	—	—	2
48·3	5959	5958	—	—	2
49·4	5914	5913	—	—	2
—	—	5790	—	—	2
—	—	5687	—	—	4
—	—	5489	—	—	2
—	—	5471	—	—	4
66·5	5377	5378	{5379, 5378}	5377	12
68·2	5334	5338	{5339, 5337}	5336	12
69·5	5304	5304	—	—	2
75·6	5153	5153	—	—	4

No.	Huggins.	Thalén.	Kirchhoff.	Mascart.	Int.
78·7	5085	5085	5085	5084	10
93·0	4798	4799	4800	4799	10
100·8	4677	4677	4677	4677	10
119·1	4416	4416	4416	4415	8

Cæsium.

BUNSEN. *Pogg. Ann.*, cxix., 6.
JOHNSON and ALLEN. *Phil. Mag.* [4], xxv., 199.

No.	Thalén.	Intensity.
84·1	4972	10

Calcium.

BUNSEN and KIRCHHOFF. *Pogg. Ann.*, cx., 161.
ROSCOE and CLIFTON. *Proc. Lit. and Phil. Soc. Manchester*, 1862.
ERDMANN. *Journ. Prak. Chem.*, lxxxv., 394.

No.	Huggins.	Thalén.	Kirchhoff.	Intensity.
31·9	6710	—	6722	1
35·8	6498	6498	6499	8
35·9	6492	6492	6492	10
36·2	6468	6468	6468	8
36·4	6458	6462	6462	10
36·7	6445	6449	6447	8
36·9	6434	6438	6438	10
—	6352	—	—	1
—	6336	—	—	1
—	6311	—	—	1
—	—	—	6209	—
—	—	—	6202	—
—	—	—	{6194 6192}	—

No.	Huggins.	Thalén.	Kirchhoff.	Intensity.
—	—	—	{6180, 6175}	—
42·9	—	6168	6167	8
43·1	6163	6161	6161	10
—	6154	—	—	4
44·1	6116	6121	6121	10
44·6	—	6102	6101	8
—	6093	—	—	1
—	6087	—	—	1
—	6060	—	—	—
47·2	6002	—	{6006, 6003}	1
—	5986	—	—	—
51·1	5854	5857	5857	6
58·6	—	5602	5602	4
58·7	5600	5600	5600	6
58·8	5598	5597	5597	6
58·9	5594	5593	5595	8
—	5591	—	—	3
59·0	5588	5589	5589	4
59·1	5587	5588	5588	10
59·3	5581	5581	5581	4
—	5509	—	—	1
67·7	5348	5349	5348	8
70·7	5269	5269	5269	8
70·9	5264	5264	5264	6
71·0	—	5263	5263	4
71·1	5261	5261	5261	2
71·1	5258	5261	5261	2
74·3	5187	5188	5188	6
80·8	5040	5041	5041	8
—	5021	—	—	1
89·0	4877	4877	—	6
—	—	4841	—	4
—	—	4832	—	2
—	—	4812	—	4
—	—	4607	—	4

No.	Huggins.	Thalén.	Kirchhoff.	Intensity.
106·7	4584	4585	—	4
106·9	4581	4581	—	4
107·1	4578	4578	—	4
115·9	—	4455	4456	2
116·0	4454	4454	4454	10
117·5	—	4435	4435	2
117·6	4434	4434	4434	10
118·4	4424	4425	4424	10
—	—	4408	—	2
—	—	4407	—	2
—	—	4406	—	2
—	—	4393	—	4
—	—	4389	—	4
—	—	4385	—	4
—	—	4379	—	4
127·5	4318	4318	4318	8
128·3	4306	4307	4307	6
128·7	4302	4302	4302	10
129·0	4298	4298	4298	6
129·8	4288	4289	—	8
130·2	4282	4282	—	8
—	—	4274	—	2
—	—	4271	—	2
—	—	4254	—	2
—	—	4250	—	4
—	—	4247	—	4
—	—	4237	—	2
—	—	4233	—	2
135·5	4227	4226	—	10
—	—	4215	—	8
—	—	4192	—	2
—	—	4188	—	4
—	—	4143	—	4
—	—	4131	—	4
—	—	4098	—	2
—	—	4095	—	2

No.	Huggins.	Thalén.	Kirchhoff.	Intensity.
—	—	4092	—	2
—	—	4077	—	6
170·2	3969	3968	—	10
—	—	3934	—	10

Carbon.

Swan. *Edinb. Phil. Trans.*, xxi., 411.
Attfield. *Phil. Trans.*, 1862, 221.
Plücker. *Pogg. Ann.*, cvii., 497.
Dibbits. *De Spectraal Analyse.*
Plücker and Hittorf. *Phil. Trans.*, 1865, 1.
Morren. *Ann. de Chim. et de Phys.*, 1865, iv., 305.
Thalen. "Om Spektralanalys."
Lielegg. *Phil. Mag.* [4], xxxvii., 208.
Watts. *Phil. Mag.* [4], xxxviii., 249; xli., 12.

Spectrum No. I.

α	42·5	Wave-length	6190
	44·2	,,	6110
	46·0	,,	6050
	47·2	,,	5990
	48·5	,,	5955
γ	58·0	,,	5622
	60·0	,,	5582
	61·5	,,	5534
	63·0	,,	5495
	64·5	,,	5463
	66·0	,,	5440
	67·0	,,	5425
δ	75·0	,,	5170
	77·0	,,	5139
	79·3	,,	5100
	80·2	,,	5082

ε	97·0	Wave-length	4734
	98·5	,,	4710
	100·0	,,	4689
	101·5	,,	4675
	101·7	,,	4670
ζ	105·0	,,	4600
	107·5	,,	4574
	109·5	,,	4550
	110·5	,,	4534
	112·0	,,	4514
	113·0	,,	4505
	114·0	,,	4502

f { Broad band intersected by a great number of fine dark lines.

Fine bright line.

128·0 Wave-length 4313. Least refracted edge of a broad band made up of a great number of fine bright lines separated by dark spaces. At first these lines are too close to be read; then several bright lines gave the readings :—

4290
4285
4279
4274
4268
4261
4256
4249
4243
4239
4232

The lines become fainter, but read as far as 4195.

θ	136·0	Wave-length	4220
	237·5	,,	4210
	138·5	,,	4190
	140·0	,,	4174
	141·0	,,	4166
	142·0	,,	4160 4158

Each of the bands of which the groups δ, γ, and α consist is made up of an immense number of fine bright lines separated by dark spaces. These lines are closer together on the side towards the red, till where they make up the bright edge of the band the dark lines can no longer be observed.

Spectrum No. II.

	40	Wave-length	6060
h	45	,,	5803
j	58	,,	5602
k	74	,,	5195
l	92	,,	4834
m	112	,,	4505
n	121	,,	4395

Each of the bands of this spectrum is brightest on the least refracted side, and fades away towards the blue. Each band is shaded with dark lines which are closer together at the bright edge—so that the band presents the appearance of a cylindrical pillar with equal flutings, seen at a little distance. The dark lines are not so close together in the band *j* as they are in the band *k*.

Spectrum No. IV.

a {	34·0	Wave-length	6578	
	34·5	,,	6562	Coincident with hydrogen α.
	43·0	,,	6165	
	44·5	,,	6095	
Two not very bright lines, each triple.				
	48·0	Wave-length	5954	Double.
	51·0	,,	5855	Double.
Three faint lines, the first double.				
β {	56·0	Wave-length	5688	
	56·5	,,	5652	
	57·2	,,	5640	
	57·5	,,	5635	Double.
	62·7	,,	5426	Double.
	66·0	,,	5385	Triple.

69·0 Wave-length 5306
Three faint lines.

γ	75·0	Wave-length	5160	
γ	75·6	,,	5152	
γ	76·4	,,	5140	
	79·7	,,	5065	Triple.
	84·0	,,	4969	
	84·2	,,	4960	Double.

Faint double line.

δ	85·5	Wave-length	4947	
δ	86·6	,,	4927	
δ	87·3	,,	4911	
δ	88·0	,,	4900	
δ	89·5	,,	4874	
δ	90·3	,,	4860	Double.
ε	99·2	,,	4730	Double.
ε	99·6	,,	4696	
	101·0	,,	4674	
	102·0	,,	4656	
ζ	103·0	,,	4646	
ζ	103·5	,,	4637, 4632	
η	106·0	,,	4590	
η	106·5	,,	4585	

Five faint lines, of which the fourth is double and the fifth triple.

θ	119·5	Wave-length	4417	Middle of rather wide line.
	123·3	,,	4368	Most refracted edge of band.

Perfectly black interval.

125·0 Wave-length 4350 Least refracted edge of band.

Two fine lines.

	127·0	Wave-length	4320	Double.
ι	133·0	,,	4272	Maximum of broad band 130 to 134.
κ	139·8	,,	4196	
κ	140·4	,,	4192	

Three faint lines.

146·0 Wave-length 4141

147·4 Wave-length 4130
Three faint lines.

152·0 Wave-length 4092		
to to		Broad band, fine line at 4089.
154·0 ,, 4080		

Chlorine.

PLÜCKER. *Pogg. Ann.*, cvii., 497.
PLÜCKER and HITTORF. *Phil. Trans.*, 1865, I.

No.	Plücker.	Int.	No.	Plücker.	Int.
31·5	6730	2	74·6	5180	2
32·2	6692	2	74·7	5176	2
32·7	6665	2	75·3	5161	2
33·1	6645	2	75·3	5160	2
44·4	6108	8	75·7	5150	2
48·5	5952	1	75·8	5148	2
48·9	5934	1	78·1	5101	4
52·7	5788	2	78·1	5099	6
55·1	5716	2	79·0	5077	6
56·0	5685	2	79·6	5066	1
56·4	5674	2	80·6	5044	1
57·4	5640	2	82·4	5006	2
58·7	5601	2	82·5	5004	2
59·4	5577	2	82·8	4998	4
60·8	5540	2	84·0	4974	4
61·0	5533	2	85·3	4948	2
63·3	5460	10	85·6	4942	2
63·9	5444	10	86·2	4930	4
64·8	5422	10	86·5	4924	4
66·2	5385	10	87·3	4907	6
67·8	5346	2	87·7	4899	6
68·6	5325	2	91·7	4825	10
70·5	5274	4	92·3	4814	10
73·3	5212	10	93·0	4800	10
73·6	5205	10	93·5	4790	2

No.	Plücker.	Int.	No.	Plücker.	Int.
93·7	4786	6	106·4	4590	2
94·0	4782	1	107·0	4579	band
94·2	4778	2	107·4	4574	band
94·2	4777	6	125·3	4346	10
94·9	4765	2	125·9	4338	2
95·7	4749	8	128·1	4310	4
98·5	4711	1	129·4	4293	2
102·5	4650	2	130·4	4280	1
103·6	4634	2	130·7	4277	1
104·9	4615	2	132·4	4258	4

Cerium.

No.	Thalén.	Kirchhoff.	Intensity.
57·3	5654	5638	2
58·7	5600	—	2
59·8	5564	5563 5554	2
61·6	5511	—	8
63·0	5472	5471	6
63·1	5467	5467	4
63·2	5463	5463	2
65·3	5409	5409	8
65·9	5392	5392	8
67·5	5352	5352	10
68·4	5330	5329	6
70·6	5273	5273	10
—	—	5230 5229	—
74·2	5191	5191	4
74·4	5187	5186	6
75·3	5161	—	2
—	—	5146	—
—	—	5116	—
78·9	5079	5079	6

No.	Thalén.	Kirchhoff.	Intensity.
79·3	5072	5075	4
84·2	4970	4971	2
—	—	4882	—
—	—	4737	—
98·4	4713	{4713 4712}	9
104·0	4628	4628	10
104·3	4624	—	2
105·5	4605	—	2
106·2	4594	4594	6
106·9	4582	—	2
107·1	4578	—	2
107·4	4573	4573	10
108·0	4564	—	2
108·2	4562	{4562 4561}	10
108·2	4561	{4561 4560}	9
109·8	4540	4540	8
110·5	4528	{4528 4527}	9
110·6	4527	{4527 4526}	10
110·8	4523	—	8
113·5	4486	—	2
113·8	4483	—	2
114·1	4479	—	2
114·7	4471	4471	9
115·0	4467	—	2
115·4	4463	—	2
115·6	4460	{4460 4459}	10
116·5	4448	—	6
116·9	4443	—	6
118·1	4428	—	8
118·9	4419	4419	8
119·5	4410	—	2

No.	Thalén.	Kirchhoff.	Intensity.
120·4	4398	—	2
121·0	4391	4391	8
121·5	4385	4385	8
121·8	4382	4382	8
123·5	4365	—	2
129·2	4296	—	10
129·7	4289	—	10
140·6	4186	—	6
143·2	4165	—	4
145·0	4149	—	4
146·5	4136	—	4
146·9	4132	—	4
147·4	4127	—	2
147·8	4124	—	2

Chromium.

No.	Huggins.	Thalén.	Kirchhoff.	Intensity.
—	6659	—	—	1
—	6499	—	—	1
—	6461	—	—	1
—	6436	—	—	1
—	6157	—	—	1
—	6116	—	—	2
—	6100	—	—	1
—	5790	—	—	1
—	5784	—	—	1
—	5780	—	—	1
—	5638	—	—	1
—	5605	—	—	2
65·3	5411	5409	5409	8
—	5346	—	—	1
67·9	5342	5342	—	2
68·8	5321	5318	—	2
—	—	5313	—	2
—	—	5297	—	2

No.	Huggins.	Thalén.	Kirchhoff.	Intensity.
69·8	5295	5296	—	2
70·5	5274	5274	—	4
—	5265	—	—	1
70·9	5264	5263	—	4
71·3	5252	5254	—	4
71·7	5246	5246	—	4
—	5236	—	—	1
—	5224	—	—	1
73·5	5207	5208	5207	10
73·6	5203	5205	5205	10
73·7	5202	5204	5203	10
—	5152	—	—	2
—	5104	—	—	1
86·5	4921	4924	—	4
—	4886	—	—	1
—	4876	—	—	1
—	4871	—	—	1
—	4862	—	—	1
—	4829	—	—	1
—	4824	—	—	2
—	4788	—	—	1
—	4756	—	—	1
—	4753	—	—	1
—	4738	—	—	1
—	4730	—	—	1
—	4718	—	—	1
102·3	4652	4654	—	4
—	4648	—	—	1
102·8	4646	4646	—	4
—	4631	—	—	1
—	4615	—	—	1
—	4600	—	—	1
—	4587	—	—	1
—	4559	—	—	1
—	4546	—	—	1
—	4541	—	—	1
—	4535	—	—	1
—	4529	—	—	1

No.	Huggins.	Thalén.	Kirchhoff.	Intensity.
—	4524	—	—	1
102·7	4497	4495	—	4
—	—	4382	—	4
—	—	4369	—	4
—	—	4359	—	4
124·8	4350	4352	—	8
125·5	4343	4344	—	8
125·8	4341	4338	—	8
126·0	4337	4338	—	8
—	—	4337	—	6
129·7	4289	4289	—	10
130·9	4274	4275	—	10
132·7	4255	4254	—	10
—	4227	—	—	—
—	4216	—	—	—

Cobalt.

No.	Huggins.	Thalén.	Kirchhoff.	Intensity.
—	6453	—	—	1
—	6349	—	—	1
—	6298	—	—	1
—	6275	—	—	1
—	6247	—	—	1
43·6	—	6143	6144	6
44·1	—	6121	6121	6
—	6116	—	—	1
—	6084	—	—	1
—	6047	—	—	1
—	—	—	6006	—
47·2	6002	6003	6003	8
—	6000	—	—	1
—	5989	—	—	1
—	5983	—	—	1
—	5915	—	—	2
—	5843	—	—	1

No.	Huggins.	Thalén.	Kirchhoff.	Intensity.
—	5838	—	—	1
—	5644	—	—	1
—	5634	—	—	1
—	5590	—	—	1
62·7	5481	5482	5482	4
63·5	—	5452	5452	6
63·9	5443	5443	5442	6
—	5379	—	—	1
66·9	5368	5368	5368	6
67·1	5360	5363	5363	2
67·2	5356	5359	5359	2
67·5	5351	5352	5353	6
67·6	5350	5351	5351	6
67·8	5344	5343	—	2
67·9	—	5342	{5342, 5341}	2
—	5338	—	—	4
—	5329	—	—	1
—	5320	—	—	1
—	5317	—	—	1
—	5313	—	—	1
—	5309	—	—	1
—	5290	—	—	1
—	5285	—	—	1
—	5281	—	—	1
70·3	5279	5280	5279	6
—	5274	—	—	1
70·8	5267	5267	5268	2
70·9	5265	5266	5265	6
—	5254	—	—	1
—	5252	—	—	1
—	5249	—	—	1
—	5247	—	—	1
72·3	5234	5234	5234	2
72·5	5228	5230	5230	2
73·3	5213	5212	5211	2
—	5200	—	—	1

No.	Huggins.	Thalén.	Kirchhoff.	Intensity.
—	5190	—	—	1
—	5184	—	—	1
—	5156	—	—	1
—	5147	—	—	1
—	5128	—	—	1
—	5105	—	—	1
—	5074	—	—	1
—	5061	—	—	1
—	5054	—	—	1
—	5028	—	—	1
—	4967	—	—	1
89·5	4870	4867	4867	10
91·0	4841	4839	4839	10
92·3	4814	4813	4813	10
93·4	4793	4792	4792	10
94·2	—	4779	4778	10
95·7	4751	4749	4749	4
—	4737	—	—	1
—	4720	—	—	1
—	4683	—	—	1
106·9	4581	4581	4581	4
—	4565	—	—	1
—	4549	—	—	1
110·3	4530	4531	4531	4
—	4120	—	—	3
—	4119	—	—	3
—	4113	—	—	1
—	4097	—	—	1

Copper.

DIACON. *Ann. de Chim. et de Phys.* [4], vi., 1.
LEEDS. *Quart. Journ. Science*, Jan., 1871.

No.	Thalén.	Kirchhoff.	Intensity.
38·0	6380	—	8
41·8	6218	—	2
53·2	5781	5782	8

No.	Thalén.	Kirchhoff.	Intensity.
55·7	5700	—	10
69·9	5292	5292	8
73·1	5217	5217	10
75·6	5153	5153	10
77·8	5105	5105	10
82·1	5011	—	4
84·9	4955	—	6
86·1	4932	—	6
87·2	4911	—	6
98·9	4703	—	6
102·4	4651	4651	6
130·8	4275	—	6

Didymium.

GLADSTONE. *Chem. Soc. Journ.*, x., 219.
BUNSEN. *Phil. Mag.* [4], xxviii., 246; xxxii., 177.
DELAFONTAINE. *Pogg. Ann.*, cxxiv., 635.

(See "LANTHANUM."

Erbium and Yttrium.

BUNSEN and BAHR. *Ann. Chem. Pharm.*, cxxxvii., 1.
HUGGINS. *Proc. Roy. Soc.*, June 16, 1870.

No.	Thalén.	Int.	No.	Thalén.	Int.
37·0	6434	8	43·9	6131 EY	10
41·4	6235	2	44·3	6112	2
41·7	6223	2	44·4	6106	2
41·8	6218 E	8	44·7	6094	2
42·2	6199	4	44·9	6088	2
42·4	6190 E	8	45·4	6071	4
42·7	6179	6	45·9	6053	4
43·0	6164	6	46·3	6038	6
43·5	6148 EY	8	46·8	6019	6

No.	Thalén.	Int.	No.	Thalén.	Int.
47·2	6003 EY	8	71·1	5261	4
47·6	5988 EY	8	72·0	5239	4
47·7	5982 E	4	73·6	5205 EY	8
48·0	5971 EY	10	73·9	5200 EY	8
55·5	5706	4	74·1	5195	4
56·8	5661	10	76·4	5134	2
57·2	5646	4	76·8	5126	4
57·4	5641	4	77·1	5121	8
57·7	5629	8	77·2	5117	6
58·5	5604	4	78·6	5087 EY	10
58·9	5594	4	83·7	4981	4
59·1	5588	4	84·2	4971	4
59·3	5580	8	85·9	4935 E	4
59·4	5576	4	87·7	4900 EY	10
59·7	5567	4	88·7	4882 EY	10
60·2	5555 E	6	90·2	4854 EY	10
60·6	5544	6	90·7	4845	2
60·7	5542	6	90·9	4842	2
61·1	5527	10	91·0	4839	2
61·2	5522	4	91·9	4822	4
61·6	5509	6	93·8	4785 E	6
61·9	5502	4	95·2	4760	4
62·2	5496	8	101·0	4674	4
62·8	5479	4	103·0	4643	8
62·9	5477	2	112·1	4505	4
62·9	5476 E	8	118·6	4422	8
62·9	5473	4	120·5	4397	4
63·1	5468	2	122·6	4374 EY	10
63·2	5465	10	124·3	4357	6
64·1	5437	4	128·2	4309	10
65·7	5401	10	134·5	4236	6
67·5	5352 E	4	135·5	4227	2
67·8	5345 E	4	142·0	4176	8
68·2	5335 E	6	143·1	4167	6
70·1	5287	4	145·9	4142	6
70·7	5269	4	147·4	4127	6
70·9	5264	4	150·7	4102	6

Fluorine.

No observations of the spectrum of this element exist.

Glucinum.

No.	Thalén.	Kirchhoff.	Intensity.
107·5	4572	4572	6
113·4	4488	4488	6

Gold.

No.	Huggins.	Thalén.	Kirchhoff.	Intensity.
—	6710	—	—	1
—	6670	—	—	1
—	6660	—	—	1
—	6457	—	—	1
—	6428	—	—	1
—	6304	—	—	1
—	6291	—	—	1
40·3	6276	6276	6275	8
48·3	5961	5960	5961	6
48·4	5954	5955	5956	6
—	5920	—	—	1
—	5880	—	—	1
—	5862	—	—	2
51·7	5835	5836	5838	10
—	5790	—	—	1
—	5758	—	—	1
—	5653	—	—	1
—	5580	—	—	1
72·5	5231	5230	5230	10
—	5067	—	—	1
—	4811	—	—	1
93·4	4793	4792	4792	6
—	4489	—	—	3

Hydrogen.

PLÜCKER. *Pogg. Ann.*, cvii., 497.
PLÜCKER and HITTORF. *Phil. Trans.*, 1865, I.
ÅNGSTRÖM. *Pog. Ann.*, cxxiii.
,, *Recherches sur le Spectre Solaire.*
WÜLLNER. *Phil. Mag.* [4], xxxvii., 405.
,, *Phil. Mag.* [4], xxxix., 365; *Pogg. Ann.*, cxxxvii., 337.
LECLANCHÉ. *Bull. Soc. Chim.*, v., 338.

No.	Ångström.
34·6	6562
89·8	4861
125·8	4340
150·9	4101

Indium.

REICH and RICHTER. *Journ. Prak. Chem.*, lxxxix., 441.
SCHRÖTTER. *Les Mondes*, viii., 148.
MÜLLER. *Pogg. Ann.*, cxxiv., 637.
BÖTTGER. *Jahresb. d. Frankfurt Ver.*, 1863, 25.

No.	Thalén.	Müller.	Intensity.
110·3	4532	—	8
111·8	4509	4550	10
150·9	4101	—	10

Iodine.

PLÜCKER and HITTORF. *Phil. Trans.*, 1865, I.

No.	Plücker.	Int.	No.	Plücker.	Int.
29·3	6861	2	32·2	6690	2
29·9	6825	2	33·2	6640	2
31·0	6757	2	34·3	6576	2

No.	Plücker.	Int.	No.	Plücker.	Int.
35·9	6494	2	63·3	5460	2
38·9	6339	2	64·0	5441	8
40·0	6292	2	64·8	5422	2
40·9	6257	4	65·6	5402	10
42·0	6210	4	66·5	5377	2
42·9	6169	2	67·0	5365	8
43·3	6154	2	68·0	5339	10
43·9	6131	10	68·4	5330	10
44·9	6087	2	69·0	5314	2
45·3	6073	10	69·9	5292	2
45·5	6067	2	71·0	5262	4
48·4	5956	10	71·2	5257	4
49·3	5920	2	72·2	5235	8
50·1	5889	2	73·1	5218	2
50·8	5866	1	73·4	5209	6
52·1	5821	2	74·7	5176	2
53·0	5790	4	75·1	5166	2
53·3	5777	10	75·7	5150	2
53·7	5763	10	76·3	5138	10
54·3	5739	10	77·7	5107	2
55·2	5713	10	78·0	5102	2
55·5	5705	2	79·8	5064	6
55·8	5696	10	80·5	5047	2
56·1	5683	10	81·3	5028	2
57·1	5649	2	83·2	4990	2
57·6	5632	10	84·1	4972	2
58·0	5620	4	84·7	4960	2
58·4	5607	4	85·4	4946	2
58·7	5600	2	86·6	4922	2
60·1	5558	2	88·4	4886	2
61·0	5530	2	90·2	4853	4
61·6	5511	4	91·1	4838	1
62·0	5499	10	91·4	4832	1
62·2	5494	2	92·5	4809	2
62·7	5482	2	103·5	4636	4
63·1	5468	10			

Iridium and Ruthenium.

No.	Kirchhoff.	Intensity.
38·7	6347	—
63·6	5449	2
69·7	5299	2

Iron.

No.	Huggins.	Thalén.	Kirchhoff.	Intensity.
35·9	6497	6490	6490	6
—	6460	—	—	1
—	6414	—	—	1
—	6401	—	—	1
37·7	6400	6399	6399	10
—	6386	—	—	1
—	6360	—	—	1
—	6338	—	—	1
—	6320	—	—	1
39·9	6306	6300	6300	6
—	6254	—	—	1
41·1	6246	6245	—	8
41·5	6231	6230	6229	8
42·4	6190	6190	6190	8
43·8	6138	6136	6136	8
—	6103	—	—	1
45·6	6080 (?)	6065	6065	8
46·7	6020	6023	6023	6
—	—	6019	—	4
—	—	6007	—	4
—	—	6002	—	4
47·6	5984	5986	—	4
—	—	5984	—	4
—	—	5983	—	4
—	—	5976	—	4
—	—	5975	—	4

No.	Huggins.	Thalén.	Kirchhoff.	Intensity.
—	—	—	5914	—
—	5958	—	—	1
—	5902	—	—	1
—	5880	—	—	1
—	5855	—	—	1
—	5780	—	—	1
53·7	—	5762	5762	6
—	—	5708	—	6
—	—	5681	—	6
—	—	5661	—	6
—	—	5658	—	10
—	—	5654	—	6
57·9	5624	5623	5623	6
58·2	5612	5614	5614	10
58·7	5601	5602	5601	10
58·8	5594	5597	—	10
—	—	5591	—	8
59·2	5584	5586	5585	10
59·4	—	5575	5575	8
59·5	5571	5572	5572	10
59·6	5569	5569	5569	8
61·8	5503	5506	—	6
—	—	5500	—	6
63·3	5460	—	5462	2
—	—	5497	—	6
—	—	5487	—	4
63·5	5454	5455	5454	10
63·8	5444	5446	5446	10
—	—	—	5444	—
64·3	5432	—	5433	2
64·4	5426	5429	5429	10
64·7	5424	—	5423	2
65·1	5412	—	5415	1
65·3	5409	5405	5410	8
65·6	5402	5403	5405	8
65·7	5401	—	5403	2
65·8	5392	5396	5396	8

No.	Huggins.	Thalén.	Kirchhoff.	Intensity.
65·9	5388	5392	5392	8
66·3	5383	5382	5382	6
66·8	5370	5371	5371	10
66·8	—	5369	5369	6
66·9	5366	5367	5367	6
67·0	5365	5364	5364	6
67·1	5363	5362	—	4
—	—	5352	—	4
—	—	5349	—	4
68·0	—	5346	5340	8
68·0	—	5339	5339	8
68·5	5322	5327	5327	10
68·7	5318	5323	5323	8
69·0	5314	5316	5316	1
69·2	5312	5307	—	6
69·7	5299	5301	5301	6
70·2	5289	5283	5282	8
70·3	5282	5281	5280	6
—	5274	—	—	1
70·7	E { 5270	5269	5269	10
70·8	5269	5268	5268	10
70·9	5267	5266	5265	8
71·0	5262	5262	—	4
—	5256	—	—	1
—	5250	—	—	1
—	5241	—	—	1
72·4	5232	5232	5232	10
72·7	5226	5226	5226	10
—	5218	—	—	1
—	—	5208	—	6
73·8	5202	5204	—	6
—	—	5201	—	4
—	—	5194	—	6
74·1	5192	5192	5192	8
74·2	5190	5190	5191	4
—	5180	—	—	1
74·9	—	5171	5171	4

No.	Huggins.	Thalén.	Kirchhoff.	Intensity.
75·0	5168	5168	5168	6
75·0	5166	5167	5167	8
75·2	—	5162	5162	4
—	5148	—	—	1
76·2	5139	5139	5139	8
76·5	5133	—	5133	2
—	—	5107	—	6
—	5099	—	—	—
—	—	5064	—	4
—	—	5051	—	8
—	—	5049	—	8
—	—	5041	—	6
—	—	5040	—	6
81·8	5017	—	5017	3
—	—	5005	—	4
—	—	5002	—	2
—	—	4993	—	2
—	—	4990	—	4
—	—	4988	—	2
84·8	4958	4957	4956	10
86·5	4923	4923	4923	6
86·7	4920	4920	4920	10
86·8	—	4918	4919	8
88·2	4893	4890	4890	10
88·9	—	4877	4877	6
89·3	—	4871	4871	8
89·3	—	4870	4870	8
89·9	—	4859	4858	4
—	—	4789	—	2
—	—	4786	—	2
—	—	4709	—	2
—	—	4708	—	2
—	—	4706	—	2
—	—	4691	—	6
—	—	4653	—	6
—	—	4632	—	6
—	—	4611	—	6

No.	Huggins.	Thalén.	Kirchhoff.	Intensity.
—	—	4603	—	4
106·6	4582	4592	—	6
—	—	4528	—	6
119·1	—	4415	4415	10
119·9	4406	4404	4404	10
121·7	4380	4383	4383	10
—	—	4343	—	6
126·9	4324	4325	4325	10
—	—	4315	—	6
128·3	4307	4307	4307	10
—	4303	—	—	3
130·0	4300	4299	—	4
129·3	4294	4294	—	4
—	—	4286	—	4
131·1	4272	4271	—	10
132·3	4259	4260	—	8
133·1	4251	4251	—	10
—	—	4250	—	10
—	—	4247	—	4
—	—	4235	—	6
—	—	4233	—	6
—	—	4227	—	2
—	—	4222	—	2
—	—	4218	—	2
—	—	4210	—	2
138·4	4201	4201	—	8
138·7	4199	4198	—	8
—	—	4191	—	8
—	—	4187	—	10
—	—	4187	—	10
—	—	4181	—	4
—	—	4177	—	4
—	—	4154	—	6
144·8	4151	4151	—	4
—	—	4149	—	4
145·8	4142	4143	—	10
—	—	4134	—	8

No.	Huggins.	Thalén.	Kirchhoff.	Intensity.
147·0	4131	4131	—	10
—	—	4118	—	8
155·0	4074	4071	—	10
156·1	4067	4063	—	10
158·8	4047	4045	—	10
—	—	4005	—	6

Lanthanum and Didymium.

No.	Thalén.	Kirchhoff.	Intensity.
38·7	6346 Di	—	2
40·0	6292	6292	2
47·9	5973	—	2
48·2	5963	—	2
—	—	5863	—
52·6	5805	5805	2
—	—	5803	—
52·9	5797	5796	2
53·0	5790	5790	4
—	—	5788	—
53·6	5768	5767	2
—	—	5593 Di	—
—	—	5587 Di	—
—	—	5502	—
62·0	5500	5500	6
—	—	5484	—
63·5	5454	5452	8
—	—	5432 Di	—
—	—	5431 Di	—
66·4	5381	5381 La	6
—	—	5380 La	—
66·6	5376	5376 La	6
—	—	5360 Di	—
68·0	5339	5340 La	4
68·1	5337	—	6
—	—	5319 Di	—

No.	Thalén.	Kirchhoff.	Intensity.
69·6	5303	5302	8
—	—	5300	—
70·6	5270	5273 Di	4
—	—	5272 Di	—
71·2	5258	5258 Di	2
71·4	5252 Di	5254 Di	4
—	—	5249 Di	—
72·3	5233	5233 Di	4
72·7	5225	—	2
73·4	5211	—	4
73·7	5203	5203 La	4
—	—	5192	—
—	—	5191	—
74·3	5187	5187 La	10
74·5	5182	5182 La	10
74·7	5177	—	4
75·4	5157	5155	4
76·0	5144	5144	4
76·6	5130 Di	5128 Di	6
77·0	5122	—	6
77·4	5114	—	6
80·2	5055	—	2
82·7	4999	4999	4
—	—	4994	—
84·2	4968	4970	4
85·2	4950	—	4
86·0	4934	4934	4
—	—	4933	—
86·7	4920	4921	10
87·7	4900	—	10
88·7	4882	4879	10
89·9	4860	—	4
90·0	4858	4859	4
91·8	4823	4823	4
92·5	4811	4809 La	4
92·9	4802	—	4
96·0	4747	4748	6

No.	Thalén.	Kirchhoff.	Intensity.
96·4	4742	4743	6
96·6	4739	4740	2
99·0	4702	4702	6
99·8	4691	4692	10
101·2	4671	4670	8
101·3	4668	4667	8
101·6	4663	4662	10
101·7	4661	4661	10
102·2	4654	4654	10
104·6	4620	4620	10
—	—	4619	—
105·0	4614	4614	8
108·4	4559	4559	8
—	—	4558	—
110·7	4525	4526	8
—	—	4524	—
110·9	4521	4521	10
117·9	4430	4429	10
124·5	4354	4354	4
126·1	4335	4335	10
129·2	4295	—	8
129·8	4287	—	8
131·5	4268	—	8
132·0	4262	—	10
134·4	4237	—	10
136·6	4217	—	4
139·1	4196	—	4
139·6	4192	—	4
146·0	4141	—	4
147·9	4123	—	4

Lead.

Werther. *Journ. Prakt. Chem.*, lxxxviii., 180.
Leeds. *Quart. Journ. Science*, Jan., 1871.
Plücker and Hittorf. *Phil. Trans.*, 1856, 1.

No.	Huggins.	Thalén.	Kirchhoff.	Intensity.
—	6790	—	—	3
33·0	6655	6656	6657	10
36·6	—	6452	6452	6
—	—	6059	—	2
46·3	6034	6040	6041	6
—	—	—	6039	—
—	—	6009	—	2
47·3	5997	6001	6003	6
—	—	—	6001	—
49·9	5895	5895	—	2
50·5	5876	5874	—	6
51·2	5853	5856	—	4
—	5823	—	—	—
53·2	5776	5779	—	2
58·4	5608	5607	5608	10
—	—	—	5607	—
60·6	5566*	5546	5547	8
—	—	—	5543	—
—	—	5523	—	—
66·6	5372	5372	5374	10
—	—	—	5372	—
70·5	5274	5274	—	2
—	—	5206	—	2
73·9	5199	5201	—	6
74·2	5190	5189	—	2
75·2	5163	5163	—	4
80·6	5044	5045	5045	8
—	—	—	5042	—
—	—	5005	—	6

* Huggins's scale-number is 1279. It is probably a misprint for 1297, which would correspond to the wave-length 5548.

No.	Huggins.	Thalén.	Kirchhoff.	Intensity.
—	—	4802	—	2
—	—	4796	—	2
95·1	4763	4760	—	4
—	—	4573	—	2
—	—	4401	—	2
121·5	4386	4386	4387	10
—	—	—	4386	—
—	4271	—	—	2
133·5	4247	4246	—	10
—	—	4167	—	6
156·2	4066	4062	—	4
—	—	4058	—	4

Lithium.

MÜLLER. *Pogg. Ann.*, cxviii., 641.
MASCART. *Annales de l'Ecole Normale Superieure*, iv.
KETTELER. *Pogg. Ann.*, civ., 390.
RÜHLMANN. *Pogg. Ann.*, cxxxii., 1.
FIZEAU. *Pogg. Ann.*, cxix., 87; *Ann. de Chim. et de Phys.* [3], lxvi., 429.
TYNDALL. *Phil. Mag.* [4], xxii., 151 and 473.
FRANKLAND. *Phil. Mag.* [4], xxii., 472.
ROSCOE and CLIFTON. *Proc. Lit. and Phil. Soc. Manchester*, ii., 227.
WOLF and DIACON. *Comptes Rendus*, lv., 334.

No.	Huggins.	Thalén.	Kirchhoff.	Mascart.	Intensity.
32·0	6705	6705	6708	6706	10
44·6	6098	6102	6101	—	6
—	4972	—	—	—	4
105·7	4602	4603	—	4602	10

Müller.	Ketteler.	Rühlmann.	Fizeau.
6763	6706	6708	6703

Magnesium.

No.	Thalén.	Kirchhoff.	Intensity.
61·1	5527	—	10
74·5	5183	5183	12
74·8	5172	5172	12
75·0	5167	5167	12
98·9	4703	—	6
106·6	4586	{4587 4586}	6
113·9	4481	{4481 4479}	6

Manganese.

No.	Huggins.	Thalén.	Intensity.
—	6344	—	1
—	6128	—	1
—	6117	—	1
46·8	6021	6021	10
46·9	6014	6016	10
47·0	6012	6012	10
—	5556	—	1
61·5	5513	5516	2
—	5467	—	1
63·9	5432	5443	2
64·9	5419	5419	6
—	—	5412	6
65·4	5407	5406	2
—	5404	—	1
65·8	5396	5400	4
65·9	5392	5393	4
66·5	5377	5377	6
—	—	5359	4
—	5348	—	1
68·1	5338	5340	6

No.	Huggins.	Thalén.	Intensity.
—	{5300 5290}	—	—
71·3	5254	5254	4
—	—	5234	4
—	—	5195	4
91·8	4824	4823	10
93·8	4785	4783	10
—	—	4766	2
94·9	4765	4765	10
95·1	4762	4762	10
—	—	4761	2
95·6	4754	4753	10
96·6	4738	4738	6
97·4	4728	4729	6
—	—	4726	6
98·5	4710	4709	6
112·3	4503	4503	2
—	—	4501	8
112·6	4499	4498	8
—	—	4495	2
113·2	4490	4491	2
—	—	4489	6
—	—	4479	2
114·2	4477	4472	8
—	—	4470	8
115·3	4464	4464	6
115·4	4461	4462	6
—	—	4461	6
—	—	4460	2
115·8	4457	4458	6
—	—	4457	4
—	—	4456	4
115·9	4455	4455	6
116·2	4452	4452	2
116·2	4451	4450	6
—	4449	—	1
117·4	4436	4436	4

No.	Huggins.	Thalén.	Intensity.
—	—	4435	2
119·1	4415	4415	8
130·3	4281	4281	5
131·6	4267	4265	6
132·4	4259	4258	6
134·6	4237	4235	10
—	—	4227	10
—	—	4083	6
—	—	4080	6
—	—	4063	2
—	—	4054	6
—	—	4048	6
—	—	4040	6
—	—	4034	2
—	—	4033	2
—	—	4032	6
—	—	4029	8
—	—	3988	2

Mercury.

GLADSTONE. *Phil. Mag.*, xx., 249.
PLÜCKER. *Pogg. Ann.*, cvii., 497.

No.	Huggins.	Thalén.	Kirchhoff.	Plücker.	Intensity.
—	6383	—	—	—	1
—	6360	—	—	—	1
43·4	6144	6151	6152	—	10
—	6088	—	—	—	1
50·3	5885	5884	—	—	8
50·7	5871	5871	—	—	4
—	5817	—	—	—	1
52·8	5800	—	5791	—	1
53·0	5788	5789	5788	—	10
53·6	5768	5768	{5769 5766}	5772	10

No.	Huggins.	Thalén.	Kirchhoff.	Plücker.	Intensity.
56·3	5678	5678	{5681 5676}	—	8
58·9	5594	5595	—	—	6
63·3	5460	5460	{5461 5458}	5461	12
64·6	5425	5426	{5427 5424}	—	8
67·0	5364	5364	—	—	4
70·4	5281	5278	—	—	2
73·1	5218	5217	—	—	2
—	—	5206	—	—	4
76·5	5132	5131	—	—	4
84·8	4959	4958	—	—	6
86·3	4918	4916	—	—	4
—	4826	—	—	—	1
124·2	4357	4358	{4351 4350}	4358	12
—	—	4078	—	—	6
158·6	4055	4047	—	—	6
168·5	3990	3982	—	—	4

Molybdenum.

No.	Thalén.	Int.
46·5	6029	10
50·2	5887	10
51·1	5857	8
53·0	5791	6
54·0	5750	6
56·0	5687	6
57·1	5649	4
57·7	5631	4
59·6	5569	10
60·8	5540	2
61·0	5531	10
61·8	5505	10
67·2	5360	4
83·7	4979	2
89·5	4867	4
91·5	4829	4
92·1	4818	4
95·4	4757	4
97·2	4730	4
98·7	4706	4

No.	Thalén.	Int.	No.	Thalén.	Int.
110·0	4536	4	122·0	4380	4
114·4	4475	4	126·8	4326	4
117·7	4433	4	130·7	4277	6
119·4	4411	4			

Nickel.

No.	Thalén.	Kirchhoff.	Intensity.
42·8	6176	{6176 6175}	6
44·2	6115	6116	4
44·4	6108	6108	4
50·1	5892	5891	10
51·1	5856	5856	4
62·9	5476	5477	6
74·7	5176	5176	2
75·0	5168	5168	2
75·5	5155	5154	2
75·9	5146	5146	2
76·1	5142	5141	2
76·3	5137	5136	2
77·3	5115	5115	2
78·1	5100	5099	2
78·2	5098	5098	2
78·9	5081	5081	2
78·9	5080	5080	2
81·0	5035	5035	6
81·8	5017	5017	6
83·5	4983	4983	2
83·7	4980	4979	2
85·9	4935	4935	6
86·8	4918	4918	6
87·5	4904	4904	6
89·1	4873	4873	10
89·6	4865	4865	10
90·2	4855	4854	10

No.	Thalén.	Kirchhoff.	Intensity.
91·5	4830	4831	2
91·6	4828	4828	2
93·7	4786	4786	8
95·5	4755	4755	2
98·3	4714	4714	10
102·7	4647	4647	2
120·1	4402	—	2

Niobium.

Thalén ("Determination des Longeurs d'Onde de Raies Metalliques," p. 11) states that the lines of Niobium are too faint to be measured satisfactorily.

Nitrogen.

Plücker and Hittorf. *Phil. Trans.*, 1865, 1.
Wüllner. *Phil. Mag.* [4], xxxvii., 405.
,, *Phil. Mag.* [4], xxxix., 365; *Pogg. Ann.*, cxxxvii., 337.

(See "Air.")

Osmium.

Fraser. *Chemical News*, viii., 34.

No.	Huggins.	Thalén.	Intensity.
36·4	6460	—	2
40·2	6280	—	1
47·5	5991	—	1
51·1	5858	—	2
53·3	5777	—	1
54·9	5719	—	2

No.	Huggins.	Thalén.	Intensity.
59·2	5582	—	2
61·3	5521	—	4
64·0	5440	—	1
65·1	5414	—	3
73·9	5201	—	1
79·2	5073	—	1
109·0	4550	—	1
118·7	4419	4422	8
124·3	4357	—	2
128·0	4311	—	2
129·3	4294	—	2
132·2	4260	—	6

Oxygen.

PLÜCKER and HITTORF. *Phil. Trans.*, 1865, 1.
WÜLLNER. *Phil. Mag.* [4], xxxvii., 405.
,, *Phil. Mag.* [4], xxxix., 365; *Pogg. Ann.*, cxxxvii., 337.

(See "AIR.")

Palladium.

No.	Huggins.	Thalen.	Kirchhoff.	Intensity.
—	6381	—	—	1
—	6248	—	—	1
43·9	6125	6129	6130	2
—	{5903 5888}	—	—	—
—	5866	—	—	3
—	5854	—	—	1
—	5823	—	—	1
—	5805	—	—	—
—	5787	—	—	—

No.	Huggins.	Thalen.	Kirchhoff.	Intensity.
54·4	5737	—	5737	1
—	5733	—	—	1
55·8	—	5694	5694	6
56·5	5669	5668	5669	6
57·0	5653	5651	—	4
57·4	5638	5640	5643	4
57·7	5630 }	5618	—	6
58·2	5614 }			
—	5607	—	—	1
—	5599	—	—	1
—	5587	—	—	1
—	5564	—	—	1
60·6	5546	5546	5545	6
60·8	5540	5542	5540	6
—	—	—	5529	—
—	5512	—	—	2
—	5465	—	—	2
—	5436	—	—	1
65·9	5394	5394	5393	8
67·1	5359	5362	5362	4
67·8	5342	5345	5344	4
69·1	5310	—	5313	1
69·9	5292	5295	5294	10
71·3	5254	5257	5255	4
—	5249	—	—	1
72·3	5233	5234	5234	8
73·5	5209	5208	5207	4
75·2	5163	5163	5163	10
77·3	5116	5116	—	8
77·6	5110	5110	5110	8
79·9	5062	—	5062	1
89·1	4876	4874	4874	6
92·1	4818	4817	4820	6
93·7	—	4787	4787	6
114·5	4474	4474	—	6
—	—	4278	—	2
137·2	4212	4212	—	8

Phosphorus.

Plücker. *Pogg. Ann.*, cvii., 497.
Plücker and Hittorf. *Phil. Trans.*, 1865, 1.
Christofle and Beilstein. *Ann. Chem. Phys.* [4], iii., 280.
Mulder. *Journ. Prakt. Chem.*, xci.
Seguin. *Comptes Rendus*, liii., 1272.

No.	Plücker.	Int.	No.	Plücker.	Int.
35·6	6505	6	66·4	5381	8
36·5	6457	4	67·3	5358	1
37·0	6433	1	68·1	5337	8
38·2	6370	2	69·4	5306	8
42·2	6200	1	70·2	5284	10
42·8	6173	4	71·8	5243	10
44·6	6100	4	74·7	5178	4
45·4	6071	4	84·1	4972	4
45·9	6057	10	105·8	4600	10
46·2	6043	4	106·5	4588	10
46·5	6032	10	108·2	4562	band
47·5	5990	2	108·7	4554	
48·2	5964	2	110·3	4532	band
58·7	5601	2	110·7	4526	
59·0	5589	2	112·3	4503	band
60·3	5552	2	112·5	4499	
60·8	5540	2	114·2	4477	4
62·0	5500	4	114·2	4477	band
62·6	5486	2	115·0	4468	
62·8	5480	2	118·5	4423	4
63·2	5462	4	135·0	4232	2
63·5	5452	4	136·1	4222	2
64·9	5420	10	141·5	4180	2
65·6	5402	8			

Platinum.

No.	Huggins.	Thalén.	Kirchhoff.	Intensity.
35·3	—	6522	6522	6
—	6374	—	—	1
47·1	6015	—	5994	—
—	—	—	5988	—
—	—	—	5986	—
—	—	—	5983	—
47·8	5979	—	5980	—
—	—	—	5977	—
48·2	5964	5964	5964	6
—	—	—	5954	—
48·5	5952	—	5952	1
51·5	5840	5845	—	4
51·7	5835	5837	—	4
52·7	5800	5806	—	4
62·9	5477	5478	5475	4
—	—	5476	—	4
66·0	5389	5389	—	6
66·9	5367	5367	—	8
69·7	5299	5301	{5301, 5300}	10
72·7	5226	5226	5226	8
74·0	5196	5198	—	4
80·0	5059	5059	{5060, 5059}	8
88·9	—	4879	4878	4
—	—	4851	—	4
—	—	4803	—	4
108·9	4553	4552	4551	1
111·0	4521	—	4518	4
112·6	4499	4498	4497	8
116·9	4444	4442	4442	4
—	—	4389	—	4
126·7	4327	4327	—	4

Potassium.

BUNSEN and KIRCHHOFF. *Phil. Mag.* [4], xx.
KIRCHHOFF. *Untersuchungen über das Sonnenspectrum*, ii., 5.
RUTHERFORD. *Silliman's Journal* [2], xxxv., 407.
WOLF and DIACON. *Comptes Rendus*, lv., 334.

No.	Huggins.	Thalén.	Kirchhoff.	Intensity.
18·0	—	—	{7700, 7670}	—
27·8	6953	—	6940	6
28·2	6932	—	6920	6
—	6305	—	—	1
—	6246	—	—	1
—	6120	—	—	3
51·8	5831	5829	—	10
—	5811	—	—	1
52·8	5800	5802	—	10
—	—	5782	—	10
—	5516	—	—	2
—	—	5353	—	8
—	—	5338	—	8
—	—	5322	—	8
91·6	4827	4827	—	6
—	4386	—	—	4
128·2	4309	4309	—	4
—	4263	—	—	4
—	4184	—	—	6
—	4044	—	—	6

Rhodium.

THALÉN. " Determination des Longeurs d'Onde des Raies Metalliques." Lines too faint to measure.

Rubidium.

Bunsen and Kirchhoff. *Phil. Mag.* [4], xxii.

No.	Thalén.	Kirchhoff.	Intensity.
39·9	6296	6296	10
42·1	6204	6205	8
43·1	6160	{6161 6159}	6
45·4	6070	—	6
94·3	4776	—	4
107·7	4569	—	2
108·9	4551	—	2
138·3	4202	—	8

Ruthenium.

(See "Iridium.")

Selenium.

Plücker and Hittorf. *Phil. Trans.*, 1865, 1.
Mulder. *Journ. Prakt. Chem.*, xci.
Werther. *Journ. Prakt. Chem.*, lxxxviii., 180.

No.	Plücker.	Int.	No.	Plücker.	Int.
35·7	6503	6	48·5	5952	2
36·0	6480	6	51·2	5856	6
37·0	6431	6	51·4	5845	2
39·7	6308	6	54·1	5746	2
42·8	6173	band	55·7	5700	2
43·1	6160		56·1	5683	4
43·3	6152	band	56·6	5668	2
44·1	6119		57·8	5628	6
45·4	6070	6	58·8	5596	6
46·4	6035	2	59·8	5566	6

No.	Plücker.	Int.
61·2	5524	6
63·1	5466	band
63·4	5457	
63·5	5452	band
63·8	5444	
66·0	5391	2
66·6	5374	8
69·9	5293	10
71·1	5259	8
71·8	5243	8
72·4	5232	4
73·0	5220	4
73·2	5215	10
75·2	5162	10
75·6	5153	2
76·9	5124	10
77·3	5115	4
77·9	5103	4
78·1	5099	4
78·5	5091	10
78·5	5089	4
79·6	5066	6
80·5	5048	2
81·2	5029	6
82·0	5014	2
82·5	5003	2
82·7	5000	2
83·0	4994	10
83·9	4975	10
90·7	4845	10
91·0	4840	10
94·3	4776	10
95·9	4748	band
96·4	4741	
96·7	4737	band
97·1	4731	

No.	Plücker.	Int.
98·7	4707	4
99·1	4700	4
100·8	4677	band
101·0	4673	
101·4	4666	band
101·7	4661	
102·2	4654	10
103·3	4638	8
104·7	4619	8
105·4	4606	10
106·1	4596	4
107·8	4567	2
111·1	4519	band
111·4	4514	
114·6	4473	band
115·2	4465	
116·2	4451	band
116·9	4443	
118·9	4418	band
119·5	4410	
119·8	4406	band
120·4	4398	
121·5	4386	band
122·1	4379	
124·7	4352	band
125·3	4346	
127·1	4322	band
127·7	4315	
131·1	4272	band
131·7	4266	
136·1	4222	band
136·7	4216	
139·9	4190	band
143·0	4168	
145·1	4148	band
147·3	4128	

Silver.

MASCART. *Annales Scientifiques de l'Ecole Normale Superieure*, iv.

No.	Huggins.	Thalén.	Kirchhoff.	Mascart.	Intensity.
—	6371	—	—	—	1
—	6249	—	—	—	1
46·4	6034	6036	—	—	2
—	5973	—	—	—	1
—	5854	—	—	—	1
57·3	5644	5645	—	—	4
57·8	5626	5626	—	—	4
57·9	5622	5622	—	—	8
58·4	5607	5610	—	—	4
59·0	5590	5590	—	—	4
59·6	5570	5568	—	—	4
—	—	5556	—	—	2
60·2	5558	5552	—	—	8
—	—	5522	—	—	4
—	—	5486	—	—	2
63·0	5471	5470	5470	—	8
63·2	5463	5464	5465	5464	12
64·6	5426	5424	—	—	6
65·2	5412	5411	—	—	2
65·7	5401	5401	—	—	8
—	—	5299	—	—	6
73·5	5207	5209	5208	5207	12
—	—	4874	—	—	8
—	—	4666	—	—	4
—	—	4475	—	—	4

Silicon.

Plücker. (Spectrum of Silicon-chloride), *Pogg. Ann.*, cvii.

No.	Plücker.	Kirchhoff.
39·1	$SiCl_4$ α 6329	—
47·8	$SiCl_4$ β 5978	—
80·0	—	{5060
80·2	—	{5056
80·7	$SiCl_4$ γ 5043	{5045 {5042

$SiCl_4$ α is a brilliant red line; β a somewhat weaker orange band; γ a brilliant green double band with a bright line in the middle. The spectrum contains also two dark violet bands whose wave-lengths are about 4205 and 4160.

Sodium.

Bunsen and Kirchhoff. *Phil. Mag.* [4], xx.
Rutherford. *Silliman's Journal* [2], xxxv., 407.
Wolf and Diacon. *Comptes Rendus*, lv., 334.
Attfield. *Phil. Trans.*, 1862, 221.
Müller. *Pogg. Ann.*, cxviii., 641.

No.	Huggins.	Thalén.	Kirchhoff.	Müller.	Intensity.
43·2	{6155	6160	—	—	8
43·3	{6149	6154	—	—	8
49·9	{5895	5895	5895}	5918	{10
50·1	{5889	5889	5889}		{10
56·0	{5687	5687	—	—	6
56·2	{5681	5681	—	—	6
75·5	{5154	5155	—	—	6
75·7	{5149	5152	—	—	6
83·5	4985	4983	—	—	4

Strontium.

Bunsen and Kirchhoff. *Phil. Mag.* [4], xx.
Mascart. *Annales de l'Ecole Normale,* iv.
Müller. *Pogg. Ann.*, cxviii., 641.

No.	Huggins.	Thalén.	Kirchhoff.	Mascart.	Müller.	Int.
—	7108	—	—	—	—	4
—	6885	—	—	—	—	4
—	6790	—	—	—	—	4
—	6641	—	—	—	—	1
—	6606	—	—	—	—	2
34·9	6548	6550	—	—	—	4
35·8	6502	6502	6502	—	—	8
—	6435	—	—	—	—	—
37·4	6410	6407	6406	—	—	10
37·8	6388	6387	—	—	—	6
37·9	6383	6380	—	—	—	4
—	6369	—	—	—	—	1
—	6347	—	—	—	—	1
—	6343	—	—	—	—	1
—	6311	—	—	—	—	—
—	6274	—	—	—	—	1
—	6251	—	—	—	—	—
—	6220	—	—	—	—	—
—	6172	—	—	—	—	1
—	6098	—	—	—	—	2
—	5998	—	—	—	—	—
—	5977	—	—	—	—	—
48·0	5971	5971	—	—	—	2
—	—	5850	—	—	—	2
—	5816	—	—	—	—	1
—	5766	—	—	—	—	1
—	5647	—	—	—	—	2
—	5623	—	—	—	—	3
—	5579	—	—	—	—	1
—	5543	—	—	—	—	4
60·8	5540	5540	5540	—	—	6

No.	Huggins.	Thalén.	Kirchhoff.	Mascart.	Müller.	Int.
60·9	5531	5534	5534	—	—	8
61·3	5519	5522	5521	—	—	8
61·9	5500	5503	5503	—	—	8
—	5496	—	—	—	—	—
62·6	5487	5485	5485	—	—	6
62·8	5480	5480	5480	—	—	10
—	5450	—	—	—	—	5
—	5423	—	—	—	—	2
—	5383	—	—	—	—	3
71·3	5254	5256	5256	—	—	3
72·1	5238	5238	5238	—	—	10
72·6	5228	5228	5228	—	—	6
72·7	5224	5225	5225	—	—	6
72·9	5221	5223	5222	—	—	6
—	5217	—	—	—	—	2
—	5155	—	—	—	—	2
—	5102	—	—	—	—	1
84·3	4967	4967	—	—	—	4
84·6	4962	4962	—	—	—	8
—	4943	—	—	—	—	1
—	4893	—	—	—	—	1
89·0	4875	4876	—	—	—	6
89·2	4872	4872	—	—	—	2
—	4865	—	—	—	—	2
—	4853	—	—	—	—	2
91·5	4830	4831	—	—	—	6
92·4	4811	4812	—	—	—	6
93·9	4784	4784	—	—	—	6
95·8	4750	—	—	—	—	1
96·4	4742	4741	—	—	—	6
97·9	4721	4721	—	—	—	6
105·4	4604	4607	{4608 / 4607}	4607	4631	10
—	4438	—	—	—	—	2
—	4367	—	—	—	—	1
—	4361	—	—	—	—	1
—	4337	—	—	—	—	2

No.	Huggins.	Thalén.	Kirchhoff.	Mascart.	Müller.	Int.
—	4319	—	—	—	—	2
128·5	4305	4305	{4305 / 4304}	—	—	10
135·6	—	4226	—	—	—	6
136·8	4215	4215	—	—	—	10
143·6	4161	4161	—	—	—	6
154·3	4078	4078	—	—	—	10

Sulphur.

PLÜCKER and HITTORF. *Phil. Trans.*, 1865, p. 1.
MULDER. *Journ. Prakt. Chem.*, xci., 111.

No.	Plücker.	Int.	No.	Plücker.	Int.
34·2	6579	2	60·1	5558	4
36·5	6454	2	61·0	5532	2
37·2	6421	4	61·2	5522	4
37·6	6404	8	61·7	5508	8
37·8	6390	6	62·9	5473	8
39·3	6321	8	63·5	5452	10
39·6	6309	8	64·1	5438	8
40·0	6290	10	64·6	5425	6
43·3	6152	2	68·1	5338	10
44·3	6111	2	69·5	5304	10
47·0	6009	4	70·7	5269	2
50·8	5866	4	72·5	5231	4
52·4	5810	4	73·1	5218	2
53·2	5780	4	73·5	5207	8
56·6	5667	6	73·9	5199	10
56·9	5657	8	74·2	5191	2
57·1	5650	8	74·5	5182	10
57·4	5641	10	76·0	5143	6
58·1	5618	4	76·2	5141	2
58·3	5609	10	76·2	5140	2
59·2	5584	4	76·9	5124	4
59·7	5568	8	77·6	5110	2

No.	Plücker.	Int.
78·3	5096	8
79·5	5068	2
80·6	5044	4
81·0	5036	2
81·2	5030	10
81·5	5024	10
82·0	5013	8
82·5	5004	8
82·6	5003	2
82·7	5000	4
83·2	4990	6
85·6	4942	4
86·5	4924	8
86·6	4922	6
87·6	4902	6
88·6	4884	6
91·7	4825	6
92·3	4813	8
92·8	4804	4
93·4	4791	4
94·2	4777	2
94·7	4768	2
95·1	4762	2
96·9	4734	2
97·8	4723	2
98·1	4718	8
99·6	4694	band
99·9	4690	
100·8	4677	band
101·4	4666	
101·7	4661	band
102·2	4654	
103·8	4632	band
104·0	4628	
105·0	4613	band
105·3	4608	
106·0	4596	band
106·4	4590	
106·8	4583	band
107·1	4578	
108·1	4563	band
108·3	4560	
108·9	4552	10
110·8	4523	10
113·6	4485	10
115·1	4466	10
117·6	4434	band
117·9	4430	
118·4	4424	band
118·7	4421	
121·2	4389	band
121·6	4384	
124·2	4358	4
124·9	4350	4
125·5	4343	4
126·1	4336	4
126·6	4329	4
127·5	4317	band
127·9	4313	
129·1	4297	8
130·1	4284	8
130·5	4279	4
131·1	4272	8
132·3	4259	4
132·7	4255	8
133·9	4242	band
134·1	4240	
135·2	4230	band
135·5	4227	
138·8	4198	band
139·3	4194	
141·4	4181	6
143·0	4168	8
143·9	4158	6
146·1	4140	6

Tantalum.

THALÉN. " Determination des Longeurs d'Onde des Raies Metalliques." Lines too faint to measure.

Tellurium.

WERTHER. *Journ. Prakt. Chem.*, lxxxviii., 180.

No.	Huggins.	Thalén.	Intensity.
—	6645	—	4
37·0	6431	6437	10
—	6366	—	1
—	6347	—	1
—	6290	—	2
—	6243	—	3
—	6228	—	3
46·2	6042	6046	6
47·0	6010	6012	6
—	5995	—	1
47·9	5970	5973	10
48·9	5934	5935	8
51·2	5854	5856	4
51·3	5849	5852	4
—	—	5825	4
—	—	5805	4
53·9	5756	5755	10
54·3	5740	5741	2
55·4	5708	5707	10
57·2	5646	5647	10
58·1	5618	5616	4
59·5	5575	5574	6
62·6	5486	5488	6
62·9	5476	5477	6
63·7	5447	5447	8
65·3	5409	5409	4
67·0	5366	5366	6

No.	Huggins.	Thalén.	Intensity.
69·2	5309	5310	6
69·7	5298	5299	2
73·0	5222	5217	8
—	—	5172	2
—	—	5152	6
76·4	5134	5133	2
—	—	5104	6
81·0	5038	5035	4
—	—	4895	2
89·5	4866	4866	4
91·4	4832	4832	2
93·8	4785	4785	2
—	4709	—	—
—	4664	—	1
—	4652	—	1
105·7	4602	4603	4
—	4599	—	1
—	4544	—	—
—	4479	—	1
—	4352	—	1
—	4302	—	2
—	4259	—	—
—	4063	—	3

Thallium.

CROOKES. *Phil. Trans.*, 1863, 173.
MILLER. *Proc. Roy. Soc.*, xii., 407.
GASSIOT. *Proc. Roy. Soc.*, xii., 536.
KETTELER. *Pogg. Ann.*, civ., 390.
BERNARD. *Les Mondes*, v., 181.
MASCART. *Annales de l'Ecole Normale*, iv.
NICKLÉS. *Comptes Rendus*, lviii., 132.
MÜLLER. *Pogg. Ann.*, cxviii., 641.
RÜLHMANN. *Pogg. Ann.*, cxxxii., 1.

No.	Huggins.	Thalén.		Intensity.
—	6547	—	—	4
—	6240	—	—	1
—	6002	—	—	2
48·6	5949	5948	—	6
—	5824	—	—	2
—	5771	—	—	1
—	—	5608	—	2
62·4	5487	5490	—	1
—	—	5412	—	4
—	—	5360	—	4
67·7	5347	5349	5348* 5345† 5352‡ 5348‖ 5349§	10
75·6	5153	5153	—	8
—	—	5085	—	4
79·0	5078	5078	—	6
80·2	5054	5053	—	6
83·7	4980	4981	—	6
—	—	4945	—	4
88·1	4893	4892	—	4
—	4767	—	—	2
96·8	4737	4736	—	6
—	4112	—	—	3

Thorium.

No.	Thalén.	Int.	No.	Thalén.	Int.
55·7	5698	2	89·7	4863	6
57·4	5640	2	120·9	4392	10
60·9	5537	6	121·9	4381	10
63·8	5446	6	130·3	4281	10
66·6	5374	6	130·7	4277	8
86·7	4919	6	131·1	4272	6

* Müller. † Ketteler. ‡ Bernard. ‖ Rühlmann. § Mascart.

Tin.

MASCART. *Annales de l'Ecole Normale*, iv.

No.	Huggins.	Thalén.	Kirchhoff.	Mascart.	Int.
29·7	6840	—	{6842 6840}	—	3
—	6769	—	—	—	1
—	6573	—	—	—	1
36·6	6447	6452	{6453 6448}	—	10
52·8	5798	5798	{5799 5796}	—	10
57·7	5630	5630	—	—	8
59·1	5587	5588	{5591 5586}	—	10
59·9	5564	5563	{5564 5560}	—	10
67·0	5366	5368	—	—	2
67·7	5347	5347	—	—	4
68·3	5333	5332	—	—	8
—	5328	—	—	—	4
70·0	5287	5289	—	—	2
72·8	5224	5224	—	—	4
78·1	5098	5100	{5100 5099}	—	6
—	—	5021	—	—	—
—	—	4923	—	—	—
89·0	4858	4858	4857	—	6
106·7	4584	4585	4585	—	8
110·8	4523	4524	4524	4523	10

Titanium.

No.	Thalén.	Int.	No.	Thalén.	Int.
34·8	6556	4	62·4	5489	8
35·0	6543	2	62·5	5487	6
40·8	6260	8	62·8	5480	8
40·9	6257	10	62·9	5476	6
41·8	6221	6	62·9	5473	6
41·9	6214	6	63·0	5470	4
44·0	6125	8	63·7	5448	6
44·7	6097	6	63·8	5446	4
44·8	6090	8	64·4	5429	8
45·0	6083	6	64·6	5425	6
45·6	6064	8	65·0	5418	4
47·3	5999	8	65·3	5409	8
47·8	5978	10	65·6	5403	6
48·1	5965	10	65·8	5396	8
48·5	5952	10	66·4	5380	6
49·3	5921	6	66·8	5369	8
49·3	5919	6	67·6	5350	8
49·8	5899	10	68·1	5337	10
50·8	5865	10	69·8	5298	6
54·4	5738	6	69·8	5297	10
55·1	5714	4	69·9	5295	6
55·7	5701	2	70·1	5288	4
56·0	5688	8	70·2	5283	10
56·2	5679	6	70·7	5271	4
56·4	5674	10	70·8	5267	4
56·8	5661	10	70·9	5265	8
57·2	5647	4	71·0	5263	4
57·3	5643	10	71·1	5260	4
57·7	5629	2	71·3	5255	4
58·8	5597	2	71·5	5251	4
59·8	5565	6	71·7	5246	8
61·5	5513	10	72·1	5238	8
61·5	5512	10	72·7	5226	6
61·9	5503	8	72·8	5223	10

No.	Thalén.	Int.	No.	Thalén.	Int.
73·1	5217	4	82·7	5001	4
73·4	5209	10	82·7	4999	10
73·6	5205	6	83·2	4990	10
73·9	5200	6	83·3	4988	6
74·1	5192	10	83·7	4981	10
74·3	5188	8	83·8	4978	6
74·4	5185	6	83·9	4975	4
74·8	5173	8	84·1	4972	2
75·6	5153	6	84·3	4968	2
75·7	5151	8	84·5	4964	2
75·8	5147	6	85·3	4947	2
76·0	5144	8	85·8	4937	8
76·6	5129	10	86·3	4927	8
76·7	5127	4	86·4	4925	4
77·1	5120	10	86·7	4921	6
77·4	5113	8	86·7	4919	6
77·6	5109	4	87·0	4913	6
78·0	5102	4	87·2	4911	6
78·7	5086	8	87·5	4904	4
79·1	5076	4	87·7	4899	8
79·3	5072	4	88·6	4884	10
79·7	5065	4	89·1	4873	4
79·8	5064	10	89·4	4869	8
79·9	5061	6	89·5	4867	8
80·3	5052	6	90·1	4855	8
80·7	5043	6	90·5	4848	6
80·8	5039	8	91·0	4840	8
80·9	5038	8	91·2	4835	4
81·0	5036	10	92·0	4819	8
81·4	5025	6	92·8	4804	10
81·5	5024	6	93·1	4797	4
81·7	5021	6	93·4	4792	8
81·7	5019	8	94·1	4779	6
81·9	5015	8	95·3	4758	10
82·0	5013	10	95·4	4757	10
82·1	5012	4	96·4	4742	8
82·3	5007	10	97·8	4723	8

No.	Thalén.	Int.	No.	Thalén.	Int.
98·6	4709	8	116·4	4449	8
99·3	4698	8	116·6	4446	8
99·8	4691	8	116·9	4443	10
100·6	4681	8	118·2	4427	10
101·3	4666	8	118·9	4418	8
102·1	4656	10	119·4	4411	6
102·9	4644	4	120·0	4403	6
103·3	4639	10	120·4	4398	6
104·0	4629	6	120·8	4393	10
104·4	4623	8	126·0	4337	10
104·8	4617	8	127·1	4323	8
107·5	4571	10	127·3	4320	2
108·1	4563	8	127·5	4318	2
108·6	4555	6	127·9	4313	2
108·9	4552	6	127·9	4312	2
109·1	4549	10	128·3	4307	2
109·6	4543	6	128·5	4305	8
110·0	4536	10	129·0	4299	10
110·3	4532	10	129·2	4295	2
110·6	4526	10	129·3	4294	2
110·9	4522	6	129·5	4291	8
111·2	4517	6	129·8	4287	2
111·6	4511	6	130·2	4282	2
112·4	4501	10	131·0	4273	2
112·8	4496	8	131·6	4263	8
113·9	4481	6	134·5	4236	8
115·0	4468	10	140·7	4185	6
115·8	4457	8	142·7	4171	10
115·9	4455	8	143·4	4163	10
116·1	4453	8			

Tungsten.

No.	Thalén.	Int.	No.	Thalén.	Int.
52·6	5805	4	57·2	5648	4
54·5	5733	6	57·7	5631	2

No.	Thalén.	Int.	No.	Thalén.	Int.
61·5	5513	10	88·4	4887	8
62·4	5491	8	90·7	4842	10
72·8	5223	10	100·7	4680	2
79·4	5070	6	101·8	4660	2
79·5	5068	6	101·9	4659	2
80·3	5053	10	128·7	4302	6
82·0	5014	6	129·2	4295	6
82·3	5007	6	131·4	4269	6
83·7	4981	4			

Uranium.

No.	Thalén.	Int.	No.	Thalén.	Int.
49·4	5913	8	66·2	5384	6
58·0	5619	6	81·3	5027	6
59·3	5579	6	97·1	4731	6
59·9	5562	6	97·8	4723	6
61·1	5527	10	109·6	4543	8
61·6	5509	6	114·6	4472	10
62·3	5493	10	120·8	4393	6
62·8	5481	10	122·6	4374	6
62·8	5479	10	123·8	4362	10
62·9	5477	10	125·8	4340	10
62·9	5474	10			

Vanadium.

No.	Thalén.	Int.	No.	Thalén.	Int.
41·3	6241	6	53·1	5786	4
43·8	6134	4	54·7	5725	10
44·1	6119	10	55·5	5706	4
44·3	6109	4	55·6	5702	6
44·8	6089	10	55·8	5697	8
45·1	6080	4	56·6	5668	6
46·3	6039	10	57·8	5626	6

No.	Thalén.	Int.	No.	Thalén.	Int.
57·9	5622	6	120·2	4400	2
65·1	5414	6	120·6	4395	6
65·7	5401	4	121·2	4389	8
72·0	5240	6	121·6	4384	10
72·3	5233	6	122·1	4379	10
74·0	5195	4	124·7	4352	2
74·2	5191	4	125·8	4340	2
88·8	4881	6	126·4	4332	2
89·1	4874	6	126·6	4329	2
89·7	4864	4	128·1	4310	2
90·4	4851	2	129·1	4297	4
90·8	4843	6	129·5	4292	2
91·5	4831	2	130·2	4283	2
106·2	4593	6	130·7	4277	2
106·7	4585	4	131·1	4272	4
107·1	4579	2	131·5	4268	4
107·2	4576	2	149·6	4110	6
115·7	4459	8	147·1	4130	several
119·7	4407	10		to	faint
119·8	4406	4	153·2	4085	lines.

Yttrium.

(See "ERBIUM.")

Zinc.

MASCART. *Annales de l'Ecole Normale*, iv.

No.	Huggins.	Thalén.	Kirchhoff.	Mascart.	Intensity.
—	6581	—	—	—	1
38·4	6360	6362	6362	6361	10
—	6211	—	—	—	2
44·5	6100	6102	{6106 6099}	—	10
—	6041	—	—	—	2

No.	Huggins.	Thalén.	Kirchhoff.	Mascart.	Intensity.
46·7	—	6023	6025 6019	—	8
—	5910	—	—	—	10
50·0	5894	5894	5894	—	8
52·3	5814	5816	—	—	4
53·9	5755	5756	—	—	2
54·3	5741	5745	—	—	2
—	—	5608	—	—	4
59·4	5577	5577	—	—	4
59·9	5563	5563	—	—	4
—	—	5436	—	—	2
68·2	5333	5336	—	—	2
71·9	5247	5249	—	—	4
72·4	5232	5233	—	—	4
75·4	5157	5158	—	—	4
77·0	5122	5121	—	—	4
—	5117	—	—	—	1
—	5083	—	—	—	1
79·3	5072	5074	—	—	4
80·5	5049	5048	—	—	4
84·2	4970	4971	—	—	4
86·5	4924	4924	4928 4924	4923	10
87·2	4911	4911	4911	4911	10
—	—	4878	—	—	2
89·5	4867	4865	—	—	2
92·5	4809	4810	4810	4809	10
97·9	4722	4721	4721	4721	10
100·8	4679	4679	4679	4679	10

Zirconium.

No.	Thalén.	Int.	No.	Thalén.	Int.
38·8	6343	6	43·9	6132	6
39·6	6310	6	44·0	6127	10
43·7	6140	10	66·2	5384	4

No.	Thalén.	Int.	No.	Thalén.	Int.
67·6	5349	6	122·0	4380	4
74·2	5190	6	123·0	4370	4
92·2	4815	10	124·0	4360	4
94·6	4771	10	133·9	4242	4
96·6	4738	10	134·0	4241	4
98·5	4709	10	135·4	4228	4
100·2	4686	10	137·4	4210	4
112·7	4497	4	137·5	4209	4
112·9	4494	4	144·3	4155	8
116·9	4443	4	145·0	4149	8

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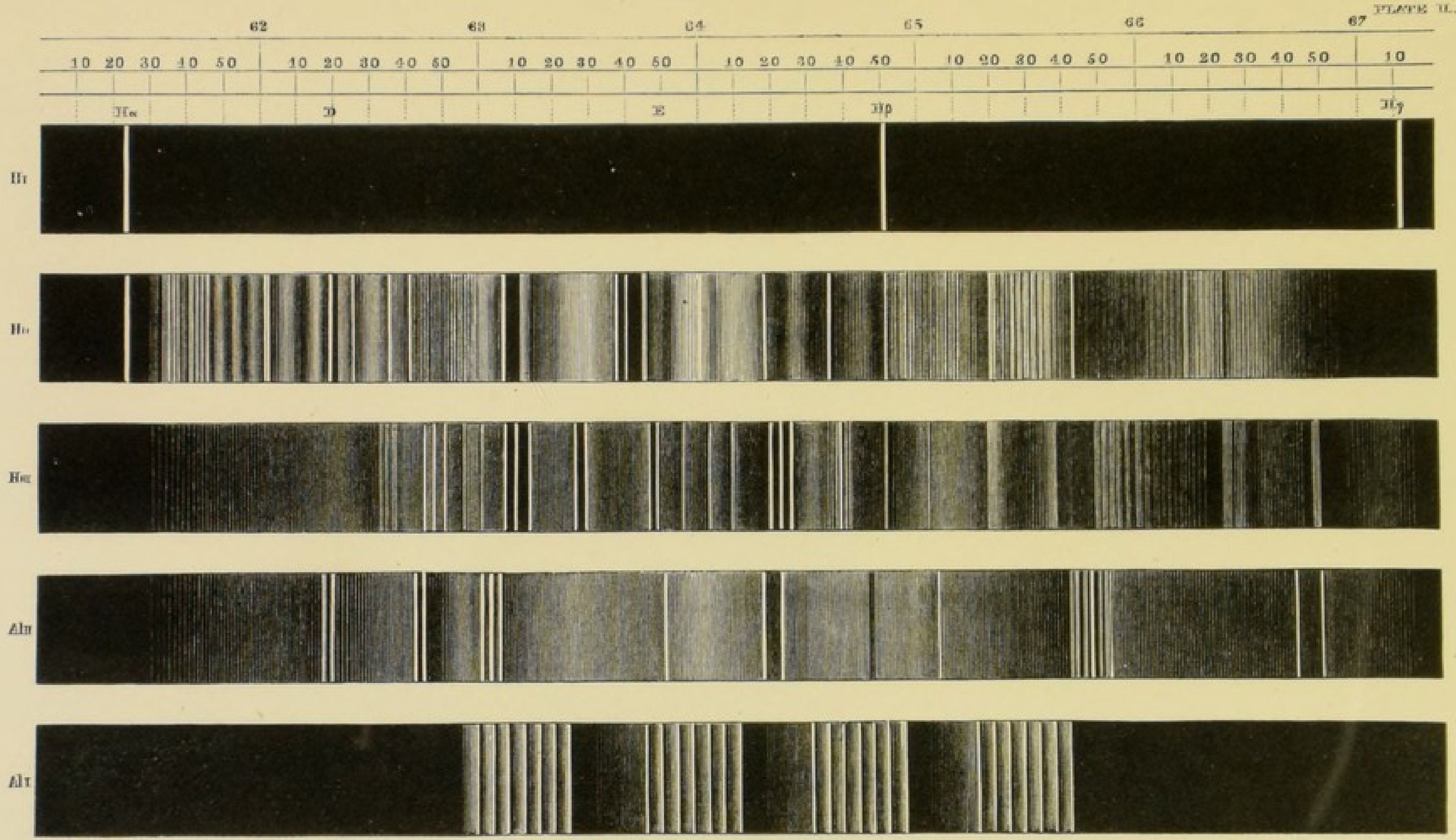
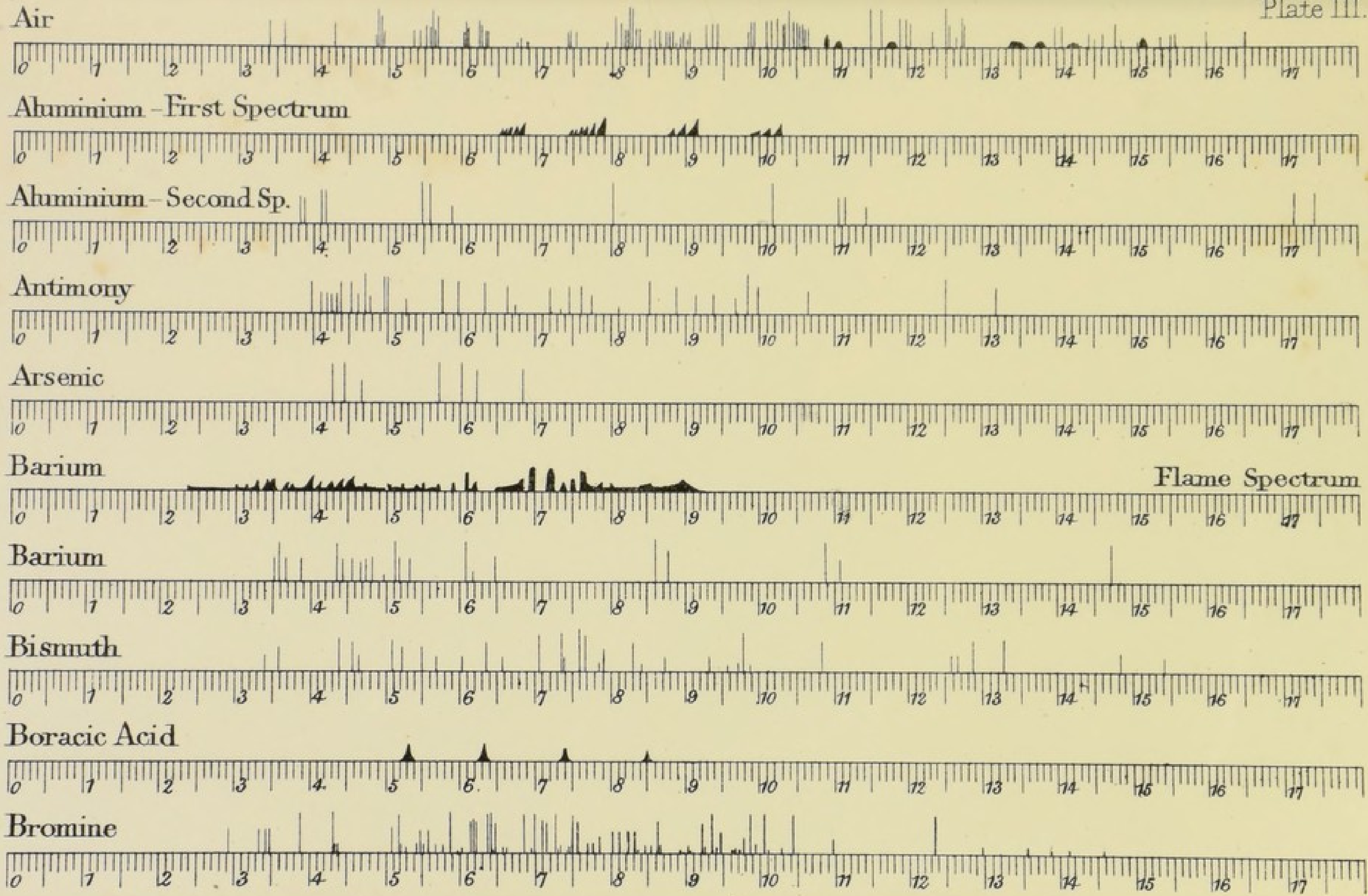
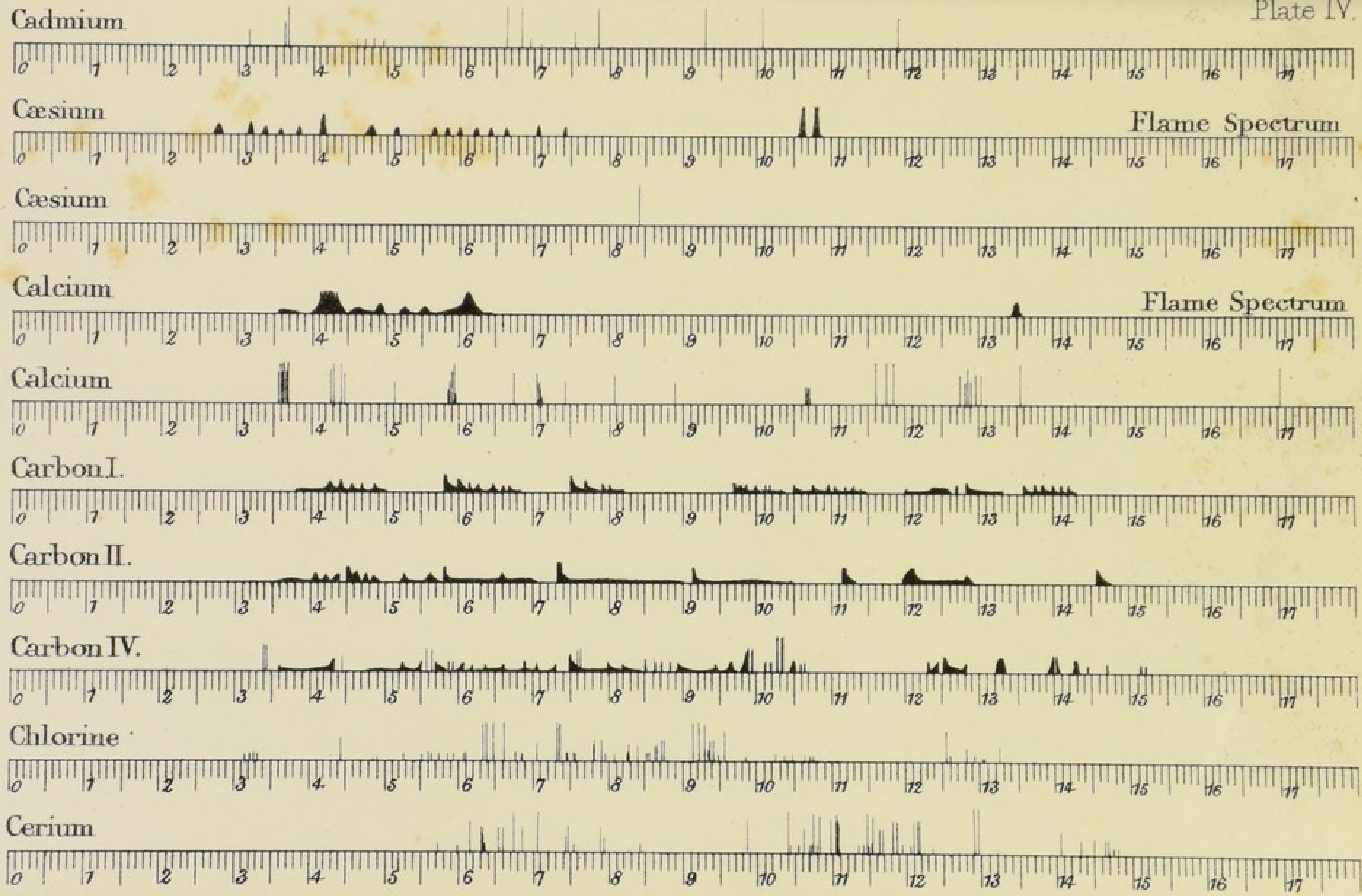


SPECTRA OF HYDROGEN AND ALUMINIUM.

Plate III.



Air
Aluminium - First Spectrum
Aluminium - Second Sp.
Antimony
Arsenic
Barium
Flame Spectrum
Barium
Bismuth
Boracic Acid
Bromine
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17


Cadmium
Cæsium
Flame Spectrum
Cæsium
Calcium
Flame Spectrum
Calcium
Carbon I.
Carbon II.
Carbon IV.
Chlorine
Cerium
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17

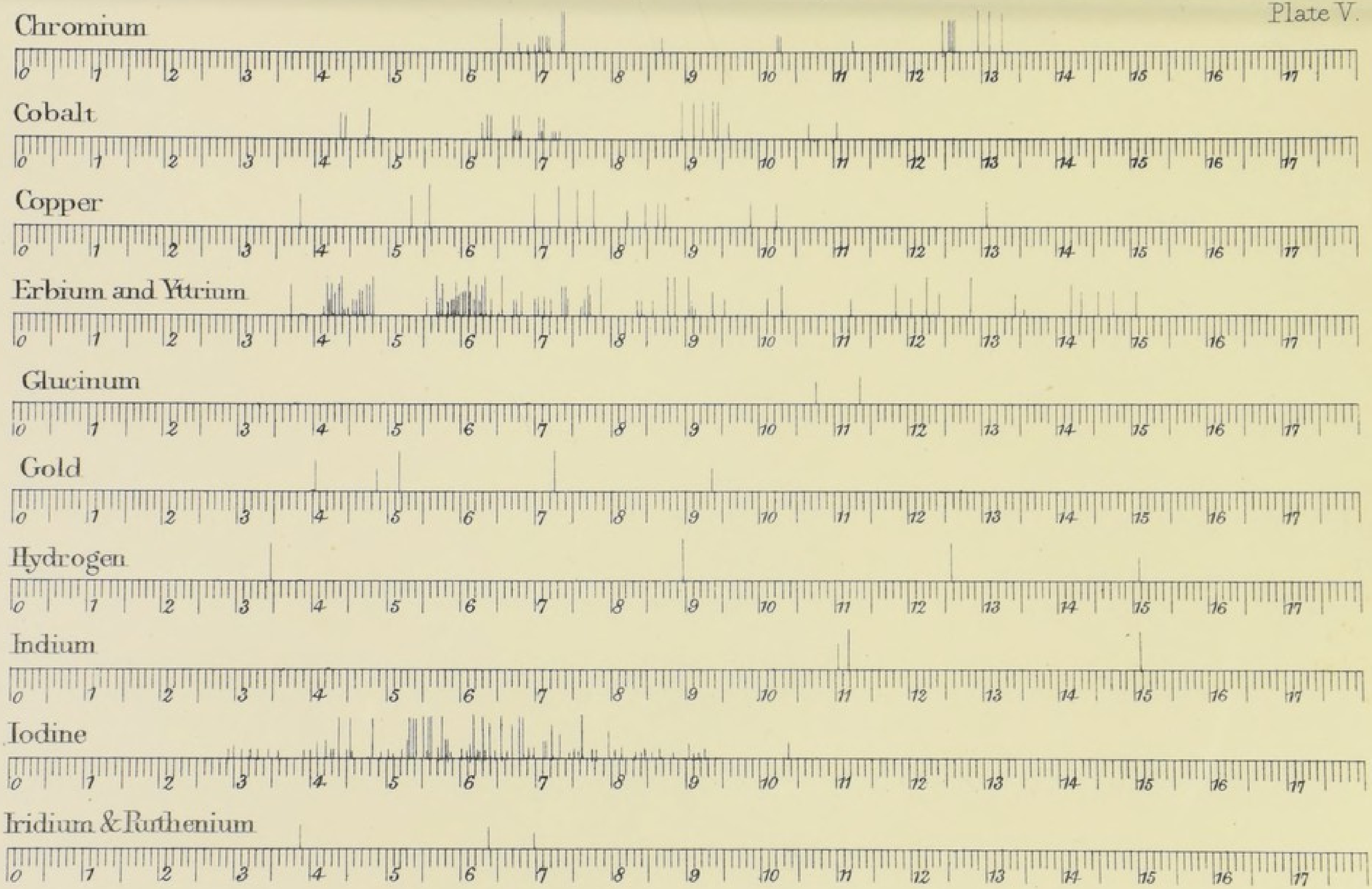
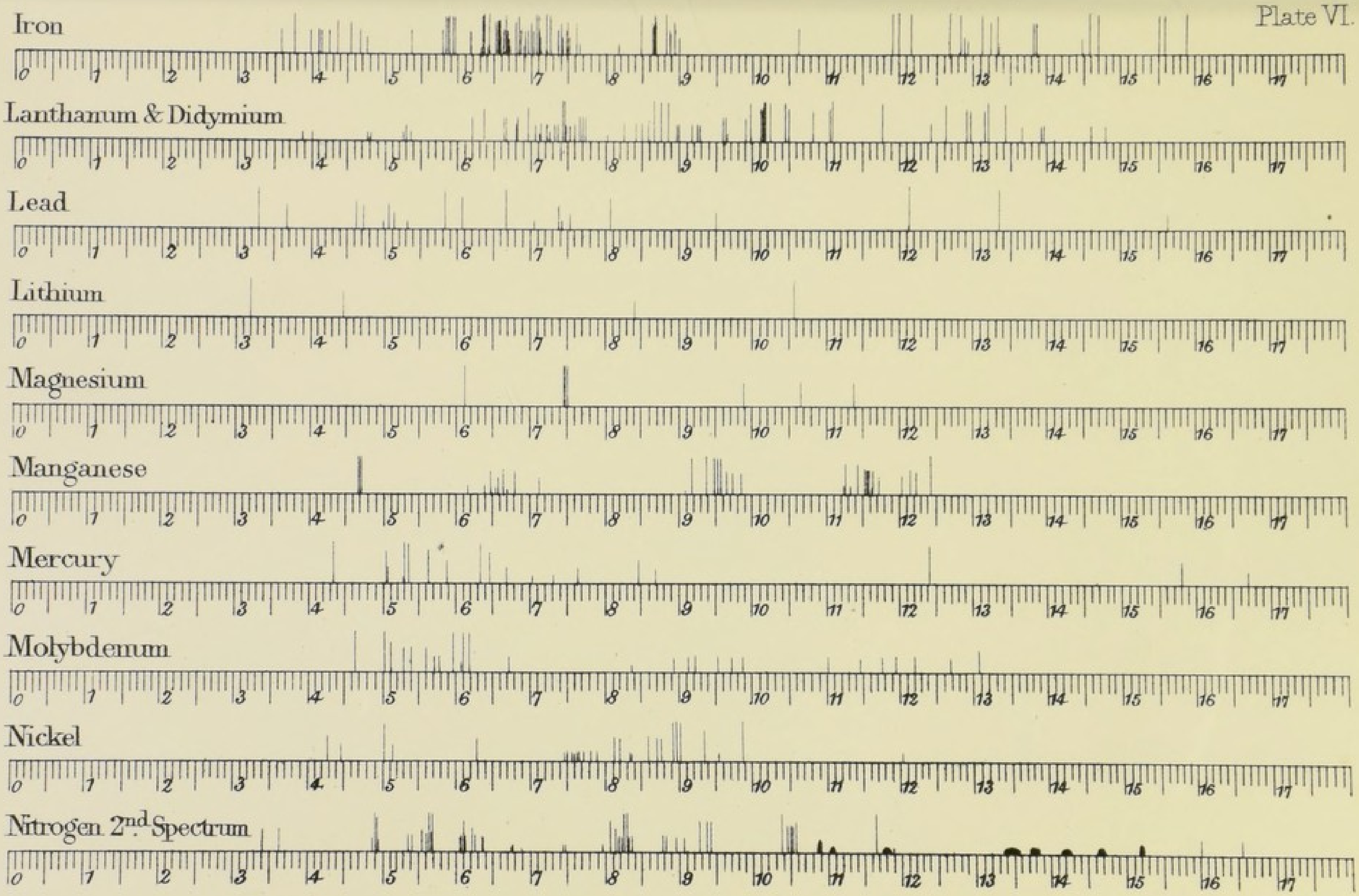
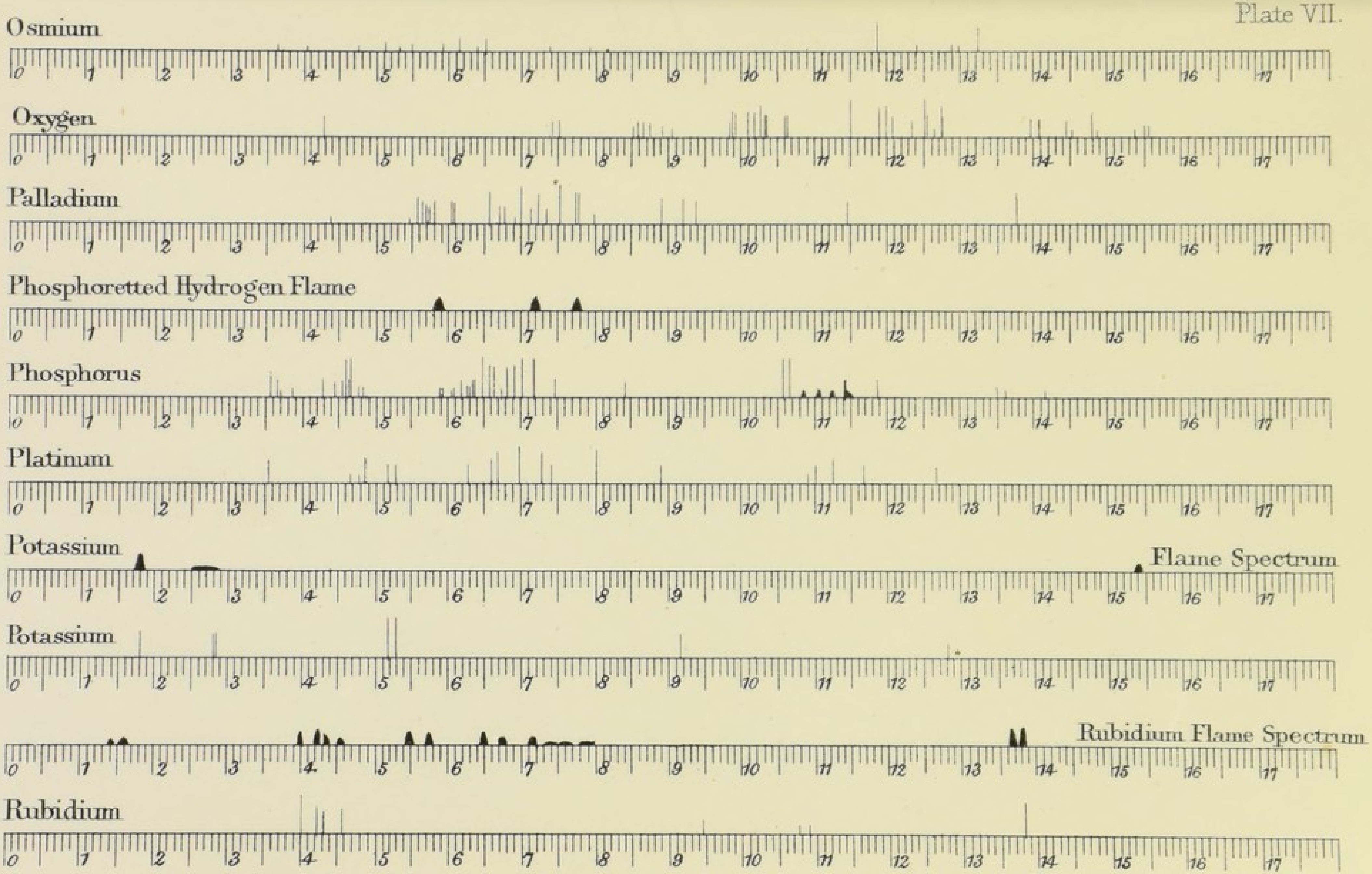

Chromium
Cobalt
Copper
Erbium and Yttrium
Glucinum
Gold
Hydrogen
Indium
Iodine
Iridium & Ruthenium
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17

Plate VI.



Iron
Lanthanum & Didymium
Lead
Lithium
Magnesium
Manganese
Mercury
Molybdenum
Nickel
Nitrogen 2nd. Spectrum
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17



Osmium
Oxygen
Palladium
Phosphoretted Hydrogen Flame
Phosphorus
Platinum
Potassium Flame Spectrum
Potassium
Rubidium Flame Spectrum
Rubidium
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17

Plate VIII.

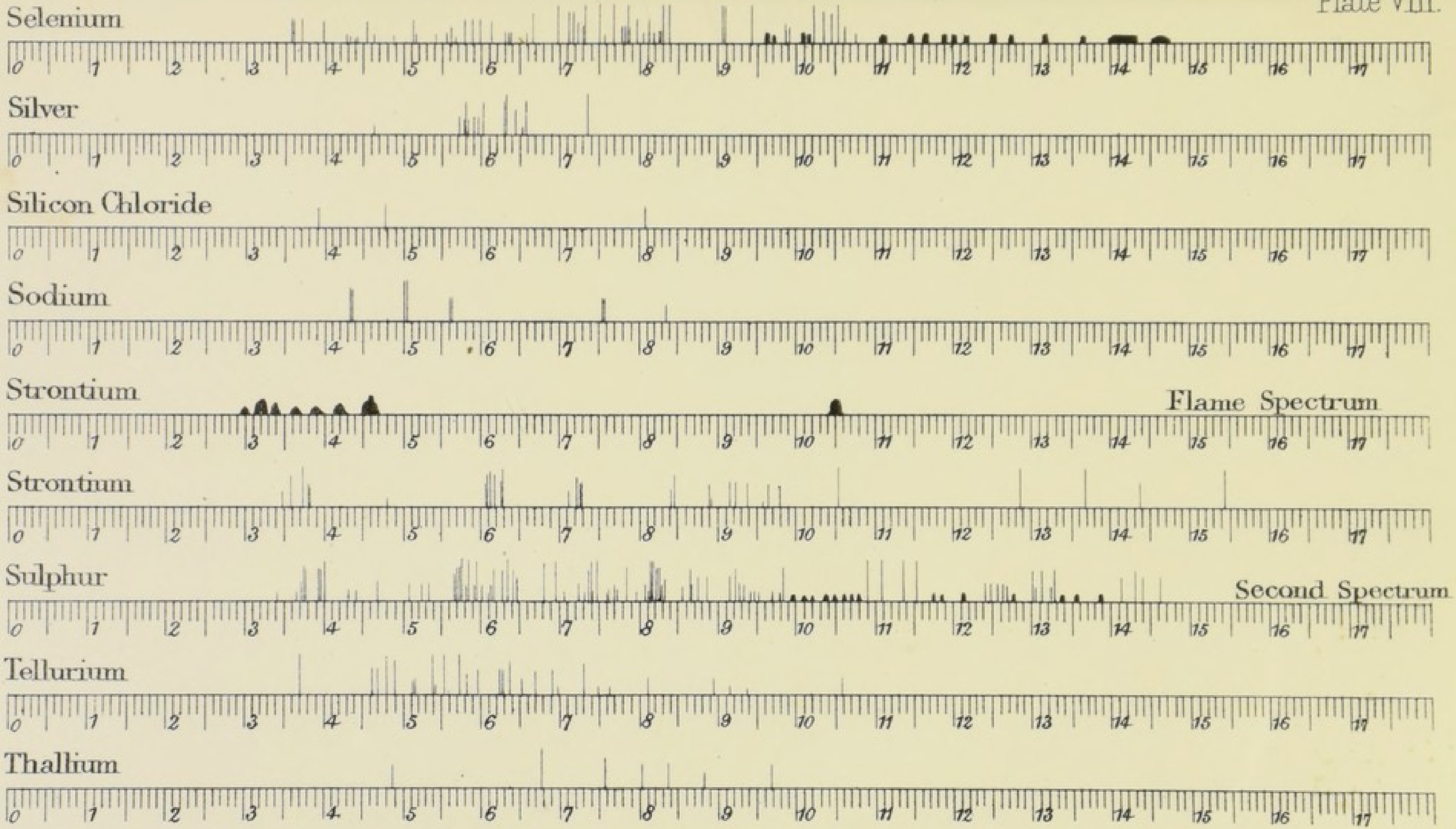
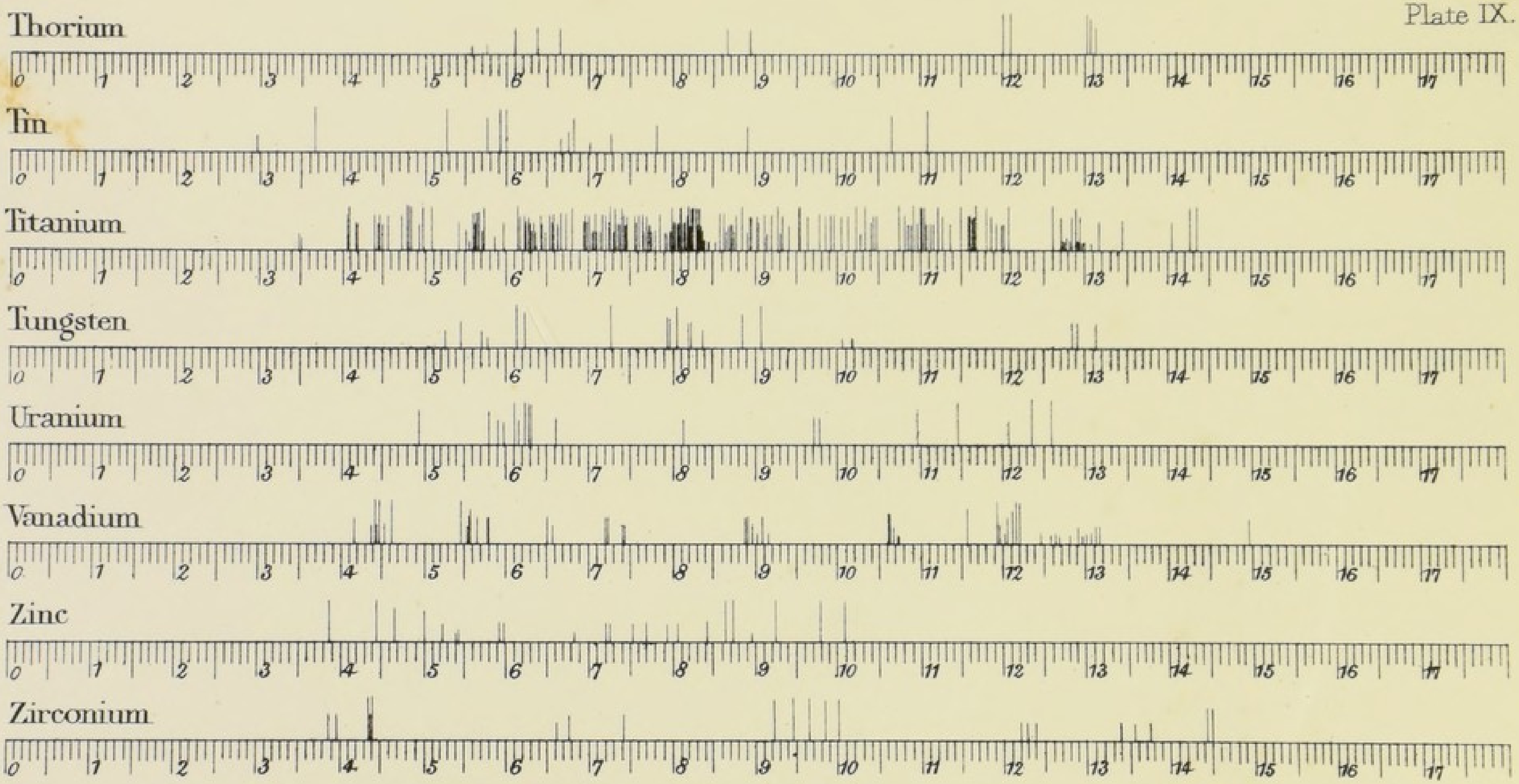

Selenium
Silver
Silicon Chloride
Sodium
Strontium
Flame Spectrum
Strontium
Sulphur
Second Spectrum
Tellurium
Thallium
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17

Plate IX.


Thorium
Tin
Titanium
Tungsten
Uranium
Vanadium
Zinc
Zirconium
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17