IONIZATION ENERGIES OF ATOMS AND ATOMIC IONS

The ionization energies (often called ionization potentials) of neutral and partially ionized atoms are listed in this table. Data were obtained from the compilations cited below, supplemented by results from the recent research literature. Values for the first and second ionization energies come from Reference 6. All values are given in electron volts (eV).

Following the traditional spectroscopic notation, columns are headed I, II, III, etc. up to XXX, where I indicates the neutral atom, II the singly ionized atom, III the doubly ionized atom, etc. The first section of the table includes spectra I to VIII of all the elements through rutherfordium; subsequent sections cover higher spectra (ionization stages) for those elements for which data are available.

References

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- Martin, W. C., Zalubas, R., and Hagan, L., Atomic Energy Levels The Rare Earth Elements, Natl. Stand. Ref. Data Ser. — Natl. Bur. Stand. (U.S.), No. 60, 1978.
- 3. Sugar, J. and Corliss, C., Atomic Energy Levels of the Iron Period Elements: Potassium through Nickel, J. Phys. Chem. Ref. Data, Vol.14, Suppl. 2, 1985.
- 4. References to papers in *J. Phys. Chem. Ref. Data*, in the period 1973–91 covering other elements may be found in the cumulative index to that journal.
- Martin, W.C., and Wiese, W.L., in Atomic, Molecular, and Optical Physics Handbook, Drake, G.W.F., Ed., AIP Press, New York, 1996.
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			Neu	tral Aton	ns to +7 I	ons			
\boldsymbol{Z}	Element	I	II	III	IV	V	VI	VII	VIII
1	Н	13.598443							
2	He	24.587387	54.417760						
3	Li	5.391719	75.6400	122.45429					
4	Be	9.32270	18.21114	153.89661	217.71865				
5	В	8.29802	25.1548	37.93064	259.37521	340.22580			
6	C	11.26030	24.3833	47.8878	64.4939	392.087	489.99334		
7	N	14.5341	29.6013	47.44924	77.4735	97.8902	552.0718	667.046	
8	O	13.61805	35.1211	54.9355	77.41353	113.8990	138.1197	739.29	871.4101
9	F	17.4228	34.9708	62.7084	87.1398	114.2428	157.1651	185.186	953.9112
10	Ne	21.56454	40.96296	63.45	97.12	126.21	157.93	207.2759	239.0989
11	Na	5.139076	47.2864	71.6200	98.91	138.40	172.18	208.50	264.25
12	Mg	7.646235	15.03527	80.1437	109.2655	141.27	186.76	225.02	265.96
13	Al	5.985768	18.82855	28.44765	119.992	153.825	190.49	241.76	284.66
14	Si	8.15168	16.34584	33.49302	45.14181	166.767	205.27	246.5	303.54
15	P	10.48669	19.7695	30.2027	51.4439	65.0251	220.421	263.57	309.60
16	S	10.36001	23.33788	34.79	47.222	72.5945	88.0530	280.948	328.75
17	Cl	12.96763	23.8136	39.61	53.4652	67.8	97.03	114.1958	348.28
18	Ar	15.759610	27.62966	40.74	59.81	75.02	91.009	124.323	143.460
19	K	4.3406633	31.63	45.806	60.91	82.66	99.4	117.56	154.88
20	Ca	6.11316	11.87172	50.9131	67.27	84.50	108.78	127.2	147.24
21	Sc	6.56149	12.79977	24.75666	73.4894	91.65	110.68	138.0	158.1
22	Ti	6.82812	13.5755	27.4917	43.2672	99.30	119.53	140.8	170.4
23	V	6.74619	14.618	29.311	46.709	65.2817	128.13	150.6	173.4
24	Cr	6.76651	16.4857	30.96	49.16	69.46	90.6349	160.18	184.7
25	Mn	7.43402	15.6400	33.668	51.2	72.4	95.6	119.203	194.5
26	Fe	7.9024	16.1877	30.652	54.8	75.0	99.1	124.98	151.06
27	Co	7.88101	17.084	33.50	51.3	79.5	102.0	128.9	157.8
28	Ni	7.6398	18.16884	35.19	54.9	76.06	108	133	162
29	Cu	7.72638	20.2924	36.841	57.38	79.8	103	139	166
30	Zn	9.394199	17.96439	39.723	59.4	82.6	108	134	174
31	Ga	5.999301	20.51515	30.7258	63.241	86.01	112.7	140.9	169.9
32	Ge	7.89943	15.93461	34.2241	45.7131	93.5			
33	As	9.7886	18.5892	28.351	50.13	62.63	127.6		
34	Se	9.75239	21.19	30.8204	42.9450	68.3	81.7	155.4	
35	Br	11.8138	21.591	36	47.3	59.7	88.6	103.0	192.8
36	Kr	13.99961	24.35984	36.950	52.5	64.7	78.5	111.0	125.802
37	Rb	4.177128	27.2895	40	52.6	71.0	84.4	99.2	136
38	Sr	5.69485	11.0301	42.89	57	71.6	90.8	106	122.3
39	Y	6.2173	12.224	20.52	60.597	77.0	93.0	116	129
40	Zr	6.63390	13.1	22.99	34.34	80.348			
41	Nb	6.75885	14.0	25.04	38.3	50.55	102.057	125	

			Neu	tral Atom	s to +7 Io	ons			
\boldsymbol{Z}	Element	I	II	III	IV	V	VI	VII	VIII
42	Mo	7.09243	16.16	27.13	46.4	54.49	68.8276	125.664	143.6
43	Tc	7.28	15.26	29.54					
44	Ru	7.36050	16.76	28.47					
45	Rh	7.45890	18.08	31.06					
46	Pd	8.3369	19.43	32.93					
47	Ag	7.57623	21.47746	34.83					
48	Cd	8.99382	16.90831	37.48					
49	In C.,	5.78636	18.8703	28.03	54	70.00			
50 51	Sn Sb	7.34392	14.6322	30.50260	40.73502	72.28	100		
51 52	Te	8.60839 9.0096	16.63 18.6	25.3 27.96	44.2 37.41	56 58.75	108 70.7	137	
53	I	10.45126	19.1313	33	37.41	30.73	70.7	137	
54	Xe	12.12984	20.9750	32.1230					
55	Cs	3.893905	23.15744	32.1230					
56	Ba	5.211664	10.00383						
57	La	5.5769	11.059	19.1773	49.95	61.6			
58	Ce	5.5387	10.85	20.198	36.758	65.55	77.6		
59	Pr	5.473	10.55	21.624	38.98	57.53			
60	Nd	5.5250	10.72	22.1	40.4				
61	Pm	5.582	10.90	22.3	41.1				
62	Sm	5.6437	11.07	23.4	41.4				
63	Eu	5.67038	11.25	24.92	42.7				
64	Gd	6.14980	12.09	20.63	44.0				
65	Tb	5.8638	11.52	21.91	39.79				
66	Dy	5.9389	11.67	22.8	41.47				
67	Но	6.0215	11.80	22.84	42.5				
68 69	Er Tm	6.1077	11.93	22.74 23.68	42.7 42.7				
70	Yb	6.18431 6.25416	12.05 12.176	25.05	43.56				
70	Lu	5.42586	13.9	20.9594	45.25	66.8			
72	Hf	6.82507	15.5	23.3	33.33	00.0			
73	Ta	7.54957	10	20.0	55.55				
74	W	7.86403	16.1						
75	Re	7.83352							
76	Os	8.43823							
77	Ir	8.96702							
78	Pt	8.9588	18.563						
79	Au	9.22553	20.20						
80	Hg	10.4375	18.7568	34.2					
81	Tl	6.108194	20.4283	29.83	42.22				
82	Pb	7.41663	15.03248	31.9373	42.32	68.8	00.0		
83	Bi	7.2855	16.703	25.56	45.3	56.0	88.3		
84	Po	8.414							
85	At	10.7405							
86 87	Rn Fr	10.7485 4.072741							
88	Ra	5.278423	10.14715						
89	Ac	5.17	11.75						
90	Th	6.3067	11.9	20.0	28.8				
91	Pa	5.89							
92	U	6.1941	10.6						
93	Np	6.2657							
94	Pu	6.0260	11.2						
95	Am	5.9738							
96	Cm	5.9914							
97	Bk	6.1979							
98	Cf	6.2817	11.8						
99	Es	6.42	12.0						
100	Fm	6.50							
101	Md	6.58							
102 103	No Lr	6.65 4.9							
103	Rf	6.0							
IUI	1/1	0.0							

+8 Ions to +15 Ions									
Z	Element	IX	X	XI	XII	XIII	XIV	XV	XVI
9	F	1103.1176							
10	Ne	1195.8286	1362.1995						
11	Na	299.864	1465.121	1648.702					
12	Mg	328.06	367.50	1761.805	1962.6650				
13	Al	330.13	398.75	442.00	2085.98	2304.1410			
14	Si	351.12	401.37	476.36	523.42	2437.63	2673.182		
15	P	372.13	424.4	479.46	560.8	611.74	2816.91	3069.842	
16	S	379.55	447.5	504.8	564.44	652.2	707.01	3223.78	3494.1892
17	Cl	400.06	455.63	529.28	591.99	656.71	749.76	809.40	3658.521
18	Ar	422.45	478.69	538.96	618.26	686.10	755.74	854.77	918.03
19	K	175.8174	503.8	564.7	629.4	714.6	786.6	861.1	968
20	Ca	188.54	211.275	591.9	657.2	726.6	817.6	894.5	974
21	Sc	180.03	225.18	249.798	687.36	756.7	830.8	927.5	1009
22	Ti	192.1	215.92	265.07	291.500	787.84	863.1	941.9	1044
23	V	205.8	230.5	255.7	308.1	336.277	896.0	976	1060
24	Cr	209.3	244.4	270.8	298.0	354.8	384.168	1010.6	1097
25	Mn	221.8	248.3	286.0	314.4	343.6	403.0	435.163	1134.7
26	Fe	233.6	262.1	290.2	330.8	361.0	392.2	457	489.256
27	Co	186.13	275.4	305	336	379	411	444	511.96
28	Ni	193	224.6	321.0	352	384	430	464	499
29	Cu	199	232	265.3	369	401	435	484	520
30	Zn	203	238	274	310.8	419.7	454	490	542
31	Ga	210.8	244.0	280.7	319.2	357.2	471.2	508.8	548.3
36	Kr	230.85	268.2	308	350	391	447	492	541
37	Rb	150	277.1						
38	Sr	162	177	324.1					
39	Y	146.2	191	206	374.0				
42	Mo	164.12	186.4	209.3	230.28	279.1	302.60	544.0	570
				16 10 00 0 4	~ . ?? I ~ ~.	~			
7	Floment	VVII			0 +23 Ions		YYII	YYIII	YYIV
Z 17	Element	XVII 3946 2960	XVIII +	16 Ions to XIX	o +23 Ions XX	S XXI	XXII	XXIII	XXIV
17	Cl	3946.2960	XVIII				XXII	XXIII	XXIV
17 18	Cl Ar	3946.2960 4120.8857	XVIII 4426.2296	XIX			XXII	XXIII	XXIV
17 18 19	Cl Ar K	3946.2960 4120.8857 1033.4	XVIII 4426.2296 4610.8	XIX 4934.046	XX		XXII	XXIII	XXIV
17 18 19 20	Cl Ar K Ca	3946.2960 4120.8857 1033.4 1087	XVIII 4426.2296 4610.8 1157.8	XIX 4934.046 5128.8	XX 5469.864	XXI	XXII	XXIII	XXIV
17 18 19 20 21	Cl Ar K Ca Sc	3946.2960 4120.8857 1033.4 1087 1094	XVIII 4426.2296 4610.8 1157.8 1213	XIX 4934.046 5128.8 1287.97	XX 5469.864 5674.8	XXI 6033.712		XXIII	XXIV
17 18 19 20 21 22	Cl Ar K Ca Sc Ti	3946.2960 4120.8857 1033.4 1087 1094 1131	XVIII 4426.2296 4610.8 1157.8 1213 1221	XIX 4934.046 5128.8 1287.97 1346	XX 5469.864 5674.8 1425.4	XXI 6033.712 6249.0	6625.82		XXIV
17 18 19 20 21 22 23	Cl Ar K Ca Sc Ti V	3946.2960 4120.8857 1033.4 1087 1094 1131 1168	XVIII 4426.2296 4610.8 1157.8 1213 1221 1260	XIX 4934.046 5128.8 1287.97 1346 1355	XX 5469.864 5674.8 1425.4 1486	XXI 6033.712 6249.0 1569.6	6625.82 6851.3	7246.12	
17 18 19 20 21 22 23 24	Cl Ar K Ca Sc Ti V Cr	3946.2960 4120.8857 1033.4 1087 1094 1131 1168 1185	XVIII 4426.2296 4610.8 1157.8 1213 1221 1260 1299	4934.046 5128.8 1287.97 1346 1355 1396	XX 5469.864 5674.8 1425.4 1486 1496	XXI 6033.712 6249.0 1569.6 1634	6625.82 6851.3 1721.4	7246.12 7481.7	7894.81
17 18 19 20 21 22 23 24 25	Cl Ar K Ca Sc Ti V Cr Mn	3946.2960 4120.8857 1033.4 1087 1094 1131 1168 1185 1224	XVIII 4426.2296 4610.8 1157.8 1213 1221 1260 1299 1317	XIX 4934.046 5128.8 1287.97 1346 1355 1396 1437	5469.864 5674.8 1425.4 1486 1496 1539	6033.712 6249.0 1569.6 1634 1644	6625.82 6851.3 1721.4 1788	7246.12 7481.7 1879.9	7894.81 8140.6
17 18 19 20 21 22 23 24 25 26	Cl Ar K Ca Sc Ti V Cr Mn Fe	3946.2960 4120.8857 1033.4 1087 1094 1131 1168 1185 1224 1266	XVIII 4426.2296 4610.8 1157.8 1213 1221 1260 1299 1317 1358	4934.046 5128.8 1287.97 1346 1355 1396 1437 1456	5469.864 5674.8 1425.4 1486 1496 1539 1582	6033.712 6249.0 1569.6 1634 1644 1689	6625.82 6851.3 1721.4 1788 1799	7246.12 7481.7 1879.9 1950	7894.81 8140.6 2023
17 18 19 20 21 22 23 24 25 26 27	Cl Ar K Ca Sc Ti V Cr Mn Fe Co	3946.2960 4120.8857 1033.4 1087 1094 1131 1168 1185 1224 1266 546.58	XVIII 4426.2296 4610.8 1157.8 1213 1221 1260 1299 1317 1358 1397.2	4934.046 5128.8 1287.97 1346 1355 1396 1437 1456 1504.6	5469.864 5674.8 1425.4 1486 1496 1539 1582 1603	6033.712 6249.0 1569.6 1634 1644 1689 1735	6625.82 6851.3 1721.4 1788 1799 1846	7246.12 7481.7 1879.9 1950 1962	7894.81 8140.6 2023 2119
17 18 19 20 21 22 23 24 25 26 27 28	Cl Ar K Ca Sc Ti V Cr Mn Fe Co Ni	3946.2960 4120.8857 1033.4 1087 1094 1131 1168 1185 1224 1266 546.58 571.08	XVIII 4426.2296 4610.8 1157.8 1213 1221 1260 1299 1317 1358 1397.2 607.06	4934.046 5128.8 1287.97 1346 1355 1396 1437 1456 1504.6 1541	5469.864 5674.8 1425.4 1486 1496 1539 1582 1603 1648	6033.712 6249.0 1569.6 1634 1644 1689 1735 1756	6625.82 6851.3 1721.4 1788 1799 1846 1894	7246.12 7481.7 1879.9 1950 1962 2011	7894.81 8140.6 2023 2119 2131
17 18 19 20 21 22 23 24 25 26 27 28 29	Cl Ar K Ca Sc Ti V Cr Mn Fe Co Ni	3946.2960 4120.8857 1033.4 1087 1094 1131 1168 1185 1224 1266 546.58 571.08 557	XVIII 4426.2296 4610.8 1157.8 1213 1221 1260 1299 1317 1358 1397.2 607.06 633	4934.046 5128.8 1287.97 1346 1355 1396 1437 1456 1504.6 1541 670.588	5469.864 5674.8 1425.4 1486 1496 1539 1582 1603 1648 1697	6033.712 6249.0 1569.6 1634 1644 1689 1735 1756 1804	6625.82 6851.3 1721.4 1788 1799 1846	7246.12 7481.7 1879.9 1950 1962	7894.81 8140.6 2023 2119
17 18 19 20 21 22 23 24 25 26 27 28 29 30	Cl Ar K Ca Sc Ti V Cr Mn Fe Co Ni Cu Zn	3946.2960 4120.8857 1033.4 1087 1094 1131 1168 1185 1224 1266 546.58 571.08 557 579	XVIII 4426.2296 4610.8 1157.8 1213 1221 1260 1299 1317 1358 1397.2 607.06 633 619	4934.046 5128.8 1287.97 1346 1355 1396 1437 1456 1504.6 1541 670.588 698	5469.864 5674.8 1425.4 1486 1496 1539 1582 1603 1648 1697 738	6033.712 6249.0 1569.6 1634 1644 1689 1735 1756 1804 1856	6625.82 6851.3 1721.4 1788 1799 1846 1894 1916	7246.12 7481.7 1879.9 1950 1962 2011 2060	7894.81 8140.6 2023 2119 2131 2182
17 18 19 20 21 22 23 24 25 26 27 28 29 30 36	Cl Ar K Ca Sc Ti V Cr Mn Fe Co Ni Cu Zn	3946.2960 4120.8857 1033.4 1087 1094 1131 1168 1185 1224 1266 546.58 571.08 557 579 592	XVIII 4426.2296 4610.8 1157.8 1213 1221 1260 1299 1317 1358 1397.2 607.06 633 619 641	4934.046 5128.8 1287.97 1346 1355 1396 1437 1456 1504.6 1541 670.588 698 786	5469.864 5674.8 1425.4 1486 1496 1539 1582 1603 1648 1697 738 833	6033.712 6249.0 1569.6 1634 1644 1689 1735 1756 1804 1856 884	6625.82 6851.3 1721.4 1788 1799 1846 1894 1916	7246.12 7481.7 1879.9 1950 1962 2011 2060	7894.81 8140.6 2023 2119 2131 2182
17 18 19 20 21 22 23 24 25 26 27 28 29 30	Cl Ar K Ca Sc Ti V Cr Mn Fe Co Ni Cu Zn	3946.2960 4120.8857 1033.4 1087 1094 1131 1168 1185 1224 1266 546.58 571.08 557 579	XVIII 4426.2296 4610.8 1157.8 1213 1221 1260 1299 1317 1358 1397.2 607.06 633 619	4934.046 5128.8 1287.97 1346 1355 1396 1437 1456 1504.6 1541 670.588 698	5469.864 5674.8 1425.4 1486 1496 1539 1582 1603 1648 1697 738	6033.712 6249.0 1569.6 1634 1644 1689 1735 1756 1804 1856	6625.82 6851.3 1721.4 1788 1799 1846 1894 1916	7246.12 7481.7 1879.9 1950 1962 2011 2060	7894.81 8140.6 2023 2119 2131 2182
17 18 19 20 21 22 23 24 25 26 27 28 29 30 36 42	Cl Ar K Ca Sc Ti V Cr Mn Fe Co Ni Cu Zn Kr	3946.2960 4120.8857 1033.4 1087 1094 1131 1168 1185 1224 1266 546.58 571.08 557 579 592 636	XVIII 4426.2296 4610.8 1157.8 1213 1221 1260 1299 1317 1358 1397.2 607.06 633 619 641 702	4934.046 5128.8 1287.97 1346 1355 1396 1437 1456 1504.6 1541 670.588 698 786 767	5469.864 5674.8 1425.4 1486 1496 1539 1582 1603 1648 1697 738 833 833	6033.712 6249.0 1569.6 1634 1644 1689 1735 1756 1804 1856 884 902	6625.82 6851.3 1721.4 1788 1799 1846 1894 1916	7246.12 7481.7 1879.9 1950 1962 2011 2060	7894.81 8140.6 2023 2119 2131 2182
17 18 19 20 21 22 23 24 25 26 27 28 29 30 36 42	Cl Ar K Ca Sc Ti V Cr Mn Fe Co Ni Cu Zn Kr Mo	3946.2960 4120.8857 1033.4 1087 1094 1131 1168 1185 1224 1266 546.58 571.08 557 579 592 636	XVIII 4426.2296 4610.8 1157.8 1213 1221 1260 1299 1317 1358 1397.2 607.06 633 619 641 702	4934.046 5128.8 1287.97 1346 1355 1396 1437 1456 1504.6 1541 670.588 698 786 767	5469.864 5674.8 1425.4 1486 1496 1539 1582 1603 1648 1697 738 833 833	6033.712 6249.0 1569.6 1634 1644 1689 1735 1756 1804 1856 884 902	6625.82 6851.3 1721.4 1788 1799 1846 1894 1916	7246.12 7481.7 1879.9 1950 1962 2011 2060	7894.81 8140.6 2023 2119 2131 2182
17 18 19 20 21 22 23 24 25 26 27 28 29 30 36 42	Cl Ar K Ca Sc Ti V Cr Mn Fe Co Ni Cu Zn Kr Mo	3946.2960 4120.8857 1033.4 1087 1094 1131 1168 1185 1224 1266 546.58 571.08 557 579 592 636	XVIII 4426.2296 4610.8 1157.8 1213 1221 1260 1299 1317 1358 1397.2 607.06 633 619 641 702	4934.046 5128.8 1287.97 1346 1355 1396 1437 1456 1504.6 1541 670.588 698 786 767	5469.864 5674.8 1425.4 1486 1496 1539 1582 1603 1648 1697 738 833 833	6033.712 6249.0 1569.6 1634 1644 1689 1735 1756 1804 1856 884 902	6625.82 6851.3 1721.4 1788 1799 1846 1894 1916	7246.12 7481.7 1879.9 1950 1962 2011 2060	7894.81 8140.6 2023 2119 2131 2182
17 18 19 20 21 22 23 24 25 26 27 28 29 30 36 42 Z 25 26	Cl Ar K Ca Sc Ti V Cr Mn Fe Co Ni Cu Zn Kr Mo	3946.2960 4120.8857 1033.4 1087 1094 1131 1168 1185 1224 1266 546.58 571.08 557 579 592 636 XXV 8571.94 8828	XVIII 4426.2296 4610.8 1157.8 1213 1221 1260 1299 1317 1358 1397.2 607.06 633 619 641 702 + XXVI	4934.046 5128.8 1287.97 1346 1355 1396 1437 1456 1504.6 1541 670.588 698 786 767 24 Ions to XXVII	5469.864 5674.8 1425.4 1486 1496 1539 1582 1603 1648 1697 738 833 833	6033.712 6249.0 1569.6 1634 1644 1689 1735 1756 1804 1856 884 902	6625.82 6851.3 1721.4 1788 1799 1846 1894 1916	7246.12 7481.7 1879.9 1950 1962 2011 2060	7894.81 8140.6 2023 2119 2131 2182
17 18 19 20 21 22 23 24 25 26 27 28 29 30 36 42 2 2 5 26 27	Cl Ar K Ca Sc Ti V Cr Mn Fe Co Ni Cu Zn Kr Mo Element Mn Fe Co	3946.2960 4120.8857 1033.4 1087 1094 1131 1168 1185 1224 1266 546.58 571.08 557 579 592 636 XXV 8571.94 8828 2219.0	XVIII 4426.2296 4610.8 1157.8 1213 1221 1260 1299 1317 1358 1397.2 607.06 633 619 641 702 + XXVI 9277.69 9544.1	4934.046 5128.8 1287.97 1346 1355 1396 1437 1456 1504.6 1541 670.588 698 786 767 24 Ions to XXVII	5469.864 5674.8 1425.4 1486 1496 1539 1582 1603 1648 1697 738 833 833 80 +29 Ions	6033.712 6249.0 1569.6 1634 1644 1689 1735 1756 1804 1856 884 902	6625.82 6851.3 1721.4 1788 1799 1846 1894 1916	7246.12 7481.7 1879.9 1950 1962 2011 2060	7894.81 8140.6 2023 2119 2131 2182
17 18 19 20 21 22 23 24 25 26 27 28 29 30 36 42 25 26 27 28 29 27 28 29 29 20 21 21 22 23 24 25 26 27 28 29 29 20 20 20 20 20 20 20 20 20 20 20 20 20	Cl Ar K Ca Sc Ti V Cr Mn Fe Co Ni Cu Zn Kr Mo Element Mn Fe Co Ni	3946.2960 4120.8857 1033.4 1087 1094 1131 1168 1185 1224 1266 546.58 571.08 557 579 592 636 XXV 8571.94 8828 2219.0 2295	XVIII 4426.2296 4610.8 1157.8 1213 1221 1260 1299 1317 1358 1397.2 607.06 633 619 641 702 + XXVI 9277.69 9544.1 2399.2	4934.046 5128.8 1287.97 1346 1355 1396 1437 1456 1504.6 1541 670.588 698 786 767 24 Ions to XXVII	5469.864 5674.8 1425.4 1486 1496 1539 1582 1603 1648 1697 738 833 833 80 +29 Ions XXVIII	6033.712 6249.0 1569.6 1634 1644 1689 1735 1756 1804 1856 884 902	6625.82 6851.3 1721.4 1788 1799 1846 1894 1916	7246.12 7481.7 1879.9 1950 1962 2011 2060	7894.81 8140.6 2023 2119 2131 2182
17 18 19 20 21 22 23 24 25 26 27 28 29 30 36 42 Z 25 26 27 28 29 29 30 36 42	Cl Ar K Ca Sc Ti V Cr Mn Fe Co Ni Cu Zn Kr Mo Element Mn Fe Co Ni Cu	3946.2960 4120.8857 1033.4 1087 1094 1131 1168 1185 1224 1266 546.58 571.08 557 579 592 636 XXV 8571.94 8828 2219.0 2295 2308	XVIII 4426.2296 4610.8 1157.8 1213 1221 1260 1299 1317 1358 1397.2 607.06 633 619 641 702 + XXVI 9277.69 9544.1 2399.2 2478	4934.046 5128.8 1287.97 1346 1355 1396 1437 1456 1504.6 1541 670.588 698 786 767 24 Ions to XXVII 10012.12 10288.8 2587.5	5469.864 5674.8 1425.4 1486 1496 1539 1582 1603 1648 1697 738 833 833 60 +29 Ions XXVIII	XXI 6033.712 6249.0 1569.6 1634 1644 1689 1735 1756 1804 1856 884 902 XXIX	6625.82 6851.3 1721.4 1788 1799 1846 1894 1916 937 968	7246.12 7481.7 1879.9 1950 1962 2011 2060	7894.81 8140.6 2023 2119 2131 2182
17 18 19 20 21 22 23 24 25 26 27 28 29 30 36 42 Z 25 26 27 28 29 30 36 42	Cl Ar K Ca Sc Ti V Cr Mn Fe Co Ni Cu Zn Kr Mo Element Mn Fe Co Ni Cu Kr	3946.2960 4120.8857 1033.4 1087 1094 1131 1168 1185 1224 1266 546.58 571.08 557 579 592 636 XXV 8571.94 8828 2219.0 2295 2308 1151	XVIII 4426.2296 4610.8 1157.8 1213 1221 1260 1299 1317 1358 1397.2 607.06 633 619 641 702 + XXVI 9277.69 9544.1 2399.2 2478 1205.3	4934.046 5128.8 1287.97 1346 1355 1396 1437 1456 1504.6 1541 670.588 698 786 767 24 Ions to XXVII 10012.12 10288.8 2587.5 2928	5469.864 5674.8 1425.4 1486 1496 1539 1582 1603 1648 1697 738 833 833 0 +29 Ions XXVIII	XXI 6033.712 6249.0 1569.6 1634 1644 1689 1735 1756 1804 1856 884 902 XXIX	6625.82 6851.3 1721.4 1788 1799 1846 1894 1916 937 968	7246.12 7481.7 1879.9 1950 1962 2011 2060	7894.81 8140.6 2023 2119 2131 2182
17 18 19 20 21 22 23 24 25 26 27 28 29 30 36 42 Z 25 26 27 28 29 29 30 36 42	Cl Ar K Ca Sc Ti V Cr Mn Fe Co Ni Cu Zn Kr Mo Element Mn Fe Co Ni Cu	3946.2960 4120.8857 1033.4 1087 1094 1131 1168 1185 1224 1266 546.58 571.08 557 579 592 636 XXV 8571.94 8828 2219.0 2295 2308	XVIII 4426.2296 4610.8 1157.8 1213 1221 1260 1299 1317 1358 1397.2 607.06 633 619 641 702 + XXVI 9277.69 9544.1 2399.2 2478	4934.046 5128.8 1287.97 1346 1355 1396 1437 1456 1504.6 1541 670.588 698 786 767 24 Ions to XXVII 10012.12 10288.8 2587.5	5469.864 5674.8 1425.4 1486 1496 1539 1582 1603 1648 1697 738 833 833 60 +29 Ions XXVIII	XXI 6033.712 6249.0 1569.6 1634 1644 1689 1735 1756 1804 1856 884 902 XXIX	6625.82 6851.3 1721.4 1788 1799 1846 1894 1916 937 968	7246.12 7481.7 1879.9 1950 1962 2011 2060	7894.81 8140.6 2023 2119 2131 2182