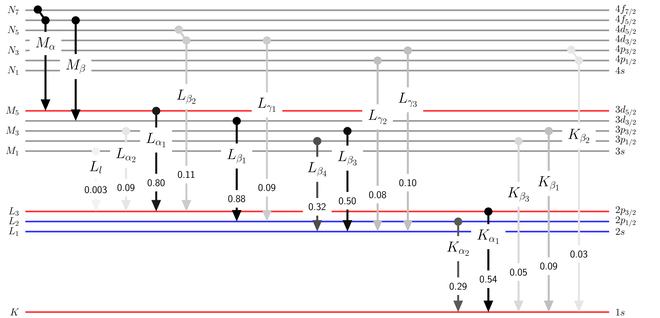
X-ray Absorption and Emission Energies of the Elements



Atomic Data and Energies from
W. T. Elam, B. D. Ravel and J. R. Sieber,
Radiation Physics and Chemistry **63**, pp 121-128 (2002)

Common oxidation states from wikipedia.org, after
N. N. Greenwood and A. Earnshaw,
Chemistry of the Elements, 2nd ed. (1997).

All energies in eV.
Emission line strengths are approximate, and vary with element.

Symbol	Z
name	
K edge	K_{α_1} K_{β_3}
L_1 edge	L_{β_3} L_{β_4}
L_2 edge	L_{β_1} L_{γ_1}
L_3 edge	L_{α_1} L_{β_2}
M_5 edge	M_α M_β
Mass	oxidation states

H 1 hydrogen
14
1.0079 +1

He 2 helium
25
4.0026

Li 3 lithium
55 5
6.941 +1

Be 4 beryllium
112 8 3 3 108
9.0122 +2

B 5 boron
188 13 5 5 183
10.81 +3

C 6 carbon
284 18 7 7 277
12.011 -4, -3, . . . , +2, +3, +4

N 7 nitrogen
410 37 18 18 392
14.0067 -3, +3, +5

O 8 oxygen
543 42 18 18 525
15.9994 -2

F 9 fluorine
697 45 20 20 677
18.9984 -1

Ne 10 neon
870 48 22 22 849
20.179

Na 11 sodium
1071 64 30 30 1040
22.9898 +1

Mg 12 magnesium
1303 89 50 49 1254 88 1302 88
24.305 +2

Al 13 aluminum
1559 118 73 72 1486 116 1557 116
26.9815 +3

Si 14 silicon
1839 150 100 99 1740 148 1837 148
28.0855 -4, +4

P 15 phosphorus
2146 189 136 135 2010 183 2140 182
30.9738 -3, +3, +5

S 16 sulfur
2472 231 164 162 2310 224 2465 223
32.06 -2, +2, +4, +6

Cl 17 chlorine
2822 270 202 200 2622 260 2812 260
35.453 -1, +1, +3, +5, +7

Ar 18 argon
3206 326 251 248 2958 311 3190 310
39.948

K 19 potassium
3608 379 297 295 3314 360 3590 360
39.0983 +1

Ca 20 calcium
4038 438 350 346 3692 413 4013 413
40.08 +2

Sc 21 scandium
4492 498 404 399 4093 470 4464 470
44.9559 +3

Ti 22 titanium
4966 561 460 454 2 4512 528 4933 528
47.88 +3, +4

V 23 vanadium
5465 627 520 512 2 4953 590 5428 590
50.9415 +2, +3, +4, +5

Cr 24 chromium
5989 769 584 574 2 5415 654 5947 654
51.996 +2, +3, +6

Mn 25 manganese
6539 769 650 639 2 5900 722 6492 722
54.938 +2, +3, +4, +7

Fe 26 iron
7112 845 720 707 2 6405 792 7059 792
55.847 +2, +3

Co 27 cobalt
7709 925 793 778 3 6931 865 7649 866
58.9332 +2, +3

Ni 28 nickel
8333 1009 870 853 4 7480 942 8267 941
58.69 +2

Cu 29 copper
8979 1097 952 933 5 8046 1022 8904 1019
63.546 +1, +2

Zn 30 zinc
9659 1196 1045 1022 10 8637 1108 9570 1105
65.38 +2

Ga 31 gallium
10367 1299 1143 1116 19 9251 1199 10267 1196
69.72 +3

Ge 32 germanium
11103 1415 1248 1217 29 9886 1294 10982 1290
72.59 -4, +2, +4

As 33 arsenic
11867 1527 1359 1324 42 10543 1386 11726 1381
74.9216 -3, +3, +5

Se 34 selenium
12658 1652 1474 1434 55 11224 1491 12497 1486
78.96 -2, +2, +4, +6

Br 35 bromine
13474 1782 1596 1550 69 11924 1600 13292 1593
79.904 -1, +1, +3, +5

Kr 36 krypton
14326 1921 1731 1678 94 12648 1707 14112 1699
83.8

Rb 37 rubidium
15200 2065 1864 1804 112 13396 1826 14961 1816
85.4678 +1

Sr 38 strontium
16105 2216 2007 1940 134 14165 1946 15835 1936
87.62 +2

Y 39 yttrium
17038 2373 2156 2080 156 14958 2074 16739 2062
88.9059 +3

Zr 40 zirconium
17998 2532 2307 2223 179 15775 2202 17668 2188
91.22 +4

Nb 41 niobium
18986 2698 2465 2371 202 16615 2337 18625 2322
92.9064 +4, +5

Mo 42 molybdenum
20000 2866 2625 2520 228 17480 2472 19606 2454
95.94 +3, +4, +6

Tc 43 technetium
21044 3043 2793 2677 254 18367 2625 20626 2595
97.907 +4, +7

Ru 44 ruthenium
22117 3224 2967 2838 280 19279 2762 21656 2741
101.07 +3, +4, +6

Rh 45 rhodium
23220 3412 3146 3004 307 20216 2916 22724 2891
102.906 +2, +3, +4

Pd 46 palladium
24350 3604 3330 3173 335 21177 3072 23818 3044
106.42 +2, +4

Ag 47 silver
25514 3806 3524 3351 368 22163 3150 24941 3202
107.868 +1

Cd 48 cadmium
26711 4018 3727 3538 405 23173 3400 26093 3365
112.41 +2

In 49 indium
27940 4238 3938 3730 444 24210 3573 27275 3535
114.82 +3

Sn 50 tin
29200 4465 4156 3929 485 25271 3750 28485 3708
118.69 -4, +2, +4

Sb 51 antimony
30491 4698 4380 4132 528 26359 3932 29725 3885
121.75 -3, +3, +5

Te 52 tellurium
31814 4939 4612 4341 573 27473 4118 30993 4068
127.6 -2, +2, +4, +6

I 53 iodine
33169 5188 4852 4557 619 28612 4313 32294 4257
126.905 -1, +1, +3, +5, +7

Xe 54 xenon
34561 5453 5107 4786 676 29775 4512 33620 4451
131.29

Cs 55 cesium
35985 5714 5359 5012 727 30973 4711 34982 4643
132.905 +1

Ba 56 barium
37441 5989 5624 5247 780 32194 4926 36378 4852
137.33 +2

La 57 lanthanum
38925 6266 5891 5483 836 33442 5138 37797 5057
138.906 +3

Hf 72 hafnium
65351 11271 10739 9561 1662 55790 9164 63244 8906
178.49 +4

Ta 73 tantalum
67416 11682 11136 9881 1735 57535 9488 65222 9213
180.948 +5

W 74 tungsten
69525 12100 11544 10207 1809 59318 9819 67244 9525
183.85 +4, +6

Re 75 rhenium
71676 12527 11959 10535 1883 61141 10160 69309 9845
186.207 +4

Os 76 osmium
73871 12968 12385 10871 1960 63000 10511 71414 10176
190.2 +4

Ir 77 iridium
76111 13419 12824 11215 2040 64896 10868 73560 10510
192.22 +3, +4

Pt 78 platinum
78395 13880 13273 11564 2122 66831 11235 75750 10853
195.08 +2, +4

Au 79 gold
80725 14353 13734 11919 2206 68806 11610 77982 11205
196.967 +1, +3

Hg 80 mercury
83102 14839 14209 12284 2295 70818 11992 80255 11560
200.59 +1, +2

Tl 81 thallium
85530 15347 14698 12658 2389 72872 12390 82573 11931
204.383 +1, +3

Pb 82 lead
88005 15861 15200 13035 2484 74970 12795 84939 12307
207.2 +2, +4

Bi 83 bismuth
90526 16388 15711 13419 2580 77107 13211 87349 12692
208.98 +3, +5

Po 84 polonium
93105 16939 16244 13814 2683 79291 13637 89803 13085
208.982 -2, +2, +4

At 85 astatine
95730 17493 16785 14214 2787 81516 14067 92304 13485
209.987 -1, +1

Rn 86 radon
98404 18049 17337 14619 2892 83785 14511 94866 13890
222.018

Fr 87 francium
101137 18639 17907 15031 3000 86106 14976 97474 14312
223.02 +1

Ra 88 radium
103922 19237 18484 15444 3105 88478 14312 100130 12339
226.025 +2

Ac 89 actinium
106755 19840 19083 15871 3219 90884 15931 102846 15184
227.028 +3

Ce 58 cerium
40443 6548 6164 5723 884 34720 5361 39256 5274
140.12 +3, +4

Pr 59 praseodymium
41991 6835 6440 5964 929 36027 5593 40749 5498
140.908 +3, +4

Nd 60 neodymium
43569 7126 6722 6208 980 37361 5829 42272 5723
144.24 +3

Pm 61 promethium
45184 7428 7013 6459 1027 38725 6071 43827 5957
144.913 +3

Sm 62 samarium
46834 7737 7312 6716 1083 40118 6317 45414 6196
150.36 +3

Eu 63 europium
48519 8052 7617 6977 1128 41542 6571 47038 6438
151.96 +2, +3

Gd 64 gadolinium
50239 8376 7930 7243 1190 42996 6832 48695 6688
157.25 +3

Tb 65 terbium
51996 8708 8252 7514 1241 44482 7097 50385 6940
158.925 +3, +4

Dy 66 dysprosium
53789 9046 8581 7790 1292 45999 7370 52113 7204
162.5 +3

Ho 67 holmium
55618 9394 8918 8071 1351 47547 7653 53877 7471
164.93 +3

Er 68 erbium
57486 9751 9264 8358 1409 49128 7911 55674 7686
167.26 +3

Tm 69 thulium
59390 10116 9617 8648 1468 50742 8231 57505 8026
168.934 +3

Yb 70 ytterbium
61332 10486 9978 8944 1528 52388 8536 59382 8313
173.04 +3

Lu 71 lutetium
63314 10870 10349 9244 1589 54070 8846 61290 8606
174.967 +3

Th 90 thorium
109651 20472 19693 16300 3332 93351 16426 105605 15642
232.038 +4

Pa 91 protactinium
112601 21105 20314 16733 3442 95868 16931 108427 16104
231.036 +5

U 92 uranium
115606 21757 20948 17166 3552 98440 17454 111303 16575
238.051 +4, +6

Np 93 neptunium
118669 22427 21600 17610 3664 101059 17992 114234 17061
237.048 +3, +4, +5

Pu 94 plutonium
121791 23104 22266 18057 3775 103734 18541 117228 17557
239.052 +3, +4, +5

Am 95 americium
124982 23808 22952 18510 3890 106472 19110 120284 18069
243.061 +3, +4, +5

Cm 96 curium
128241 24526 23651 18970 4009 109271 19688 123403 18589
247.07 +3

Bk 97 berkelium
131556 25256 24371 19435 4127 112121 20280 126580 19118
247.07 +3, +4

Cf 98 californium
134939 26010 25108 19907 4247 115032 20894 129823 19665
251.08 +3

Es 99 einsteinium

Fm 100 fermium

Md 101 mendelevium

No 102 nobelium

Lr 103 lawrencium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https://xrayabsorption.org/xraytable
Version 4, 2020-April-19