

Electron Binding Energies in eV for the Elements in their Natural Forms

Values compiled by Gwyn Williams

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The energies are given relative to the vacuum level for rare gases and H, N, O, F, and Cl diatomic molecules; relative to the Fermi level for metals; and relative to the top of the valence band for semiconductors.

Values are taken from J. A. Bearden and A. F. Burr, "Reevaluation of X-Ray Atomic Energy Levels," Rev. Mod. Phys. 39, (1967) p.125, except values marked '*' are from M. Cardona and L. Ley, Eds., Photoemission in Solids I: General Principles (Springer-Verlag, Berlin, 1978) with additional corrections, and values marked with '+' are from J. C. Fuggle and N. Mårtensson, "Core-Level Binding Energies in Metals," J. Electron Spectrosc. Relat. Phenom. 21, (1980) p.275.

Notes: (a) One-particle approximation not valid owing to short core-hole lifetime. (b) Values derived from Bearden and Burr.

	K 1s	L-I 2s	L-II 2p _{1/2}	L-III 2p _{3/2}	M-I 3s	M-II 3p _{1/2}	M-III 3p _{3/2}	M-IV 3d _{3/2}	M-V 3d _{5/2}	N-I 4s	N-II 4p _{1/2}	N-III 4p _{3/2}
1 H	13.6											
2 He	24.6*											
3 Li	54.7*											
4 Be	111.5*											
5 B	188*											
6 C	284.2*											
7 N	409.9*	37.3*										
8 O	543.1*	41.6*										
9 F	696.7*											
10 Ne	870.2*	48.5*	21.7*	21.6*								
11 Na	1070.8+	63.5+	30.4+	30.5*								
12 Mg	1303.0+	88.6*	49.6+	49.21								
13 Al	1559.0	117.8*	72.9*	72.5*								
14 Si	1839	149.7*b	99.8*	99.2*								
15 P	2145.5	189*	136*	135*								
16 S	2472	230.9	163.6*	162.5*								
17 Cl	2822.0	270*	202*	200*								
18 Ar	3205.9*	326.3*	250.6+	248.4*	29.3*	15.9*	15.7*					
19 K	3608.4*	378.6*	297.3*	294.6*	34.8*	18.3*	18.3*					
20 Ca	4038.5*	438.4+	349.7+	346.2+	44.3+	25.4+	25.4+					
21 Sc	4492	498.0*	403.6*	398.7*	51.1*	28.3*	28.3*					
22 Ti	4966	560.9+	460.2+	453.8+	58.7+	32.6+	32.6+					
23 V	5465	626.7+	519.8+	512.1+	66.3+	37.2+	37.2+					

	K	L-I	L-II	L-III	M-I	M-II	M-III	M-IV	M-V	N-I	N-II	N-III
	1s	2s	2p _{1/2}	2p _{3/2}	3s	3p _{1/2}	3p _{3/2}	3d _{3/2}	3d _{5/2}	4s	4p _{1/2}	4p _{3/2}
24 Cr	5989	696.0+	583.8+	574.1+	74.1+	42.2+	42.2+					
25 Mn	6539	769.1+	649.9+	638.7+	82.3+	47.2+	47.2+					
26 Fe	7112	844.6+	719.9+	706.8+	91.3+	52.7+	52.7+					
27 Co	7709	925.1+	793.2+	778.1+	101.0+	58.9+	59.9+					
28 Ni	8333	1008.6+	870.0+	852.7+	110.8+	68.0+	66.2+					
29 Cu	8979	1096.7+	952.3+	932.7	122.5+	77.3+	75.1+					
30 Zn	9659	1196.2*	1044.9*	1021.8*	139.8*	91.4*	88.6*	10.2*	10.1*			
31 Ga	10367	1299.0*b	1143.2+	1116.4+	159.51	103.5+	100.0+	18.7+	18.7+			
32 Ge	11103	1414.6*b	1248.1*b	1217.0*b	180.1*	124.9*	120.8*	29.8*	29.2*			
33 As	11867	1527.0*b	1359.1*b	1323.6*b	204.7*	146.2*	141.2*	41.7*	41.7*			
34 Se	12658	1652.0*b	1474.3*b	1433.9*b	229.6*	166.5*	160.7*	55.5*	54.6*			
35 Br	13474	1782*	1596*	1550*	257*	189*	182*	70*		69*		
36 Kr	14326	1921	1730.9*	1678.4*	292.8*	222.2*	214.4	95.0*	93.8*	27.5*	14.1*	14.1*
37 Rb	15200	2065	1864	1804	326.7*	248.7*	239.1*	113.0*	112*	30.5*	16.3*	15.3*
38 Sr	16105	2216	2007	1940	358.7+	280.3+	270.0+	136.0+	134.2+	38.9+	21.6+	20.1+
39 Y	17038	2373	2156	2080	392.0*b	310.6*	298.8*	157.7+	155.8+	43.8*	24.4*	23.1*
40 Zr	17998	2532	2307	2223	430.3+	343.5+	329.8+	181.1+	178.8+	50.6+	28.5+	27.1+
41 Nb	18986	2698	2465	2371	466.6+	376.1+	360.6+	205.0+	202.3+	56.4+	32.6+	30.8+
42 Mo	20000	2866	2625	2520	506.3+	411.6+	394.0+	231.1+	227.9+	63.2+	37.6+	35.5+
43 Tc	21044	3043	2793	2677	544*	447.6*	417.7*	257.6*	253.9*	69.5*	42.3*	39.9*
44 Ru	22117	3224	2967	2838	586.1*	483.3+	461.5+	284.2+	280.0+	75.0+	46.3+	43.2+
45 Rh	23220	3412	3146	3004	628.1+	521.3+	496.5+	311.9+	307.2+	81.4*b	50.5+	47.3+
46 Pd	24350	3604	3330	3173	671.6+	559.9+	532.3+	340.5+	335.2+	87.1*b	55.7+a	50.9+
47 Ag	25514	3806	3524	3351	719.0+	603.8+	573.0+	374.0+	368.3	97.0+	63.7+	58.3+
48 Cd	26711	4018	3727	3538	772.0+	652.6+	618.4+	411.9+	405.2+	109.8+	63.9+a	63.9+a
49 In	27940	4238	3938	3730	827.2+	703.2+	665.3+	451.4+	443.9+	122.9+	73.5+a	73.5+a
50 Sn	29200	4465	4156	3929	884.7+	756.5+	714.6+	4g _{3/2} +	484.9+	137.1+	83.6+a	83.6+a
51 Sb	30491	4698	4380	4132	940+	812.7+	766.4+	537.5+	528.2+	153.2+	95.6+a	95.6+a
52 Te	31814	4939	4612	4341	1006+	870.8+	820.8+	583.4+	573.0+	169.4+	103.3+a	103.3+a
53 I	33169	5188	4852	4557	1072*	931*	875*	630.8	619.3	186*	123*	123*
54 Xe	34561	5453	5107	4786	1148.7*	1002.1*	940.6*	689.0*	676.4*	213.2*	146.7	145.5*
55 Cs	35985	5714	5359	5012	1211*b	1071*	1003*	740.5*	726.6*	232.3*	172.4*	161.3*
56 Ba	37441	5989	5624	5247	1293*b	1137*b	1063*b	795.7+	780.5*	253.5+	192	178.6+
57 La	38925	6266	5891	5483	1362*b	1209*b	1128*b	853*	836*	274.7*	205.8	196.0*
58 Ce	40443	6548	6164	5723	1436*b	1274*b	1187*b	902.4*	883.8*	291.0*	223.2	206.5*
59 Pr	41991	6835	6440	5964	1511	1337	1242	948.3*	928.8*	304.5	236.3	217.6
60 Nd	43569	7126	6722	6208	1575	1403	1297	1003.3*	980.4*	319.2*	243.3	224.6
61 Pm	45184	7428	7013	6459	-	1471.4	1357	1052	1027	-	242	242
62 Sm	46834	7737	7312	6716	1723	1541	1419.8	1110.9*	1083.4*	347.2*	265.6	247.4
63 Eu	48519	8052	7617	6977	1800	1614	1481	1158.6*	1127.5*	360	284	257

	K	L-I	L-II	L-III	M-I	M-II	M-III	M-IV	M-V	N-I	N-II	N-III
	1s	2s	2p _{1/2}	2p _{3/2}	3s	3p _{1/2}	3p _{3/2}	3d _{3/2}	3d _{5/2}	4s	4p _{1/2}	4p _{3/2}
64 Gd	50239	8376	7930	7243	1881	1688	1544	1221.9*	1189.6*	378.6*	286	271
65 Tb	51996	8708	8252	7514	1968	1768	1611	1276.9*	1241.1*	396.0*	322.4*	284.1*
66 Dy	53789	9046	8581	7790	2047	1842	1676	1333	1292*	414.2*	333.5*	293.2*
67 Ho	55618	9394	8918	8071	2128	1923	1741	1392	1351	432.4*	343.5	308.2*
68 Er	57486	9751	9264	8358	2206	2006	1812	1453	1409	449.8*	366.2	320.2*
69 Tm	59390	10116	9617	8648	2307	2090	1885	1515	1468	470.9*	385.9*	332.6*
70 Yb	61332	10486	9978	8944	2398	2173	1950	1576	1528	480.5*	388.7*	339.7*
71 Lu	63314	10870	10349	9244	2491	2264	2024	1639	1589	506.8*	412.4*	359.2*
72 Hf	65351	11271	10739	9561	2601	2365	2107	1716	1662	538*	438.2+	380.7+
73 Ta	67416	11682	11136	9881	2708	2469	2194	1793	1735	563.4+	463.4+	400.9+
74 W	69525	12100	11544	10207	2820	2575	2281	1949	1809	594.1+	490.4+	423.61
75 Re	71676	12527	11959	10535	2932	2682	2367	1949	1883	625.4+	518.7+	446.8+
76 Os	73871	12968	12385	10871	3049	2792	2457	2031	1960	658.2+	549.1+	470.7+
77 Ir	76111	13419	12824	11215	3174	2909	2551	2116	2040	691.1+	577.8+	495.8+
78 Pt	78395	13880	13273	11564	3296	3027	2645	2202	2122	725.4+	609.1+	519.4+
79 Au	80725	14353	13734	11919	3425	3148	2743	2291	2206	762.1+	642.7+	546.3+
80 Hg	83102	14839	14209	12284	3562	3279	2847	2385	2295	802.2+	680.2+	576.6+
81 Tl	85530	15347	14698	12658	3704	3416	2957	2485	2389	846.2+	720.5+	609.5+
82 Pb	88005	15861	15200	13035	3851	3554	3066	2586	2484	891.8+	761.9+	643.5+
83 Bi	90526	16388	15711	13419	3999	3696	3177	2688	2580	939+	805.2+	678.8+
84 Po	93105	16939	16244	13814	4149	3854	3302	2798	2683	995*	851*	705*
85 At	95730	17493	16785	14214	4317	4008	3426	2909	2787	1042*	886*	740*
86 Rn	98404	18049	17337	14619	4482	4159	3538	3022	2892	1097*	929*	768*
87 Fr	101137	18639	17907	15031	4652	4327	3663	3136	3000	1153*	980*	810*
88 Ra	103922	19237	18484	15444	4822	4490	3792	3248	3105	1208*	1058	879*
89 Ac	106755	19840	19083	15871	5002	4656	3909	3370	3219	1269*	1080*	890*
90 Th	109651	20472	19693	16300	5182	4830	4046	3491	3332	1330*	1168*	966.4+
91 Pa	112601	21105	20314	16733	5367	5001	4174	3611	3442	1387*	1224*	1007*
92 U	115606	21757	20948	17166	5548	5182	4303	3728	3552	1439*b	1271*b	1043+
93 Np	118678	22427	21601	17610	5723.2	5366.2	4434.7	3850.3	3665.8	1500.7	1327.7	1086.8
94 Pu	121818	23097	22266	18057	5932.9	5541.2	4556.6	3972.6	3778.1	1558.6	1372.1	1114.8
95 Am	125027	23773	22944	18504	6120.5	5710.2	4667	4092.1	3886.9	1617.1	1411.8	1135.7

	4d3/2	4d5/2	4f5/2	4f7/2	5s	5p1/2	5p3/2	5d3/2	5d5/2	6s	6p1/2	6p3/2
48 Cd	11.7+	10.7+										
49 In	17.7+	16.9+										
50 Sn	24.9+	23.9+										
51 Sb	33.3+	32.1+										
52 Te	41.9+	40.4+										
53 I	50.6	48.9										
54 Xe	69.5*	67.5*	-	-	23.3*	13.4*	12.1*					
55 Cs	79.8*	77.5*	-	-	22.7	14.2*	12.1*					
56 Ba	92.6+	89.9+	-	-	30.3+	17.0+	14.8+					
57 La	105.3*	102.5*	-	-	34.3*	19.3*	16.8*					
58 Ce	109*	-	0.1	0.1	37.8	19.8*	17.0*					
59 Pr	115.1*	115.1*	2.0	2.0	37.4	22.3	22.3					
60 Nd	120.5*	120.5*	1.5	1.5	37.5	21.1	21.1					
61 Pm	120	120	-	-	-	-	-					
62 Sm	129	129	5.2	5.2	37.4	21.3	21.3					
63 Eu	133	127.7*	0	0	32	22	22					
64 Gd	-	142.6*	8.6*	8.6*	36	20	20					
65 Tb	150.5*	150.5*	7.7*	2.4*	45.6*	28.7*	22.6*					
66 Dy	153.6*	153.6*	8.0*	4.3*	49.9*	26.3	26.3					
67 Ho	160*	160*	8.6*	5.2*	49.3*	30.8*	24.1*					
68 Er	167.6*	167.6*	-	4.7*	50.6*	31.4*	24.7*					
69 Tm	175.5*	175.5*	-	4.6	54.7*	31.8*	25.0*					
70 Yb	191.2*	182.4*	2.5*	1.3*	52.0*	30.3*	24.1*					
71 Lu	206.1*	196.3*	8.9*	7.5*	57.3*	33.6*	26.7*					
72 Hf	220.0+	211.5+	15.9+	14.2+	64.2+	38*	29.9+					
73 Ta	237.9+	226.4+	23.5+	21.6+	69.7+	42.2*	32.7+					
74 W	255.9+	243.5+	33.6*	31.4+	75.6+	45.3*b	36.8+					
75 Re	273.9+	260.5+	42.9*	40.5*	83+	45.6+	34.6*b					
76 Os	293.1+	278.5+	53.4+	50.7+	84*	58*	44.5+					
77 Ir	311.9+	296.3+	63.8+	60.8+	95.2*b	63.0*b	48.0+					
78 Pt	331.6+	314.6+	74.5+	71.2+	101.7*b	65.3*b	51.7+					
79 Au	353.2+	335.1+	87.6+	83.9+	107.2*b	74.2+	57.2+					
80 Hg	378.2+	358.8+	104.0+	99.9+	127+	83.1+	64.5+	9.6+	7.8+			
81 Tl	405.7+	385.0+	122.2+	117.8+	136.0*b	94.6+	73.5+	14.7+	12.5+			
82 Pb	434.3+	412.2+	141.7+	136.9+	147*b	106.4+	83.3+	20.7+	18.1+			
83 Bi	464.0+	440.1+	162.3+	157.0+	159.3*b	119.0+	92.6+	26.9+	23.8+			
84 Po	500*	473*	184*	184*	177*	132*	104*	31*	31*			
85 At	533*	507	210*	210*	195*	148*	115*	40*	40*			
86 Rn	567*	541*	238*	238*	214*	164*	127*	48*	48*	26		
87 Fr	603*	577*	268*	268*	234*	182*	140*	58*	58*	34	15	15

	4d_{3/2}	4d_{5/2}	4f_{5/2}	4f_{7/2}	5s	5p_{1/2}	5p_{3/2}	5d_{3/2}	5d_{5/2}	6s	6p_{1/2}	6p_{3/2}
88 Ra	636*	603*	299*	299*	254*	200*	153*	68*	68*	44	19	19
89 Ac	675*	639*	319*	319*	272*	215*	167*	80*	80*	–	–	–
90 Th	712.1+	675.2+	342.4+	333.1+	290*a	229*a	182*a	92.5+	85.4+	41.4+	24.5+	16.6+
91 Pa	743*	708*	371*	360*	310*	232*	232*	94*	94*	–	–	–
92 U	778.3+	736.2+	388.2*	377.4+	321*ab	257*ab	192*ab	102.8+	94.2+	43.9+	26.8+	16.8+
93 Np	815.9	770.3	415	404.4		283.4	206.1	109.3	101.3			
94 Pu	848.9	801.4	445.8	432.4	351.9	274.1	206.5	116	105.4			
95 Am	878.7	827.6						115.8	103.3			