electron binding energies for the Elements

National Synchrotron Light Source
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Electron binding energies represent the energy required to remove an electron from a particular orbital in an atom. They are essential pieces of information for scientists in the light source community as they probe the electronic properties of wide-ranging materials. This chart gives the electron binding energies for the periodic table up to uranium, which is the most common range of elements studied by synchrotron scientists.

Data originally compiled by Gwyn P. Williams

Groups: IA, IIA, IIIB, IVB, VB, VIB, VIIB, VIIIB, IB, IIB, IIIA, IVA, VA, VIA, VIIA, VIIIA

Categories: Alkali metals · Alkaline earth metals · Transitional metals · Other metals · Nonmetals · Noble gases

Z	Symbol	Element	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} $3d_{5/2}$
1	H	Hydrogen	13.6								
2	He	Helium	24.6*								
3	Li	Lithium	54.7*								
4	Be	Beryllium	111.5*								
5	B	Boron	188*								
6	C	Carbon	284.2*								
7	N	Nitrogen	409.9*	37.3*							
8	O	Oxygen	543.1*	41.6*							
9	F	Fluorine	696.7*								
10	Ne	Neon	870.2*	48.5*	21.7*	21.6*					
11	Na	Sodium	1070.8+	63.5+	30.65	30.81					
12	Mg	Magnesium	1303.0+	88.7	49.78	49.50					
13	Al	Aluminum	1559.6	117.8*	72.95	72.55					
14	Si	Silicon	1839	149.7*b	99.82	99.42					
15	P	Phosphorus	2145.5	189*	136*	135*					
16	S	Sulfur	2472	230.9	163.6*	162.5*					
17	Cl	Chlorine	2822.4	270*	202*	200*					
18	Ar	Argon	3205.9*	326.3*	250.6+	248.4*	29.3*	15.9*	15.7*		
19	K	Potassium	3608.4*	378.6*	297.3*	294.6*	34.8*	18.3*	18.3*		
20	Ca	Calcium	4038.5*	438.4+	349.7+	346.2+	44.3+	25.4+	25.4+		
21	Sc	Scandium	4492	498.0*	403.6*	398.7*	51.1*	28.3*	28.3*		
22	Ti	Titanium	4966	560.9+	460.2+	453.8+	58.7+	32.6+	32.6+		
23	V	Vanadium	5465	626.7+	519.8+	512.1+	66.3+	37.2+	37.2+		
24	Cr	Chromium	5989	696.0+	583.8+	574.1+	74.1+	42.2+	42.2+		
25	Mn	Manganese	6539	769.1+	649.9+	638.7+	82.3+	47.2+	47.2+		
26	Fe	Iron	7112	844.6+	719.9+	706.8+	91.3+	52.7+	52.7+		
27	Co	Cobalt	7709	925.1+	793.2+	778.1+	101.0+	58.9+	59.9+		
28	Ni	Nickel	8333	1008.6+	870.0+	852.7+	110.8+	68.0+	66.2+		
29	Cu	Copper	8979	1096.7+	952.3+	932.7	122.5+	77.3+	75.1+		
30	Zn	Zinc	9659	1196.2*	1044.9*	1021.8*	139.8*	91.4*	88.6*	10.2*	10.1*
31	Ga	Gallium	10367	1299.0*b	1143.2+	1116.4+	159.5+	103.5+	100.0+	18.7+	18.7+
32	Ge	Germanium	11103	1414.6*b	1248.1*b	1217.0*b	180.1*	124.9+	120.8+	29.8	29.2
33	As	Arsenic	11867	1527.0*b	1248.1*b	1217.0*b	204.7*	146.2*	141.2*	41.7*	41.7*
34	Se	Selenium	12658	1652.0*b	1474.3*b	1433.9*b	229.6*	166.5*	160.7*	55.5*	54.6*
35	Br	Bromine	13474	1782*	1596*	1550*	257*	189*	182*	70*	69*
36	Kr	Krypton	14326	1921	1730.9*	1678.4*	292.8*	222.2*	214.4	95.0*	93.8*
37	Rb	Rubidium	15200	2065	1864	1804	326.7*	248.7*	239.1*	113.0*	112*
38	Sr	Strontium	16105	2216	2007	1940	358.7+	280.3+	270.0+	136.0+	134.2+
39	Y	Yttrium	17038	2373	2156	2080	392.0*b	310.6*	298.8*	157.7+	155.8+
40	Zr	Zirconium	17998	2532	2307	2223	430.3+	343.5+	329.8+	181.1+	178.8+
41	Nb	Niobium	18986	2698	2465	2371	466.6+	376.1+	360.6+	205.0+	202.3+
42	Mo	Molybdenum	20000	2866	2625	2520	506.3+	411.6+	394.0+	231.1+	227.9+
43	Tc	Technetium	21044	3043	2793	2677	544*	447.6	417.7	257.6	253.9*
44	Ru	Ruthenium	22117	3224	2967	2838	586.1*	483.5+	461.4+	284.2+	280.0+
45	Rh	Rhodium	23220	3412	3146	3004	628.1+	521.3+	496.5+	311.9+	307.2+
46	Pd	Palladium	24350	3604	3330	3173	671.6+	559.9+	532.3+	340.5+	335.2+
47	Ag	Silver	25514	3806	3524	3351	719.0+	603.8+	573.0+	374.0+	368.3
48	Cd	Cadmium	26711	4018	3727	3538	772.0+	652.6+	618.4+	411.9+	405.2+
49	In	Indium	27940	4238	3938	3730	827.2+	703.2+	665.3+	451.4+	443.9+
50	Sn	Tin	29200	4465	4156	3929	884.7+	756.5+	714.6+	493.2	484.9+
51	Sb	Antimony	30491	4698	4380	4132	946+	812.7+	766.4+	537.5+	528.2+
52	Te	Tellurium	31814	4939	4612	4341	1006+	870.8+	820.0+	583.4+	573.0+
53	I	Iodine	33169	5188	4852	4557	1072*	931*	875*	630.8	619.3
54	Xe	Xenon	34561	5453	5107	4786	1148.7*	1002.1*	940.6*	689.0*	676.4*
55	Cs	Cesium	35985	5714	5359	5012	1211*b	1071*	1003*	740.5*	726.6*
56	Ba	Barium	37441	5989	5624	5247	1293*b	1137*b	1063*b	795.7+	780.5*
57	La	Lanthium	38925	6266	5891	5483	1362*b	1209*b	1128*b	853*	836*
58	Ce	Cerium	40443	6549	6164	5723	1436*b	1274*b	1187*b	902.4*	883.8*
59	Pr	Praseodymium	41991	6835	6440	5964	1511	1337	1242	948.3*	928.8*
60	Nd	Neodymium	43569	7126	6722	6208	1575	1403	1297	1003.3*	980.4*
61	Pm	Promethium	45184	7428	7013	6459	—	1471	1357	1052	1027
62	Sm	Samarium	46834	7737	7312	6716	1723	1541	1420	1110.9*	1083.4*
63	Eu	Europium	48519	8052	7617	6977	1800	1614	1481	1158.6*	1127.5*
64	Gd	Gadolinium	50239	8376	7930	7243	1881	1688	1544	1221.9*	1189.6*
65	Tb	Terbium	51996	8708	8252	7514	1968	1768	1611	1276.9*	1241.1*
66	Dy	Dyprosium	53789	9046	8581	7790	2047	1842	1676	1333	1292.6*
67	Ho	Holmium	55618	9394	8918	8071	2128	1923	1741	1392	1351
68	Er	Erbium	57486	9751	9264	8358	2207	2006	1812	1453	1409
69	Tm	Thulium	59390	10116	9617	8648	2307	2090	1885	1515	1468
70	Yb	Ytterbium	61332	10486	9978	8944	2398	2173	1950	1576	1528
71	Lu	Lutetium	63314	10870	10349	9244	2491	2264	2024	1639	1589
72	Hf	Hafnium	65351	11271	10739	9561	2601	2365	2108	1716	1662
73	Ta	Tantalum	67416	11682	11136	9881	2708	2469	2194	1793	1735
74	W	Tungsten	69525	12100	11544	10207	2820	2575	2281	1872	1809
75	Re	Rhenium	71676	12527	11959	10535	2932	2682	2367	1949	1883
76	Os	Osmium	73871	12968	12385	10871	3049	2792	2457	2031	1960
77	Ir	Iridium	76111	13419	12824	11215	3174	2909	2551	2116	2040
78	Pt	Platinum	78395	13880	13273	11564	3296	3027	2645	2202	2122
79	Au	Gold	80725	14353	13734	11919	3425	3148	2743	2291	2206
80	Hg	Mercury	83102	14839	14209	12284	3562	3279	2847	2385	2295
81	Tl	Thallium	85530	15347	14698	12658	3704	3416	2957	2485	2389
82	Pb	Lead	88005	15861	15200	13035	3851	3554	3066	2586	2484
83	Bi	Bismuth	90526	16388	15711	13419	3999	3696	3177	2688	2580
84	Po	Polonium	93105	16939	16244	13814	4149	3854	3302	2798	2683
85	At	Astatine	95730	17493	16785	14214	4317	4008	3426	2909	2787
86	Rn	Radon	98404	18049	17337	14619	4482	4159	3538	3022	2892
87	Fr	Francium	101137	18639	17907	15031	4652	4327	3663	3136	3000
88	Ra	Radium	103922	19237	18484	15444	4822	4490	3792	3248	3105
89	Ac	Actinium	106755	19840	19083	15871	5002	4656	3909	3370	3219
90	Th	Thorium	109651	20472	19693	16300	5182	4830	4046	3491	3332
91	Pa	Protactinium	112601	21105	20314	16733	5367	5001	4174	3611	3442
92	U	Uranium	115606	21757	20948	17166	5548	5182	4303	3728	3552
93	Np	Neptunium									
94	Pu	Plutonium									
95	Am	Americium									
96	Cm	Curium									
97	Bk	Berkelium									
98	Cf	Californium									
99	Es	Einsteinium									
100	Fm	Fermium									
101	Md	Mendelevium									
102	No	Nobelium									
103	Lr	Lawrencium									

Units: Electron Volts

All values are with reference to the Fermi level for metals, the valence band max for semiconductors and the vacuum level for rare gases.

+	From Fuggle And Martensson, *J. Elect. Spect.* 21 275 (1980)
*	From Cardona and Ley "*Photoemission from Solids*" Springer Verlag (1978)
b	Derived from Bearden and Burr

The remainder are from Bearden and Burr. *Rev. Mod. Phys.* 39 125 (1967) and private communications