3. Atomic-Electron Binding Energies

The binding energies given in Table 2 are those reported by Larkins,[1] mainly from the compilations of Sevier[2] (for Z≤83) and of Porter and Freedman[3] (for Z≥84). All binding energies listed are for solid systems referenced to the Fermi level, except those for Ne, Cl, Ar, Br, Kr, Xe, and Rn. These latter binding energies are for vapor-phase systems referenced to the vacuum level.

The binding energies are accurate to better than 1-2 *eV* for most of the subshells in the lighter elements, and for the outer orbitals in the heavier elements. Uncertainties may be as large as 10 or 20 *eV* for the inner orbitals in the high-Z elements, and changes in chemical state can lead to substantial shifts in the binding energies of non-valence shells.[4] Bearden and Burr[5] reevaluated existing data on x-ray emission wavelengths and discussed binding energies determined from atomic energy-level differences.

Table 2. Atomic-Electron Binding Energies (keV)

El	K	L_1	L_2	L_3	M_1	M_2	M_3	M_4	M_5	N_1	N_2	N_3	N_4	N_5
1 H	0.0136													
2 He	0.0246													
3 Li	0.0548	0.0053												
4 Be	0.1121	0.0080												
5 B	0.1880	0.0126	0.0047	0.0047										
6 C	0.2838	0.0180	0.0064	0.0064										
7 N	0.4016	0.0244	0.0092	0.0092										
8 O	0.5320	0.0285	0.0071	0.0071										
9 F	0.6854	0.0340	0.0086	0.0086										
10 Ne	0.8701	0.0485	0.0217	0.0216										
11 Na	1.0721	0.0633	0.0311	0.0311	0.0007									
12 Mg	1.3050	0.0894	0.0514	0.0514	0.0021									
13 Al	1.5596	0.1177	0.0732	0.0727	0.0007	0.0055	0.0055							
14 Si	1.8389	0.1487	0.0995	0.0989	0.0076	0.0030	0.0030							
15 P	2.1455	0.1893	0.1362	0.1353	0.0162	0.0099	0.0099							
16 S	2.4720	0.2292	0.1654	0.1642	0.0158	0.0080	0.0080							
17 Cl	2.8224	0.2702	0.2016	0.2000	0.0175	0.0068	0.0068							
18 Ar	3.2060	0.3263	0.2507	0.2486	0.0292	0.0159	0.0158							
19 K	3.6074	0.3771	0.2963	0.2936	0.0339	0.0178	0.0178							
20 Ca	4.0381	0.4378	0.3500	0.3464	0.0437	0.0254	0.0254							
21 Sc	4.4928	0.5004	0.4067	0.4022	0.0538	0.0323	0.0323	0.0066	0.0066					
22 Ti	4.9664	0.5637	0.4615	0.4555	0.0603	0.0346	0.0346	0.0037	0.0037					
23 V	5.4651	0.6282	0.5205	0.5129	0.0665	0.0378	0.0378	0.0022	0.0022					
24 Cr	5.9892	0.6946	0.5837	0.5745	0.0741	0.0425	0.0425	0.0023	0.0023					
25 Mn	6.5390	0.7690	0.6514	0.6403	0.0839	0.0486	0.0486	0.0033	0.0033					
26 Fe	7.1120	0.8461	0.7211	0.7081	0.0929	0.0540	0.0540	0.0036	0.0036					
27 Co	7.7089	0.9256	0.7936	0.7786	0.1007	0.0595	0.0595	0.0029	0.0029					
28 Ni	8.3328	1.0081	0.8719	0.8547	0.1118	0.0681	0.0681	0.0036	0.0036					
29 Cu	8.9789	1.0961	0.9510	0.9311	0.1198	0.0736	0.0736	0.0016	0.0016					
30 Zn	9.6586	1.1936	1.0428	1.0197	0.1359	0.0866	0.0866	0.0081	0.0081					
31 Ga	10.3671	1.2977	1.1423	1.1154	0.1581	0.1068	0.1029	0.0174	0.0174	0.0015	0.0008	0.0008		
32 Ge	11.1031	1.4143	1.2478	1.2167	0.1800	0.1279	0.1208	0.0287	0.0287	0.0050	0.0023	0.0023		
33 As	11.8667	1.5265	1.3586	1.3231	0.2035	0.1464	0.1405	0.0412	0.0412	0.0085	0.0025	0.0025		
34 Se	12.6578	1.6539	1.4762	1.4358	0.2315	0.1682	0.1619	0.0567	0.0567	0.0120	0.0056	0.0056		
35 Br	13.4737	1.7820	1.5960	1.5499	0.2565	0.1893	0.1815	0.0701	0.0690	0.0273	0.0052	0.0046		
36 Kr	14.3256	1.9210	1.7272	1.6749	0.2921	0.2218	0.2145	0.0950	0.0938	0.0275	0.0147	0.0140		
37 Rb	15.1997	2.0651	1.8639	1.8044	0.3221	0.2474	0.2385	0.1118	0.1103	0.0293	0.0148	0.0140		
38 Sr	16.1046	2.2163	2.0068	1.9396	0.3575	0.2798	0.2691	0.1350	0.1331	0.0377	0.0199	0.0199		
39 Y	17.0384	2.3725	2.1555	2.0800	0.3936	0.3124	0.3003	0.1596	0.1574	0.0454	0.0256	0.0256	0.0024	0.0024
40 Zr	17.9976	2.5316	2.3067	2.2223	0.4303	0.3442	0.3305	0.1824	0.1800	0.0513	0.0287	0.0287	0.0030	0.0030
41 Nb	18.9856	2.6977	2.4647	2.3705	0.4684	0.3784	0.3630	0.2074	0.2046	0.0581	0.0339	0.0339	0.0032	0.0032
42 Mo	19.9995	2.8655	2.6251	2.5202	0.5046	0.4097	0.3923	0.2303	0.2270	0.0618	0.0348	0.0348	0.0018	0.0018
43 Tc	21.0440	3.0425	2.7932	2.6769	0.5440	0.4449	0.4250	0.2564	0.2529	0.0680	0.0389	0.0389	0.0020	0.0020
44 Ru	22.1172	3.2240	2.9669	2.8379	0.5850	0.4828	0.4606	0.2836	0.2794	0.0749	0.0431	0.0431	0.0020	0.0020
45 Rh	23.2199	3.4119	3.1461	3.0038	0.6271	0.5210	0.4962	0.3117	0.3070	0.0810	0.0479	0.0479	0.0025	0.0025
El	K	L_1	L_2	L_3	M_1	M_2	M_3	M_4	M_5	N_1	N_2	N_3	N_4	N_5

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