# ELECTRON BINDING ENERGIES FOR THE ELEMENTS

## Units: Electron Volts

**Notes:**
All values are with respect to the Fermi level for metals, the valence band max for semiconductors and the vacuum level for gases.
This chart is intended as a guide, and for more precise numbers, other reference material should be consulted. The format is based on an original idea by Cliff Olson, Ames Lab, who was a synchrotron radiation user at the University of Wisconsin's Tantalus and Aladdin facilities.
Most of the data were taken from refs [1 -3] (+ from Ref. 1, * from Ref 2, remainder from Ref. 3), with mark-ups to ref [2] by Robert Johnson, U. Hamburg, Germany. For 2013 this was updated with new input from Cedric Powell at NIST, Gaithersburg, MD, USA (labeled **, private communication and ref. 4 with some additional material from refs. [5-8]). I also acknowledge input from numerous colleagues, and in particular B. O'Brien, M. Olmstead, F. Boscherini, P. Dowben, E. Gullikson, and G. Ice.

A: One-particle approximation not valid
B: Derived from Ref. 3.

**References:**

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2. M. Cardona and L. Ley, "Photoemission from Solids", Springer-Verlag (1978).
3. J.A. Beardon and A.F. Burr, "Reevaluation of X-Ray Atomic Energy Levels", Rev. Mod. Phys. 39 125 (1967).
4. C. J. Powell, "Recommended Auger parameters for 42 elemental solids", J. Electron Spectrosc. Relat. Phenom, 185 1 (2012), and refs therein.
5. J. F. Moulder, W. F. Stickle, P. E. Sobol and K. D. Bomben, Handbook of X-ray Photoelectron Spectroscopy", (Perkin-Elmer, Eden Prairie, 1992).
6. Wolfgang Lotz, "Electron Binding Energies in Free Atoms", J. Opt. Soc. Am. 60 206 (1970).
7. NIST XPS Database: http://srdata.nist.gov/xps
8. T. A. Carlson, Photoelectron and Auger Spectroscopy (Plenum Press, New York, 1975).


- Alkali metals
- Alkaline earth metals
- Transition metals
- Other metals
- Nonmetals
- Noble gases

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1 H**<br>K 1s 13.6 | | | | | | | | | | | | | | | | | **2 He**<br>K 1s 24.6* |
| **3 Li**<br>K 1s 54.7* | **4 Be**<br>K 1s 111.5* | | | | | | | | | | | **5 B**<br>K 1s 188* | **6 C**<br>K 1s 284.4** | **7 N**<br>K 1s 409.9*<br>Ll 2s 20.3** | **8 O**<br>K 1s 538**<br>Ll 2s 28.5** | **9 F**<br>K 1s 696.7* | **10 Ne**<br>K 1s 870.2*<br>Ll 2s 48.5*<br>L₃ 2p3/2 21.7*<br>L₂ 2p1/2 21.6* |
| **11 Na**<br>K 1s 1070.8+<br>Ll 2s 63.5+<br>L₃ 2p3/2 30.65<br>L₂ 2p1/2 30.81 | **12 Mg**<br>K 1s 1303.0+<br>Ll 2s 88.7<br>L₃ 2p3/2 49.78<br>L₂ 2p1/2 49.50 | | | | | | | | | | | **13 Al**<br>K 1s 1559.6<br>Ll 2s 117.8*<br>L₃ 2p3/2 72.84**<br>L₂ 2p1/2 72.55 | **14 Si**<br>K 1s 1839<br>Ll 2s 149.7*b<br>L₃ 2p3/2 99.82<br>L₂ 2p1/2 99.31** | **15 P**<br>K 1s 2145.5<br>Ll 2s 189*<br>L₃ 2p3/2 136*<br>L₂ 2p1/2 129.98** | **16 S**<br>K 1s 2472<br>Ll 2s 230.9<br>L₃ 2p3/2 163.6*<br>L₂ 2p1/2 162.5* | **17 Cl**<br>K 1s 2822.4<br>Ll 2s 270*<br>L₃ 2p3/2 202*<br>L₂ 2p1/2 200* | **18 Ar**<br>K 1s 3205.9*<br>Ll 2s 326.3*<br>L₃ 2p3/2 250.6+<br>L₂ 2p1/2 248.4*<br>M₁ 3s 29.3*<br>M₃ 3p3/2 15.9*<br>M₂3p1/2 15.7* |
| **19 K**<br>K 1s 3608.4* M₃ 3s 34.8*<br>Ll 2s 378.6* M₃ 3p3/2 18.3*<br>L₃ 2p3/2 297.3* M₃3p1/2 18.3*<br>L₂ 2p1/2 294.6* | **20 Ca**<br>K 1s 4038.5* M₃ 3s 44.3+<br>Ll 2s 438.4+ M₃ 3p3/2 25.4+<br>L₃ 2p3/2 349.7+ M₃3p1/2 25.4+<br>L₂ 2p1/2 346.2+ | **21 Sc**<br>K 1s 4492 M₃ 3s 51.1*<br>Ll 2s 498.0* M₃ 3p3/2 28.3*<br>L₃ 2p3/2 403.6* M₃3p1/2 28.3*<br>L₂ 2p1/2 398.49** | **22 Ti**<br>K 1s 4966 M₃ 3s 58.7+<br>Ll 2s 560.9+ M₃ 3p3/2 32.6+<br>L₃ 2p3/2 460.2+ M₃3p1/2 32.6+<br>L₂ 2p1/2 453.94** | **23 V**<br>K 1s 5465 M₃ 3s 66.3+<br>Ll 2s 626.7+ M₃ 3p3/2 37.2+<br>L₃ 2p3/2 519.8+ M₃3p1/2 37.2+<br>L₂ 2p1/2 512.1+ | **24 Cr**<br>K 1s 5989 M₃3s 74.1+<br>Ll 2s 696.0+ M₃ 3p3/2 42.2+<br>L₃ 2p3/2 583.8+ M₃3p1/2 42.2+<br>L₂ 2p1/2 574.31** | **25 Mn**<br>K 1s 6539 M₃ 3s 82.3+<br>Ll 2s 769.1+ M₃ 3p3/2 47.2+<br>L₃ 2p3/2 649.9+ M₃3p1/2 47.2+<br>L₂ 2p1/2 638.85** | **26 Fe**<br>K 1s 7112 M₃ 3s 91.3+<br>Ll 2s 844.6+ M₃ 3p3/2 52.7+<br>L₃ 2p3/2 719.9+ M₃3p1/2 52.7+<br>L₂ 2p1/2 706.8+ | **27 Co**<br>K 1s 7709 M₃ 3s 101.0+<br>Ll 2s 925.1+ M₃ 3p3/2 58.9+<br>L₃ 2p3/2 793.2+ M₃3p1/2 59.9+<br>L₂ 2p1/2 778.3** | **28 Ni**<br>K 1s 8333 M₃3s 110.8+<br>Ll 2s 1008.6+ M₃ 3p3/2 68.0+<br>L₃ 2p3/2 870.0+ M₃3p1/2 66.2+<br>L₂ 2p1/2 852.7+ | **29 Cu**<br>K 1s 8979 M₃3s 122.5+<br>Ll 2s 1096.7+ M₃ 3p3/2 77.3+<br>L₃ 2p3/2 952.3+ M₃3p1/2 75.1+<br>L₂ 2p1/2 932.62** | **30 Zn**<br>K 1s 9659 M₃ 3p3/2 91.4*<br>Ll 2s 1196.2* M₃3p1/2 88.6*<br>L₃ 2p3/2 1044.9* M₃3s 10.2*<br>L₂ 2p1/2 1021.8* M₃ 3s 10.1*<br>M₃ 3s 139.8* | **31 Ga**<br>K 1s 10367 M₃ 3p3/2 103.5+<br>Ll 2s 1299.0*b M₃3p1/2 100.0+<br>L₃ 2p3/2 1143.2+ M₃3s 18.7+<br>L₂ 2p1/2 1116.4+ M₃ 3s 18.7+<br>M₃ 3s 159.5+ | **32 Ge**<br>K 1s 11103 M₃ 3p3/2 124.9+<br>Ll 2s 1414.6*b M₃3p1/2 120.8+<br>L₃ 2p3/2 1248.1*b M₃3s 29.36*<br>L₂ 2p1/2 1217.0*b M₃ 3s 29.2<br>M₃ 3s 180.1* | **33 As**<br>K 1s 11867 M₃ 3p3/2 146.2*<br>Ll 2s 1527.0*b M₃3p1/2 141.2*<br>L₃ 2p3/2 1359.1*b M₃3s41.62**<br>L₂ 2p1/2 1323.6*b M₃ 3s41.7*<br>M₃ 3s 204.7* | **34 Se**<br>K 1s 12658 M₃ 3p3/2 166.5*<br>Ll 2s 1652.0*b M₃3p1/2 160.7*<br>L₃ 2p3/2 1474.3*b M₃3s 55.5*<br>L₂ 2p1/2 1433.9*b M₃ 3s 55.6*<br>M₃ 3s 229.6* | **35 Br**<br>K 1s 13474 M₃ 3p3/2 189*<br>Ll 2s 1782* M₃3p1/2 182*<br>L₃ 2p3/2 1596* M₃3s 70*<br>L₂ 2p1/2 1550* M₃ 3s 69*<br>M₃ 3s 257* | **36 Kr**<br>K 1s 14326 M₃3p3/2 214.4<br>Ll 2s 1921 M₃3s1 95.0*<br>L₃ 2p3/2 1730.9* M₃ 3s1 93.8*<br>L₂ 2p1/2 1678.4* M₃ 4s 27.5*<br>M₃ 3s 292.8* M₂4p3/2 14.1*<br>M₃ 3p3/2 222.2* M₂4p1/2 14.1* |
| **37 Rb**<br>K 1s 15200 M₄3p3/2 239.1*<br>Ll 2s 2065 M₄3s1 113.0*<br>L₃ 2p3/2 1864 M₄ 3s1 112*<br>L₂ 2p1/2 1804 M₄ 4s 30.5*<br>M₄ 3s 326.7* M₃4p3/2 16.3*<br>M₃ 3p3/2 248.7* M₃4p1/2 15.3* | **38 Sr**<br>K 1s 16105 M₄3p3/2 270.0+<br>Ll 2s 2216 M₄3s1 136.0+<br>L₃ 2p3/2 2007 M₄ 3s1 134.2+<br>L₂ 2p1/2 1940 M₄ 4s 38.9+<br>M₄ 3s 358.7+ M₃4p3/2 21.3<br>M₃ 3p3/2 280.3+ M₃4p1/2 20.1+ | **39 Y**<br>K 1s 17038 M₄3p3/2 298.8*<br>Ll 2s 2373 M₄3s1 157.7+<br>L₃ 2p3/2 2156 M₄ 3s1 155.87**<br>L₂ 2p1/2 2080 M₄ 4s 43.8*<br>M₄ 3s 392.0*b M₃4p3/2 24.4*<br>M₃ 3p3/2 310.6* M₃4p1/2 23.1* | **40 Zr**<br>K 1s 17998 M₄3p3/2 329.8+<br>Ll 2s 2532 M₄3s1 181.1+<br>L₃ 2p3/2 2307 M₄ 3s1 178.8+<br>L₂ 2p1/2 2223 M₄ 4s 50.6+<br>M₄ 3s 430.3+ M₃4p3/2 28.5+<br>M₃ 3p3/2 343.5+ M₃4p1/2 27.1+ | **41 Nb**<br>K 1s 18986 M₄3p3/2 360.6+<br>Ll 2s 2698 M₄3s1 205.0+<br>L₃ 2p3/2 2465 M₄ 3s1 202.3+<br>L₂ 2p1/2 2371 M₄ 4s 56.4+<br>M₄ 3s 466.6+ M₃4p3/2 32.6+<br>M₃ 3p3/2 376.1+ M₃4p1/2 30.8+ | **42 Mo**<br>K 1s 20000 M₄3p3/2 394.0+<br>Ll 2s 2866 M₄3s1 231.1+<br>L₃ 2p3/2 2625 M₄ 3s1 227.9+<br>L₂ 2p1/2 2520 M₄ 4s 63.2+<br>M₄ 3s 506.3+ M₃4p3/2 37.6+<br>M₃ 3p3/2 411.6+ M₃4p1/2 35.5+ | **43 Tc**<br>K 1s 21044 M₄3p3/2 427.2*<br>Ll 2s 3043 M₄3s1 257.6<br>L₃ 2p3/2 2793 M₄ 3s1 253.9*<br>L₂ 2p1/2 2677 M₄ 4s 69.5*<br>M₄ 3s 544* M₃4p3/2 42.3*<br>M₃ 3p3/2 447.6* M₃4p1/2 39.9* | **44 Ru**<br>K 1s 22117 M₄3p3/2 461.4+<br>Ll 2s 3224 M₄3s1 284.2+<br>L₃ 2p3/2 2967 M₄ 3s1 280.0+<br>L₂ 2p1/2 2838 M₄ 4s 75.0+<br>M₄ 3s 586.1* M₃4p3/2 46.3+<br>M₃ 3p3/2 483.5+ M₃4p1/2 43.2+ | **45 Rh**<br>K 1s 23220 M₄3p3/2 496.5+<br>Ll 2s 3412 M₄3s1 311.9+<br>L₃ 2p3/2 3146 M₄ 3s1 307.2+<br>L₂ 2p1/2 3004 M₄ 4s 81.4*b<br>M₄ 3s 628.1+ M₃4p3/2 50.5+<br>M₃ 3p3/2 521.3+ M₃4p1/2 47.3+ | **46 Pd**<br>K 1s 24350 M₄3p3/2 532.3+<br>Ll 2s 3604 M₄3s1 340.5+<br>L₃ 2p3/2 3330 M₄ 3s1 335.08**<br>L₂ 2p1/2 3173 M₄ 4s 87.1*b<br>M₄ 3s 671.6+ M₃4p3/2 55.7+a<br>M₃ 3p3/2 559.9+ M₃4p1/2 50.9+ | **47 Ag**<br>K 1s 25514 M₄3p3/2 573.0+<br>Ll 2s 3806 M₄3s1 374.0+<br>L₃ 2p3/2 3524 M₄ 3s1 368.22**<br>L₂ 2p1/2 3351 M₄ 4s 97.0+<br>M₄ 3s 719.0+ M₃4p3/2 63.7+<br>M₃ 3p3/2 603.8+ M₃4p1/2 58.3+ | **48 Cd**<br>K 1s 26711 M₄3s1 411.9+<br>Ll 2s 4018 M₄ 3s1 405.1**<br>L₃ 2p3/2 3727 M₄ 4s 109.8+<br>L₂ 2p1/2 3538 M₄ 4p3/2 69**<br>M₄ 3s 772.0+ M₃4p3/2 69.7*<br>M₃ 3p3/2 652.6+ M₃4p1/2 11.7+<br>M₃3p1/2 618.4+ M₃ 4d3/2 10.7+ | **49 In**<br>K 1s 27940 M₄3d3/2 451.4+<br>Ll 2s 4238 M₄ 3d3/2 443.9+<br>L₃ 2p3/2 3938 M₄ 4s 122.9+<br>L₂ 2p1/2 3730 M₄ 4p3/2 73.5+a<br>M₄ 3s 827.2+ M₃4p3/2 75.6+a<br>M₃ 3p3/2 703.2+ M₃4p1/2 17.7+<br>M₃3p1/2 665.3+ M₃ 4d3/2 16.9+ | **50 Sn**<br>K 1s 29200 M₄3d3/2 493.2<br>Ll 2s 4465 M₄ 3d3/2 484.9+<br>L₃ 2p3/2 4156 M₄ 4s 137.1+<br>L₂ 2p1/2 3929 M₄ 4p3/2 83.6+a<br>M₄ 3s 884.7+ M₃4p3/2 83.6+a<br>M₃ 3p3/2 756.5+ M₃4p1/2 24.9+<br>M₃3p1/2 714.6+ M₃ 4d3/2 23.9+ | **51 Sb**<br>K 1s 30491 M₄3d3/2 537.5+<br>Ll 2s 4698 M₄ 3d3/2 528.2+<br>L₃ 2p3/2 4380 M₄ 4s 153.2+<br>L₂ 2p1/2 4132 M₄ 4p3/2 95.6+a<br>M₄ 3s 946+ M₃4p3/2 95.6+a<br>M₃ 3p3/2 812.7+ M₃4d3/2 33.3+<br>M₃3p1/2 766.4+ M₃4d3/2 32.1+ | **52 Te**<br>K 1s 31814 M₄3d3/2 583.4+<br>Ll 2s 4939 M₄ 3d3/2 573.0+<br>L₃ 2p3/2 4612 M₄ 4s 169.4+<br>L₂ 2p1/2 4341 M₄ 4p3/2 103.3+a<br>M₄ 3s 1006+ M₃4p3/2 103.3+a<br>M₃ 3p3/2 870.8+ M₃4d3/2 41.9+<br>M₃3p1/2 820.0+ M₃4d3/2 40.4+ | **53 I**<br>K 1s 33169 M₄3d3/2 634.4**<br>Ll 2s 5188 M₄ 3d3/2 619.3<br>L₃ 2p3/2 4852 M₄ 4s 186*<br>L₂ 2p1/2 4557 M₄ 4p3/2 123*<br>M₄ 3s 1072* M₃4p3/2 123*<br>M₃ 3p3/2 931* M₃4d3/2 50.6<br>M₃3p1/2 875* M₃ 4d3/2 48.9 | **54 Xe**<br>K 1s 34561 N₄ 4p3/2 146.7<br>Ll 2s 5453 N₄4p1/2 145.5*<br>L₃ 2p3/2 5107 N₄4d3/2 69.5*<br>L₂ 2p1/2 4786 N₄4d5/2 67.5*<br>M₄ 3s 1148.7* N₄4f5/2 —<br>M₃ 3p3/2 1002.1* N₄4f7/2 —<br>M₃3p1/2 940.6* O₅5s 23.3*<br>M₃ 3d3/2 689.0* O₅5p3/2 13.4*<br>M₃ 3d5/2 676.4* O₅5p1/2 12.1*<br>M₄ 4s 213.2* |
| **55 Cs**<br>K 1s 35985 N₄ 4p3/2 172.4*<br>Ll 2s 5714 N₄4p1/2 161.3*<br>L₃ 2p3/2 5359 N₄4d3/2 79.8*<br>L₂ 2p1/2 5012 N₄ 4d5/2 77.5*<br>M₄ 3s 1218.1** N₄4f5/2 —<br>M₃ 3p3/2 1071* N₄4f7/2 —<br>M₃3p1/2 1003* O₅5s 22.7*<br>M₃ 3d3/2 740.5* O₅5p3/2 14.2*<br>M₃ 3d5/2 726.6* O₅5p1/2 12.1*<br>N₄ 4s 232.3* | **56 Ba**<br>K 1s 37441 N₄ 4p3/2 192<br>Ll 2s 5989 N₄4p1/2 178.6+<br>L₃ 2p3/2 5624 N₄4d3/2 92.6+<br>L₂ 2p1/2 5247 N₄ 4d5/2 89.9+<br>M₄ 3s 1293*b N₄4f5/2 —<br>M₃ 3p3/2 1137*b N₄4f7/2 —<br>M₃3p1/2 1063*b O₅5s 30.3+<br>M₃ 3d3/2 795.7+ O₅5p3/2 17.0+<br>M₃ 3d5/2 780.5+ O₅5p1/2 14.8+<br>N₄ 4s 253.5+ | **57 La**<br>K 1s 38925 N₄ 4p3/2 205.8<br>Ll 2s 6266 N₄4p1/2 196.0*<br>L₃ 2p3/2 5891 N₄4d3/2 105.3*<br>L₂ 2p1/2 5483 N₄ 4d5/2 102.5*<br>M₄ 3s 1362*b N₄4f5/2 —<br>M₃ 3p3/2 1209*b N₄4f7/2 —<br>M₃3p1/2 1128*b O₅5s 34.3*<br>M₃ 3d3/2 853* O₅5p3/2 19.3*<br>M₃ 3d5/2 836* O₅5p1/2 16.8*<br>N₄ 4s 274.7* | **72 Hf**<br>K 1s 65351 N₄ 4p3/2 438.2+<br>Ll 2s 11271 N₄4p1/2 380.7+<br>L₃ 2p3/2 10739 N₄4d3/2 220.0+<br>L₂ 2p1/2 9561 N₄ 4d5/2 211.5+<br>M₄ 3s 2601 N₄4f5/2 15.9+<br>M₃ 3p3/2 2365 N₄4f7/2 14.28**<br>M₃3p1/2 2108 O₅5s 64.2+<br>M₃ 3d3/2 1716 O₅5p3/2 38*<br>M₃ 3d5/2 1662 O₅5p1/2 29.9+<br>N₄ 4s 538* | **73 Ta**<br>K 1s 67416 N₄ 4p3/2 463.4+<br>Ll 2s 11636 N₄4p1/2 400.9+<br>L₃ 2p3/2 11136 N₄4d3/2 237.9+<br>L₂ 2p1/2 9881 N₄ 4d5/2 226.4+<br>M₄ 3s 2708 N₄4f5/2 23.5+<br>M₃ 3p3/2 2469 N₄4f7/2 21.8*<br>M₃3p1/2 2194 O₅ 5s 69.7+<br>M₃ 3d3/2 1735 O₅5p3/2 42.2+<br>M₃ 3d5/2 1735 O₅5p1/2 32.7+<br>N₄ 4s 563.4+ | **74 W**<br>K 1s 69525 N₄ 4p3/2 490.4+<br>Ll 2s 12100 N₄4p1/2 423.6+<br>L₃ 2p3/2 11544 N₄4d3/2 255.9+<br>L₂ 2p1/2 10207 N₄ 4d5/2 243.5+<br>M₄ 3s 2820 N₄4f5/2 33.6*<br>M₃ 3p3/2 2575 N₄4f7/2 31.34**<br>M₃3p1/2 2281 O₅ 5s 75.6+<br>M₃ 3d3/2 1872 O₅5p3/2 45.3*b<br>M₃ 3d5/2 1809 O₅5p1/2 36.8+<br>N₄ 4s 594.1+ | **75 Re**<br>K 1s 71676 N₄ 4p3/2 518.7+<br>Ll 2s 12527 N₄4p1/2 446.8+<br>L₃ 2p3/2 11959 N₄4d3/2 273.9+<br>L₂ 2p1/2 10535 N₄ 4d5/2 260.5+<br>M₄ 3s 2932 N₄4f5/2 42.9*<br>M₃ 3p3/2 2682 N₄4f7/2 40.31**<br>M₃3p1/2 2367 O₅ 5s 83+<br>M₃ 3d3/2 1949 O₅5p3/2 45.6+<br>M₃ 3d5/2 1883 O₅5p1/2 34.6*b<br>N₄ 4s 625.4+ | **76 Os**<br>K 1s 73871 N₄ 4p3/2 549.1+<br>Ll 2s 12968 N₄4p1/2 470.7+<br>L₃ 2p3/2 12385 N₄4d3/2 293.1+<br>L₂ 2p1/2 10871 N₄ 4d5/2 278.5+<br>M₄ 3s 3049 N₄4f5/2 53.4+<br>M₃ 3p3/2 2792 N₄4f7/2 50.7+<br>M₃3p1/2 2457 O₅ 5s 84*<br>M₃ 3d3/2 2031 O₅5p3/2 58*<br>M₃ 3d5/2 1960 O₅5p1/2 44.5+<br>N₄ 4s 658.2+ | **77 Ir**<br>K 1s 76111 N₄ 4p3/2 577.8+<br>Ll 2s 13419 N₄4p1/2 495.8+<br>L₃ 2p3/2 12824 N₄4d3/2 311.9+<br>L₂ 2p1/2 11215 N₄ 4d5/2 296.3+<br>M₄ 3s 3174 N₄4f5/2 63.8+<br>M₃ 3p3/2 2909 N₄4f7/2 60.8+<br>M₃3p1/2 2551 O₅ 5s 95.2*b<br>M₃ 3d3/2 2116 O₅5p3/2 63.0*b<br>M₃ 3d5/2 2040 O₅5p1/2 48.0+<br>N₄ 4s 691.1+ | **78 Pt**<br>K 1s 78395 N₄ 4p3/2 609.1+<br>Ll 2s 13880 N₄4p1/2 519.4+<br>L₃ 2p3/2 13273 N₄4d3/2 331.6+<br>L₂ 2p1/2 11564 N₄ 4d5/2 314.6+<br>M₄ 3s 3296 N₄4f5/2 74.5+<br>M₃ 3p3/2 3027 N₄4f7/2 71.2+<br>M₃3p1/2 2645 O₅ 5s 101.7*b<br>M₃ 3d3/2 2202 O₅5p3/2 65.3*b<br>M₃ 3d5/2 2122 O₅5p1/2 51.7+<br>N₄ 4s 725.4+ | **79 Au**<br>K 1s 80725 N₄ 4p3/2 642.7+<br>Ll 2s 14353 N₄4p1/2 546.3+<br>L₃ 2p3/2 13734 N₄4d3/2 353.2+<br>L₂ 2p1/2 11919 N₄ 4d5/2 335.1+<br>M₄ 3s 3425 N₄4f5/2 87.6+<br>M₃ 3p3/2 3148 N₄4f7/2 84.0<br>M₃3p1/2 2743 O₅ 5s 107.2*b<br>M₃ 3d3/2 2291 O₅5p3/2 74.2+<br>M₃ 3d5/2 2206 O₅5p1/2 57.2+<br>N₄ 4s 762.1+ | **80 Hg**<br>K 1s 83102 N₄4p3/2 576.6+<br>Ll 2s 14839 N₄4d3/2 378.2+<br>L₃ 2p3/2 14209 N₄ 4d5/2 358.8+<br>L₂ 2p1/2 12284 N₄4f5/2 104.0+<br>M₄ 3s 3562 N₄4f7/2 99.82**<br>M₃ 3p3/2 3279 O₅ 5s 127+<br>M₃3p1/2 2847 O₅5p3/2 83.1+<br>M₃ 3d3/2 2385 O₅5p1/2 64.5+<br>M₃ 3d5/2 2295 O₅5d3/2 9.6+<br>N₄ 4s 802.2+ O₅5d5/2 7.8+<br>N₄ 4p3/2 680.2+ | **81 Tl**<br>K 1s 85530 N₄4p3/2 609.5+<br>Ll 2s 15347 N₄4d3/2 405.7+<br>L₃ 2p3/2 14698 N₄ 4d5/2 385.0+<br>L₂ 2p1/2 12658 N₄4f5/2 122.2+<br>M₄ 3s 3704 N₄4f7/2 117.7**<br>M₃ 3p3/2 3416 O₅ 5s 136.0*b<br>M₃3p1/2 2957 O₅5p3/2 94.6+<br>M₃ 3d3/2 2485 O₅5p1/2 73.5+<br>M₃ 3d5/2 2389 O₅5d3/2 14.7+<br>N₄ 4s 846.2+ O₅5d5/2 12.5+<br>N₄ 4p3/2 720.5+ | **82 Pb**<br>K 1s 88005 N₄4p3/2 643.5+<br>Ll 2s 15861 N₄4d3/2 434.3+<br>L₃ 2p3/2 15200 N₄ 4d5/2 412.2+<br>L₂ 2p1/2 13035 N₄4f5/2 141.7+<br>M₄ 3s 3851 N₄4f7/2 136.82**<br>M₃ 3p3/2 3554 O₅ 5s 147*b<br>M₃3p1/2 3066 O₅5p3/2 106.4+<br>M₃ 3d3/2 2586 O₅5p1/2 83.3+<br>M₃ 3d5/2 2484 O₅5d3/2 20.7+<br>N₄ 4s 891.8+ O₅5d5/2 18.1+<br>N₄ 4p3/2 761.9+ | **83 Bi**<br>K 1s 90526 N₄4p3/2 678.8+<br>Ll 2s 16388 N₄4d3/2 464.0+<br>L₃ 2p3/2 15711 N₄ 4d5/2 440.1+<br>L₂ 2p1/2 13419 N₄ 4f5/2 162.3+<br>M₄ 3s 3999 N₄4f7/2 157.0+<br>M₃ 3p3/2 3696 O₅ 5s 159.3*b<br>M₃3p1/2 3177 O₅5p3/2 119.0+<br>M₃ 3d3/2 2688 O₅5p1/2 92.6+<br>M₃ 3d5/2 2580 O₅5d3/2 26.9+<br>N₄ 4s 939+ O₅5d5/2 23.8+<br>N₄ 4p3/2 805.2+ | **84 Po**<br>K 1s 93105 N₄4p3/2 705*<br>Ll 2s 16939 N₄4d3/2 500*<br>L₃ 2p3/2 16244 N₄ 4d5/2 473*<br>L₂ 2p1/2 13814 N₄ 4f5/2 184*<br>M₄ 3s 4149 N₄4f7/2 184*<br>M₃ 3p3/2 3854 O₅ 5s 177*<br>M₃3p1/2 3302 O₅5p3/2 132*<br>M₃ 3d3/2 2798 O₅5p1/2 104*<br>M₃ 3d5/2 2683 O₅5d3/2 31*<br>N₄ 4s 995* O₅5d5/2 31*<br>N₄ 4p3/2 851* | **85 At**<br>K 1s 95730 N₄4p3/2 740*<br>Ll 2s 17493 N₄4d3/2 533*<br>L₃ 2p3/2 16785 N₄ 4d5/2 507*<br>L₂ 2p1/2 14214 N₄4f5/2 210*<br>M₄ 3s 4317 N₄4f7/2 210*<br>M₃ 3p3/2 4008 O₅ 5s 195*<br>M₃3p1/2 3426 O₅5p3/2 148*<br>M₃ 3d3/2 2909 O₅5p1/2 115*<br>M₃ 3d5/2 2787 O₅5d3/2 40*<br>N₄ 4s 1042* O₅5d5/2 40*<br>N₄4p3/2 886* | **86 Rn**<br>K 1s 98404 N₄4p3/2 768*<br>Ll 2s 18049 N₄4d3/2 567*<br>L₃ 2p3/2 17337 N₄ 4d5/2 541*<br>L₂ 2p1/2 14619 N₄4f5/2 238*<br>M₄ 3s 4482 N₄4f7/2 238*<br>M₃ 3p3/2 4159 O₅ 5s 214*<br>M₃3p1/2 3538 O₅5p3/2 164*<br>M₃ 3d3/2 3022 O₅5p1/2 127*<br>M₃ 3d5/2 2892 O₅5d3/2 48*<br>N₄ 4s 1097* O₅5d5/2 48*<br>N₄ 4p3/2 929* P₁ 6s 26 |
| **87 Fr**<br>K 1s 101137 N₄4d3/2 603*<br>Ll 2s 18639 N₄ 4d5/2 577*<br>L₃ 2p3/2 17907 N₄4f5/2 268*<br>L₂ 2p1/2 15033 N₄4f7/2 268*<br>M₄ 3s 4652 O₅ 5s 234*<br>M₃ 3p3/2 4327 O₅ 5p3/2 142*<br>M₃3p1/2 3663 O₅5p3/2 140*<br>M₃ 3d3/2 3136 O₅5d3/2 58*<br>M₃ 3d5/2 3000 O₅5d5/2 58*<br>N₄ 4s 1153* P₁ 6s 34<br>N₄ 4p3/2 980* P₁6p3/2 15<br>N₄4p1/2 810* P₁6p1/2 15 | **88 Ra**<br>K 1s 103922 N₄ 4d3/2 636*<br>Ll 2s 19237 N₄4d3/2 639*<br>L₃ 2p3/2 18484 N₄ 4f5/2 299*<br>L₂ 2p1/2 15444 N₄4f7/2 299*<br>M₄ 3s 4822 O₅ 5s 254*<br>M₃ 3p3/2 4490 O₅ 5p3/2 200*<br>M₃3p1/2 3792 O₅5p3/2 153*<br>M₃ 3d3/2 3248 O₅5d3/2 68*<br>M₃ 3d5/2 3105 O₅5d5/2 68*<br>N₄ 4s 1208* P₁ 6s 44<br>N₄4p3/2 1058* P₁6p3/2 19<br>N₄4p1/2 879* P₁6p1/2 19 | **89 Ac**<br>K 1s 106755 N₄4d3/2 675*<br>Ll 2s 19840 N₄ 4d5/2 639*<br>L₃ 2p3/2 19083 N₄4f5/2 319*<br>L₂ 2p1/2 16300 N₄4f7/2 319*<br>M₄ 3s 5002 O₅ 5s 272*<br>M₃ 3p3/2 4656 O₅ 5p3/2 215*<br>M₃3p1/2 3909 O₅5p3/2 167*<br>M₃ 3d3/2 3370 O₅5d3/2 80*<br>M₃ 3d5/2 3219 O₅5d5/2 80*<br>N₄ 4s 1269* P₁ 6s —<br>N₄4p3/2 1080* P₁6p3/2 —<br>N₄4p1/2 890* P₁6p1/2 — | | | | | | | | | | | | | | | | |
| | | | **58 Ce**<br>K 1s 40443 N₄4p3/2 223.2<br>Ll 2s 6549 N₄4p1/2 206.5<br>L₃ 2p3/2 6164 N₄ 4d3/2 109<br>L₂ 2p1/2 5723 N₄ 4d5/2 —<br>M₄ 3s 1436*b N₄4f5/2 0.1<br>M₃ 3p3/2 1274*b N₄4f7/2 0.1<br>M₃3p1/2 1187*b O₅ 5s 37.8<br>M₃ 3d3/2 902.4* O₅5p3/2 19.8*<br>M₃ 3d5/2 883.8* O₅5p1/2 17.0*<br>N₄ 4s 291.0* | **59 Pr**<br>K 1s 41991 N₄4p3/2 236.3<br>Ll 2s 6835 N₄4p1/2 217.6<br>L₃ 2p3/2 6440 N₄ 4d3/2 115.1*<br>L₂ 2p1/2 5964 N₄4d5/2 115.1<br>M₄ 3s 1511 N₄4f5/2 2.0<br>M₃ 3p3/2 1337 N₄4f7/2 2.0<br>M₃3p1/2 1242 O₅5s 37.4<br>M₃ 3d3/2 948.3* O₅5p3/2 22.3<br>M₃ 3d5/2 931.84** O₅5p1/2 22.3<br>N₄ 4s 304.5 | **60 Nd**<br>K 1s 43569 N₄4p3/2 243.3<br>Ll 2s 7126 N₄4p1/2 224.6<br>L₃ 2p3/2 6722 N₄ 4d3/2 120.5*<br>L₂ 2p1/2 6208 N₄ 4d5/2 120.5*<br>M₄ 3s 1575 N₄4f5/2 1.5<br>M₃ 3p3/2 1403 N₄4f7/2 1.5<br>M₃3p1/2 1297 O₅ 5s 37.5<br>M₃ 3d3/2 1003.3* O₅5p3/2 21.1<br>M₃ 3d5/2 980.85** O₅5p1/2 21.1<br>N₄ 4s 319.2* | **61 Pm**<br>K 1s 45184 M₅3d5/2 1052<br>Ll 2s 7428 M₅ 3d5/2 1027<br>L₃ 2p3/2 7013 N₄ 4s —<br>L₂ 2p1/2 6459 N₄4p3/2 242<br>M₄ 3s — N₄4p1/2 242<br>M₃ 3p3/2 1471 N₄ 4d3/2 120<br>M₃3p1/2 1357 N₄ 4d5/2 120 | **62 Sm**<br>K 1s 46834 N₄4p3/2 265.6<br>Ll 2s 7737 N₄4p1/2 247.4<br>L₃ 2p3/2 7312 N₄ 4d3/2 129<br>L₂ 2p1/2 6716 N₄ 4d5/2 129<br>M₄ 3s 1723 N₄4f5/2 5.2<br>M₃ 3p3/2 1541 N₄4f7/2 5.2<br>M₃3p1/2 1420 O₅ 5s 37.4<br>M₃ 3d3/2 1110.9* O₅5p3/2 21.3<br>M₃ 3d5/2 1083.4* O₅5p1/2 21.3<br>N₄ 4s 347.2* | **63 Eu**<br>K 1s 48519 N₄ 4s 360<br>Ll 2s 8052 N₄4p3/2 284<br>L₃ 2p3/2 7617 N₄4p1/2 257<br>L₂ 2p1/2 6977 N₄ 4d5/2 133<br>M₄ 3s 1800 N₄4d5/2 134.5**<br>M₃ 3p3/2 1614 N₄4f5/2 0<br>M₃3p1/2 1481 N₄4f7/2 0<br>M₃ 3d3/2 1158.6* O₅ 5s 39**<br>M₃ 3d5/2 1136.8** O₅5p3/2 22<br>O₅5p1/2 22 | **64 Gd**<br>K 1s 50239 N₄4p3/2 291**<br>Ll 2s 8376 N₄4p1/2 271<br>L₃ 2p3/2 7930 N₄ 4d3/2 140.34**<br>L₂ 2p1/2 7243 N₄ 4d5/2 140.34**<br>M₄ 3s 1881 N₄4f5/2 8.6*<br>M₃ 3p3/2 1688 N₄4f7/2 8.6*<br>M₃3p1/2 1544 O₅5s 36<br>M₃ 3d3/2 1221.9* O₅5p3/2 28<br>M₃ 3d5/2 1189.6* O₅5p1/2 21<br>N₄ 4s 378.6* | **65 Tb**<br>K 1s 51996 N₄4p3/2 322.4*<br>Ll 2s 8708 N₄4p1/2 284.1*<br>L₃ 2p3/2 8252 N₄ 4d5/2 145.98**<br>L₂ 2p1/2 7514 N₄4d5/2 145.98**<br>M₄ 3s 1968 N₄4f5/2 7.7*<br>M₃ 3p3/2 1768 N₄4f7/2 2.4*<br>M₃3p1/2 1611 O₅5s 45.6*<br>M₃ 3d3/2 1276.9* O₅5p3/2 28.7*<br>M₃ 3d5/2 1241.1* O₅5p1/2 22.6*<br>N₄ 4s 396.0* | **66 Dy**<br>K 1s 53789 N₄ 4p3/2 333.5*<br>Ll 2s 9046 N₄4p1/2 293.2*<br>L₃ 2p3/2 8581 N₄4d3/2 152.22**<br>L₂ 2p1/2 7790 N₄