Chapter 1

THE ELECTRONIC STRUCTURE OF THE ATOM: A REVIEW

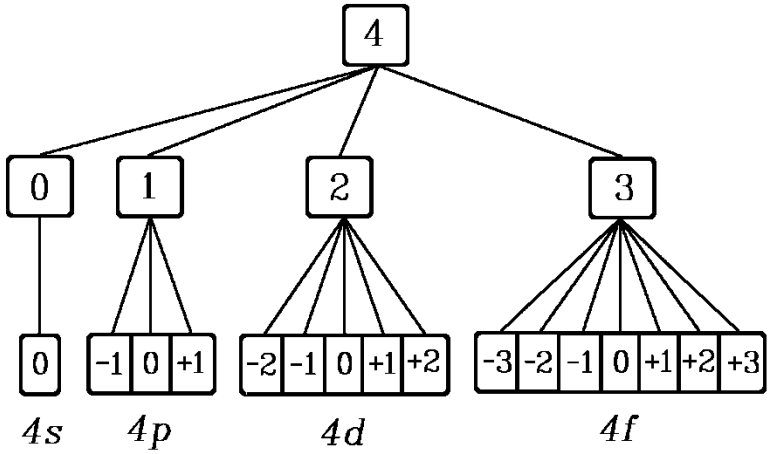
Exercises

1.1 (a) Surface where the electron probability is zero.

(b) No two electrons in an atom can have exactly the same set of quantum numbers.

(c) Paramagnetic—the attraction into a magnetic field by an unpaired electron.

1.3



1.5 5*p*.

1.7 The quantum number *n* relates to the size of an orbital.

1.9 The two electrons paired and occupying the same orbital would be least favorable, because the pairing energy would be necessary to overcome the repulsive forces. Paired but in different orbitals also comes with an energy cost because there is a finite probability that the electrons will occupy the same volume of space, again resulting in a repulsive energy factor. With parallel spins there is zero probability that the electrons will occupy the same volume of space; hence this is the lowest energy condition.

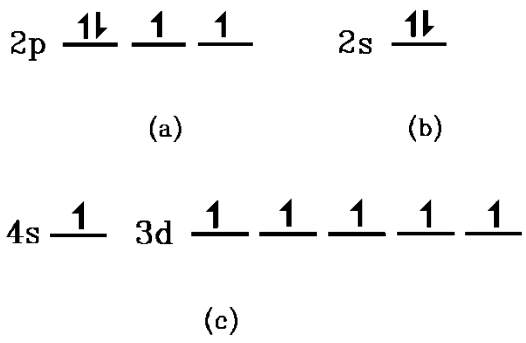
1.11 (a) [Ne]$3s^1$; (b) [Ar]$4s^2 3d^8$; (c) [Ar]$4s^1 3d^{10}$.

1.13 (a) [Ar]; (b) [Ar]; (c) [Ar]$3d^9$.

1.15 1+ and 3+. Thallium has a noble gas core ground-state electron configuration of [Xe]$6s^2 4f^{14} 5d^{10} 6p^1$. The 6*p* electron is lost first, giving an ion of 1+ charge; the two 6*s* electrons are lost next, giving an ion of 3+ charge and corresponding to the removal of all outer electrons: [Xe]$4f^{14} 5d^{10}$.

1.17 1+. Silver has a noble gas core ground state electron configuration of [Kr]$5s^1 4d^{10}$. The 5*s* electron is lost first, giving an ion of 1+ charge and corresponding to the removal of all outer electrons: [Kr]$4d^{10}$.

1.19 (a) 2; (b) 0; (c) 4.



(a) (b)

(c)

1.21 Electron configuration of atom: [Rn]$7s^2 5f^{14} 6d^{10} 7p^1$.
Electron configuration of +1 ion: [Rn]$7s^2 5f^{14} 6d^{10}$.
Electron configuration of +3 ion: [Rn]$5f^{14} 6d^{10}$.

Beyond the Basics

1.23 9, 5, 121.

1.25 There are seven *f* orbitals. There are (at least) two separate ways of depicting them and designating them: the general set and the cubic set. The seven solutions for the cubic set are: x^3, y^3, z^3, xyz, $z(x^2-y^2)$, $y(z^2-x^2)$, and $x(z^2-y^2)$. The f_{x3}, f_{y3}, f_{z3} resemble the d_{z2} in that they have lobes along the particular axis, but with double "doughnut" rings around the middle

rather than single rings. The other *f* orbitals resemble the $d_{x^2-y^2}$, d_{xy}, d_{xz}, and d_{yz} orbitals in that they consist of eight lobes (rather than four) between the axes. Several texts, such as that by Huheey, discuss *f* orbitals. See also E.A. Ogryzlo, On the Shapes of *f* Orbitals, *J. Chem. Educ*. **42** (1965): 150–151 (1965) and refs. therein.

1.27 Hydrogen heads the alkali metal group even though hydrogen is a non-metal with unique properties. Helium heads the alkaline earth metal group even though helium is better classified as a noble gas.