Chapter 4

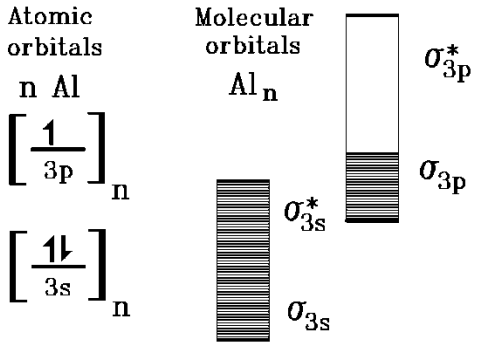
METALLIC BONDING

Exercises

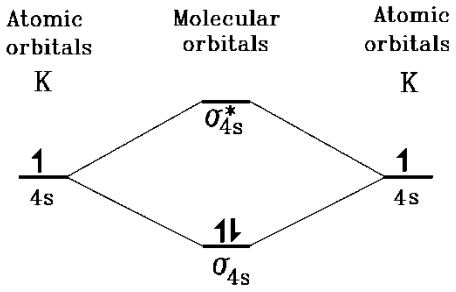
4.2 (a) The repeating array of atoms in the crystal.
(b) The number of neighboring (touching) atoms around a central atom.
(c) The combination of one liquid metal with one or more solid metals.

4.4 Iron, copper, aluminum, and zinc.

4.6

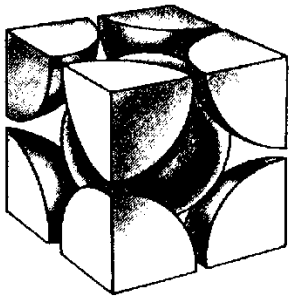


4.8 Potassium has the electron configuration [Ar]$4s^1$. By pairing to form K_2 molecules in the gas phase, a single covalent bond can be formed.



4.10 It is the placing of the third layer that distinguishes the two hexagonal-based packing arrangements. In the hexagonal close-packed, the third layer is placed over the first layer, while in the cubic close-packed, the third layer is placed over the holes in the first and second layers.

4.12 The body-centered cubic unit cell contains [(4 × $\frac{1}{4}$) + 1] atoms; that is, two atoms.



4.14 Potassium has a much greater metallic radius than zinc (227 pm versus 133 pm); they adopt different packing (potassium is body-centered cubic while zinc is hexagonal close-packed); potassium is very reactive, forming a 1+ ion, while zinc is much less reactive, forming a 2+ ion.

Beyond the Basics

4.16 If we take the radius of an atom as *r*, then, as the atoms touch through the diagonal through the cell center, the diagonal length will be 4*r*. Thus the side length of a unit cell for the body-centered cubic lattice will be $[4/(3)^{½}]r = 2.31r$ (using Pythagoras's theorem). The volume of the atoms will be $2 \times ({}^{4}/_{3}\pi r^3)$, while the volume of the cube will be $(2.31r)^3$. The ratio of these gives 0.69. Thus the empty space expressed as a percentage will be 31 percent.

4.18 The diagonal length through the center of the unit cell will be 4*r*. Using Pythagoras's theorem, the length of the unit cell edge will be $[4/(3)^{½}]r = 2.31r$.

4.20 A body-centered cubic unit cell contains two atoms. Thus

$$\text{Mass} = \frac{2 \times 137.3\ \text{g} \cdot \text{mol}^{-1}}{6.02 \times 10^{23}\ \text{mol}^{-1}} = 4.56 \times 10^{-22}\ \text{g}$$

$$\text{Volume} = \frac{4.56 \times 10^{-22}\ \text{g}}{3.50\ \text{g} \cdot \text{cm}^{-3}} = 1.30 \times 10^{-22}\ \text{cm}^3 = 1.30 \times 10^{8}\ \text{pm}^3$$

Length of side = $\sqrt[3]{(1.30 \times 10^8\ \text{pm}^3)} = 507$ pm

Using the result from 4.18, radius of barium atom = 507 pm/2.31

= 219 pm.

4.22 If the surfaces were clean at the molecular level, they would fuse together.