Additional Problems – Solid-State Chemistry (Chapter 7)
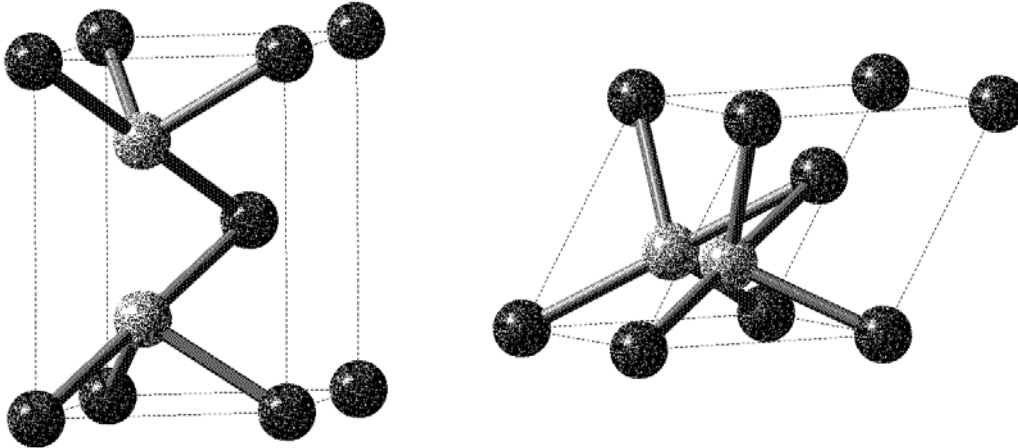
1. The unit cell for an ionic compound of generic formula M_aX_b (where M is a metal and X is a nonmetal) is shown below, from two different perspectives. In each case, the darker spheres represent the anions.

   a. What formula correctly reflects the stoichiometry of this compound? (That is, identify a and b in M_aX_b.)
   b. How many formula units are there per unit cell?
   c. Refer to the figure below, which depicts a more extended view of this structure (four unit cells). What are the coordination numbers for the cation (M^{n+}) and anion (X^{m-})?
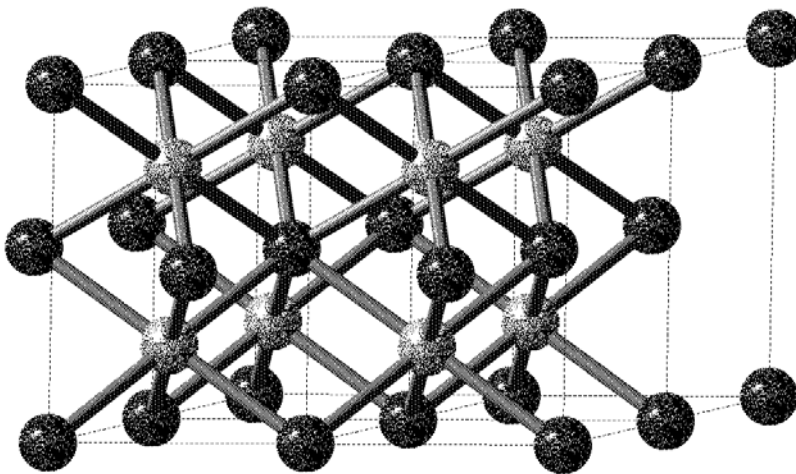
2. Manganese(II) oxide, MnO is a common component of fertilizers and feed additives. The relevant ionic radii are: r_{Mn2+} = 89 pm and r_{O2-} = 126 pm.

   a. What crystal structure is predicted for this compound?
   b. Please draw the unit cell for the predicted structure, using filled circles for cations and open circles for anions.
   c. Do you think that MnO is likely to adopt the predicted structure? Why or why not?
   d. Please calculate the unit cell edge length in pm (assuming that the predicted structure is, in fact, the one experimentally observed).

3. a.) Please draw a qualitative band diagram representing germanium doped with gallium. Label your bands and use shading to represent electron occupation. b.) What type of doping does this exemplify? Please explain specifically how this type of doping increases semiconductor conductivity.