Ch 14.4 – 14.7 Worksheet

1) What is vapor pressure? On a microscopic basis, how does a vapor pressure develop in a closed flask containing a small amount of liquid? What processes are going on in the flask?

2) Predict which substance in each of the following pairs will show the largest vapor pressure at a given temperature. Explain your reasoning.
   a. H₂O(l) or HF(l)
   b. CH₃OH(l) or CH₃CH₂CH₂CH₂OH(l)

3) Which substance in each pair would be expected to be more volatile at a particular temperature? Explain your reasoning.
   a. H₂O(l) or H₂S(l)
   b. H₂O(l) or CH₃OH(l)
   c. CH₃OH(l) or CH₃CH₂OH(l)

4) Why is the boiling temperature of water less than 100°C at high altitudes?

5) How do the physical properties of ionic solids, in general, differ from the properties of molecular solids? Give an example of each to illustrate your answer.

6) Name the type of crystalline solid formed by each of the following substances:
   a. ammonia (NH₃)
   b. iron (Fe)
   c. cesium fluoride (CsF)
   d. argon (Ar)
   e. sulfur trioxide (SO₃)
   f. barium oxide (BaO)
   g. gold (Au)

7) Ionic solids are generally considerably harder that most molecular solids. Explain why.

8) Ionic solids typically have melting points hundreds of degrees higher than the melting points of molecular solids. Explain why.

9) What is an alloy? Explain the difference in structure between substitutional and interstitial alloys. Give an example of each type.

10) Metals are very difficult to separate but the atoms can be moved rather easy as in hammering metal into a sheet or pulled into a wire (malleable and ductile). Explain this phenomenon (hint: sea of electrons).
1) Vapor pressure is the pressure of vapor at equilibrium above a liquid in a sealed container at a given temperature. Molecules in the liquid evaporate, but as the number of molecules in the vapor state increases, some of these molecules rejoin (condense). Eventually dynamic equilibrium is reached between evaporation and condensation.

2)  
   a. HF. Hydrogen bonding occurs in both samples, but H\textsubscript{2}O has two O-H bonds that are capable of hydrogen bonding with other water molecules. Therefore water has the lower vapor pressure.  
   b. Each of these molecules has one polar O-H bond. However, because CH\textsubscript{3}CH\textsubscript{2}CH\textsubscript{2}CH\textsubscript{2}OH is a much larger molecule than CH\textsubscript{3}OH, it has much greater London forces and thus is less likely to escape from its liquid. Thus CH\textsubscript{3}CH\textsubscript{2}CH\textsubscript{2}CH\textsubscript{2}OH\textsubscript{(l)} has a lower vapor pressure than CH\textsubscript{3}OH\textsubscript{(l)}.

3)  
   a. H\textsubscript{2}S. H\textsubscript{2}O exhibits hydrogen bonding and H\textsubscript{2}S does not.  
   b. CH\textsubscript{3}OH. H\textsubscript{2}O exhibits stronger hydrogen bonding than CH\textsubscript{3}OH because there are two locations where hydrogen bonding is possible on water.  
   c. CH\textsubscript{3}OH. Both are capable of hydrogen bonding, but generally lighter molecules are more volatile than heavier molecules.

4) The boiling point is the point at which the vapor pressure of the liquid is equal to the atmospheric pressure. At higher altitudes, the atmospheric pressure is lower, so the boiling temperature is lower.

5) Ionic solids tend to be harder and have higher melting and boiling points. Compare table salt (NaCl) to sugar (sucrose), for example.

6)  
   a. Solid ammonia contains NH\textsubscript{3} molecules, so it is a molecular solid.  
   b. Solid iron contains iron atoms as the fundamental particles. It is an atomic solid.  
   c. Solid cesium fluoride contains Cs\textsuperscript{2+} and F\textsuperscript{-} ions. It is an ionic solid.  
   d. Solid argon contains argon atoms, which cannot form covalent bonds to each other. It is an atomic solid.  
   e. Contains SO\textsubscript{3} molecules. It is a molecular solid.  
   f. Contains Ba\textsuperscript{2+} and O\textsuperscript{2-} ions – an ionic solid.  
   g. Contains Au atoms. An atomic solid.

7) The strong electrostatic forces make it very difficult to move or displace ions from one another; the solid is therefore perceived as hard. Molecular solids are held together be dipole-dipole forces, which are weaker than electrostatic forces. The molecular solid is more easily deformed.

8) Ionic solids have strong electrostatic forces (due to the attraction of positively and negatively charged ions). These forces require a great deal of energy to be overcome.

9) An alloy represents a mixture of elements that, as a whole, show metallic properties. In a substitutional alloy some of the host metals atoms are replaced by (substituted with) other atoms (i.e. brass). In an interstitial alloy, other small atoms occupy the spaces between the larger host metal atoms (carbon steel, for example).

10) Metals exist in a sea of electrons that are bonded between the atoms in a non-directional way. Since the electrons are non-directional we can bend and mold metals without breaking them apart.