Lesson 19: Colligative Properties

- Colligative properties, what they are, how they relate to the concentration of solution, and their application to life around us, §6-6
- Osmosis, dialysis and your kidneys, p-263

What to know:

1. Which of the following statements are true?
   a. 1.0 M aqueous HCl would have a lower freezing point than a 1.0 M acetic acid solution because HCl is a strong acid and the concentration of dissolved particles is higher in the HCl.
   b. The vapor pressure of pure benzene at 26.1 °C is 100 mm Hg. The mole fraction of a nonvolatile solute dissolved in the benzene is 0.20.
      1) The vapor pressure of the solution is 0.2 x 100 mm Hg.
      2) The boiling point of the solution would be lower than the boiling point of pure benzene.
   c. In an ideal solution of two volatile components, the total vapor pressure at temperature T is equal to the sum of the vapor pressures of each of the pure substances at temperature T.
   d. The freezing point of 0.200 M NaCl would be lowered twice as much as that of 0.100 M NaCl when compared to the freezing point of pure water.
   e. If red blood cells are placed into a hypotonic solution, they will swell and burst.
   f. If one knew the g/L of a solution of an unknown substance and determined the molarity of the solution by measuring the osmotic pressure, the MW of the substance could be easily calculated.
   g. The following aqueous solutions are arranged according to decreasing freezing points:
      0.35 M NaCl, 0.10 M Na₂PO₄, 0.20 M MgCl₂.
   h. Water is forced up to the top of tall trees by a process of reverse osmosis.
   i. Salt helps melt ice on sidewalks by supplying the energy required for the melting process.
   j. A 5.0 M aqueous solution of methyl alcohol will protect a radiator from freezing just as well as a 5.0 M solution of ethylene glycol (normal antifreeze).
   k. A red blood cell with dissolved particles of 0.25 M will shrink when placed into pure water.
   l. 0.25 M solutions of NaCl and KNO₃ in water will have the same osmotic pressure.

2. Draw a phase diagram for water labeling the axes and various areas on the graph. Also show what the graph would look like for a solution of sugar in water.

3. Which is not a colligative property? Osmotic pressure, solubility, boiling point elevation

4. What is reverse osmosis and how does it work?

5. As compared to the vapor pressure of 0.10 M aqueous glucose (C₆H₁₂O₆), the vapor pressure of 0.10 M aqueous sucrose (C₁₂H₂₂O₁₁) will be (-almost twice as high, -the same, -1/2 as high).

6. Given an aqueous unknown liquid with a freezing point of -0.50 °C. The boiling point of the liquid under the same conditions will be (-higher than pure water, -lower than pure water, -the same as pure water, -either lower or higher than pure water depending on the atmospheric pressure).

7. The temperature of a 6 molal aqueous solution of sodium chloride in equilibrium with ice will be:
   - Zero degrees Celsius, -lower than zero degrees C, -dependent on the atmospheric pressure.

8. Why are mole fraction and molality used instead of molarity when dealing with colligative properties?

9. Why does an ice-water bath get colder when salt is dissolved in the water?

10. How does salt keep a salt-cured ham from spoiling?