Chem 116 Student Notes September 23, 2008 (EC)

Lecture 10: Concentrations and Colligative Properties

4 Ways to Express Mixture Density (aka Concentration)

- 3 kinds of "particle density"
  - Molarity (n/V)
    - $Molarity = \frac{\text{moles of solute}}{\text{1L of solute+solvent}}$
    - Useful for stoichiometry calculations
  - Molality (n/m)
    - $Molality = \frac{\text{moles of solute}}{\text{1kg of solvent}}$
    - Useful for boiling/freezing point calculations
  - Mole Fraction (decimal # between 0-1)
    - $Mole\ Fraction = \frac{\text{moles of substance}}{\text{total moles (of all substances)}}$
    - Useful for partial pressure calculations
- 1 kind of "mass density"
  - Weight Percent (0 – 100%)
    - $Weight\ \% - \frac{\text{grams of subtance}}{\text{total grams (of all substances)}}$
    - Useful for chemical analysis of the unknowns

"solution" = "mixture" in liquid phase

Clicker Question:

	Solute	Solvent	
1.	Na^+ and Cl^- ions	Water	(correct) the Na and Cl ions separate
2.	Water	Na^+ and Cl^- ions	(wrong) water = solvent since there is more of it
3.	NaCl (s)	Water	(wrong) NaCl is not in solid form in the solution
4.	Water	NaCl (s)	(wrong) water = solvent since there is more of it

In a Solution:

1. BPE: Boiling Point = Higher
   a. Solute increases the BP of the solvent
      i. $\Delta T_{bp} = i\, m_{solute} K_{bp}$
         = (effective molality) (solvent factor)
         =(# of ions) ($\frac{\text{moles of solute}}{\text{1kg of solvent}}$) (solvent factor given or looked up)
         =change in boiling temperature caused by the solute
         1. Add this number to the $T^{o}_{bp(solvent)}$
   b. Solute increase the BP by lowering the vapor pressure (Raoult's Law)
      i. $P_{solvent} = X_{solvent}\, P^{o}_{solvent}$
         fraction of surface taken up by solvent = (fraction of surface taken up by solute) (fraction taken up by pure solvent-1.0)
         1. $X_{solvent}$ = mole fraction of the solvent
         2. $X_{solvent} + X_{solute1}\ (+ X_{solute2} + X_{solute3}) = 1$
      ii. This is done by blocking some of the solvent from escaping on the surface
      iii. For this we have to assume that the solute has no vapor pressure
      iv. A higher temperature is therefore needed to reach the vapor pressure of the atmosphere (boiling)
2. FPD: Freezing Point = Lower
   a. Solute decreases the FP of the solvent
      i. $\Delta T_{fp} = i\, m_{solute} K_{fp}$
         = (effective molality) (solvent factor)
         =(# of ions) ($\frac{\text{moles of solute}}{\text{1kg of solvent}}$) (solvent factor given or looked up)
         =change in freezing temperature caused by the solute
         1. Subtract this number to the $T^{o}_{fp(solvent)}$
   b. Solute increase the FP by lowering the vapor pressure (Raoult's Law)
      i. $P_{solvent} = X_{solvent}\, P^{o}_{solvent}$
         fraction of surface taken up by solvent = (fraction of surface taken up by solute) (fraction taken up by pure solvent-1.0)
         1. $X_{solvent}$ = mole fraction of the solvent
         2. $X_{solvent} + X_{solute1}\ (+ X_{solute2} + X_{solute3}) = 1$
3. Osmotic Pressure
   a. (osmotic pressure, π)V = nRT
   b. $\pi = \frac{n}{V}RT = \left(\text{effective molarity in } \frac{\text{mol}}{\text{L}}\right)RT$
   c. $\pi = i\left(\text{molarity in } \frac{\text{mol}}{\text{L}}\right)RT$