# Announcements

To join clicker to class today (Clickers with LCD display join automatically):

- Turn on the Clicker (the red LED comes on).
- Push "Join" button followed by "20" followed by the "Send" button (switches to flashing green LED if successful).

- Discussion Quiz Today covers through Osmosis/Osmotic Pressure in Monday's Lecture.

- Will be starting next section on bonding Friday.  Suggested reading and problems will be posted and e-mailed out.

# Review

- Colligative properties depend on the concentration of solute particles.
  - Example 1: Osmosis
    - Osmotic pressure $\Pi = iMRT$.
    - i= van't Hoff factor.
  - Example 2: Bp elevation $\Delta T_b = imK_b$
    - uses concentration units of molality (mol/kg solvent).
    - practiced conversion between M and *m*.
      - account for difference between mass of solvent and mass of solution
      - Mass solution includes mass of solute.
      - $mass_{sol'n} = mass_{solv} + mass_{solute}$

# Boiling Point Elevation Calculation.

- Relation: $\Delta T_b = i m K_b$
- Ex. How much higher is Bp of 0.500 m NaCl than pure water?
  - $K_b(H_2O)$ = 0.5121 K or ˚C/m
  - Assume i = ?

# Freezing Point Depression

- Same idea as Bp elevation except that solute gets in the way of solid formation and lowers the freezing point.
- Observed relation is: $\Delta T_f = i m K_f$
  - Note that $K_f$ is usually reported as positive
  - $\Delta T$ comes out positive.
  - You must subtract a positive $\Delta T$ from the freezing point of the pure solvent since the freezing point drops.
- Other types of calculations you could do.
  - How much $CaCl_2$ do you need in some amount of water to drop the freezing point 10 ˚C?
  - What molarity $CaCl_2$ sol'n is necessary?
  - Account for the van't Hoff factor.

# Molar Mass from Π, Bp or Fp

- We know: $\Pi = iMRT$, $\Delta T_b = imK_b$, $\Delta T_f = imK_f$
  - Each of these can be solved for iM or i*m*
  - For molecular compounds i= 1 => get concentration.
- Consider Π, where we get molarity.
  - M = Π/(RT) = Y moles solute/L sol'n
  - Ex. Given 6.50 g solute/L sol'n and Π = 1.6 atm, find molar mass.
- For Bp and Fp get molality => need g solute/kg solv.

# Acid-Base Reactions

- $H^+(aq) + OH^-(aq) \rightarrow H_2O$
  - This is the net ionic equation.
  - Full equation might be:
  - $HCl(aq) + NaOH(aq) \longrightarrow H_2O + NaCl(aq)$
- Also called acid-base neutralization reactions.
- Acids = compounds that release $H^+$ in water.
- Bases = compounds that release $OH^-$ in water.
- Common acids you should know: $HCl$, $HNO_3$, $H_2SO_4$, $H_3PO_4$.
- Bases: $M(OH)_n$, where n = charge on metal ion represented by M.

# How acid rain dissolves limestone

Overall:

$H_2SO_4(aq) + CaCO_3(s)$ —> $CaSO_4(aq\ \&\ s) + H_2O + CO_2(g)$

One pathway in the process is:

- $CaCO_3(s) + H_2O$ —> $Ca^{2+}(aq) + CO_3^{2-}(aq)$ (slightly soluble)
- $Ca^{2+} + CO_3^{2-} + H_2O$ —> $Ca^{2+} + OH^-(aq) + HCO_3^-(aq)$
- $H_2SO_4(aq) + OH^-(aq) + HCO_3^-(aq)$ —> $H_2O + SO_4^{2-}(aq) + H_2CO_3(aq)$
- $H_2CO_3(aq)$ (not very stable)—> $H^+(aq) + CO_2(g) + OH^-(aq)$ —> $H_2O + CO_2$
- Don't need to be able to reproduce, but should recognize the acid-base neutralization steps (red).