

# Colligative Properties

↳ properties that depend on the # of particles in solution and not on the nature of the solute particles

## Vapor Pressure Lowering

I when solute is nonvolatile (immeasurable vapor pressure), Raoult's Law:

$$P_1 = X_1 P_1^*$$

$$X_1 = \frac{\text{mol solute}}{\text{total mol}}$$

$P_1$  = vapor pressure of solution

$P_1^*$  = vapor pressure of pure solvent

$$\Delta P = X_2 P_1^*$$

$$X_2 = \frac{\text{mol solute}}{\text{total mol}}$$

- surface area of solvent decreased % of solute molecules  $\therefore$  rate of vaporization lowered  $\therefore$  vapor pressure lowered

II when both solute + solvent are volatile (measurable vapor pressure), use Raoult's Law twice

note: if e.g.:

$$\left. \begin{aligned} P_1 &= X_1 P_1^* \\ P_2 &= X_2 P_2^* \end{aligned} \right\}$$

true for ideal solutions

## Boiling Point Elevation

↳ BP = the temp at which the vapor pressure is equal to external atmospheric pressure

$$\Delta T_b = T_b - T_b^* = K_b i m$$

$K_b$  = bp elevation constant

$m$  = molality

## Freezing Point Depression

↳ freezing point = melting point

$$\Delta T_f = T_f^* - T_f = K_f i m$$

$K_f$  = fp depression constant

$m$  = molality

## Osmotic Pressure

↳ osmosis: selective passage of solvent molecules through a porous membrane from a dilute solution to a more concentrated one

- hypotonic:  $[out] < [in]$  ; 

- isotonic:  $[out] = [in]$  ; 

- hypertonic:  $[out] > [in]$  ; 

$$\Pi = iMRT$$

$M$  = molarity  
 $R = 0.08206 \frac{\text{L atm}}{\text{mol K}}$



Electrolytes: break apart into ions in solution

- ionic compounds (ex:  $\text{AgNO}_3$ ,  $\text{NH}_4\text{Cl}$ ,  $\text{MgCl}_2$ )
- acids + bases (ex:  $\text{HCl}$ ,  $\text{H}_3\text{PO}_4$ ,  $\text{Ba}(\text{OH})_2$ ,  $\text{NH}_3$ )
- concentration of solute  $\neq$  concentration of particles

Nonelectrolytes: do not break apart into ions

- covalent compounds (ex:  $\text{C}_6\text{H}_{12}\text{O}_6$ ,  $\text{PCl}_5$ )
- concentration of solute = concentration of particles

## Vant Hoff Factor (i)

$$i = \frac{\text{actual \# of particles in soln. after dissociation}}{\text{\# of formula units initially dissolved in soln.}}$$

$$i = \# \text{ of ions in any strong electrolyte}$$

- nonelectrolyte:  $i = 1$
- weak acids + bases:  $1 < i < 2$

## Example Calculations

# Chemistry Study Guide Calculations Involving Colligative Properties

**Barron's Educational Series, Mark  
Kernion, Joseph A. Mascetta**



## **Chemistry Study Guide Calculations Involving Colligative Properties:**

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