Concentrations

Mole concentrations:

1) Molarity - the number of moles of solute dissolved in each liter of solution.

$$\text{Molarity (M)} = \frac{\text{moles solute}}{\text{liters solution}}$$

2) Molality - the number of moles of solute dissolved in each kilogram of solvent.

$$\text{molality (m)} = \frac{\text{moles solute}}{\text{kg solvent}}$$

Concentrations

3) Mole Fraction - the number of moles of one component divided by the total number of moles in solution.

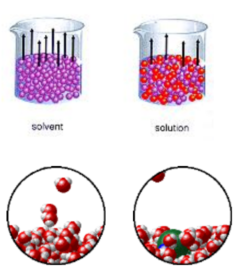
$$\text{Mole fraction (X)} = \frac{\text{moles component}}{\text{total moles of solution}}$$

Vapor Pressure Reduction

Vapor pressure is due to molecules at the surface of a liquid which break their intermolecular forces and become a gas.

By adding a nonvolatile substance to a liquid, the vapor pressure is reduced due to the solute taking up more room at the surface, so less solvent can vaporize.

Raoult's Law: $P_A = X_A P^o_A$



Boiling Point Elevation

When a solvent boils, the vapor pressure needs to be at the same pressure as the atmospheric pressure.

By adding solute, the solution's vapor pressure is reduced, therefore needing a higher temperature to boil off the liquid.

ΔT_b , the difference between the normal boiling point and the new boiling point depends on the molality of the solution:

$\Delta T_b = iK_b m$, where K_b depends on the solvent.

Freezing Point Depression

Same as BPE, except this colligative property requires a lower temperature to overcome the molecules of solute getting in the way of intermolecular forces.

Difference between the solvent freezing point and the solution freezing point is ΔT_f :

$\Delta T_f = iK_f m$, where K_f depends on the solvent

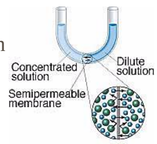
Using C.P. to find molar mass

Example: A solution of an unknown nonvolatile nonelectrolyte was prepared by dissolving 0.250 g of the substance in 40.0 g of CCl_4. The boiling point of the solution was 0.357 ^{O}C higher than that of the pure solvent. Calculate the molar mass of the solute.

Osmosis

A semipermeable membrane is a material that lets some substances through but not others.

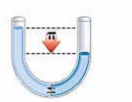
When a concentrated solution is separated from a dilute solution by a semipermeable membrane, solvent molecules move from the area of lower concentration to higher concentration. The net movement of solvent is always toward the higher concentration



The process of osmosis attempts to bring the two concentrations to equilibrium.

Osmotic Pressure

At some point though, the liquid levels of the two solutions becomes uneven enough that osmosis stops. This difference in height of the two columns causes osmotic pressure, and osmosis stops.



To prevent the net flow of solvent through osmosis, a pressure can be applied to the concentrated solution. This osmotic pressure is found to obey the ideal gas law, so that:

$$\pi = i\left(\frac{n}{V}\right)RT \quad \text{or} \quad \pi = iMRT$$