Overview of Chapter 14

- Solutions
- Concentrations:
  - Molarity
  - Molality
  - Mole fraction
- Colligative Properties
  - Freezing point depression
  - Boiling point elevation
- Osmosis

Today's questions to consider:

- What is the effect of adding a solute on a vapor pressure curve?
- How much salt do we need to add to ice to melt it?
- How does antifreeze work?

Today's Topics

- Colligative Properties
- Raoult's Law
- Vapor pressure depression
- Boiling point elevation
- Freezing point depression

Colligative Properties

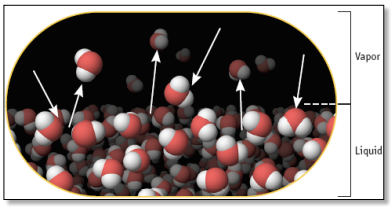
On adding a solute to a solvent, the props. of the solvent are modified.

- Vapor pressure decreases
- Melting point decreases
- Boiling point increases
- Osmosis is possible (osmotic pressure)

They depend only on the NUMBER of solute particles relative to solvent particles, not on the KIND of solute particles.

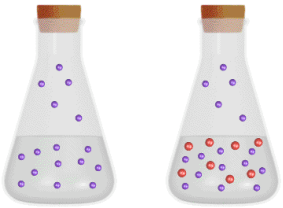
Understanding Colligative Properties

To understand colligative properties, study the LIQUID-VAPOR EQUILIBRIUM for a solution.



Understanding Colligative Properties

Look at the liquid-vapor equilibrium for a solution.



Understanding Colligative Properties

VP of H_2O over a solution depends on the number of H_2O molecules per solute molecule.

$P_{solvent}$ *proportional to* $X_{solvent}$

$$P_{solvent} = X_{solvent} \cdot P^o_{solvent}$$

VP of solvent over solution
= (Mol frac solvent)·(VP pure solvent)
= RAOULT'S LAW

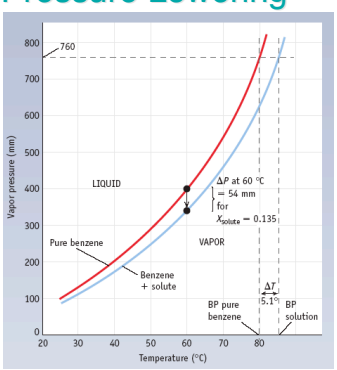
Raoult's Law

An ideal solution is one that obeys Raoult's law.

$$P_A = X_A \cdot P^o_A$$

Because mole fraction of solvent, X_A, is always less than 1, then P_A is always less than P^o_A. The vapor pressure of solvent over a solution is always LOWERED!

Vapor Pressure Lowering



Raoult's Law

Assume a solution containing 62.1 g (1.00 mole) of ethlene glycol in 250. g of water is ideal. What is the vapor pressure of water over the solution at 30°C?

(The VP of pure H_2O at 30°C is 31.8 mm Hg)

Solution

$X_{glycol} = 0.0672$ and so X_{water} = ?

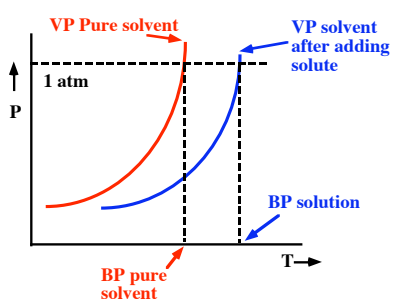
Because $X_{glycol} + X_{water} = 1$

$X_{water} = 1.000 - 0.0672 = 0.9328$

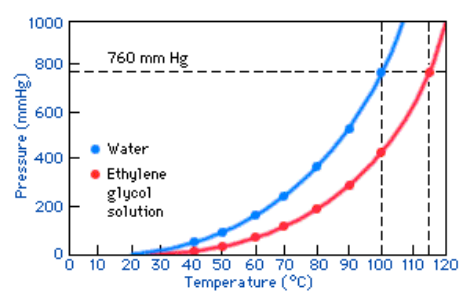
$P_{water} = X_{water} \cdot P^o_{water} = (0.9382)(31.8 \text{ mm Hg})$

$P_{water} = 29.7$ mm Hg

Changes in Freezing and Boiling Points of Solvent



Boiling Point Changes



The boiling point of a solution is higher than that of the pure solvent.