Colligative Properties

Changes of phase depend on vapor pressure, there for the adding a solute to a solvent will affect the freezing and boiling points. Freezing point depression and boiling point elevation are called colligative properties. Colligative properties are grouped together because the depend on the number of solute particles not the nature of the particles.

$$m = \frac{\text{moles solute}}{\text{mass of solvent}}$$

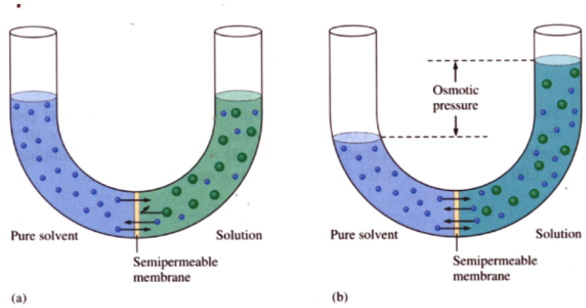
Freezing-point depression occurs when a nonvolatile solute is added to a solvent. As the vapor pressure of the solution decreases the solution must be cooled to freeze the solvent. $\Delta T = K_f \; m_{solute}$ $K_{f(H2O)}$= 1.86 K kg mol^{-1}

Ex:

Boiling-point elevation occurs when a nonvolatile solute is added to a solvent. As the vapor pressure decreases the temperature must increase to maintain a boil. $\Delta T = K_b \; m_{solute}$ $K_{b(H2O)}$= 0.512 K kh mol^{-1}

Osmotic Pressure

In addition to freezing-point depression, and boiling-point elevation there is a third colligative property that is most used in biology. That is the Osmotic pressure.



Osmotic pressure is measured by the height of the water column that different solutions will generate across a semi-permeable membrane.

Mathematically we can describe this with the following equation: $\pi = MRT$

Electrolytes

Since colligative properties depend on the number of particles if the solute is an electrolyte and breaks apart in to multiple ions then we need to take that in to account when we are doing molality calculations.

We use the van't Hoff factor (i) to measure the extent that the solute breaks apart into ions.

$$i = \frac{\text{moles of particles in solution}}{\text{moles of solute dissolved}}$$

In an ideal solution the van't Hoff factor would be equal to the number of ions the solute breaks apart into, in the real world the van't Hoff factor is generally less. The van't Hoff factor needs to be measure experimentally. We now need to add the van't Hoff factor to all the colligative property equations:

$$\Delta T = iK_f \ m_{solute}$$

Ex: