# Colligative Properties of Solutions

One of the properties of a solution is a **colligative property** if it depends only on the ratio of the **number of particles of solute** and solvent in the solution, not the identity of the solute. For solutions of electrolytes, one must take into account the additional particles (ions) formed during dissolution. We assign the symbol **i** to be the number of ions formed from one electrolyte unit dissolved, and this is multiplied by the concentration in each equation.

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## Raoult's Law (Vapor Pressure Lowering)

$$VP_{solution} = \chi_{solvent} \bullet VP_{pure\ solvent} \qquad \text{or} \qquad \Delta VP = \chi_{solute} \bullet VP_{pure\ solvent}$$

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## Boiling Point Elevation and Freezing Point Depression

$$\Delta T_{BP} = k_b \bullet m$$

$$\Delta T_{FP} = -k_f \bullet m$$

| | | | |
|---|---|---|---|
| Freezing Point Depression Constants | Compound | Freezing Point (°C) | $k_f$ (°C/m) |
| | water | 0.000 | 1.858 |
| | cyclohexane | 6.55 | 20.0 |
| | | | |
| Boiling Point Elevation Constants | Compound | Boiling Point (°C) | $k_b$ (°C/m) |
| | water | 100.000 | 0.512 |
| | cyclohexane | 80.74 | 2.79 |

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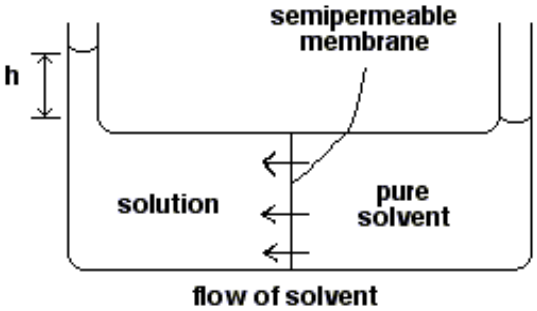
## Osmotic Pressure




Semipermeable membrane allows solvent through but not solute.
Solvent flows "naturally" in order to dilute the solution on the left until pressure equilibrium is reached.
The osmotic pressure is the pressure due to the liquid rising to the height, h, above the pure solvent.

$$\Pi = MRT$$