SOLUTION - PART I

Solution : Homogeneous mixture of two or more substances

Solute	Solvent
which gets dissolves and is present in the smaller quantity Which gets dissolved and is present in the smaller quantity	Present in larger quantity, state of solution is determined by it

Types of Solution

Type of Solvent

Aqueous
Solvent Is water

Non-Aqueous
Solvent Is other than water

Amount of Solvent

Concentrated
Large amounts of solute in the given solvent.

Dilute
Small amount of solute in a large amount of solvent.

Amount of Solute

Unsaturated
Can dissolve more solute

Saturated
Cannot dissolve more solute

Super saturated
Solute is present inexcess andcan be dissolved by increasing temperature

Amount of solute in two solutions

Hypotonic
Lower concentration of solute

Isotonic
Same concentration

Hypertonic
Higher concentration of solute

Expressing the concentration of Solutions

| Method of Expressing	Formula
Mass percentage	$\left[\dfrac{w}{W}\right]\% = \dfrac{w_2}{w_1 + w_2} \times 100$
Volume percentage	$\left[\dfrac{v}{V}\right]\% = \dfrac{V_2}{V_1 + V_2} \times 100$
Mass by Volume percentage	$\left[\dfrac{w}{V}\right]\% = \dfrac{w_2}{V_{solution(in\,ml)}} \times 100$
Parts per million(ppm)	$\dfrac{w_2}{(w_1 + w_2)} \times 10^6$
Molarity, (M) (mol L^{-1})	$\dfrac{w_2 \times 1000}{M_2 \times V_{solution(in\,ml)}}$
Molality, (m) (mol kg^{-1})	$\dfrac{w_2 \times 1000}{M_2 \times w_{1(in\,g)}}$
Mole fraction, (x)	$x_1 = \dfrac{n_1}{n_1 + n_2}$ or $x_2 = \dfrac{n_1}{n_1 + n_2}$, $(x_1 + x_2 = 1)$ In case of gases only, $y_1 = \dfrac{P_1}{P_1 + P_2}$ or $y_2 = \dfrac{P_1}{P_1 + P_2}$, $(y_1 + y_2 = 1)$

Solubility: Maximum amount of a substance that can be dissolved in a specified amount of solvent at a specified temperature
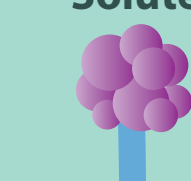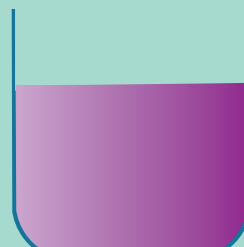
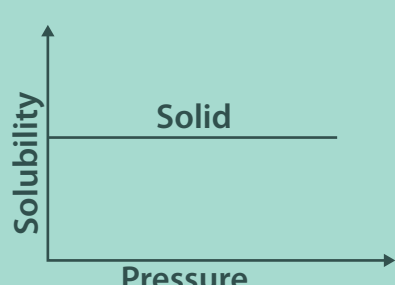Solute → Solvent → Solution

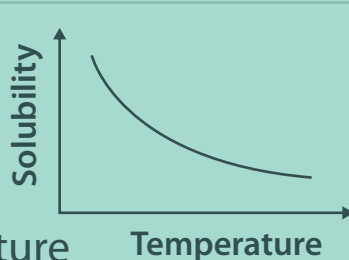| Solubility of a solid in a liquid	Solubility of a gas in a liquid
• Polar solutes dissolve in polar solvents and non polar solutes in non-polar solvents. Solute + Solvent ⇌ Solution	• Many gases like oxygen are soluble in liquids like water Solute + Solvent ⇌ Solution
• If endothermic the solubility increases with rise in temperature	• if exothermic the solubility should decrease with rise in temperature	• Dissolution of gas is predominantly exothermic hence solubility decreases with rise in temperature
• Solids are incompressible hence pressure has no effect on solubility	• As gases are completely compressible , their solubility increases with increase in pressure
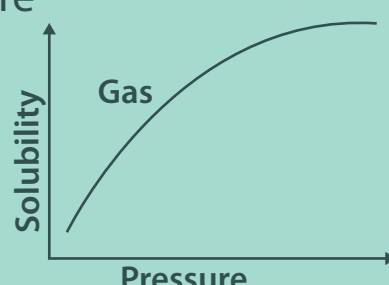
Vapour pressure of liquid solutions : Pressure formed by the vapor of the liquid over the surface of the liquid.
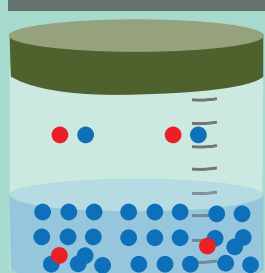
Raoult's law: "For a solution of volatile liquids, the partial vapour pressure of each component of the solution is directly proportional to its mole fraction present in solution
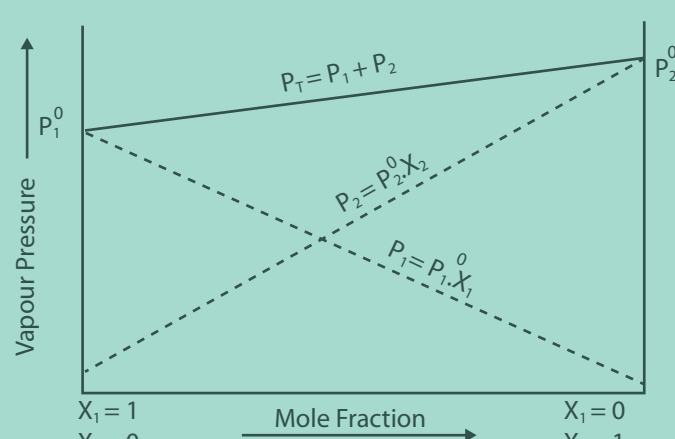
$$p_1 \propto x_1$$
$$p_1 = p_1^0 x_1$$

p_1^0 is the vapour pressure of pure component 1 at the same temperature

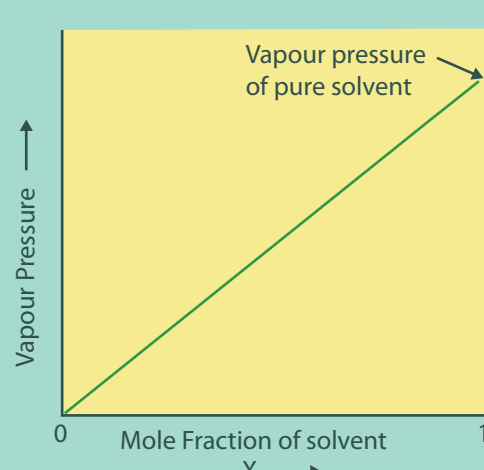| Liquid-Liquid solutions (Components 1 and 2 both are volatile)	Solid-Liquid solutions (Component 1 is volatile)
$P_1 = P_1 + P_2$ $P_{total} = x_1 P_1^0 + x_2 P_2^0$ $= (1 - x_2)P_1^0 + x_2 P_2^0$ $= P_1^0 + (P_2^0 - P_1^0)x_2$	$P_1 \propto x_1$ $P_1 = P_1^0 x_1$

Solutions : On the basis of Raoult's law.
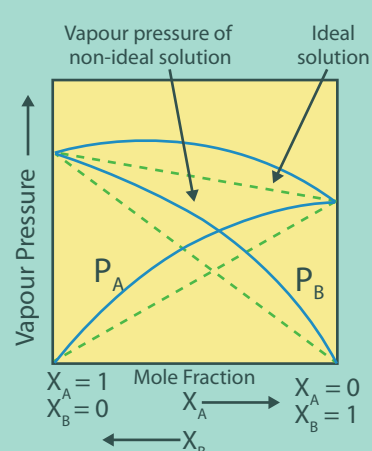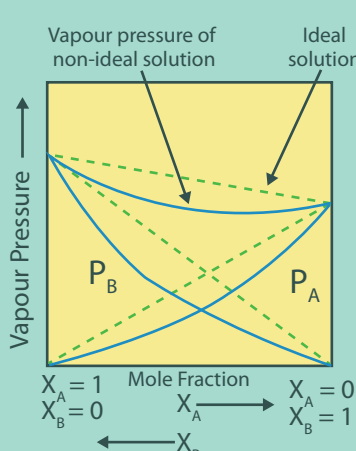
Ideal

- Obey Raoult's law over the entire range of concentration
- $\Delta_{mix}H = 0$
- $\Delta_{mix}V = 0$

- A-A and B-B interactions are equal to A-B interactions
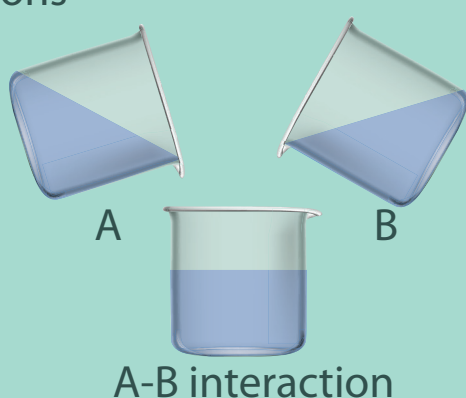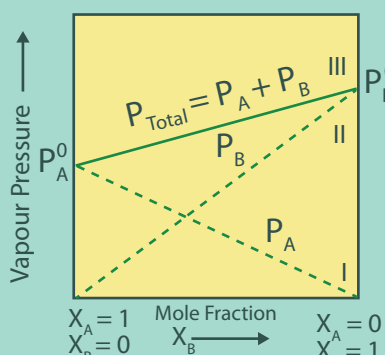
A-B interaction
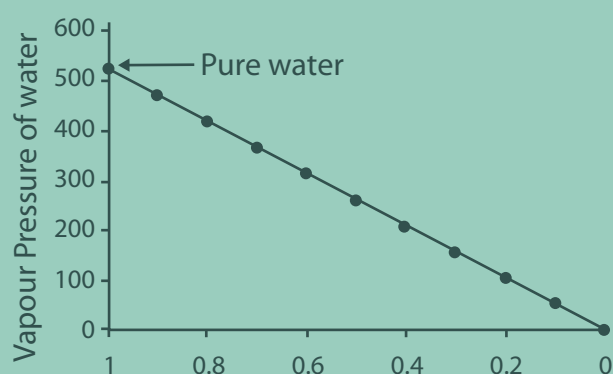
Non-ideal

- Do not obey Raoult's law over the entire range of concentration

Negative deviation
- $\Delta_{mix}H = -ve$
- $\Delta_{mix}V = -ve$

Positive deviation
- $\Delta_{mix}H = +ve$
- $\Delta_{mix}V = +ve$

- A-B interactions are stronger than those between A-A or B-B
- A-B interactions are weaker than those between A-A or B-B

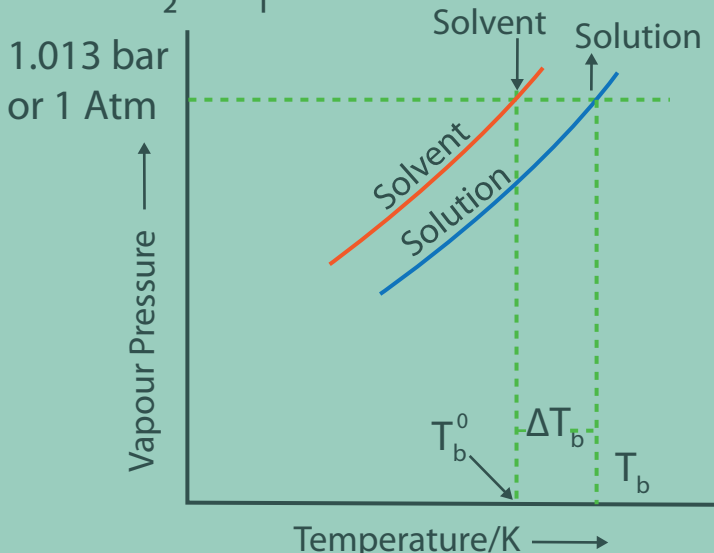## Relative Lowering of Vapour Pressure

$\Delta p_1 = p_1^0 - p_1$

$$\frac{\Delta p_1}{p_1^0} = \frac{p_1^0 - p_1}{p_1^0} = x_2$$

$$\frac{p_1^0 - p_1}{p_1^0} = \frac{w_2 \times M_1}{M_2 \times w_1}$$

Elevation of Boiling Point

$$\Delta T_b = T_b - T_b^0$$

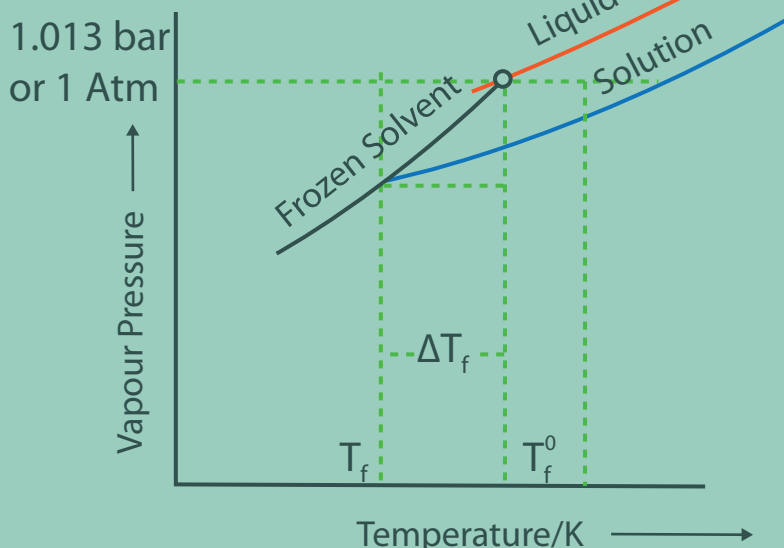$$\Delta T_b = \frac{K_b \times 1000 \times w_2}{M_2 \times w_1}$$

Colligative Properties
depend on the number and not nature of solute particles

Depression of Freezing Point

$$\Delta T_f = T_f^0 - T_f$$

$$\Delta T_f = T_f\, m$$

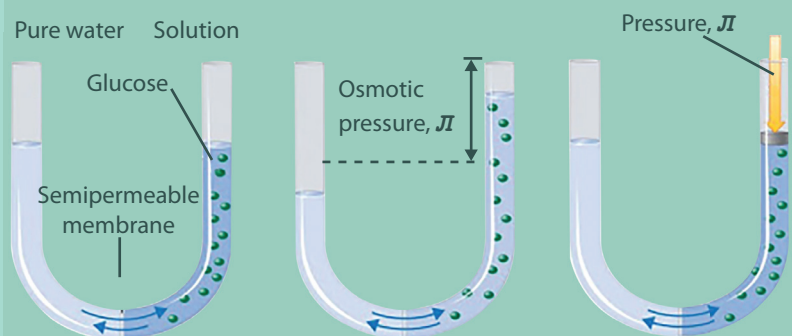$$\Delta T_f = \frac{K_f \times w_2 \times 1000}{M_2 \times w_1}$$

Osmosis and Osmotic Pressure

- Solvent molecules always flow from lower concentration to higher concentration of solution
- The pressure that just stops the flow of solvent is called osmotic pressure of the solution.

$$\Pi = CRT \qquad \Pi V = \frac{w_2 RT}{M_2}$$

$$\text{or } M_2 = \frac{w_2 RT}{\Pi V}$$

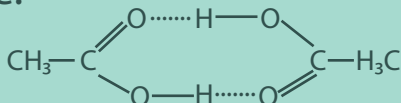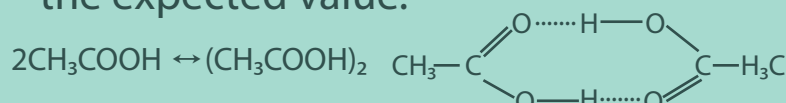## Abnormal molar mass is the experimentally determined molar mass

Association
- The experimentally determined molar mass is half than the true value

$$KCl = K^+ + Cl^-$$

Dissociation
- The molar mass calculated will be twice the expected value.

$$2CH_3COOH \leftrightarrow (CH_3COOH)_2$$

- Van't Hoff introduced a factor i, known as the Van't Hoff factor, to account for the extent of dissociation or association.

$$i = \frac{\text{Normal molar mass}}{\text{Abnormal molar mass}}$$

$$= \frac{\text{Observed colligative property}}{\text{Calculated colligative property}}$$

$$i = \frac{\text{Total number of moles of particles after association/ dissociation}}{\text{Number of moles of particles before association/ dissociation}}$$

Correction   Of the colligative property

Relative lowering of vapour pressure of solvent

$$\frac{p_1^0 - p_1}{p_1^0} = i \cdot \frac{n_2}{n_1}$$

Elevation of Boiling point, $\Delta T_b = iK_b m$

Depression of Freezing point, $\Delta T_f = iK_f m$

Osmotic pressure of solution, $\Pi = in_2 RT/V$