CHAPTER - 1

Solutions

*** Solutions are homogeneous mixtures of two or more components. They can be not separated by physical process. They have uniform composition throught the solution.

*** Concentration terms :-

(i) Molarity = $\frac{\text{no. moles of solute}}{\text{Volume of solution (L)}}$

(ii) Molality = $\frac{\text{Moles of solute}}{\text{mass of solvent in kg}}$

(iii) Mole fraction of a component (A)

$$= \frac{n_A}{n_A + n_B}$$

$$X_B = \frac{n_B}{n_A + n_B}$$

(iv) Mass percentage of any Component = $\frac{\text{Mass. Component in solution} \times 100}{\text{Total mass. Solution}}$

(v) Volume % of any component = $\frac{\text{Volume. Component} \times 100}{\text{Total volume of Soln}}$

*** Solubility - Solubility of a substance is its maximum amount of solute that can be dissolved in a specified amount of solvent.

→ It depends on Nature of Solvent/solute, Temperature and on pressure.

** Solubility of Solid in a Liquid

The solubility of a solid in a liquid is significantly affected by temperature changes.

Generaly in endothermic process the temperature increases and solubility of solid increases and in exothermic process increase in temperature decreases the solubility.

Pressure doesn't have any significant effect on Solubility of solids in liquids. It is so because solids and liquids are highly incompressible and remains unaffected by changes in pressure.

** Solubility of Grasses in Liquids

Henry's law was very important regarding solubility of gasses.

→ Henry's Law

The solubility of Gas in liquid is directly proportional to the partial pressure of Grasses above the liquid surface.

Mole fraction of gas in the solution is proportional to the partial pressure of gas over the solution.

If we use χ_{gas} in solution as measure of its Solubility

$$P_{partial} \propto \chi_{gas\ in\ liquid}$$

$$\boxed{P_{partial} = K_H \chi_{gas\ in\ liquid}}$$

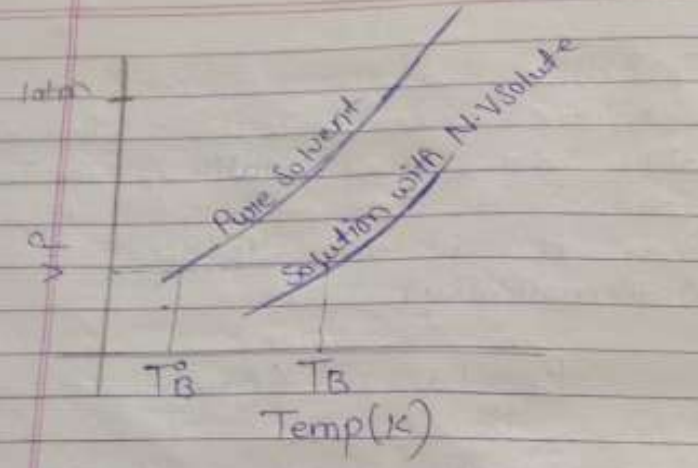
→ Where K_H is Henry's law Constant, different gases have different value of K_H

→ Effect of Temperature

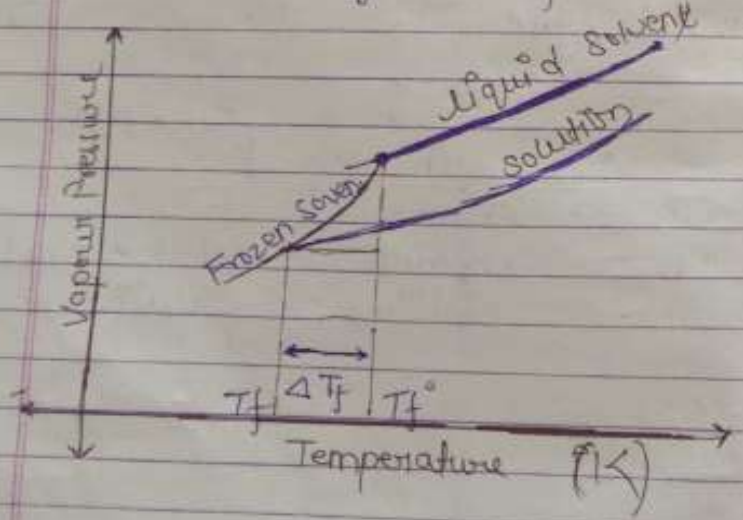
Generally K.H decreases with decrease in Temperature and hence Solubility of any gas increases.

$$\text{Solubility} \propto \frac{1}{K_H} \quad \text{or}$$

$$\text{Solubility} \propto \frac{1}{\text{Temperature}}$$



(iii) Depression in Freezing Point — As we will add Non-Volatile Solute (B) in Pure Solvent (A) then the depression in freezing point decreases from T_f° to T_f.



From experiments we get

$\Delta T_f \propto m$

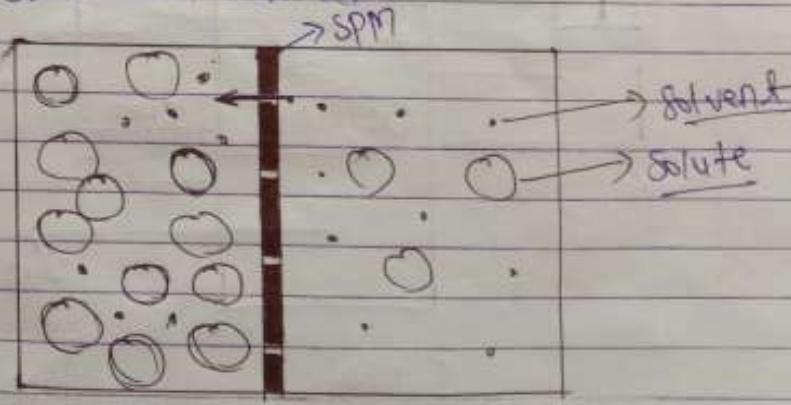
$$\Delta T_f = K_f m$$

$K_f \rightarrow$ is constant known as Freezing Point depression Constant or Molal depression constant.

(iv) Osmosis and Osmotic Pressure

Osmosis :- It is the movement of Solvent molecules from their higher Concentration to their lower concentration by Semi Permeable membrane.

Osmotic pressure :- The extra pressure required to stop the osmosis is called Osmotic Pressure.



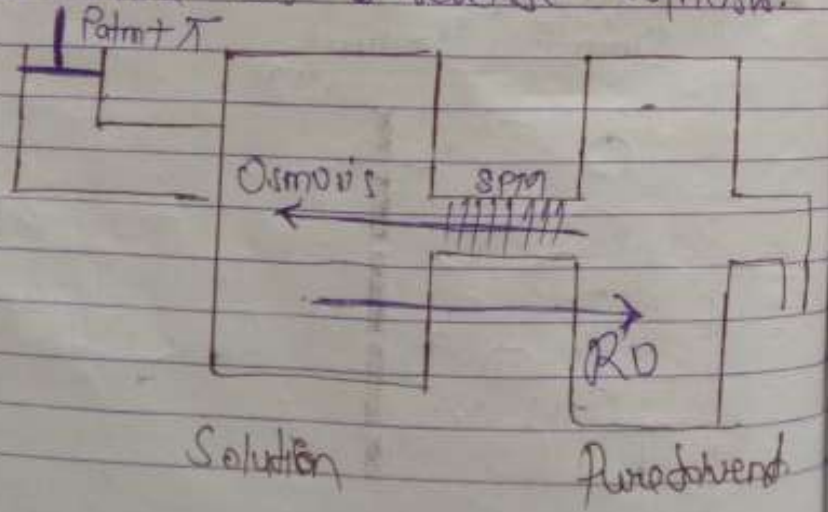
Osmotic Pressure has Symbole π

Experiments gave,

$$\pi = MRT$$

- π → Osmotic pressure
- R → Solution Constant
- T → Temperature in Kelvin
- M → Molarity

RO (Reverse Osmosis) : At osmotic pressure the osmosis stops, if we apply more pressure on solution side then molecules of solvent will move in opposite direction this process is termed as reverse osmosis.



Vant Hoff factor :-

→ Its Symbole is 'i'.
→ 'i' tells us how many times the particles are increasing or decreasing and how many times did Colligative Property is increasing or decreasing.

i = Total no. moles of solute after dissoia./association / Total no. moles of solute after dis/asso.

→ Modification from Vant hoff's factor.

(i) Relative lowering in VP

$$\frac{P_A^\circ - P_A}{P_A^\circ} = i\frac{n_B}{n_A}$$

(ii) Elevation in B.P

$$\Delta T_b = i K_b m$$

(iii) Depression in F.P

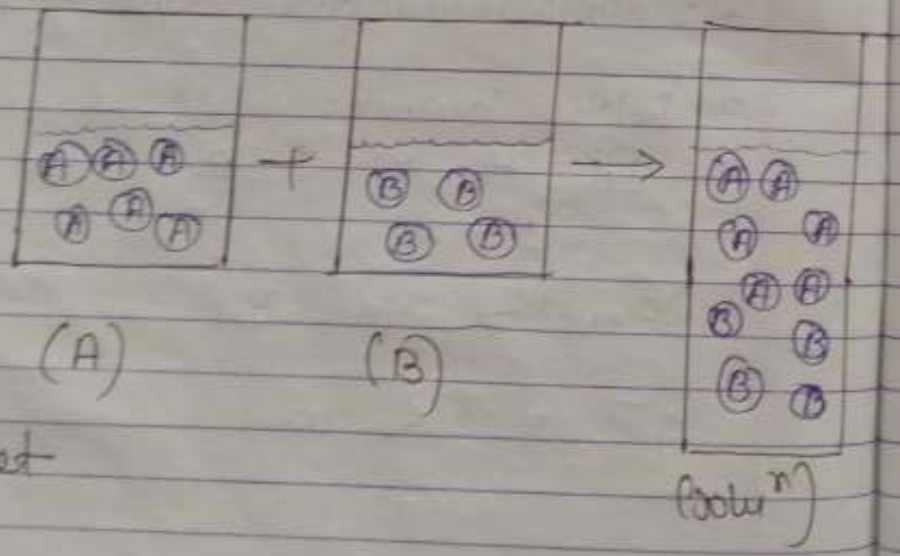
$$\Delta T_f = i K_f m$$

(iv) osmotic pressure of soln

$$\pi = i n_2 RT/V$$

Ideal and Non Ideal Solutions.

The Solution that follows Raoult's law are called Ideal ~~Solution~~ and that donot follow are called Non-Ideal Solutions



Let

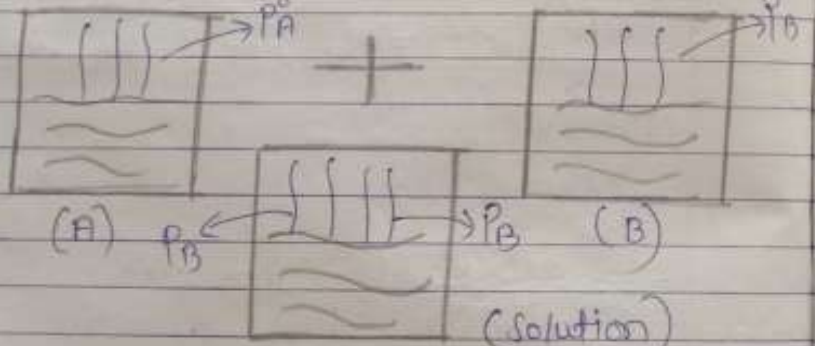
$V_f \rightarrow$ Volume of Soln
$V_1 \rightarrow$ Volume of Liquid (A)
$V_2 \rightarrow$ " " (B)

Ideal Soln	Non-Ideal Soln
(i) Follows Raoult's law	Do not follow Raoult's law
(ii) $\Delta V_{mix} = 0$ $V_f - (V_1 + V_2) = 0$	$\Delta V_{mix} \neq 0$ $V_f - (V_1 + V_2) \neq 0$
(iii) $\Delta H_{mix} = 0$	(iii) $\Delta H_{mix} \neq 0$
(iv) Force b/w A-A, A-B, B-B are Same	A-A = B-B ≠ A-B A-A ≠ B-B = A-B A-A ≠ B-B ≠ A-B

*** Vapour pressure and Raoult's law

When a volatile liquid is heated then it evaporates and hence Vapour forms. This Vapour exerts pressure that we called Vapour Pressure.

Raoult's Law :- It states the the partial pressure of each component in the Solution is directly proportional to its mole fraction in the solution.



$P_A \propto X_A$ (Raoult's law)

$\boxed{P_A = P_A^\circ X_A}$

$P_B \propto X_B$

$\boxed{P_B = P_B^\circ X_B}$ (Raoult's law)

*** Colligative properties

(i) Relative lowering in V.P - When we will add anon volatile solute in Solvent A, Then the V.P of A (P_A° = Pure A) decreases to P_A.

Mathematically,

$$\frac{P_A^\circ - P_A}{P_A^\circ} = X \text{ of Non volatile Solute}$$

$$\boxed{\frac{P_A^\circ - P_A}{P_A^\circ} = X_B}$$

(ii) Elevation in Boiling Point - On adding a non-volatile solute B in Pure Solvent A then the Boiling point from T_B° increases to T_B.

$$\Delta T_B = T_B - T_B^\circ = K_b \times m$$

$$\boxed{\Delta T_B = K_b \times m}$$

$\Delta T_B \rightarrow$ Elevation in B.P

$K_b \rightarrow$ Constant of molal elevation

$m \rightarrow$ molality of Solution.

• Graph b/w Temp & V.P.