SOLUTION & COLLIGATIVE PROPERTIES

OSMOTIC PRESSURE :

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- (i) $\pi = \rho g h$ Where, $\rho = density of soln., h = equilibrium height.$
 - **Vont Hoff Formula** (For calculation of O.P.) $\pi = CST$

$$\pi = CRT = \frac{n}{V} RT$$
 (just like ideal gas equation)

- $\therefore C = \text{total conc. of all types of particles.}$ $= C_1 + C_2 + C_3 + \dots$ $= \frac{(n_1 + n_2 + n_3 + \dots)}{V}$
- **Note :** If V_1 mL of C_1 conc. + V_2 mL of C_2 conc. are mixed.

$$\pi = \left(\frac{C_1 V_1 + C_2 V_2}{V_1 + V_2}\right) RT \quad ; \qquad \qquad \pi = \left(\frac{\pi_1 V_1 + \pi_2 V_2}{RT}\right)$$

Type of solutions :

(a) Isotonic solution - Two solutions having same O.P.

 $\pi_1 = \pi_2$ (at same temp.)

(b) Hyper tonic– If $\pi_1 > \pi_2 \Rightarrow I^{st}$ solution is hypertonic solution w.r.t. 2^{nd} solution.

(c) Hypotonic – IInd solution is hypotonic w.r.t. Ist solution.

Abnormal Colligative Properties : (In case of association or dissociation) VANT HOFF CORRECTION FACTOR (i) :

 $i = \frac{exp/observed/actual/abnormal value of colligative property}{Theoritical value of colligative property}$ $= \frac{exp./observed no. of particles / conc.}{Theoritical no. of particles} = \frac{observed molality}{Theoritical molality}$ $= \frac{theoretical molar mass(formula mass)}{experimental/observed molar mass(apparent molar mass)}$ $i > 1 \implies dissociation.$ $i < 1 \implies association.$ $i = \frac{\pi_{exp.}}{\pi_{theor}}$ $\therefore \pi = iCRT$ $\pi = (i_1C_1 + i_2C_2 + i_3C_3....) RT$

Relation between i & α (degree of dissociation) :

 $i = 1 + (n - 1) \alpha$ Where, n = x + y.

Relation b/w degree of association β & i.

$$i = 1 + \left(\frac{1}{n} - 1\right)\beta$$

RELATIVE LOWERING OF VAPOUR PRESSURE (RLVP) :

Vapour pressure : $P_{Soln.} < P$ Lowering in VP = $P - P_{S} = \Delta P$

Relative lowering in vapour pressure RLVP = $\frac{\Delta P}{P}$

Raoult's law : (For non - volatile solutes)

Experimentally relative lowering in V.P = mole fraction of the non volatile solute in solutions.

$$RLVP = \frac{P - P_s}{P} = X_{Solute} = \frac{n}{n + N}$$
$$\boxed{\frac{P - P_s}{P_s} = \frac{n}{N}}$$
$$\boxed{\frac{P - P_s}{P_s} = (\text{ molality}) \times \frac{M}{1000}}$$

(M = molar mass of solvent)

If solute gets associated or dissociated

$$\frac{P - P_s}{P_s} = \frac{i.n}{N}$$
$$\frac{P - P_s}{P_s} = i \times (\text{molality}) \times \frac{M}{1000}$$

According to Raoult's law (i) $p_1 = p_1^{0} X_1$. where X_1 is the mole fraction of the solvent (liquid).

(ii) An alternate form
$$\rightarrow \frac{p_1^0 - p_1}{p_1^0} = X_2$$
.

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Elevation in Boiling Point :

$$\Delta T_{b} = i \times K_{b}m$$

$$K_{b} = \frac{RT_{b}^{2}}{1000 \times L_{vap}} \quad \text{or} \quad K_{b} = \frac{RT_{b}^{2}M}{1000 \times \Delta H_{vap}}$$

$$L_{vap} = \left(\frac{\Delta H_{vap}}{M}\right)$$

Depression in Freezing Point :

 $\therefore \Delta T_f = i \times K_f m.$

 $\mathsf{K}_{\mathsf{f}} = \mathsf{molal} \; \mathsf{depression} \; \mathsf{constant} = \; \frac{\mathsf{RT}_{\mathsf{f}}^{\; 2}}{1000 \times \mathsf{L}_{\mathsf{fusion}}} \; = \; \frac{\mathsf{RT}_{\mathsf{f}}^{\; 2} \mathsf{M}}{1000 \times \Delta \mathsf{H}_{\mathsf{fusion}}} \, .$

Raoult's Law for Binary (Ideal) mixture of Volatile liquids :

$P_A = X_A P_A^o$	 $P_{B} = X_{B}P_{B}^{\circ}$
if $P_A^{\circ} > P_B^{\circ}$	 A is more volatile than B
	 B.P. of A < B.P. of B
	 According to Dalton's law
	$\mathbf{P}_{\mathrm{T}} = \mathbf{P}_{\mathrm{A}} + \mathbf{P}_{\mathrm{B}} = \mathbf{X}_{\mathrm{A}}\mathbf{P}_{\mathrm{A}}^{0} + \mathbf{X}_{\mathrm{B}}\mathbf{P}_{\mathrm{B}}^{0}$

 $x_{\text{A}}^{\,\prime}$ = mole fraction of A in vapour above the liquid / solution. $x_{\text{B}}^{\,\prime}$ = mole fraction of B

$$\mathbf{P}_{A} = \mathbf{X}_{A}\mathbf{P}_{A}^{\circ} = \mathbf{X}_{A}^{'}\mathbf{P}_{T}$$
$$\mathbf{P}_{B} = \mathbf{X}_{B}^{'}\mathbf{P}_{T} = \mathbf{X}_{B}\mathbf{P}_{B}^{\circ}$$
$$\frac{1}{\mathbf{P}_{T}} = \frac{\mathbf{X}_{A}^{'}}{\mathbf{P}_{A}^{\circ}} + \frac{\mathbf{X}_{B}^{'}}{\mathbf{P}_{B}^{\circ}}.$$

Graphical Representation :



A more volatile than B $(P_A^{o} > P_B^{o})$

Ideal solutions (mixtures) :

Mixtures which follow Raoul'ts law at all temperature.

 $\begin{array}{rcl} A - ---- A & \Longrightarrow & A - ---- B, \\ B - ---- B & & & \\ \Delta H_{mix} = 0 & : & \Delta V_{mix} = 0 & : \\ \Delta S_{mix} = + \mbox{ ve as for process to proceed} & : & \Delta G_{mix} = - \mbox{ ve as for process to proceed} & : & & \\ \end{array}$

eg. (1) Benzene + Toluene. (2) Hexane + heptane. (3) $C_2H_5Br + C_2H_5I$.

Non-Ideal solutions : Which do not obey Raoult's law.

(i)
$$P_{T,exp} > (X_A P_A^o + X_B P_B^o)$$

(ii)
$$A = - - - A = B = - - - B$$

Force of attraction

- (iii) $\Delta H_{mix} = +ve$ energy absorbed
- (iv) $\Delta V_{mix} = +ve (1L + 1L > 2L)$
- (v) $\Delta S_{mix} = +ve$

(vi)
$$\Delta G_{mix} = -ve$$

 $H_2O + CH_3OH.$

$$\Pi_2 U + U_2 \Pi_5 U \Pi$$

 $C_2H_5OH + hexane$

 $C_2H_5OH + cyclohexane.$

 $CHCl_3 + CCl_4 \rightarrow dipole dipole interaction becomes weak.$



(b) Negative deviation

(i) $P_T \exp \langle X_A P_A^o + X_B P_B^o \rangle$

(ii)
$$A = ---A = A = ---B$$

strength of force of altraction.



B.P. of solution is less than the individual B.P.'s of both the liquids.

Henry Law :

This law deals with dissolution of gas in liquid i.e. mass of any gas dissolved in any solvent per unit volume is proportional to pressure of gas in equilibrium with liquid.

 $\begin{array}{l} m \ \alpha \ p \\ m = kp \\ m \rightarrow \frac{\text{weight of gas}}{\text{Volume of liquid}} \end{array}$