2. Solutions.

* Solubility (molarity)

- The solubility of a solute is its amount per unit volume of saturated solution at a specific temperature.
- units mol L^{-1}.

$$\text{molarity} = \frac{\text{no. of moles solute}}{\text{volume of sol. in L}} = \frac{mol}{L} = mol\,L^{-1}$$

* Factors affecting solubility.

1.) Nature of solute and solvent

2.) Effect of Temperature on solubility

* Henry's Law. [July 24]

- It states that the solubility of a gas in a liquid is directly proportional to the pressure of the gas over the solution. Thus,

$$S \propto K_H P$$

where, S is the solubility of the gas, P is the pressure of the gas over the solution.
The proportionality constant is called Henry's law constant K_H.

* Conditions for ideal solutions: [July 2024] [2 mks]

1.) Ideal solutions obey Raoult's law over entire range of concentrations.

2.) No heat is evolved or absorbed when two components forming an ideal solution are mixed. Thus, the enthalpy of mixing is zero, $\Delta_{mix} H = 0$.

3.) There is no volume change when two components forming an ideal solution are mixed. Thus volume of an ideal solution is equal to the sum of volumes of two components taken for mixing $\Delta_{mix} V = 0$.

4.) In an ideal solution solvent-solvent, solute-solute and solvent-solvent molecular interactions are comparable.

5.) The vapour pressure of ideal solution always lies between vapour pressures of pure components.

* The Physical properties of solutions that depend on the number of solute particles in solutions and not on their nature are called colligative properties

* Vapour Pressure Lowering

$P_A = P_A^\circ . X_A$ $\quad$ $\therefore P_B$ = non volatile

$P_A = P_A^\circ . X_A$ $\quad$ $P_A^\circ . X_B = P_A^\circ - P_A$

$\boxed{X_A + X_B = 1}$ $\quad$ $X_B = \frac{P_A^\circ - P_A}{P_A^\circ}$

$P_A = P_A^\circ . (1 - X_B)$

$P_A = P_A^\circ - P_A^\circ . X_B$ $\quad$ $\boxed{X_B = \frac{\Delta P}{P_A^\circ}}$

$$X_B = \frac{n_2}{n_1 + n_2}$$

$n_1 >>> n_2$ $\quad$ $\boxed{n_1 + n_2 = 1}$

$X_B = \frac{\frac{w_2}{m_2}}{\frac{w_1}{m_1}}$ $\quad$ $\boxed{\therefore X_B = \frac{w_2 . m_1}{w_1 . m_2}}$

* Boiling Point Elevation and concentration of solute.

[March 23 ; sep. 21]

$\Delta T_b \propto m$

$\boxed{\Delta T_b = k_b . m}$

m → molality

k_b → E.C Ebullioscopic

$$\frac{\Delta T_b}{m} = k_b$$

$\frac{K}{\frac{mol}{kg}} = k_b$ $\quad$ $\boxed{k_b = K . mol^{-1} . kg}$

Define.
~~write~~ SI
⇒ ebulli
point
in

Q Q. Define : Ebullioscopic constant
~~Write~~ SI [Jul-23, Jul-22]

⇒ Ebullioscopic constant is the elevation in the boiling point produced when one mole of the solute is dissolved in one kg of solvent.

Q. Write S.I unit of cryoscopic constant [march 23]

⇒ S.I unit of cryoscopic constant : K kg mol^{-1}

* Osmotic Pressure

- Osmosis is the movement of water from an area of lower solute concentration (like pure water) to an area of higher solute concentration (like saltwater) through a semipermeable membrane.

*Osmotic Pressure.

- it is the pressure needed to stop this movement of water.

It can be calculated using the formula:

Q. Write the condition of reverse osmosis.

⇒ Reverse osmosis occurs when applied pressure is greater than osmotic pressure

Q. How will you determine molar mass of solute from osmotic pressure? [Feb 24, march 22]

⇒ For very dilute solutions, the osmotic pressure follows the equation, $\pi = \frac{n_2RT}{V}$ —— ⓘ

If the mass of solute in V litres of a solution is W_2 and its molar mass is M_2, then $n_2 = \frac{W_2}{M_2}$

Put value of n_2 in eqn ① we get,

$$\pi = \frac{W_2RT}{M_2V}$$

$$M_2 = \frac{W_2RT}{nV}$$

Above expression can be used to calculate molar mass of solute by osmotic pressure measurement

Property	[march 22] Isotonic solution	Hypertonic solution	Hypotonic solu
Defination	Solutions with equal osmotic pressure	Solutions with higher osmotic pressure than cells	Solutions with lo osmotic pressure than cells.
Solute concentration	Equal solute concentration (eg. 0.9% NaCl)	Higher solute concentration (eg>0.9% NaCl)	Lower solute concentration (eg. <0.9% NaCl)
Osmosis.	No net water movement, equilibrium reached	Water moves out of the cell to dilute the solution	water moves into the cell to dilute the solute.

* Van't Hoff factor (i)

$$i = \frac{\text{colligative property of electrolyte solution}}{\text{colligative property of nonelectrolyte solution of the same concentration.}}$$

$$= \frac{(\Delta T_f)}{(\Delta T_f)_0} = \frac{(\Delta T_b)}{(\Delta T_b)_0} = \frac{(\Delta P)}{(\Delta P)_0} = \frac{(\pi)}{(\pi)_0}$$

Q. Write the relation between van't Hoff factor and degree of dissociation of an electrolyte [July 24]

⇒ Relation between Van't Hoff factor (i) and degree of dissociation (α) of an electrolyte

$$\boxed{I = 1 + \alpha(n-1)}$$

* The modified equations are

i.) $\Delta P = i\, P_1^\circ x_2 = i\, \frac{W_2 M_1}{M_2 W_1} \times P_1^\circ$

ii) $\Delta T_b = i K_b m = i\, \frac{1000\, K_b W_2}{M_2 W_1}$.

iii) $\Delta T_f = i K_f m = i\, \frac{1000\, K_f W_2}{M_2 W_1}$

iv) $\pi = i M R T = i\, \frac{W_2 R T}{M_2 V}$