# Solutions

1. $M = \frac{\text{moles of solute}}{\text{vol. of solution (L)}} = \frac{wt}{GMM} \times \frac{1}{V(L)} = \frac{10 \times d \times (w/w)\%}{GMW}$

- $M_1V_1 = M_2V_2$.

2. $N = \frac{\text{eq. of solute}}{\text{vol. of solution (L)}} = \frac{wt}{GEW} \times \frac{1}{V(L)} = \frac{wt \times n\text{-factor} \times 1}{GMM \quad V}$

$\Rightarrow \underline{N = M \times n\text{-factor}}$.

- $N_1V_1 = N_2V_2$.

3. $m = \frac{\text{moles of solute}}{\text{mass of solvent (kg)}} = \frac{1000 \times M}{1000 \times d - M \times (GMW)}$.

4. • $\frac{wt\,(g)}{wt\,(g)}\,\%$ • $\frac{V}{V}\,\%$ • $\frac{wt\,(g)}{V\,(ml)}\,\%$.

- strength $= \frac{wt\,(g)}{Vol.\,(L)} = GMW \times M = GEW \times N$.

5. $X_A = \frac{n_A}{n_A + n_B}$ $\quad X_B = \frac{n_B}{n_A + n_B}$

- $X_A + X_B = 1$

6. PPM = Parts per million $= \frac{\text{wt. of solute}}{\text{wt. of solution}} \times 10^6$.

7. $F = \frac{wt}{\text{formal mass}} \times \frac{1}{V(L)}$ { In case of association or dissociation of solute. }

8. $D = M$ (at $0^\circ C$)
(denal)

9. Physical mixing (A+A or B+B)

$$M = \frac{n}{V} = \frac{n_1 + n_2}{V_1 + V_2} = \frac{M_1V_1 + M_2V_2}{V_1 + V_2}$$

$$N = \frac{N_1V_1 + N_2V_2}{V_1 + V_2}$$

Chemical change (A + B)

$$N = \frac{|eq_1 - eq_2|}{V_1 + V_2} = \frac{N_1V_1 - N_2V_2}{V_1 + V_2}$$

$$M = \frac{N}{n\text{-factor}}$$

n-factor ⇒ of excessive/remaining equivalents of acid/base.

10. Solubility -

I - Solid dissolved in liquid

(a) Like dissolves like (polar/non-polar) - nature

(b) If exo ⇒ If T↑ solubility ↓ } Le Chatelier
If endo ⇒ If T↑ solubility ↑ }

(c) due to incompressibility of solid, pressure does not effect solubility significantly.

II - Gas is dissolved in liquid

(a) few gases are more soluble in water due to polarity, H-bonding, etc. — nature.

(b) Dissolution of gases in water is exothermic

(c) solute + solvent ⇌ solution. ($\Delta n_g = -ve$)
(gas)

∴ If P↑ ⇒ solubility ↑.

11. **Henry's Law** – the solubility of a gas in a liquid is directly proportional to partial pressure of the gas above the liquid surface.

$P_{gas} = K_H X_{gas}$ ($P_{gas}$ ↓ outside; $X_{gas}$ → mole fraction inside; $K_H$ = henry constant.)

If T ↑, $K_H$ ↑, $P_{gas}$ = constant
∴ $X_{gas}$ ↓.
⇒ solubility ↓.

12. **Vapour Pressure** – At constant temp., the pressure exerted by the vapour of a liquid on its surface at equilibrium is known as VP.
Rate of evaporation = rate of condensation.
(a) If temp. ↑ ⇒ VP ↑
(b) If intramolecular H-bonding present ⇒ ↑ volatile ⇒ VP ↑.

13. **Raoult's Law** – The VP of any volatile constituent of a solution is directly proportional to its mole fraction in solution at constant temp.

$P_A = X_A P_A^\circ$ $\quad P_B = X_B P_B^\circ$

$P_S = \underbrace{P_A + P_B}_{\text{practical}} = \underbrace{X_A P_A^\circ + X_B P_B^\circ}_{\text{theoretical}}$.

I **Ideal solution**
practical = theoretical.

- $\Delta V_{mix} = 0$
- $\Delta H_{mix} = 0$
- no chemical reaction in liquids
- no association or dissociation of solute. (no intereaction forces).
- no attraction or repulsion between solute and soluent.
  Eg – homologous members
  – close BP

NOTES BY ISHITA KANODIA

$p_A = X_A P_A^\circ = Y_A P_S$ $\quad Y_A$ = mole fraction outside soln.

$p_B = X_A P_B^\circ = Y_B P_S$.

II Positive Deviation $\quad \{P_A > X_A P_A^\circ, \; P_B > X_B P_B^\circ\}$

practical > theoretical.

(If attraction force between A and B is less than force of attraction between A-A and B-B).

- $\Delta H_{mix} > 0$
  $\Delta V_{mix} > 0$.

III Negative Deviation $\quad \{P_A < X_A P_A^\circ, \; P_B < X_B P_B^\circ\}$

practical < theoretical

- (If attraction forces increase in final solution)
  Eg - when chemical reaction takes place.
- $\Delta H_{mix} < 0$
  $\Delta V_{mix} < 0$.

## 14. Colligative Properties (CP).

→ Those physical properties of solution which depend on the no. of particles or moles or mole fraction of solute. Equimolal solutions of different substances have same CPs.

CP are characteristic of dilute solutions
↳ Not applicable to concentrated solutions.

### I Relative Lowering In VP (RLVP)

→ $X_A$ = mole-fraction of non-volatile solute ($P_A^\circ = 0$).
$X_B$ = mole fraction of pure solvent. ($P_B^\circ$) = $P_B^\circ = P_{solvent}^\circ$.

$P_S = P_{Total} = P_{solution}$

$$\underbrace{\left(\frac{P_0^\circ - P_S}{P_0^\circ}\right)}_{RLVP} = X_A$$

$P_0 - P_S = LVP$ (not relative)

## I Elevation in BP

(BP is that temp. at which VP = atm. pressure).

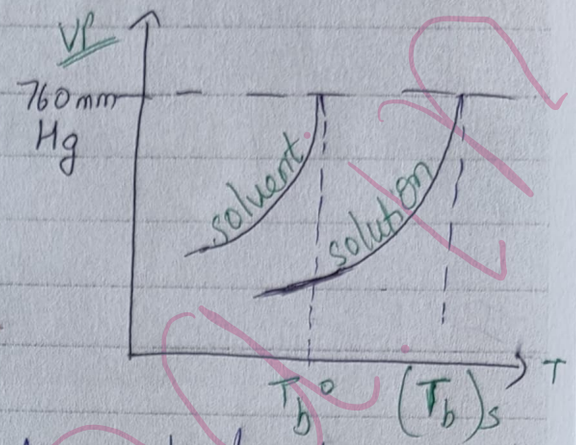
- $\Delta T_b = (T_b)_s - (T_b)^\circ$
- $\Delta T_b = K_b m$ $K_b$ = molal elevation constant.
- $K_b = \frac{k}{1000}$ (k = elevation constant).
- $K_b = \frac{MRT_b^2}{1000 \Delta H_V} = \frac{RT_b^2}{1000 l_V}$

$\Delta H_V$ = heat of vaporisation per mole

$l_V$ = latent heat of vaporisation

$\left(l_V = \frac{\Delta H_V}{M}\right)$.

- $(K_b)_{water} = 0.52$ K kg/mol.



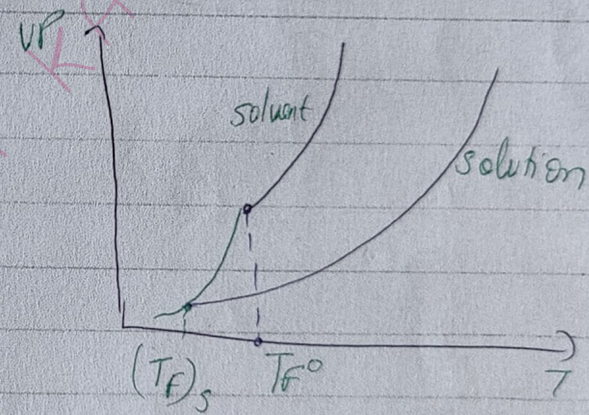

## II Depression in FP

$\Delta T_f = (T_f)^\circ - (T_f)_s = K_f m$

$K_f = \frac{k}{1000}$

$K_f = \frac{MRT_f^2}{1000 \Delta H_f} = \frac{RT_f^2}{1000 l_f}$ f = fusion

$(K_f)_{water} = 1.86$




## IV Osmotic Pressure

$\pi = CRT$ Vant Hoff Law. $C = M$

→ For isotonic solutions –

$\pi_1 = \pi_2$

→ reverse osmosis ⇒ $P_{ext} >$ Osmotic pressure ($\pi$).

15. **Abnormal CP**

(a) In association – observed CP < calculated CP. $i < 1$.
(b) In dissociation – observed CP > calculated CP. $i > 1$.

Vant hoff factor $i = \frac{\text{observed CP}}{\text{calculated CP}} = \frac{\text{actual mol. wt}}{\text{observed mol. wt}}$

I For dissociation – $(i > 1)$ $\alpha$ = degree of dissociation

$$\alpha = \frac{i-1}{n-1}$$

($n$ = total atomicity)
{Eg – $Al_2(SO_4)_3 \Rightarrow x=2, y=3$
$n = 5$}

II For Association $(i < 1)$

$$\alpha = \frac{i-1}{\frac{1}{n} - 1}$$

($n$ = no. of polymerization).

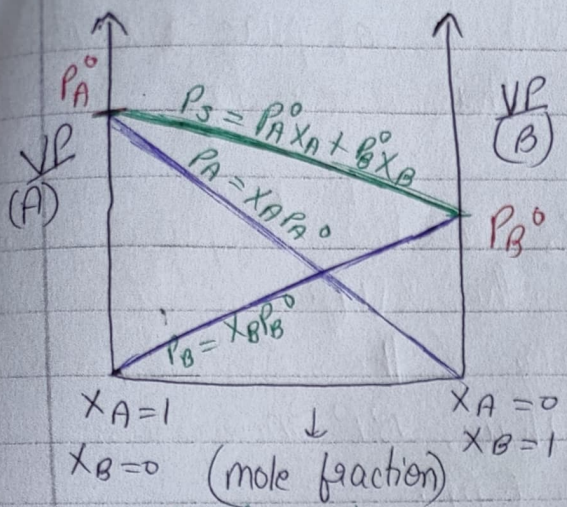
→ $\frac{P_0 - P_s}{P_0} = X_A\, i$ ($P_0$: observed; $X_A$: calculated)

$\Delta T_b = i K_b m$
$\Delta T_f = i K_f m$
$\pi = i CRT.$

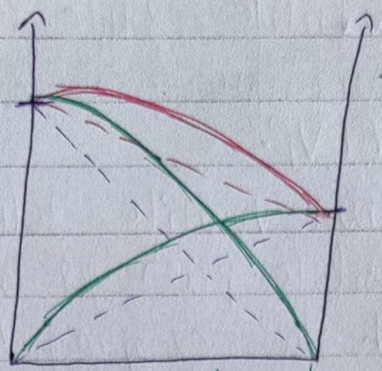
16. **Volume Strength of $H_2O_2$ (X)** $X = 11.2\ M = 5.6\ N.$

17. **Azeotropic Mixture** – If composition in liquid and vapour are same for a solution and they boil at constant temp. ⇒ azeotropic mixture.

→ Minimum boiling azeotrope ⇒ +ve deviation
Maximum boiling azeotrope ⇒ −ve deviation.




Ideal behaviour



+ve deviation

-ve deviation

## NCERT Points

1. A solution is a homogeneous mixture of two or more substances. A solution containing two substances is called binary solution.
2. The maximum amount of solute in gram that can be dissolved in a unit mass (100 gm) of solvent to form a saturated solution at a given temperature is called the solubility of the solute in that solvent at that temperature.
3. Applications of Henry's Law
   (i) Gaseous exchange in lungs
   (ii) In deep sea diving to prevent decompression sickness or bends.
   (iii) High altitude anoxia
   (iv) preparation of aerated drinks.
4. The pressure exerted by particles of liquid in vapour state at equilibrium over the surface of liquid is called as vapour pressure.
5. Those properties of ideal solution which depend only on the no. of particles of solute dissolved in a definite amount of solvent and does not depend on the nature of the solute are called CP.

6. When a non-volatile solute is added to a pure solvent, VP of solution thus formed decreases. This decrease in VP is called RLVP.

7. Whenever a non-volatile solute is added to pure solvent, some of the solute particles occupy the surface of the solvent due to which the escaping tendency of the solvent molecules decreases. Thus, VP decreases. Thus, BP increases. This increase in BP is called EBP.

8. The temp. at which VP of solid phase of a substance becomes equal to liquid phase of the substance is called FP.

9. When a non-volatile solute is added to a pure solvent, the VP of the solution decreases. Thus, at lower temp., VP of solid phase becomes equal to liquid phase. ∴ FP decreases. This decrease in FP is called DFP.

10. The movement of solvent molecules from their higher concentration (pure solvent) side towards their lower conc. (solution side) through semi-permeable membrane (SPM) is called osmosis.

→ Osmosis occurs due to difference in pressure towards solvent and solution sides.

→ The solvent molecules are under increased pressure towards pure solvent side.

11. The minimum excess pressure that can be applied on the solution to prevent the entry of the solvent into the solution through SPM is called osmotic pressure.

12. When the external pressure applied towards solution side exceeds the osmotic pressure, the solvent molecules start moving from solution side to pure solvent side through SPM. This is called reverse osmosis. This technique is used for desalination of sea water.