

# Solution :

Sol<sup>n</sup> is the homogenous mixture of 2 or more component.

Solution = Solute + Solvent  
↓ ↓  
less in amt. excess in amt.  
(moles) (in terms of moles)

180 g Urea + 90 g water  
→ 3 mol → 5 mol  
↳ solvent

→ 300 g urea + 684 g Sucrose + ~~180~~ 180 g water  
→ 5 mol → 2 mol 10 mol

Sol <sup>n</sup> component	Solute	Solvent
2	1	1
3	2	1
4	3	1

always = 1

• Nature of sol<sup>n</sup> is same as that of solvent.

Sol<sup>n</sup>

- ↳ solid
- ↳ liquid
- ↳ Gas

depend upon nature of solvent

Sol<sup>n</sup>

- liq + liq → water + alcohol
- gas + gas → air
- solid + solid → alloys
- liq. + gas → cold drink
- liq. + solid → NaCl + water

### Concentration Terms :-

1. Molarity (M)
2. Normality (N)
3. Molality (m)
4. Formality (F)
5. Strength (S)
6. Mole fraction
7. %
  - w/w %
  - ~~v/v~~ v/v %
  - w/v %
8. PPM

1. Molarity (M) :- no. of moles of solute + nt in 1L sol<sup>n</sup>.

$$M = \frac{n_{\text{solute}}}{V_{\text{sol}^n} (\text{L})}$$
$$M = \frac{n}{V} \quad \text{Unit} = \text{mol L}^{-1}$$

M

2. Normality (N) :- It is no. of g. eq. of solute + nt in 1L sol<sup>n</sup>

$$N = \frac{\text{no. of g. eq. of solute}}{V_{\text{sol}^n} (\text{L})} \quad \text{Unit: eq L}^{-1}$$

N

$$\text{no. of g. eq.} = \frac{wt}{\text{Eq wt}} = \frac{W}{E} = \frac{W}{M/n\text{-factor}} = \frac{W \times n\text{-factor}}{M} = n \times n\text{-factor}$$

$$\text{no. of g. eq.} = N \times V = \frac{W}{E} = n \times n\text{-factor}$$

$$N = \frac{n \times n\text{-factor}}{V_{\text{sol}^n} (\text{L})}$$

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

Note: First calculate Molarity then calculate Normality

3. Molality: It is moles of solute + nt in 1 kg solvent.

$$m = \frac{\text{moles of solute}}{\text{wt. of solvent (in kg)}}$$
$$m = \frac{n_{\text{solute}}}{W_{\text{solvent}} (\text{kg})}$$



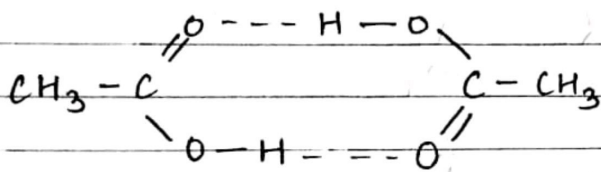
It does not depend upon Temp.

4. Formality (F) : It is no. of formula mass in 1L sol<sup>n</sup>  
→ defined for ionic compd.

$$F = \frac{\text{Molality}}{(\text{Formula mass}) \times V_{\text{sol}^n} (\text{L})}$$

$$20 \text{ g NaOH in 2L} \rightarrow F_w = 40 \quad M = \frac{20/40}{2} = 1/4$$
$$M_w = 40 \quad F = \frac{20}{40 \times 2} = 1/4$$

$$\text{When } F_w = M_w \quad F = M$$



$$F_w = 120$$

6g CH<sub>3</sub>COOH in 1L sol<sup>n</sup> , M=? F=?

$$M = \frac{6/60}{1} = 0.1 \text{ M}$$

$$N = \frac{6}{120 \times 1} = 0.05$$

Que<sup>n</sup> 44.8g benzoic acid is ppt in 2L sol<sup>n</sup> Find  
Molarity & Formality?

$$C_6H_5COOH = 7 \times 12 + 2 \times 16 + 6$$
$$= 84 + 32 + 6 = 84 + 38 = 122$$

$$M = \frac{\frac{44.8}{122} \times 10}{2} = \frac{2}{10 \times 2} = 0.1 \text{ M}$$

$$F = \frac{44.8}{122 \times 2} = \frac{2}{1 \times 2 \times 10} = 0.1$$

Strength : wt. of solute in 1 L sol<sup>n</sup>  
 $S = \frac{\text{wt. of solute}}{\text{Vol}^n \text{ (L)}}$  Unit : g/L

Mole fraction : (X)

A	B	C
$n_A$	$n_B$	$n_C$

$$X_A = \frac{n_A}{n_T}$$

$$X_A + X_B + X_C = 1$$

$$X_B = \frac{n_B}{n_T}$$

$$n_T = n_A + n_B + n_C$$

$$X_C = \frac{n_C}{n_T}$$

Sol<sup>n</sup>  $X_{\text{solute}} = \frac{n_{\text{solute}}}{n_{\text{solute}} + n_{\text{solvent}}}$

$$X_{\text{solvent}} = \frac{n_{\text{solvent}}}{n_{\text{solute}} + n_{\text{solvent}}}$$

$$X_{\text{solute}} + X_{\text{solvent}} = 1$$

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

7.  $\% \text{ w/w} = \frac{\text{wt. of solute}}{\text{wt. of sol}^n} \times 100$

20% w/w Urea = 20 g urea in 100 g sol<sup>n</sup>

$$\% \text{ v/v} = \frac{\text{Vol. of solute}}{\text{Vol. of sol}^n} \times 100$$

20% v/v NaOH = 20 ml NaOH in 100 ml sol<sup>n</sup>

$$\% \text{ w/v} = \frac{\text{wt. of solute (g)}}{\text{Vol. of sol}^n \text{ (ml)}} \times 100$$

40% w/v H<sub>2</sub>SO<sub>4</sub> sol<sup>n</sup> = 40 gm H<sub>2</sub>SO<sub>4</sub> in 100 ml sol<sup>n</sup>



Ques 20% by wt NaOH sol<sup>n</sup> Find molarity?  
20 gm NaOH + rest in 100 gm sol<sup>n</sup>  
$$\text{molarity} = \frac{20/40}{100/1000} = \frac{1/2}{1/10} = \frac{10}{2} = 5M$$

Ques 20% w/v NaOH sol<sup>n</sup> find Molarity?  
20 gm NaOH + rest in 100 ml sol<sup>n</sup>  
$$\text{Molarity} = \frac{20/40}{100/1000} = \frac{1/2}{1/10} = 5M$$

PPM : Parts Per million  
very dilute sol<sup>n</sup>

$$\text{ppm (by wt)} = \frac{\text{wt. of solute}}{\text{wt. of solvent sol}^n} \times 10^6$$

$$\text{ppm (by Vol.)} = \frac{\text{vol. of solute}}{\text{vol. of sol}^n} \times 10^6$$

ppb : Parts Per Billion

$$\text{ppb (by wt)} = \frac{\text{wt. of solute}}{\text{wt. of sol}^n} \times 10^9$$

AIPMT

Ques How many gram of dibasic acid (Mol. wt. = 200) should be + rest 100 ml of aq. sol<sup>n</sup> to give 0.1N sol<sup>n</sup>?

$$N = \frac{w/M_w \times n\text{-factor}}{V_{\text{sol}^n}}$$

$$N \times V \times M_w = w \times n\text{-factor}$$

$$\frac{0.1 \times 100 \times 200}{1000 \times 2} = w = 1 \text{ gm}$$

AIPMT-95+92

Ques which of the following conc<sup>n</sup> term is independent of Temp.?

① Molarity ② Molality ③ Normality ④ Formality

Que Calculate mass of sugar & water req.<sup>d</sup> to prepare  
250 gm of 20% w/w sol<sup>n</sup>.

~~20 gm sugar + nt in 100 gm sol<sup>n</sup>~~

$$20 = \frac{\text{Wt solute}}{250} \times 100$$

$$\frac{250}{5} = \text{W solute} = 50 \text{ gm}$$

$$\text{W solvent} = 250 - 50 = 200 \text{ gm}$$

AIPMT-07

Que Conc. of sulphuric acid is 98%  $\text{H}_2\text{SO}_4$  by mass  
& has a density of  $1.8 \text{ g L}^{-1}$ . Vol of acid req.<sup>d</sup>  
to make one litre of  $0.1 \text{ M } \text{H}_2\text{SO}_4$  sol<sup>n</sup>

- ① 11.10 ml ② 16.65 ml ③ 22.20 ml ④ 5.55 ml

98 gm  $\text{H}_2\text{SO}_4$  + nt in 100 gm sol<sup>n</sup>

$$D = \frac{M}{V}$$

$$1.8 = \frac{98}{V}$$

$$V = \frac{980}{1.8} = 5$$

$$0.1 \text{ M} = \frac{n_{\text{H}_2\text{SO}_4}}{1} \Rightarrow n_{\text{H}_2\text{SO}_4} = 0.1 \text{ mol}$$

$$V_{\text{H}_2\text{SO}_4} = 0.1 \times 22.4$$
$$= 2.24$$

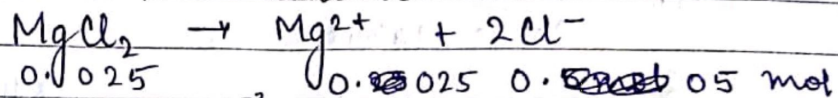


Ques Calculate Molarity of 400g pure water if  $d_{H_2O} = 1g/ml$

$$V = \frac{d_{H_2O}}{1} \quad V = \frac{400}{1} = 400 \text{ ml}$$

$$M = \frac{400/18 \times 1000}{400} = \frac{400 \times 1000}{400 \times 18} = 55.5$$

\* Ques Calculate Molarity of a sol<sup>n</sup> of  $MgCl_2$  if 400ml  $MgCl_2$  have  $3.011 \times 10^{22}$  chloride ions



$$0.025 \quad 0.025 \quad 0.05 \text{ mol}$$

$$M = \frac{3.011 \times 10^{22} \times 1000}{400} =$$

AIPMT-05  
SAS

Ques Calc. mole fraction of solute in one molal aq. sol<sup>n</sup>  
1 molal  $\rightarrow$  1 mol of solute + nt in 1kg solvent

$$n_{H_2O} = \frac{1000}{18} = 55.5$$

$$X_{\text{solute}} = \frac{1}{1 + 55.5} = \frac{1}{56.5}$$

$$= \frac{10}{565} = 0.0177$$

NCERT

Ques Calc. ~~area~~ mass of urea reqd in making 5kg 0.25 m aq. sol<sup>n</sup>

$$m = \frac{\text{moles of solute} \times 1000}{\text{wt (kg)}}$$

$$0.25 \times 5 \times 1000 = w$$

$$w = \frac{15.00 \times 5 \times 1000}{1000} = 75000 \text{ gm.}$$

$$39 + 127 = 166$$

Ques Calculate ① Molarity ② Molality ③ Mole fraction of KI if density 26% w/w aq. KI is 1.202 g/ml

①  $M = \frac{n}{V} = \frac{20/166 \times 1000}{83.3}$       20 gm KI + nt in 100 gm sol<sup>n</sup>  
 $\rho = 1.202$   
 $= \frac{20 \times 1000}{166 \times 83.3} = 1.44$        $V = \frac{M}{\rho} = \frac{100}{1.202}$

②  $m = \frac{20/166 \times 1000}{80} = \frac{20 \times 1000}{4 \times 80 \times 166} = 1.50 = \frac{10000}{120.2} \text{ ml}$

③  $X_{\text{solute}} = \frac{n_{\text{solute}}}{n_{\text{solute}} + n_{\text{solvent}}}$        $n_{\text{solute}} = \frac{20}{166} = 0.120$   
 $= \frac{0.12}{0.12 + 4.44} = 0.026$        $n_{\text{solvent}} = \frac{80}{18} = 4.44$

Ques Eq. moles of urea & water are mixed to prepare an aq. sol<sup>n</sup> what is w/w % of urea & also find Molality.

$$W/W \% = \frac{5 \times 60}{2 \times 78} \times 100 = \frac{500}{13} \%$$

$$m = \frac{n \times 1000}{n \times 18} = \frac{1000}{18} = 55.5 \text{ m}$$

Ques Calc. Molarity & molality of 25% w/w H<sub>2</sub>SO<sub>4</sub> sol<sup>n</sup> if sp. gravity of sol<sup>n</sup> is 1.2 g/ml

25 gm H<sub>2</sub>SO<sub>4</sub> + nt in 100 gm sol<sup>n</sup>

$$M = \frac{25/98 \times 1000}{\frac{100}{1.2}} = \frac{25 \times 1.2 \times 1000}{98 \times 100}$$

$$= \frac{25 \times 12 \times 1000}{100 \times 98}$$



$$M = \frac{300}{98} \approx 3M$$

$$\text{molality} = \frac{\frac{25}{98} \times 1000}{75} = \frac{25 \times 1000}{98 \times 75 \cdot 3} = \frac{1000}{294} = 3.4 \text{ m}$$

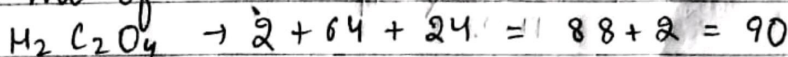
APMS

Ques 25.3 g of  $\text{Na}_2\text{CO}_3$  is dissolved in enough water to make 250 ml of sol<sup>n</sup>. If  $\text{Na}_2\text{CO}_3$  dissociates completely then molar conc<sup>n</sup> of  $\text{Na}^+$  &  $\text{CO}_3^{2-}$  ions are respectively (Given Mw. of  $\text{Na}_2\text{CO}_3 = 106 \text{ g/mol}$ )

- $\text{Na}_2\text{CO}_3 \rightarrow 2\text{Na}^+ + \text{CO}_3^{2-}$
- (a) 0.955 M & 1.910 M
- (b) 1.910 M & 0.955 M
- (c) 1.90 M & 1.910 M
- (d) 0.477 M & 0.477 M

$$C = \frac{25.3}{106} \times 1000 = \frac{25.3 \times 1000}{106} = 238.7$$

Ques Calculate amt. of oxalic acid req<sup>d</sup> to obtain 250 ml of semimolar sol<sup>n</sup>?



$$\frac{1}{2} = \frac{W/190 \times 1000}{250}$$

$$\frac{1}{2} = \frac{W \times 4}{190}$$

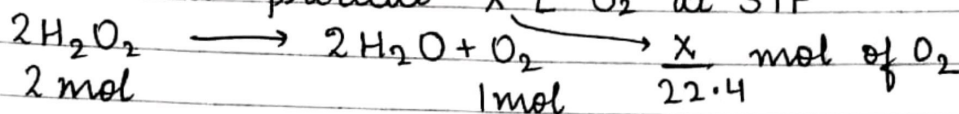
$$\frac{45}{4} = W = 11.25 \text{ gm}$$

Volume Strength of  $H_2O_2$  :- The volume of  $O_2$  produced by decomposition of unit volume of  $H_2O_2$  at NTP/STP

Relation b/w vol. strength of  $H_2O_2$ , M, N & W/V % :-

Let vol. strength of  $H_2O_2$  is 'X' V

→ 1 L  $H_2O_2$  will produce 'X' L  $O_2$  at STP



1 mol of  $O_2$  is obtained by decomposition of = 2 mol  $H_2O_2$

$$\frac{X}{22.4} \text{ mol} \xrightarrow{=} \frac{X \times 2}{22.4}$$

$$= \frac{X}{11.2} \text{ mol of } H_2O_2$$

① Molarity =  $\frac{\text{no. of moles}}{\text{Vol (L)}}$

$$M = \frac{\frac{X}{11.2}}{1} = \frac{X}{11.2} \text{ mol L}^{-1}$$

$$M = \frac{X}{11.2} *$$

② density  $M = \frac{n}{V} = \frac{w}{M_w \times V} = \frac{d}{M_w}$

$$d = M \times M_w$$

$$d = \frac{X}{11.2} \times 34$$

③ Normality  $N = M \times n\text{-factor}$

$$= \frac{X}{11.2} \times 2$$

$$N = \frac{X}{5.6} *$$

④ Strength :  $S = N \times E$

$$S = \frac{X}{5.6} \times 17 \text{ g/L}$$

$$E = \frac{34}{2} = 17$$



$$\textcircled{5} \quad \% \text{ w/v} = \frac{x}{5.6 \times 1000} \times 17 \times 100$$
$$= \frac{x}{5.6} \times \frac{17}{10}$$

Ques Find vol. strength of 1.5 N  $\text{H}_2\text{O}_2$  sol<sup>n</sup>?

$$N = \frac{x}{5.6}$$

$$1.5 \times 5.6 = x = 8.40 = 8.4 \text{ L}$$

Ques Calculate strength of 44.8 V  $\text{H}_2\text{O}_2$  sol<sup>n</sup> in terms of ① Molarity ② Normality ③ Strength ④ % w/v

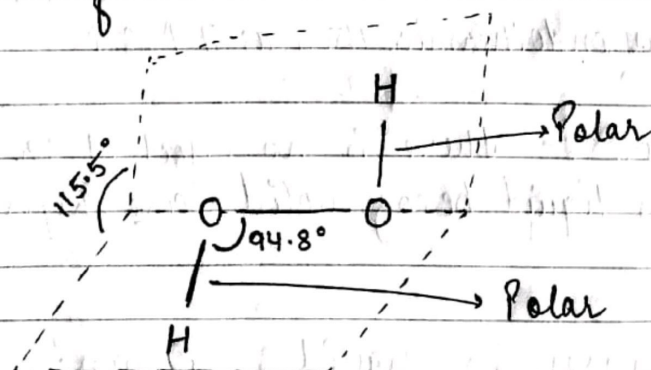
$$\textcircled{1} \quad \text{Molarity} = \frac{x}{11.2} = \frac{44.8}{11.2} = 4$$

$$\textcircled{2} \quad \text{Normality} = \frac{x}{5.6} = \frac{44.8}{5.6} = 8$$

$$\textcircled{3} \quad \text{Strength} = N \times E$$
$$= \frac{x}{5.6} \times 17 \text{ g/L} = 8 \times 17 = 136 \text{ g/L}$$

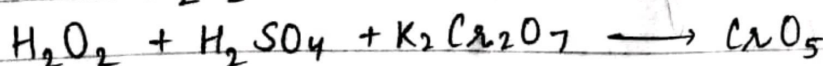
$$\textcircled{4} \quad \% \text{ w/v} = \frac{x}{5.6} \times \frac{17}{10} = \frac{136}{10} = 13.6$$

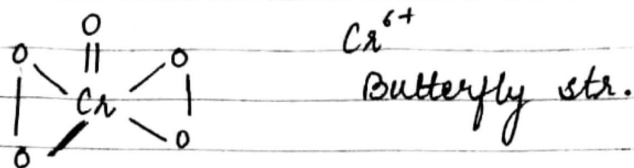
Structure of  $\text{H}_2\text{O}_2$  :-



Test of  $\text{H}_2\text{O}_2$

↳  $\text{H}_2\text{O}_2$  reacts with Titanic acid  $\text{Ti}(\text{OH})_4$





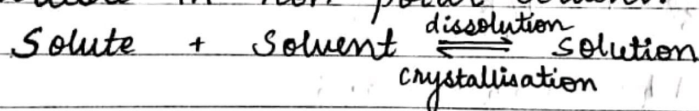
**Solubility** :- The max<sup>m</sup> amt. of solute dissolved in a specified amt of solvent at spec const. Temp.

Solubility depends upon

1. Nature of solute
2. Nature of Solvent
3. Temp.
4. Pressure

**Solubility Principle** :: Like dissolve like

Solubility of solids in liquid : Polar solute are soluble in polar solvent & non-polar solute are soluble in non-polar solvent.



**Effect of Temp.** :-

If dissolution process is exothermic then as  $T \uparrow$  Solubility  $\downarrow$   
If dissolution process is endothermic then as  $T \uparrow$   $S \uparrow$

**Effect of Pressure** :- There is no effect of Pr. on solubility of solid in liquid becoz solid are highly incompressible.

**Solubility of gases in liquid** :- Depends upon

Nature of Gas :

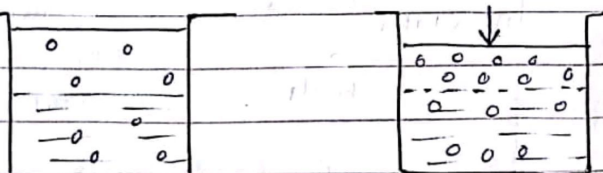
eg  $NH_3$  &  $HCl$  are highly soluble then  $O_2$ ,  $N_2$  &  $He$  are slightly soluble.



Temperature :-

Dissolution of gas in liquid is an endothermic process like condensation ( $G_{gas} + liq.$ ) as  $Temp \uparrow$  Sol.  $\downarrow$   
eg: aquatic animals remains in cold water  
Reason: Gas dissolution  $\uparrow$

Pressure: Pr.  $\uparrow$  Sol.  $\uparrow$



**Henry's Law**: It states that at constant temp. solubility of a gas in liquid is directly proportional to pressure of gas.  
OR

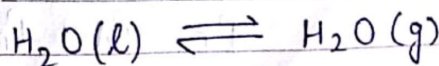
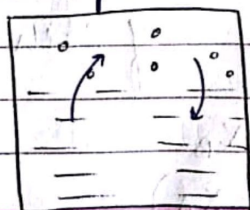
Mole fraction of a gas in sol<sup>n</sup> is directly proportional to Partial Pressure of the gas over sol<sup>n</sup>.  
OR

The partial Pressure of the gas in vapour Phase (P) is proportional to mole fraction of the gas in sol<sup>n</sup>.  
 $P \propto X$

$$P = K_H X$$

$K_H \rightarrow$  Henry's const  
 $T \uparrow$  Sol.  $\downarrow$   $X \downarrow$   $K_H \uparrow$

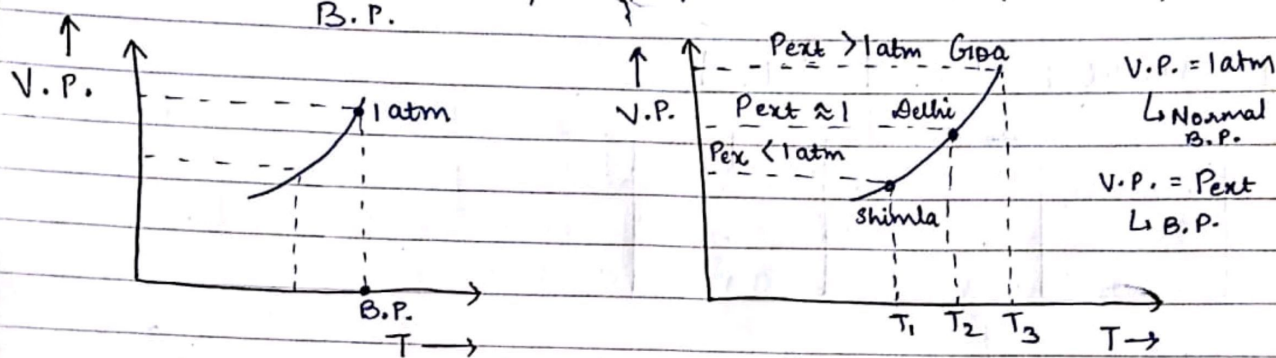
The Pressure exerted by vapour of liquid on its surface when liquid & vapours are in eq<sup>m</sup>.



### Factors affecting Vapour Pressure :-

1. Nature of liq. :- More vol volatile liq. VP ↑
2. Temp. :

Boiling Point: The temp. at which V.P. becomes equal to atmospheric press. Or ext. pr. is e/a

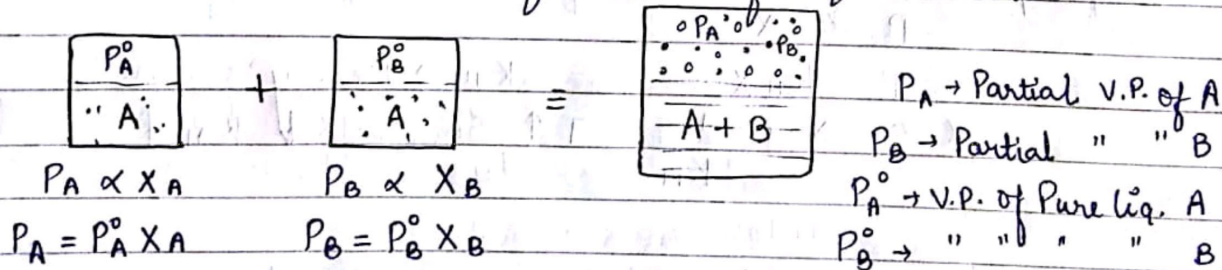


$P_{ext} \uparrow$	$P_{ext} \downarrow$
V.P. ↑	V.P. ↓
B.P. ↑	B.P. ↓

Cooking time ↓      Cooking time ↑

### V.P. of a liquid-liquid Solutions :- (i.e. both liq. are volatile)

Raoult's Law :- The V.P. of a liquid is directly proportional to mole fraction of liq. in sol<sup>n</sup>.



Total Pr. = sum of Partial Pr. of each compd.

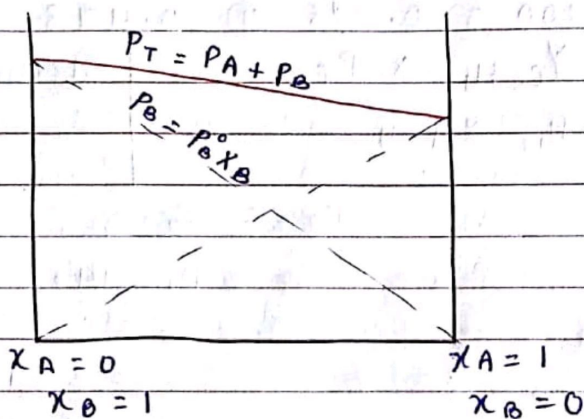
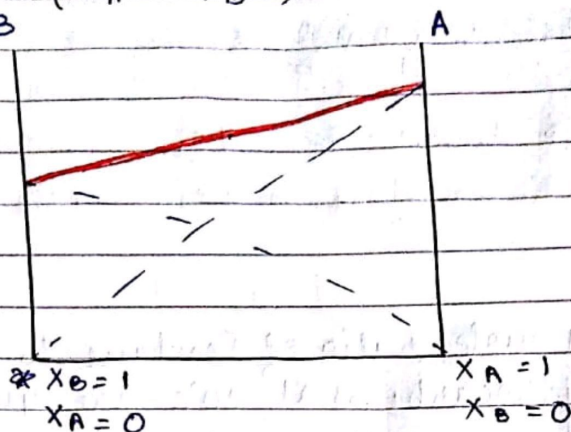
$$P_T = P_A + P_B$$

$$P_T = P_A^0 X_A + P_B^0 X_B$$

$$P_T = P_A^0 X_A + P_B^0 (1 - X_A)$$



$$P_T = (P_A^\circ - P_B^\circ) X_A + P_B^\circ \quad A > B$$



Mole fraction of A & B in vapour phase :-  
Dalton's law

Partial Pr. = mole fraction  $\times$   $P_T$

$$P_A = Y_A \times P_T$$

$$P_A^\circ X_A = Y_A \times P_T$$

$$P_B = Y_B \times P_T$$

$$P_B^\circ X_B = Y_B \times P_T$$

$Y_A$   $\rightarrow$  mole fraction of A in vapour phase

$Y_B$   $\rightarrow$  mole fraction of B in vapour phase

Ques The V.P. of a liquid P & Q are 80 & 60 torr resp.  
The total V.P. of sol<sup>n</sup> obtain by 3 moles of P &  
2 moles Q would be.

- ① 140 torr    ② 20 torr    ③ 68 torr    ④ 72 torr

$$P_T = P_A^\circ X_A + P_B^\circ X_B$$

$$= \frac{80}{5} \times 3 + \frac{60}{11} \times \frac{2}{5}$$

$$= 48 + 22 = 70$$

Ques A sol<sup>n</sup> has 1:4 mole ratio of Pentane to hexane. The V.P. of pure hydrocarbons at 20°C are 440 mm of Hg for pentane & 120 mm of Hg for hexane. The mole fraction of Pentane in vapour phase would be -

- ① 0.549    ② 0.200    ③ 0.786    ④ 0.478

$$P_{C_5H_{12}}^\circ X_{C_5H_{12}} = Y_{C_5H_{12}} \times P_T$$

$$\frac{440}{88} \times \frac{1}{5} = Y_{C_5H_{12}} \times 184$$

$$\frac{n_{C_5H_{12}}}{n_{C_6H_{14}}} = \frac{1}{4}$$

$$Y_{C_5H_{12}} = \frac{88}{184} \times 2$$

$$Y_{C_5H_{12}} = 0.478$$

~~$$P_T = 440 \times \frac{1}{5} + 120 \times \frac{4}{5}$$~~

$$P_T = 88 + 96 = 184$$

For solid - liq. sol<sup>n</sup> :-

A → solvent (liquid) → volatile

B → solute (solid) → non-volatile

⇒ V.P. of liquid in pure state →  $P_A^\circ$

V.P. of solid in pure state →  $P_B^\circ = 0$

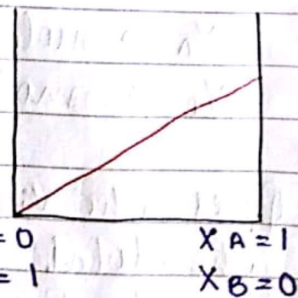
$$P_T = P_A + P_B$$

$$P_T = P_A^\circ X_A + P_B^\circ X_B$$

$$P_T = P_A^\circ X_A$$

$$P_T = P_A^\circ \frac{N}{n+N}$$

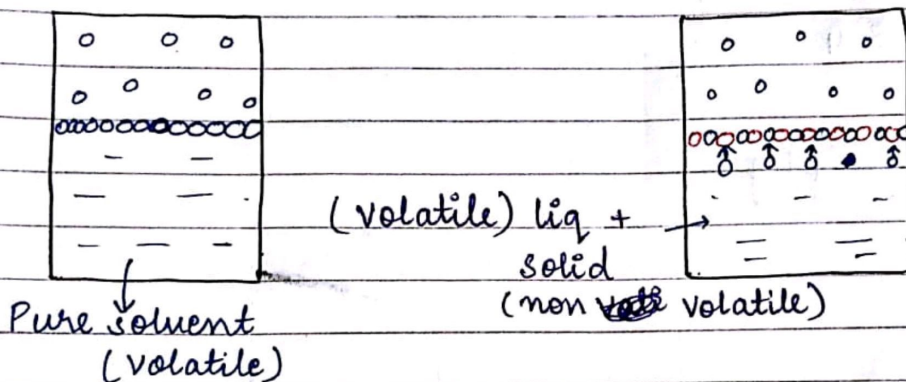
N → moles of solvent  
n → moles of solute





→ In solid-liquid sol<sup>n</sup>, v.p. of sol<sup>n</sup> is directly proportional to mole fraction of solvent (i.e. amt. of volatile component)

When a non-volatile solute is added to volatile solvent then its vapour Pressure decrease because some surface is covered by non-volatile solute so less vapours are formed hence V.P. ↓ ses.



$n$  → mole of solute (non volatile)

$N$  → moles of solvent (volatile)

$P^\circ$  → V.P. of pure solvent

$$P_T = P_A^\circ X_A + P_B^\circ X_B$$

$$P_T = P^\circ \times \frac{N}{n+N}$$

$$\frac{P_T}{P^\circ} = \frac{N}{n+N}$$

$$\frac{P^\circ}{P_T} = \frac{n+N}{N}$$

$$\frac{P^\circ}{P_T} = \frac{n}{N} + 1$$

$$\frac{P^\circ - P_T}{P_T} = \frac{n}{N}$$

→ to find out wt. & molecular wt. of solute / solvent

$$P^\circ - P_T = \Delta P \rightarrow \text{relative lowering V.P.}$$

Ques The vapour pressure at a given temp. of an ideal sol<sup>n</sup> containing 0.2 mole of a non-volatile solute & 0.8 mole of solvent is 60 mm of Hg. Find vapour pressure of pure solvent at same T.

- (a) 150 mm of Hg (b) 60 mm of Hg (c) 75 mm of Hg (d) 120 mm of Hg

$$\frac{P^{\circ} - P_T}{P_T} = \frac{n}{N}$$

$$\frac{P^{\circ} - 60}{60} = \frac{0.2}{0.8}$$

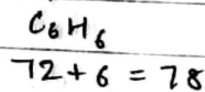
$$P^{\circ} - 60 = 15$$

$$P^{\circ} = 75 \text{ mm of Hg}$$

Ques Vapour Pressure of benzene at 30°C is 121.8 mm of Hg when 15g of non-volatile solute is dissolved in 250g of benzene its Vapour Pr. is used to 120.2 mm of Hg. Find Mw of solute.

- (1) 356.2 (2) 456.3 (3) 350 (4) 530.1 (5) 656.7

$$\frac{121.8 - 120.2}{120.2} = \frac{15}{\text{Mw} \times \frac{250}{78}}$$



$$\frac{1.6}{120.2} = \frac{15 \times 78}{\text{Mw} \times 250}$$

$$\text{Mw} = \frac{234 \times 120.2}{50 \times 1.6}$$

$$= \frac{234 \times 120.2}{80} \times 10^2$$

$$= 58.5 \times 6 = 351.0$$

Ques If v.p. of a sol<sup>n</sup> a Glucose in (water) is 750 mm at 373K. Find out (1) mole fraction of Glucose (2) Molality of sol<sup>n</sup>



$$P_T = P_A^{\circ} X_A + P_B^{\circ} X_B$$

$$750 = 760 X_A$$

$$X_A = \frac{750}{760} = \frac{75}{76}$$

$$X_B = 1 - X_A = 1 - \frac{75}{76} = \frac{1}{76}$$

$$\textcircled{2} m = \frac{\text{no. moles}}{\text{wt (kg)}} = \frac{\frac{1}{76}}{\frac{75 \times 18}{76 \times 1000}} = \frac{1}{75} \times \frac{1000}{18} = \frac{1}{75} \times 55.5$$

Que: V.P. of pure water is 112.5 mm of Hg at 300K. Find out the V.P. of 1 molal sol<sup>n</sup> of a non-volatile solute in it?

1 mol of solute + nt 1 kg solvent  
 $\rightarrow 1000g$   $n = \frac{1000}{18} = 55.5$

$$P_T = P_A^{\circ} X_A + P_B^{\circ} X_B$$

$$= 112.5 \times \frac{55.5}{1 + 55.5}$$

$$P_T = 112.5 \times \frac{55.5}{56.5}$$

Que: Calc. the wt. of non-volatile solute, should be dissolved in 78g benzene to reduce its V.P. to 80%?

(Given  $M_w^{\text{of solute}} = 60g/mol$ )

$$\frac{100 - 80}{80} = \frac{w/60}{78/78}$$

$$\frac{20}{80} = \frac{w}{60}$$

$$w = \frac{60 \times 20}{80} = 15 \text{ gm}$$

$$P^{\circ} = 100$$

$$P_T = 80$$

Ques The V.P. of liq. A & B are in ratio of  $P_A^0 : P_B^0 = 1:2$  at certain temp., the mole ratio of A & B in liq. sol<sup>n</sup> is 1:2,  $\frac{1}{5}$  what is mole fraction of A in vapour phase?

$$\frac{n_A}{n_B} = \frac{1}{2} = \frac{x_A}{x_B}$$

$$\frac{P_A^0 x_A}{P_B^0 x_B} = \frac{Y_A \times P_T}{Y_B \times P_T}$$

$$\frac{1}{2} \times \frac{1}{2} = \frac{Y_A}{Y_B} = \frac{1}{4} = \frac{n'_A}{n'_B}$$

$$Y_A = \frac{1}{5}$$

Ques 2 liq. A & B form an ideal sol<sup>n</sup> at 30°C. The V.P. of sol<sup>n</sup> = 2 mol of A & 3 mol of B is 600 mm of Hg. But if 1 mol of A & 4 moles of B are mixed then the V.P. of sol<sup>n</sup> formed is 620 mm of Hg. what is V.P. of pure A & pure B?

$$P_T = P_A^0 x_A + P_B^0 x_B$$

$$600 = P_A^0 \cdot \frac{2}{5} + P_B^0 \left(\frac{3}{5}\right) \quad \text{--- (1)}$$

$$620 = P_A^0 \cdot \frac{1}{5} + P_B^0 \cdot \frac{4}{5} \quad \text{--- (2)}$$

$$\frac{30 \cdot 600}{31} = \frac{6 \cdot \frac{1}{5} (2P_A^0 + 3P_B^0)}{1 \cdot \frac{1}{5} (P_A^0 + 4P_B^0)}$$

$$\frac{30}{31} = \frac{2P_A^0 + 3P_B^0}{P_A^0 + 4P_B^0}$$

$$30P_A^0 + 120P_B^0 = 62P_A^0 + 93P_B^0$$

$$27P_B^0 = 32P_A^0$$

$$\frac{27}{32} = \frac{P_A^0}{P_B^0}$$

Ques The V.P. of mix of 2 volatile compound A & B is  $P = 254 - 119x$  mm of Hg ( $x$  = mole fraction of B in liq. sol<sup>n</sup>) Find  $P_A^0$  &  $P_B^0$

$$P_T = 254 - 119x$$

$$= P_A^0 x_A + P_B^0 x_B$$



$$P_T = P_A^\circ (1 - X_B) + P_B^\circ X_B$$

$$P_T = P_A^\circ + (P_B^\circ - P_A^\circ) X_B$$

$$P_T = P_A^\circ - (P_A^\circ - P_B^\circ) X_B$$

$$P_A^\circ = 254 \text{ mm of Hg}$$

$$P_A^\circ - P_B^\circ = 119$$

$$254 - 119 = P_B^\circ$$

$$P_B^\circ = 135 \text{ mm of Hg}$$

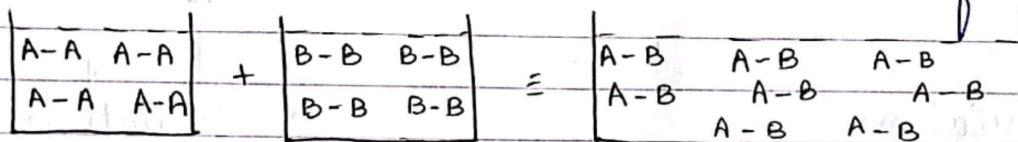
V. Imp  
\*\*

### Ideal solution :-

Sol<sup>n</sup> which follow Raoult's law at all Temp. & all conc<sup>n</sup>, called ideal sol<sup>n</sup>.

- $\Delta H_{mix} \neq 0$   $\Delta H_{mix} = 0$  i.e. there is no change in heat during form<sup>n</sup> of sol<sup>n</sup>

$$\Delta V_{mix} = 0 \quad \text{Vol. of sol}^n = \text{Vol}^m \text{ of solute} + \text{Vol}^m \text{ of solvent}$$

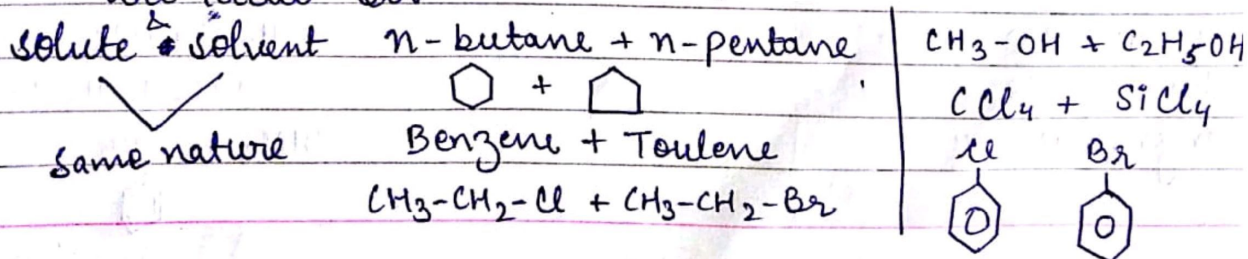


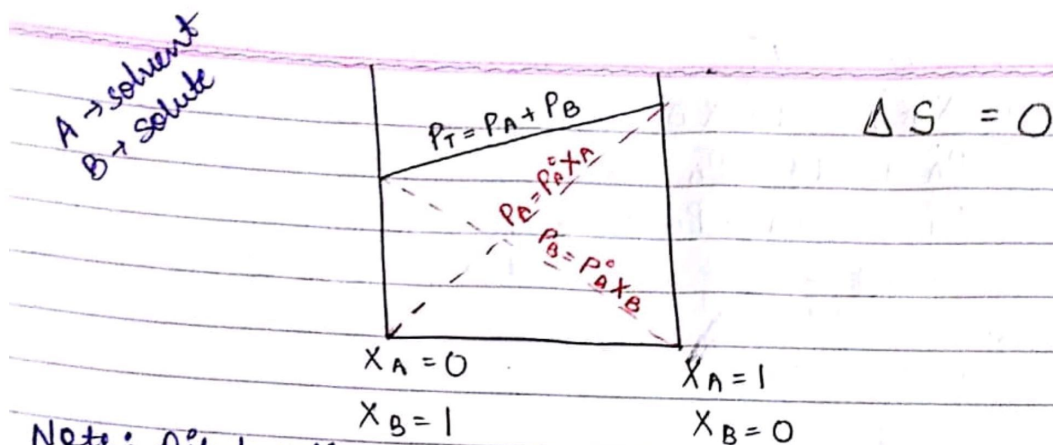
solvent (A)                  solute (B)

Forces of interaction b/w solute + Forces of interaction b/w solvent = Forces of interaction b/w solute & solvent particles

A-A + B-B = A-B

Note: No sol<sup>n</sup> is ideal / perfect sol<sup>n</sup> however sol<sup>n</sup>s which have same type of solute & solvent particles are ideal sol<sup>n</sup>





Note: Dilute sol<sup>n</sup> are considered as ideal sol<sup>n</sup> becoz amt. of solute is very less therefore effect of interaction b/w molecules (A-B) are ~~not~~ neg<sup>t</sup> neg

V.P.  
**Real sol<sup>n</sup> / Non-Ideal sol<sup>n</sup> :-**  
→ sol<sup>n</sup> which does not follow Raoult's law.

Observed V.P. (exp.)  $\neq$  calculated V.P. (Theo.)

observed B.P.  $\neq$  calculated B.P.

+ve Deviation

→ observed V.P. > calculated V.P.

$\Delta H_{mix} > 0$

$\Delta V_{mix} > 0$

A-A & B-B > A-B

Obs. B.P. < Calc. B.P.

eg CCl<sub>4</sub> & CHCl<sub>3</sub>

CCl<sub>4</sub> & C<sub>2</sub>H<sub>5</sub>OH

Benzene & CCl<sub>4</sub>

\* C<sub>2</sub>H<sub>5</sub>OH & CH<sub>3</sub>-C(=O)-CH<sub>3</sub>

C<sub>2</sub>H<sub>5</sub>OH & H<sub>2</sub>O

Phenol & CS<sub>2</sub>

Benzene & acetone

$\Delta S > 0$

-ve Deviation

observed VP < calc. V.P.

$\Delta H_{mix} < 0$

$\Delta V_{mix} < 0$

A-A & B-B < A-B

Obs. B.P. > Cal. B.P.

CHCl<sub>3</sub> + CH<sub>3</sub>-C(=O)-CH<sub>3</sub>

H<sub>2</sub>O & HNO<sub>3</sub>

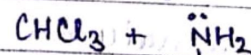
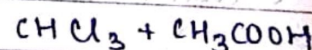
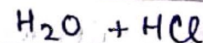
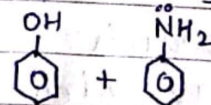
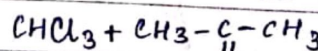
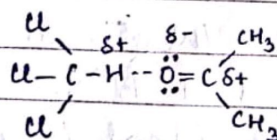
OH + NH<sub>2</sub>

H<sub>2</sub>O + HCl

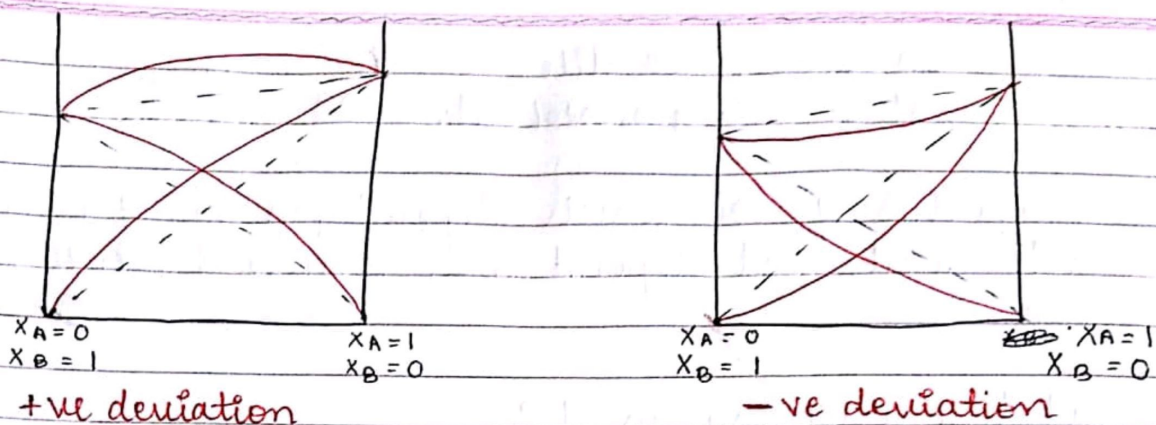
CHCl<sub>3</sub> + CH<sub>3</sub>COOH

CHCl<sub>3</sub> + NH<sub>2</sub>

$\Delta S < 0$







+ve deviation

-ve deviation

**Azeotropic Mixture** :- These are constant Boiling Mixture.

Azeotrops are formed by mixing 2 different liquid in a fixed proportion so that the whole mixture boils at const. boiling temp.

\* Azeotrops can't be separated by fractional distillation.

→ **Fractional Distillation** :-

Method of separating 2 liquids from their mixture on the basis of their different B.P.

Two types of Azeotropics :-

Min<sup>m</sup> Boiling azeotrops ; Max<sup>m</sup> Boiling azeotrops.

eg: +ve deviation real sol<sup>n</sup> | -ve deviation real sol<sup>n</sup>.

eg: $C_2H_5OH + H_2O$	eg: $H_2O + HNO_3$
95% 5%	32% 68%

B.P. of azeotrops < B.P. of mix. | component

## Colligative Properties :-

solvent  $\rightarrow$  volatile  $\rightarrow$  A  
solute  $\rightarrow$  non volatile  $\rightarrow$  B ] V.P.  $\downarrow$

The properties of sol<sup>n</sup> which depend upon no. of particles in sol<sup>n</sup> and not depend upon nature & identity of solute.

1. Relative lowering in V.P.
2. Elevation in B.P.
3. Depression in Freezing Point
4. Osmotic Pressure

These all 4 properties are connected with V.P.

### 1. Relative Lowering in V.P. :-

solvent  $\rightarrow$  volatile  $\rightarrow$  A  $\rightarrow$  N moles  
solute  $\rightarrow$  non volatile  $\rightarrow$  B  $\rightarrow$  n moles ] V.P.  $\downarrow$

$$\hookrightarrow P_B^\circ = 0$$

-	-
sol <sup>n</sup>	
-	-

Acc<sup>n</sup> to Raoult's law

$$P_T = P_A + P_B$$

$$P_T = P_A^\circ X_A + P_B^\circ X_B$$

$$P_T = P_A^\circ X_A$$

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

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

$$\frac{P_A^\circ - P_T}{P_A^\circ} = \frac{n}{n+N}$$

relative lowering of V.P.  $\leftarrow$   $\frac{\Delta P}{P_A^\circ} = \frac{n}{n+N}$

dilute sol<sup>n</sup>

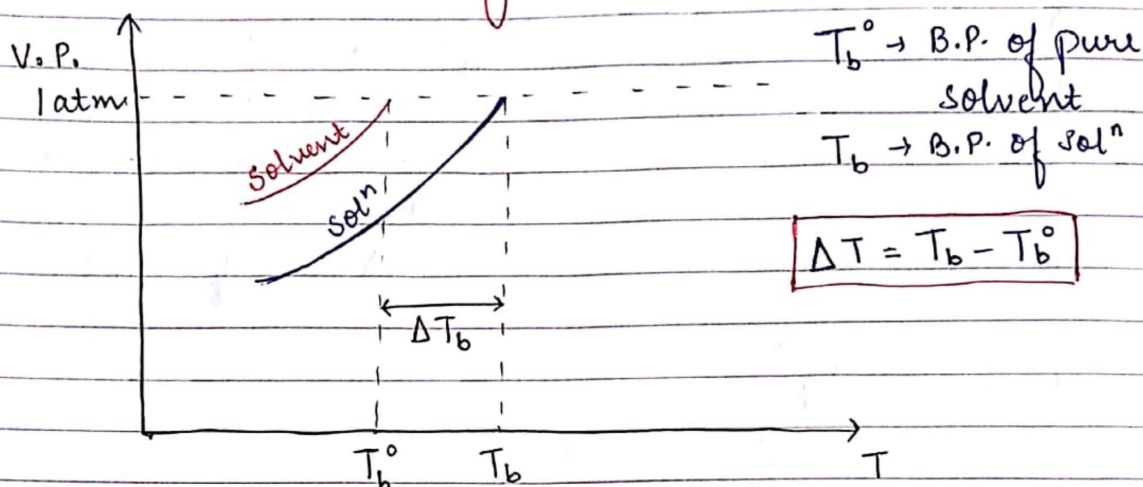
$$n+N \approx N$$

$$\frac{\Delta P}{P_A^\circ} = \frac{n}{N}$$



$$\frac{\Delta P}{P_A^0} = \frac{W_B / M_B}{W_A / M_A}$$

## 2. Elevation in Boiling Point ( $\Delta T_b$ ) :-



$\Delta T_b$  is directly proportional to molality

$$\Delta T_b \propto m$$

$$\Delta T_b = K_b m$$

Unit of  $K_b \rightarrow K \text{ kg mol}^{-1}$

$K_b \rightarrow$  Elevation const. /  
Molal Elevation const  
or

Ebullioscopic const.

$$\Delta T_b = K_b \times \frac{W_B / M_B}{W_A / 1000}$$

$$m = \frac{n_{\text{solute}}}{W_{\text{solvent}} (\text{in kg})}$$

$$\Delta T_b = K_b \times \frac{W_B \times 1000}{M_B \times W_A}$$

To calculate  
molar  
mass  
of solute

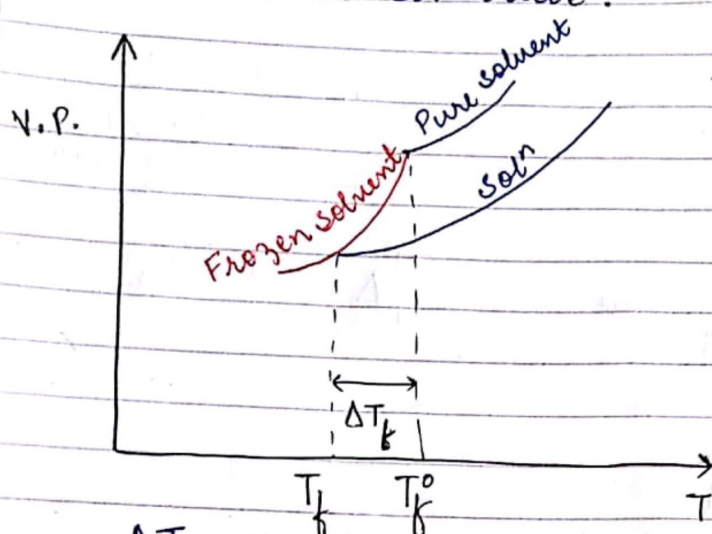
$$M_B = \frac{K_b \times W_B \times 1000}{\Delta T_b \times W_A}$$

$$K_b = \frac{R \times M_A \times T_b^{02}}{1000 \times \Delta_{\text{vap}} H}$$

$R \rightarrow$  Universal gas const.  
 $M_A \rightarrow$  molar mass of solvent  
 $T_b^0 \rightarrow$  B.P. of pure solvent  
 $\Delta_{\text{vap}} H \rightarrow$  Heat of vap.

### 3. Depression in Freezing Point ( $\Delta T_f$ )

Freezing Point  $\div$  The temp. at which vapour Pressure of solvent in liq. phase is same that of V.P. in solid state.



$T_f^0 \rightarrow$  F.P. of Pure solvent in liq. Phase

$T_f \rightarrow$  F.P. when non-volatile solute is added in it

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

$\Delta T_f$  is directly proportional to molality

$$\Delta T_f \propto m$$

$$\Delta T_f = K_f m$$

Unit of  $K_f \rightarrow K \text{ kg mol}^{-1}$

$K_f \rightarrow$  Depression const / molal Depression const  
(cryoscopic const.)

$$\Delta T_f = K_f \times \frac{W_B / M_B}{W_A / 1000}$$

$$\Delta T_f = K_f \times \frac{W_B \times 1000}{M_B \times W_A}$$

to calculate molar mass of solute

$$M_B = \frac{K_f \times W_B \times 1000}{\Delta T_f \times W_A}$$

$$K_f = \frac{R \times M_A \times T_f^{02}}{1000 \times \Delta_{\text{fusion}} H}$$

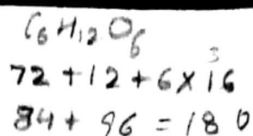
$R \rightarrow$  Universal gas const.

$M_A \rightarrow$  molar mass of solvent

$T_f^0 \rightarrow$  F.P. of pure solvent

$\Delta H_{\text{fusion}} \rightarrow$  heat of fusion





27

NCERT

Ques 36 g of glucose is dissolved in 500 gm water. At what temp. will be water boil? ( $K_b$ )<sub>water</sub> = 0.52 K kg mol<sup>-1</sup>

$$\Delta T_b = \frac{K_b \times W_B \times 1000}{M_B \times W_A}$$

$$\begin{aligned} &= \frac{0.52 \times 36 \times 1000}{180 \times 500} \\ &= \frac{104}{5 \times 100} \end{aligned}$$

$$\Delta T_b = 20.8 \times 10^{-2}$$

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

$$\Delta T_b + T_b^0 = T_b$$

$$0.2008 + 373 = T_b$$

$$T_b = 373.208$$

$$\begin{aligned} W_B &= 36 \text{ g} \\ W_A &= 500 \text{ g} \\ K_b &= 0.52 \end{aligned}$$

Ques The B.P. of Benzene is 353.23 K when 180 g non-volatile solute was dissolved in 90 g of Benzene. The B.P. is raised to 354.11 K. Calc. molar mass of solute  $K_b$  for benzene = 2.53 K kg mol<sup>-1</sup>

$$M_B = \frac{K_b \times W_B \times 1000}{\Delta T_b \times W_A}$$

$$\begin{aligned} &= \frac{2.53 \times 180 \times 1000}{0.88 \times 90} \\ &= \frac{2530}{44} = 57.5 \text{ gm} \end{aligned}$$

$$= \frac{2530}{44} = 57.5 \text{ gm}$$

$$\Delta T_b = 0.88$$

$$\begin{aligned} &354.11 \\ &353.23 \\ &----- \\ &0.88 \end{aligned}$$

$$\begin{aligned} &2 \frac{44}{.88} \\ &220 \\ &88 \\ &----- \\ &308 \end{aligned}$$

Ques B.P. of water at 750 mm of Hg is 99.63°C How much sucrose is to be added to 500 gm of water such that it boils at 100°C

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

$$= 100 - 99.63 = 0.37^\circ\text{C}$$

$$\Delta T_b = K_b m$$

$$\Delta T_b = K_b \times \frac{W_B / M_B \times 1000}{W_A}$$

$$0.37 = 0.52 \times \frac{W_B \times 1000}{342 \times 500}$$

$$\frac{0.37}{0.52} \times \frac{171}{342} = W_B$$

$$W_B = \frac{63.27}{0.52} = 121.67 \text{ g kg}^{-1}$$

$72 + 8 + 96 = 80 + 96$   
 $176$

Ques Calc. Mass of Ascorbic Acid (Vitamin C,  $C_6H_8O_6$ ) to be dissolved in 75 gm of acetic acid to lower its M.P. by ~~1.5~~  $1.5^\circ C$  ( $K_f = 3.9 \text{ K kg mol}^{-1}$ )

$$M_B = \frac{K_f \times W_B \times 1000}{\Delta T_f \times W_A}$$

$$W_B = \frac{M_B \times \Delta T_f \times W_A}{K_f \times 1000}$$

$$= \frac{176 \times 1.5 \times 75}{3.9 \times 1000}$$

$$W_B = 5.076 \text{ gm}$$

Ques A sol<sup>n</sup> of sucrose (Molar Mass =  $342 \text{ gmol}^{-1}$ ) has been prepared by dissolving 68.5 gm of sucrose in 1000 gm of water. The f.p. of sol<sup>n</sup> will be - (water  $\rightarrow K_f \approx 1.86 \text{ K kg mol}^{-1}$ )

- ①  $-0.372^\circ C$  ②  $-0.520^\circ C$  ③  $+0.372^\circ C$  ④  $-0.570^\circ C$

$$\Delta T_f = \frac{K_f \times W_B \times 1000}{M_B \times W_A}$$

$$= \frac{1.86 \times 68.5 \times 1000}{342 \times 1000}$$



$$\Delta T_f = 0.3725$$

$$\Delta T_f = T_b^{\circ} - T_f$$

$$T_f = T_b^{\circ} - \Delta T_f$$

$$= 273 - 0.3725$$

$$T_f = 272.6275 \text{ K}$$

AIRMT

Ques

A sol<sup>n</sup> of urea (Molar Mass = 56 gm mol<sup>-1</sup>) boils at 100.18 °C at atm. pressure. If  $K_f$  &  $K_b$  for water are 1.86 K kg mol<sup>-1</sup> & 0.512 K kg mol<sup>-1</sup> resp. The above sol<sup>n</sup> will freeze at.

- ① - 6.54 °C    ② 6.54 °C    ③ 0.654 °C    ④ -0.654 °C

$$\Delta T_f = \frac{K_f \times W_B \times 1000}{M_B \times W_A}$$

$$\Delta T_b = \frac{K_b \times W_B \times 1000}{M_B \times W_A}$$

$$\frac{\Delta T_f}{\Delta T_b} = \frac{K_f}{K_b}$$

$$\frac{\Delta T_b}{100.18 - 100} = \frac{1.86}{0.512}$$

$$\Delta T_b = \frac{1.86 \times 0.18}{0.512} = 0.3348$$

$$= 0.6539^{\circ}\text{C}$$

$$\Delta T_f = T_b^{\circ} - T_f$$

$$T_f = T_b^{\circ} - \Delta T_f$$

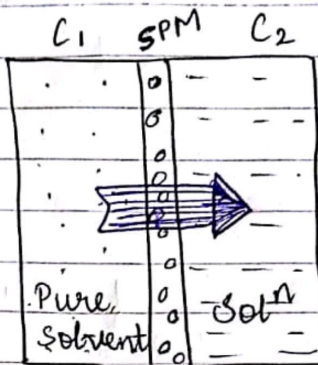
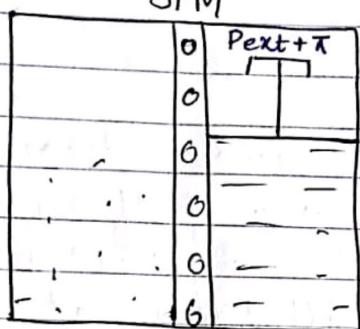
$$= 273 - 0.6539$$

$$= 272.346 \text{ K}$$

$$= -0.65^{\circ}\text{C}$$

4. Iso & Osmosis :- The flow of liquid from low dilute sol<sup>n</sup> (low conc<sup>n</sup>) to concentrated sol<sup>n</sup> (high conc<sup>n</sup>) through semi permeable membrane is c/a osmosis.

Osmotic Pressure ( $\pi$ ) :



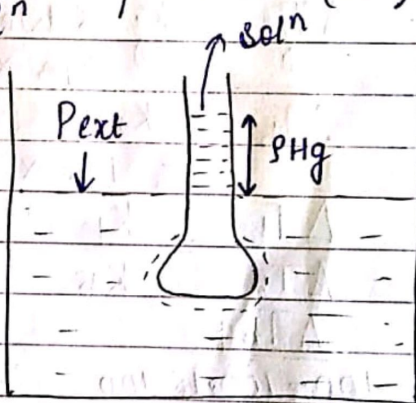
The min<sup>m</sup> ext. pr. required to apply on sol<sup>n</sup> side to prevent osmosis, is c/a Osmotic pressure ( $\pi$ )  
Osmotic pr.  $\propto$  conc. of sol<sup>n</sup>

$$\pi \propto C$$

$$\pi = CRT$$

$$\pi = \frac{n_B}{V} RT$$

$$\pi = \frac{W_B / M_B}{V} RT$$



Formula to calculate  $M_w$  to solute.

$$M_B = \frac{W_B RT}{\pi V}$$

AIPMT

This method is used to find M.w. of biomolecules like proteins, polymers & other macromolecules becoz they are not stable at high temp.

Type of Solution :-

1. Isotonic sol<sup>n</sup> : Two sol<sup>n</sup> have same osmotic pressure at a given temp. c/a isotonic sol<sup>n</sup>.



When these 2 sol<sup>n</sup> are separated by SPM there is no osmosis.

2. Hypertonic & Hypotonic sol<sup>n</sup> :-  
Osmotic pr. of blood  $\approx 0.9\%$  ( $\frac{W}{V}$ ) of NaCl

Hypertonic sol<sup>n</sup> :-

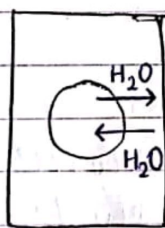
Sol<sup>n</sup> which have conc<sup>n</sup> more than  $0.9\%$   $\frac{W}{V}$  NaCl

→ when cell is placed in such sol<sup>n</sup> water will flow out of cell and cell would shrink.

Hypotonic sol<sup>n</sup> :-

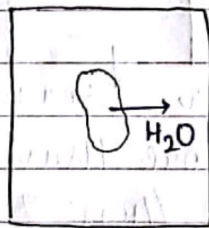
Sol<sup>n</sup> which have conc<sup>n</sup> less than  $0.9\%$   $\frac{W}{V}$  NaCl.

→ when cell is placed in such sol<sup>n</sup> water will flow inside the cell and cell would swell up.



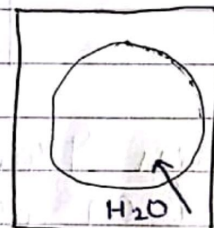
conc.  $\approx 0.9\%$   $\frac{W}{V}$  NaCl

→ isotonic



conc.  $> 0.9\%$   $\frac{W}{V}$  NaCl

→ hypertonic  
cell shrink



conc<sup>n</sup>  $< 0.9\%$   $\frac{W}{V}$  NaCl

Hypotonic sol<sup>n</sup>

**Edema** :- When a person take a lot of salt or salty food water comes out of RBC & water retention in tissue take place which cause intracellular space resulting in swelling, this is known as edema.

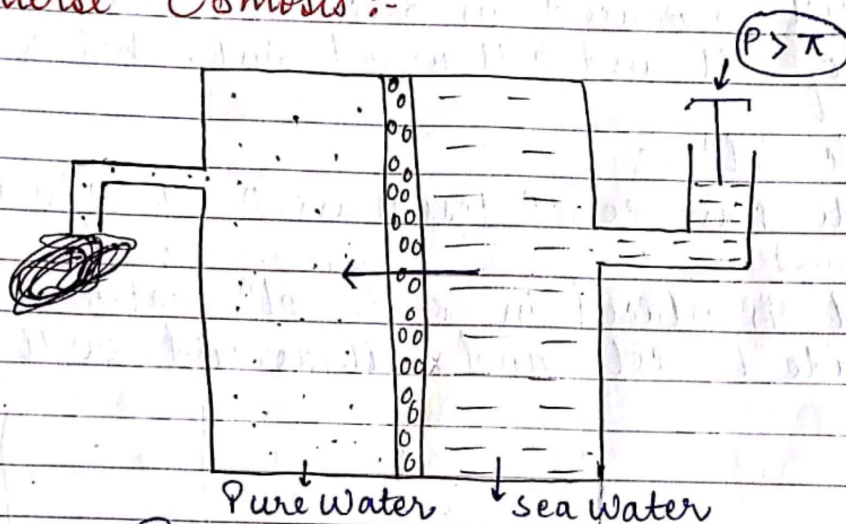
### Other Example of Osmosis :-

- Raw mangoes placed in salty water loses water via osmosis & shrivel into pickles.
- Wilted flower revive when placed in water

### Isohydric Solutions :-

2 sol<sup>n</sup>s which have same  $H^+$  conc<sup>n</sup> i.e. same pH  
c/a isohydric sol<sup>n</sup>.

### Reverse Osmosis :-



When Pressure more than osmotic Pressure is applied on sol<sup>n</sup> side then  $\phi$  molecules flow from sol<sup>n</sup> to solvent. This process is k/n as reverse osmosis.

AIPMT

Que 1 A 5% sol<sup>n</sup> of cane sugar ( $M_w = 342$ ) is isotonic with 1% sol<sup>n</sup> of a substance X. The Mol. wt. of X is -

- ① 34.2    ② 171.2    ③ 68.4    ④ 136.8

$$\pi_1 = \pi_2$$

$$\frac{5}{100} \times \frac{1}{342} RT = \frac{1}{100} RT$$

$$\frac{5}{342} = \frac{1}{M}$$

$$M = \frac{342}{5} = 68.4$$

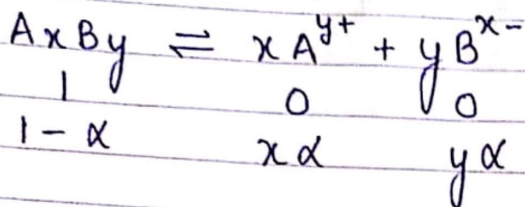




### Dissociation :-

no. of Particles  $\uparrow$   
 $i > 1 \Rightarrow$  Obs. C.P.  $>$  Calc. C.P.

normal molar mass  $>$  abnormal molar mass



$$\begin{aligned}
 \text{Total mole after dissociation} &= 1 - \alpha + x\alpha + y\alpha \\
 &= 1 - \alpha + (x+y)\alpha \\
 &= 1 - \alpha + n\alpha
 \end{aligned}$$

$$i = \frac{\text{total moles after dissociation}}{\text{total moles before dissociation}}$$

$$\begin{aligned}
 x+y &= n \\
 n &= \text{Total dissociat} \\
 &\quad \text{moles ion}
 \end{aligned}$$

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

For strong electrolyte  
DOD = 100%  $\alpha = 1$

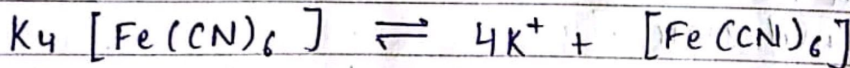
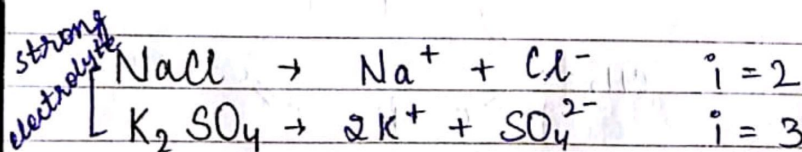
Calculation of DOD  $\leftarrow$

$$i = 1 + (n-1)\alpha$$

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

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

$$i = n$$



(1) If  $\alpha = 100\%$   $\alpha = \frac{i-1}{n-1}$

$$i = n$$

$$i = 5$$

(2) If  $\alpha = 50\%$   $\frac{50}{100} = \frac{i-1}{5-1}$

$$5-1 = 2i-2$$



$$4 = 2i - 2$$

$$i = 3$$

Observed C.P. =  $i$  Calc. C.P.

$$\frac{\Delta P}{P^0} = i \times \frac{n}{N}$$

$$\pi = i CRT$$

$$\Delta T_b = i \times K_b m$$

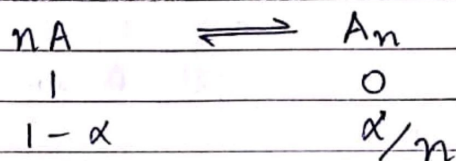
$$\pi = i \frac{n_B RT}{V}$$

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

Association :  $i < 1$

obs. C.P. < Calc. C.P.

normal molar mass < abnormal molar mass



Total moles after association =  $1 - \alpha + \alpha/n = 1 - (1 - \frac{1}{n})\alpha$

Total moles before association = 1

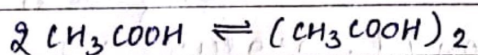
$$i = \frac{1 - (1 - \frac{1}{n})\alpha}{1}$$

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

D.O.D = 100%

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

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



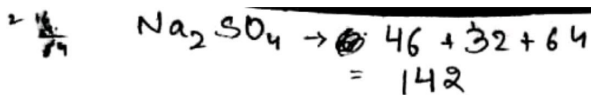
$$i = \frac{1}{2}$$

~~AIPMT-II~~

Ques The F.P. depression const. for water is  $-1.86^\circ\text{Cm}^{-1}$ . If 5.00 g  $\text{Na}_2\text{SO}_4$  is dissolved in 45.0 g  $\text{H}_2\text{O}$ . The F.P. is changed by  $-3.82^\circ\text{C}$ . Calculate the van't Hoff factor for  $\text{Na}_2\text{SO}_4$ .

$$\Delta T_f = i K_f m$$

$$\begin{array}{r} 273 \\ - 3.82 \\ \hline 269.18 \end{array}$$



~~$$269.18 = +3.82 = i \times (1.86) \times \frac{5}{142} \times 1000$$~~

$$\frac{1.86 \times 1000}{372}$$

$$3 \times 382 \times 45 \times 142 = i$$

$$\frac{43}{31} + 1.86 \times 5 \times 1000$$

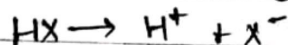
$$\begin{array}{r} 381 \\ 71 \\ \hline 381 \\ 26670 \\ \hline 27051 \end{array}$$

$$i = \frac{382 \times 3 \times 71}{31 \times 1000} = \frac{381 \times 3 \times 71}{31 \times 1000}$$

$$\approx 2.7051$$

Ques 0.5 molal aq. soln of a weak acid HX is 20% ionised.  
If  $K_f$  for water is  $1.86 \text{ kg mol}^{-1}$  The lowering in F.P. of  
soln is -

- ①  $-1.12 \text{ K}$  ②  $0.56 \text{ K}$  ③  $1.12 \text{ K}$  ④  $-0.56 \text{ K}$



$$\alpha = \frac{i-1}{n-1} = 0.20 = \frac{i-1}{2-1}$$

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

$$= 1.20 \times 1.86 \times 0.5$$

~~$$= 0.200 \times 600 \times 1.86$$~~

$$\Delta T_f = 1.116 \text{ }^\circ\text{C}$$

$$0.20 = \frac{i-1}{1}$$

$$0.20 + 1 = i$$

$$i = 1.20$$

Ques A  $0.0020 \text{ m}$  aq. soln of an ionic compd.  $\text{Co}(\text{NH}_3)_5(\text{NO}_2)$  ll Freeze at  $-0.00732 \text{ }^\circ\text{C}$ . No. of moles  
of ion which 1 mol of ionic compd. produces on  
being dissolved in water will be ( $K_f = -1.86 \text{ }^\circ\text{C/m}$ )

- ① 2 ② 3 ③ 4 ④ 1

$\Delta T$



Ques • 2.925 g of NaCl is dissolved in 100g water  
Determine B.P. of sol<sup>n</sup> ( $K_b$  for water =  $0.52 \text{ K kg mol}^{-1}$ )

$$\Delta T_b = K_b m$$

$$T_b - 373 = 0.52 \times \frac{2.925}{58.5} \times 1000$$

$$T_b = 0.52 \times \frac{2.925 \times 1000}{100 \times 58.5}$$
$$= \frac{52 \times 5 \times 10}{10000 \times 200} = 0.2$$

Calc. % DOD of <sup>an</sup> electrolyte  $XY_2$  (Normal  
 $M_w = 164$ ) in water. If observed  $M_w$  by  
measuring elevation in bp is 0.56.

$$i = 0.56$$

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

$$n = 1 + 2 = 3$$

$$\alpha \% = \frac{0.56 - 1}{3 - 1} \times 100\%$$

=

Ques F.P. of 0.01M aq. sol<sup>n</sup> of  $K_3[Fe(CN)_6]$  is  $-0.062$   
 $^{\circ}\text{C}$  what is  $\alpha$  for this complex. ( $K_f$  for water  
 $= 1.26 \text{ kg/mol}^{-1}$ )

$$\Delta T_b = i K_b m$$

$$0 - (-0.062) = i \times 1.26 \times 0.01$$

$$\frac{0.062}{1.26 \times 0.01} = i$$

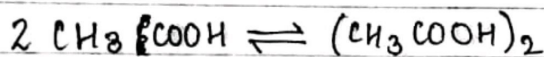
$$i = 4.9 \approx 5$$

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

$$\alpha = \frac{5 - 1}{4 - 1} = \frac{4}{3}$$

Que 1 molal carboxylic acid in benzene shows a elevation in B.P. of 1.518 K. Calculate Degree of dissociation for dimerisation of acid in benzene  $K_b$  for benzene = 2.53 K Kg mol<sup>-1</sup>

$$\Delta T_b = i K_b m \quad \rightarrow \quad i = \frac{\Delta T_b}{K_b m} = \frac{1.518}{2.53 \times 1} = 0.6$$



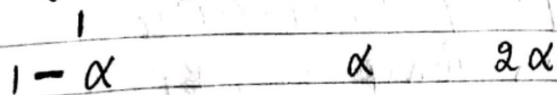
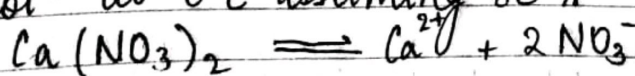
$$i = \frac{1 - \alpha/2}{1}$$

$$0.6 = 1 - \frac{\alpha}{2}$$

$$\frac{\alpha}{2} = 1 - 0.6 = 0.4$$

$$\alpha = 0.8$$

Que Calculate the osmotic pr. of 20% w/v anhy.  $\text{Ca}(\text{NO}_3)_2$  sol<sup>n</sup> at 0°C assuming 80% dissociation.



$$i = \frac{1 - \alpha + \alpha + 2\alpha}{1} = \frac{1 + 2\alpha}{1} = 1 + 2 \times 0.8 = 1 + 1.6 = 2.6$$



$$\begin{aligned} \text{Ca(NO}_3)_2 &= 40 + 28 + 6 \times 16 \\ &= 68 + 96 \\ &= 164 \end{aligned}$$

39

$$\begin{aligned} \pi &= iCRT \\ &= \frac{W}{M} \frac{RT}{V} \times i \end{aligned}$$

20 gm solute + nt  
in 100 ml sol<sup>n</sup>

$$= \frac{20}{164 \times 100} \times \frac{1000}{1000} \times 0.082 \times 273 \times 2.6$$

$$\begin{aligned} \pi &= 27.30 \times 2.6 \\ &= \end{aligned}$$

Que 2 sol<sup>n</sup> of glucose have osmotic pr 1.5 atm & 2.5 atm resp. 1 L of 1<sup>st</sup> sol<sup>n</sup> is mixed with 2 L of 2<sup>nd</sup> sol<sup>n</sup>. Find osmotic Pr. of resultant sol<sup>n</sup>.

$$\begin{aligned} \pi &= iCRT \\ &= \frac{i n}{V} RT \end{aligned}$$

$$\pi = \frac{i n}{V} RT$$

$$\frac{\pi V}{RT} = i n$$

$$\begin{aligned} \pi V_T &= (i n)_{\text{Total}} RT \\ &= \left( \frac{\pi_1 V_1}{RT} + \frac{\pi_2 V_2}{RT} \right) RT \end{aligned}$$

$$\begin{aligned} \pi V_T &= \pi_1 V_1 + \pi_2 V_2 \\ &= 1.5 \times 1 + 2.5 \times 2 \end{aligned}$$

$$\begin{aligned} \pi \times 3 &= 1.5 + 5.0 = 6.5 \\ \pi &= \frac{6.5}{3} = 2.1 \end{aligned}$$

Que Following sol<sup>n</sup> are given arrange them in  $\uparrow$  order of V.P., B.P., F.P. & O.P. sol<sup>n</sup>.

① 1 M sugar  $i=1$     ② 1 M  $\text{Na}_2\text{SO}_4$   $i=3$     ③ 1 M KCl  $i=2$     ④ 1 M  $\text{Al}_2(\text{SO}_4)_3$   $i=5$

V.P.  $\rightarrow$  4 < 2 < 3 < 1  
B.P.  $\rightarrow$  1 < 3 < 2 < 4  
F.P.  $\rightarrow$  4 < 2 < 3 < 1  
O.P.  $\rightarrow$  1 < 3 < 2 < 4

$\Delta T_b = T_b - T_b^\circ$	$\Delta T_f = T_f^\circ - T_f$	$P^\circ - P_T = \Delta P$	$\pi = iCRT$
$\Delta T_b + T_b^\circ = T_b$	$T_b = T_b^\circ - \Delta T_f$	$P^\circ - \Delta P = P_T$	
B.P. $\uparrow$	F.P. $\downarrow$	V.P. $\downarrow$	

Ques Find max<sup>n</sup> & min<sup>n</sup> c.p. of following aq. sol<sup>n</sup>.

① 1% w/v sugar	② 1% w/v urea	③ 1% w/v Na <sub>2</sub> SO <sub>4</sub>	④ 1% w/v NaCl
$C = \frac{1/342 \times 1000}{100}$	$C = \frac{1/60 \times 1000}{100}$	$C = \frac{1/142 \times 1000}{100}$	$C = \frac{1/58.5 \times 1000}{100}$
$C = \frac{10}{342}$	$C = \frac{10}{60}$	$C = \frac{10}{142}$	$C = \frac{10}{58.5}$
$i \times C = 0.029$ ↓ min <sup>m</sup>	$= \frac{1}{6} = 0.16$	$= 3 \times \frac{10}{142} = 0.211$	$= 0.34$ ↓ max

c.p. & Observed conc<sup>n</sup> (i x c)

AIPMT-14

Ques which of the following sol<sup>n</sup> will exhibit the largest F.P. depression?

- ① KCl    ② C<sub>6</sub>H<sub>12</sub>O<sub>6</sub>    ③ Al<sub>2</sub>(SO<sub>4</sub>)<sub>3</sub>    ④ K<sub>2</sub>SO<sub>4</sub>
- $i = 2$                        $i = 1$                        $i = 5$                        $k = 3$

$$\Delta T_{\bullet f} = i K_f m$$

Ques An aq. sol<sup>n</sup> is 1.00 m in KI which change will cause ↑ in v.p. of sol<sup>n</sup>.

- ① add<sup>n</sup> of NaCl    ② Add<sup>n</sup> of Na<sub>2</sub>SO<sub>4</sub>    ③ Add<sup>n</sup> 1.00 molal KI  
④ add<sup>n</sup> of water



Ques which of the following aq. sol<sup>n</sup> have min<sup>m</sup> F.P.?

- ①  $0.01\text{ M NaCl}$   $i=2$   $T_f = T_f^\circ - 0.02 K_f$   
②  $0.005\text{ m MgI}_2$   $i=3$   $T_f = T_f^\circ - 0.015 K_f$   
③  $0.005\text{ m C}_2\text{H}_5\text{OH}$   $i=2$   $T_f = T_f^\circ - 0.010 K_f$   
④  $0.005\text{ m MgSO}_4$   $i=2$   $T_f = T_f^\circ - 0.010 K_f$

$$\Delta T_f = T_f^\circ - T_f$$
$$T_f = T_f^\circ - \Delta T_f$$