

SOLUTION

A **Solution** is a homogeneous mixture of two or more substance. Where one is **solute** & one is **solvent**.

□ **Solute**: Sub. which is found in less amount of sol.

□ **Solvent**: Sub. which is found in more amount of solution.

Solute + Solvent

less amount.

more amt.

Binary Solution:

Binary solution means a solution which contains only 1 solute & 1 solvent.

Homogeneous Solution:

Homogeneous means a solution which can't be separated by normal physical method.

Eg: Ethanol + water

Salt + water.

Sugar + water.

* According to the Binary Sol.

Three Types

Gaseous Sol.

Liquid Sol.

Solid Sol.

① Gaseous Solution.

① Gas + Gas eg: Air $\rightarrow$ $O_2 + N_2$
21% + 78%.

② Liquid + Gas eg: Chloroform ($CHCl_3$)
mix in N_2 gas.

③ Solid + Gas eg: Camphor in N_2 gas.

② Liquid Solutions.

① Gas + liq eg: O_2 in water.

② Liq + Liq eg: Ethanol + water.

③ Solid + Liq eg: Sugar + water
Salt + water.

③ Solid Solutions.

① Gas + solid eg: hydrogen mix in
Palladium.

② Liq + Solid eg: Amalgam (alloy liq.)
Na, Amalgam.

③ Solid + Solid eg: Alloy
Steel, Bronze, Brass.

Expressions of Sol.

① $\frac{\text{Weight \%}}{\text{Weight}}$ or $\frac{\text{Mass \%}}{\text{Mass}}$ or Mass fraction or $\frac{W \%}{W}, \frac{M \%}{M}$

$$\frac{\text{Weight of solute}}{\text{Weight of solution}} \times 100\% \quad \underline{\text{Unit} = \%}$$

$W_A = \text{Solute}$
 $W_B = \text{Solvent}$

$$\frac{W \%}{W} = \frac{W_A}{W_A + W_B} \times 100\%$$

② $\frac{\text{Volume \%}}{\text{Volume}}$ or Volume fraction %

$$\frac{\text{Volume of solute}}{\text{Volume of solution}} \times 100\%$$

$$\frac{V \%}{V} = \frac{V_A}{V_A + V_B} \times 100\%$$

Q.1 10 g of NaOH mix in 15 g of water.
So weight by weight percent.

Solⁿ Given ;
 $W_A = 10\text{g}$

$W_B = 15\text{g}$

$$= \frac{10}{10 + 15} \times 100 = \frac{10}{25} \times 100$$
$$= \underline{40\% \text{ Ans.}}$$

2. If $\frac{w}{w}\%$ of solution is 20% and it is mix in 50 g of water. So calculate weight of solute.?

Sol] Given = $W_A = ?$

$$W_B = 50g.$$

$$\frac{W\%}{W} = 20\%$$

$$\frac{W\%}{W} = \frac{W_A}{W_A + W_B} \times 100\%$$

$$20 = \frac{W_A}{W_A + 50} \times 100$$

$$= \frac{20}{100} = \frac{W_A}{W_A + 50}$$

$$5W_A = 5W_A + 50$$

$$4W_A = 50$$

$$W_A = \frac{50}{4} = 12.5g$$

= 12.5g of solute.

3. If a solution of 24% $\frac{w}{w}$ of weight 15g. So calculate weight of solute and solvent.

Sol] Given:

$$W_A = x$$

$$W_A + W_B = 15$$

$$\frac{W\%}{W} = 24\%$$

$$\frac{W_A \times 100\%}{W_A + 15} = 24\%$$

$$\frac{W_A}{15} = \frac{24}{100}$$

$$W_A = \frac{24 \times 15}{100} = 3.6$$

$$W_A = 3.6g$$

$$W_A + W_B = 15g$$

$$W_B = 15 - 3.6g = 11.4g$$

NOTE: 35% of ethyl glycol uses as anti-freezing in Radiators & other equipments — $17.5^\circ C$

③ Mole fraction.

$$n = \frac{W}{M_w} = \frac{\boxed{\text{32g mole}}}{\boxed{\text{32g mole}}} \quad X_A = \frac{n_A \text{ (mole)}}{n_A + n_B \text{ (mole)}}$$

$$\underline{X_A + X_B = 1}$$

Ques. 4 180g of glucose mix with 180g of water what is the mole fraction of water and glucose?

Sol. $W_{\text{glu}} = 180\text{g.}$

$$M_{w\text{glu}} = 180\text{g.}$$

$$n_{\text{glu}} = \frac{180}{180} = 1 \text{ mole.}$$

$$W_{\text{water}} = 180\text{g.}$$

$$M_{w\text{H}_2\text{O}} = 18\text{g.}$$

$$n_{\text{H}_2\text{O}} = \frac{180}{18} = 10 \text{ mole}$$

$$\text{(i)} X_{\text{glu}} = \frac{n_{\text{glu}}}{n_{\text{glu}} + n_{\text{water}}}$$

$$= \frac{1}{1+10} = \frac{1}{11}$$

$$\text{(ii)} X_{\text{water}} + X_{\text{glu}} = 1$$

$$X_{\text{water}} = 1 - \frac{1}{11}$$

$$= \frac{11-1}{11} = \frac{10}{11}$$

⑤ 23g of ethanol mix with 32g of methanol calculate the mole fraction of ethanol and methanol.

Sol. $W_{\text{eth}} = 23\text{g.}$

$$W_{\text{meth}} = 32\text{g.}$$

$$n_{\text{eth}} = \frac{23}{46} = 0.5 \text{ mole}$$

$$n_{\text{meth}} = \frac{32}{32} = 1 \text{ mole}$$

$$X_{\text{meth}} = \frac{1}{1+0.5} = \frac{1}{1.5} = \frac{2}{3}$$

$$X_{\text{eth}} = 1 - \frac{2}{3} = \frac{3-2}{3} = \frac{1}{3}$$

6. Ethyl glycol content 20% $\frac{w}{w}$ in water. what is mole fraction of ethyl glycol and water.

Sol.] $W_A = 20$ (Ethyl gly)

$$M_w \text{ ethyl} = 62g$$

$$W_B = 80 \text{ (water)}$$

$$M_w H_2O = 18g$$

$$\frac{w}{w} = \frac{W_A}{W_A + W_B} \times 100\%$$

$$n_{\text{ethyl}} = \frac{20}{62} = 0.32 \text{ mol}$$

$$n_{H_2O} = \frac{80}{18} = 4.44 \text{ mol}$$

$$20\% = \frac{20}{20 + W_B} \times 100\%$$

$$X_{\text{ethylgly}} = \frac{n_{\text{eth}}}{n_{\text{eth}} + n_{H_2O}}$$

$$\frac{20}{100} = \frac{20}{20 + W_B}$$

$$= \frac{0.32}{4.44 + 0.32}$$

$$20 + W_B = 100$$

$$= \frac{0.32}{4.76} = 0.067$$

$$\boxed{W_B = 80}$$

$$X_{H_2O} = 1 - 0.067$$

$$= \underline{\underline{0.93}}$$

④ Molarity. Molarity is defined as number of Solute in per liter(l) of solution.

Another names.

$$M = \frac{\text{mole}}{\text{lit}}$$

$$S = \frac{M(\text{mole})}{V(l)}$$

Active Mass

Concentration.

Unit = Mole per liter.

$$= \text{mole/l}^4$$

$$M = \frac{\text{mole of solute}}{\text{Vol. of sol.}}$$

$$M = \frac{n_A}{V(l)}$$

$$M = \frac{W_A}{M_{WA} \times V(l)}$$

$$M = \frac{W_A \times 1000}{M_{WA} \times V(ml)}$$

7. What is the molarity of solution contains 5g of NaOH in 500 ml of solution.

Sol.]
$$M = \frac{W_A \times 1000}{M_{WA} \times V}$$

Given:

$$W_{NaOH} = 5g$$

$$M_{WNaOH} = 40g$$

$$V = 500 \text{ ml}$$

$$= \frac{5 \times 1000}{40 \times 500}$$

$$= \frac{1}{4} = \underline{\underline{0.25 M}}$$

⑤ Dilution

$$V_{\text{new}} = V_1 + V_{\text{new}}$$

$$M_1 V_1 = M_2 V_2$$

Q.8. 0.6 M NaOH of 100 ml mix with water 500ml
what is new molarity?

Sol.]

$$M_1 = 0.6$$

$$V_1 = 100 \text{ ml}$$

$$M_2 = ?$$

$$V_2 = 100 + 500.$$

$$M_1 V_1 = M_2 V_2.$$

$$0.6 \times 100 = M_2 \times 600.$$

$$\frac{100}{600} = M_2$$

$$\boxed{M_2 = 0.1} \text{ mol. L}^{-1}$$

g. 0.1 M of HCl 10ml mix with 90 ml of H_2O .
what is new concentration (M)?

Sol.]

$$M_1 = 0.1$$

$$V_1 = 10 \text{ ml}$$

$$M_2 = ?$$

$$V_2 = 10 + 90 \\ = 100 \text{ ml.}$$

$$M_1 V_1 = M_2 V_2$$

$$0.1 \times 10 = M_2 \times 100$$

$$M_2 = \frac{1}{100} = 0.01$$

10. 0.5 M of NaOH 100ml + 0.3M of LiOH 100ml
+ 300ml of H_2O . what is new concentration.

Sol.]

$$M_1 V_1 = M_2 V_2 = M (V_1 + V_2 + V_3).$$

$$M = \frac{M_1 V_1 + M_2 V_2}{V_1 + V_2 + V_3} = \frac{0.5 \times 100 + 0.3 \times 100}{500}.$$

$$= \frac{80}{500} = 0.16 \text{ Mol L}^{-1}$$

⑥ Molality

A = solute

B = solvent

mole of solute

weight of solvent (in kg).

$$m = \frac{n_A}{W_B}$$

$$m = \frac{W_A \times 1000}{M_{WA} \times W_B(\text{kg})}$$

★ Molality & Molarity (Density).

(Temp independent)

$M \propto \frac{1}{\text{Temp}}$

$$\frac{1}{m} = \frac{d}{M} = \frac{M_{WA}}{1000}$$

m = molality

d = density

M = molarity

M_{WA} = Molar mass of solute.

$$m = \frac{1000 M}{M_{WA} M - 1000 d}$$

Q.11 What is the molality of the solution. Content 2.5 g of ethanoic acid. CH_3COOH in 75 g of benzene?

Solⁿ

$$M = ?$$

$$W_A = 2.5 \text{ g.}$$

$$M_{WA} = 60 \text{ g.}$$

$$W_B = 75 \text{ g.}$$

$$m = \frac{W_A \times 1000}{M_{WA} \times W_B(\text{kg})}$$

$$m = \frac{2.5 \times 1000}{60 \times 75}$$

$$m = 0.55 \text{ mol/kg of solvent.}$$

12. 8g of NaOH is dissolved in 18g of H_2O .
Mole fraction of NaOH in solution and
molality (in mol kg^{-1}) of the solutions
respectively are:

a) 0.167, 11.11

b) 0.2, 22.20

c) 0.2, 11.11

d) 0.167, 22.20.

Given : $W_{NaOH} = 8g$.

$W_{H_2O} = 18g$.

$n_{NaOH} = \frac{8}{40} = 0.2 \text{ mole.}$

$n_{H_2O} = \frac{18}{18} = 1 \text{ mole.}$

Mole fraction.

Molality.

$$X_{NaOH} = \frac{n_{NaOH}}{n_{NaOH} + n_{H_2O}}$$

$$m = \frac{W_{NaOH} \times 1000}{M_{NaOH} \times W_{H_2O}}$$

$$= \frac{0.2 \times 10}{1 + 1} = 0.167$$

$$m = \frac{8 \times 1000}{40 \times 18}$$

$$= 11.11 \text{ mol/kg of solvent.}$$

2.5. Calculate (a) molality (b) molarity & (c) mole fraction of KI if the density of 20% (mass/mass) aq. KI is 1.202 g ml^{-1}

Sol. $\frac{w\%}{w} = 20\%$

$$m = \frac{\frac{20}{166}}{\frac{80}{1000}} = 1.51 \text{ mol.}$$

$$\text{Volume} = \frac{m}{d} = \frac{20}{1.2} = 83.2$$

$$\text{Molarity} = \frac{.120 \times 1000}{83.2} = 1.44 \text{ m.}$$

Molarity

The ratio of moles of solute to the volume of solution in liters.

$$\text{Units} = M$$

$$\frac{\text{moles solute}}{\text{liters sol.}}$$

Volume (in l)

Molality

The ratio of moles of solute to the volume

$$\text{units} = m$$

$$\frac{\text{moles solute}}{\text{kg solvent.}}$$

mass (kg)

13. The amount of sugar ($C_{12}H_{22}O_{11}$) required to prepare 2 L of its 0.1 M aqueous solution is:

(a) 68.4 g

(b) 17.1 g

(c) 34.2 g

(d) 136.8 g

$W_{\text{sugar}} = ?$

$V = 2 \text{ lit}$

$= 2 \times 1000 \text{ ml}$

$M_{\text{W sugar}} = C_{12}H_{22}O_{11}$
 $= 342 \text{ g}$

$M = 0.1 \text{ M}$

$$M = \frac{W_{\text{sugar}} \times 1000}{M_{\text{W sugar}} \times V (\text{in ml})}$$

$$= 0.1 = \frac{W_{\text{sugar}} \times 1000}{342 \times 2000}$$

$$W_{\text{sugar}} = 342 \times 2 \times 0.1$$

$$= 68.4 \text{ g}$$

14. In one molal solution that contains 0.5 mole of a solute, there is

(a) 500g of solvent

(c) 1000g of solvent

(b) 100ml of solvent

(d) 500ml of solvent

Given, A = solute
B = solvent

$$m = \frac{W_A \times 1000}{M_{\text{W A}} \times W_B}$$

$m = 1 \text{ mole/kg of solvent}$

$\frac{W_A}{M_{\text{W A}}} = n_A = 0.5$

$1 = \frac{0.5 \times 1000}{W_B}$

$W = 500 \text{ g of solvent}$

15. Which of the following is dependent on temperature?

- a) Molality
- ~~b) molarity~~
- c) mole fraction.
- d) Weight percentage.

⑦ Normality

$$N = \frac{\text{gram equivalent of solute}}{\text{Volume of solution (in l)}}$$

$$\text{Gram equivalent} = \frac{W}{\text{Equivalent weight.}}$$

$$\text{Equivalent weight} = \frac{M_w}{\text{Valency factor.}}$$

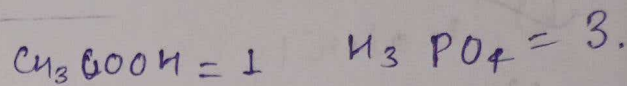
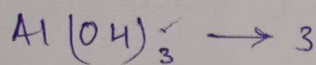
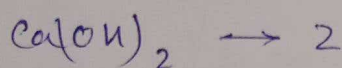
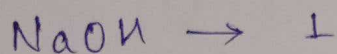
$$g \text{ equi.} = \frac{W}{\frac{M_w}{V.F.}} = \frac{W \times V.F.}{M_w}$$

$$N = \boxed{\frac{W \times V.F. \times 1000}{M_w \times V (\text{in ml})}} = N = \boxed{M \times V.F.}$$

Valence Factor.

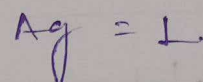
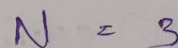
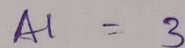
① **Acid** $\rightarrow$ H^+ देने की क्षमता Eg: $HCl = 1$, $H_2SO_4 = 2$:

② **Base** $\rightarrow$ OH^- देने की क्षमता

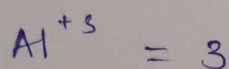
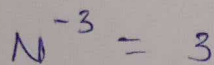
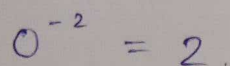
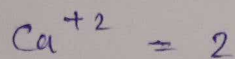


Exception
 $H_3PO_3 = 2.$

③ **Atom** $\rightarrow$ Valency.



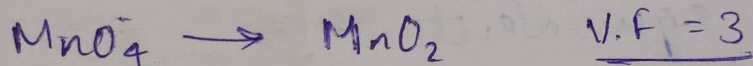
④ **Ion** $\rightarrow$ charge



⑤ **Molecule** $\rightarrow$ Oxidation No.



⑥ **Reaction** $\rightarrow$ No. of e^- transfer.



⑦ what is the normality of a solution content 9.8 g of H_2SO_4 in 500 ml of solution.

Solⁿ $w = 9.8$
 $M_w = 98 g.$

$$V = 500 \text{ ml}$$

$$V.F = 2.$$

$$N = \frac{w \times V.F \times 1000}{M_w \times V.}$$

$$= \frac{9.8 \times 2 \times 1000}{98 \times 500}$$

$$= \frac{4}{10} = 0.4$$

⑧ Parts Per million. (PPM)

$$\text{ppm} = \frac{\text{Part of solute}}{\text{Part of solution}} \times 10^6 = \text{(only for trace solvent)}$$

Q.17. A water sample contain 10 mg in a 100 ml. of solution. so calculate its ppm.

Solⁿ parts of solute = 10 mg = $10 \times 10^{-3} \text{ g}$
part of solution = 100 ml

$$= \frac{10 \times 10^{-3}}{100} \times 10^6 = 10^{-2} \times 10^6 \times 10^{-2} = 100 \text{ ppm.}$$

18. A water sample content. 20 ppm of fluoride solution in 25 ml of solution so amount of fluoride in solution?

Solⁿ ppm = 20 ppm.

part of solution = 25 ml.

Part of solute = ?

$$\text{ppm} = \frac{\text{Part of solute}}{\text{part of solution}} \times 10^6$$

$$20 = \frac{\text{Parts of solute}}{25} \times 10^6$$

$$= 500 \times 10^{-6}$$

$$\text{Parts of solute} = \frac{20 \times 25}{10^6} = 0.5 \text{ mg.}$$

TYPES OF LIQ. SOLUTION

1) Solid + Liq

→ Factors Affecting solid Liquid type of solution.

“Like dissolves Like”

• **Nature**: Polar → Polar solvent → Salt + water

Non polar → non polar solvent → Paint + Petrol
(Turpentine oil)

• **Temperature**: Temperature & Solubility.

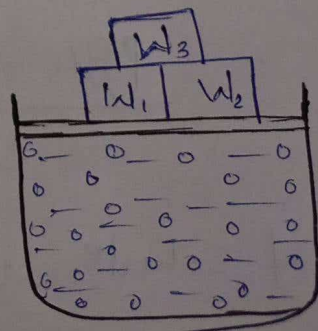
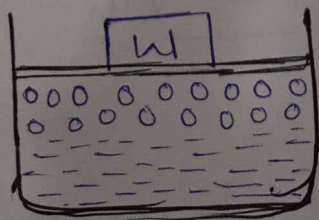
ex: Sugar Syrup.

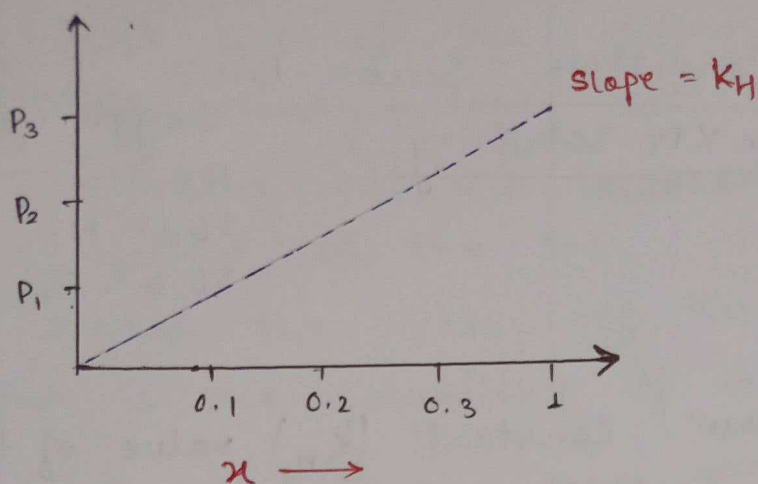
• **Pressure**: Pressure not depends on solid liq. type of solution, the process of dissolving solid substance in liq. is called **dissolution**.

The process of separating solid from sol is called crystallisation.

2) Gas + Liquid

Henry's Law: The solubility of gas in a liq. is directly proportional to the partial pressure of the gas present above the surface of liq. or sol.





$$P \propto x$$

$$P \propto \frac{n_g}{n_g + n_{\text{water}}}$$

$$P = \underbrace{K_H}_{\text{Henry's constant}} x$$

Henry's constant.

- Nature : $K_H \propto \text{Temp} \propto \frac{1}{\text{Solubility}}$.

Q. Which are more soluble.

$K_H \rightarrow$

X	Y
40	95

 $\uparrow$ more soluble

- Temperature : $\text{Temp} \propto K_H \propto \frac{1}{\text{Solubility}}$.

- Pressure : $P \propto x$.

$x = \text{mole frac.}$

- ① Cold Drink : Cold $K_H \propto \text{Temp} \propto \frac{1}{\text{Solubility}}$.

High $P \propto x \propto \text{Solubility}$

- ② Aquatic Animals : feels good in low temp
 $\text{Temp.} \propto K_H \propto \frac{1}{\text{Solubility}}$

- ③ Anoxia : Blood low oxygen due to high altitude

High Altitude, $P \downarrow \propto x \downarrow \propto \text{Solubility} \downarrow$

④ Blood Bends - Condition - Scuba Dive, Oxygen cyl. gases

↓ 10 1 atm
↓ 10 2 atm
↓ 10 3 atm

Partial Solubility

11% He
56.2% N₂
36.6% O₂

19. The Henry's law constant (K_H) value of three gases (A, B, C) in water are 145 , 2×10^{-5} and 35 K, respectively. The solubility of those gases in water follow the order.

(i) $B > A > C$

~~(ii)~~ $B > C > A$

$A = 145$

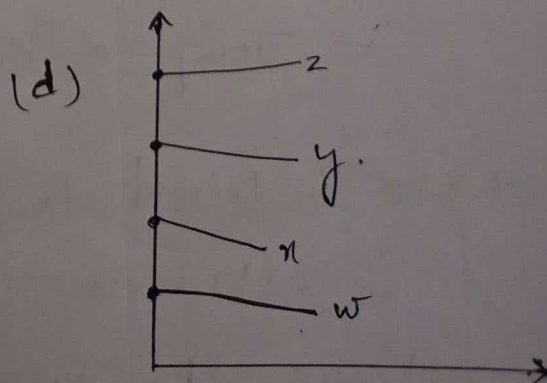
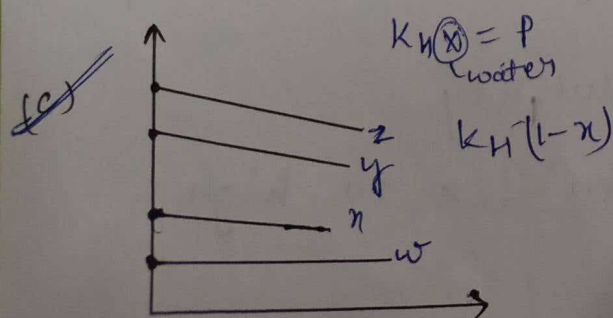
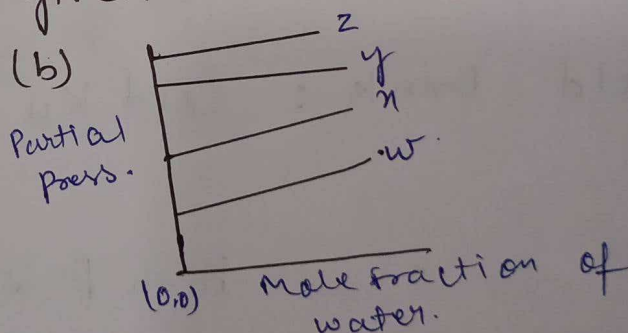
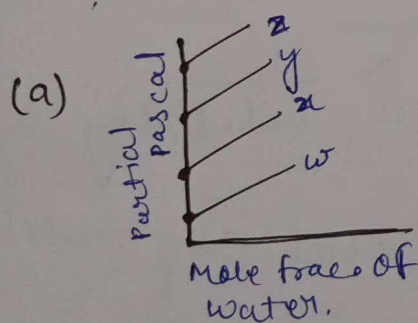
$B = 2 \times 10^{-5}$

$C = 35$

(iii) $A > C > B$

(iv) $A > B > C$

20. For the solution of the gases w, x, y and z in water at 298 K, the Henry's law constant (K_H) are 0.52, 35 and 40 K bar, respectively. The correct plot for the given data is: [JEE Mains 2019]



23. K_H value for $Ar(g)$, $CO_2(g)$, $HCHO(g)$ and $CH_4(g)$ are 40.39, 1.67, 1.83×10^{-5} and 0.413 respectively. Arrange these gases in the order of their increasing solubility, **NCERT Exemplar**.

- a) $HCHO < CH_4 < CO_2 < Ar$
- b) $HCHO < CO_2 < CH_4 < Ar$
- ☒ c) $Ar < CO_2 < CH_4 < HCHO$
- d) $Ar < CH_4 < CO_2 < HCHO$

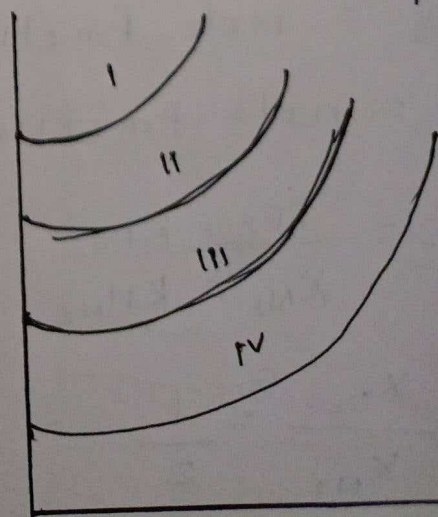
24. Low concentration of O_2 in the blood and tissues of people living at high altitude is due to _____. **(NCERT Exemplar)**

- (a) low temp.
- ☒ (b) low atmospheric pressure.
- (c) high atmo. press.
- (d) both low temp and high atmo. pressure.

25. The value of Henry's constant, K_H is _____.

- a) greater for gases with higher solubility.
- ☒ b) greater for gases with lower solubility.
- c) constant for all gases.
- d) not related to the solubility of gases.

26. The following diagram shows the vapour pressure curves for CH_3F ,



Curves I, II, III & IV respectively are for:

a) CH_3F , HCHO , CH_3OH , CH_3COOH .

b) CH_3COOH , CH_3OH , CH_3F , HCHO .

c) HCHO , CH_3F , CH_3OH , CH_3COOH .

d) CH_3OH , CH_3COOH , HCHO , CH_3F .

$V.P \propto \frac{\text{Intermolecular bond}}{\text{Hydrogen bond.}}$

$\propto \text{EN} - \text{F}$
 $\rightarrow \text{CHO}$
 OH
 COOH .

RAULT'S LAW ~

> Applicable for liq. + liq. solution.

Let us consider a binary solution of 2 volatile liquid which have a different vapour pressure [VP]

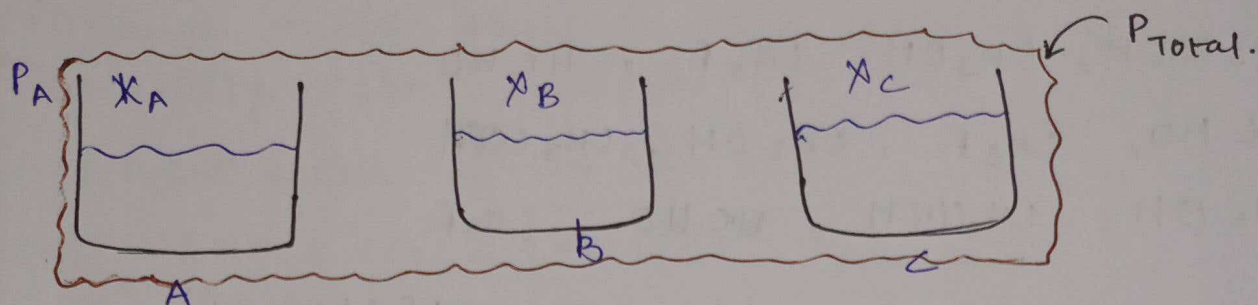
Vapour Pressure:

At a certain temperature volatile liq. converted to this vapour create force per unit area in the wall of container this force are called vapour pressure.

Roult's Law.

Roult's law is a special case of Henry's law & Dalton's partial pressure law.

Dalton's Partial Pressure Law.



$$P_A = X_A \cdot P_{\text{Total}}$$

$$P_B = X_B \cdot P_{\text{Total}}$$

$$P_C = X_C \cdot P_{\text{Total}}$$

$$P_T = P_A + P_B + P_C$$

$$= X_A P_T + X_B P_T + X_C P_T$$

$$= (X_A + X_B + X_C) P_T$$

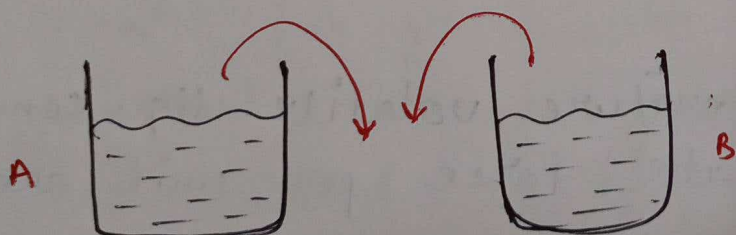
$$P_T = P_T$$

$$\therefore X_A + X_B + X_C = 1$$

ROULT'S V APOUR P RESSURE

$$P_A = P_A^\circ X_A$$

$$P_B = P_B^\circ X_B$$



Volatile Liquid.

$$P_{\text{Total}} = P_A + P_B$$

$$P_{\text{Total}} = P_A^\circ X_A + P_B^\circ X_B$$

$$X_A + X_B = 1$$

$$X_A = 1 - X_B$$

$$* P_T = P_A + P_B$$

$$P_{\text{Total}} = P_A^\circ X_A + P_B^\circ X_B$$

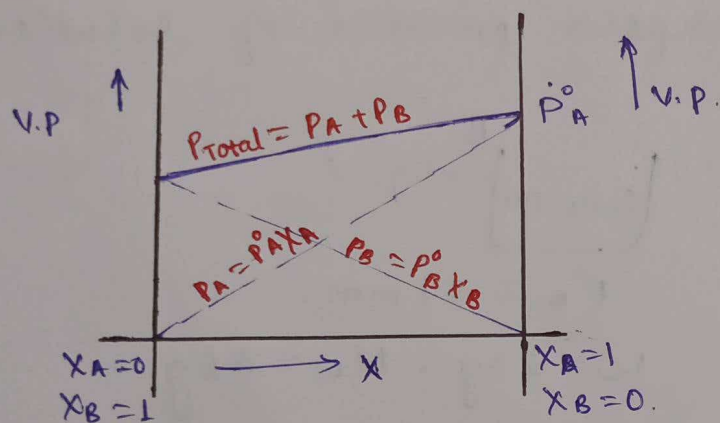
$$= P_A^\circ (1 - X_B) + P_B^\circ X_B$$

$$= P_A^\circ - P_A^\circ X_B + P_B^\circ X_B$$

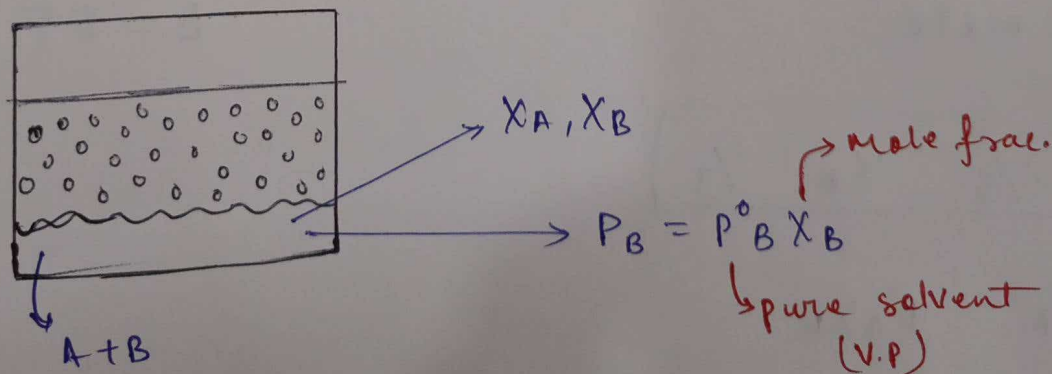
$$= P_A^\circ + P_B^\circ X_B - P_A^\circ X_B$$

$$P_{\text{Total}} = P_A^\circ + (P_B^\circ - P_A^\circ) X_B$$

GRAPH OF ROULT'S LAW



Remember: When question is about mole fraction in Vapour Phase.



Solution: $P_A = P_A^\circ$
Pure solvent.

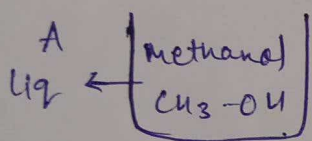
$$y_A = \frac{P_A}{P_{\text{total}}} = \frac{P_A^0 X_A}{P_{\text{total}}}$$

$$y_B = \frac{P_B}{P_{\text{total}}} = \frac{P_B^0 X_B}{P_{\text{total}}}$$

QUESTION ~

Q. Methanol and C_2H_5OH form an ideal solution. Solution is prepared by making 82g of CH_3OH and 23g of C_2H_5OH at 800K & Methanol = 90 mm of Hg and ethanol = 51 mm of Hg. Calculate Partial V.P of its constituents and total vapour pressure of solution.

Sol:

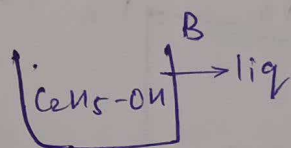


$$P_A^0 = 90 \text{ mm}$$

$$W = 32g, M_w = 32g$$

$$n_A = \frac{W_A}{M_{wA}} = \frac{32}{32} = 1$$

$$A = 1 \text{ mole}$$



$$P_B^0 = 51 \text{ mm}$$

$$W = 23g, M_w = 46g$$

$$n_B = \frac{W_B}{M_{wB}} = \frac{23}{46} = 0.5$$

$$B = 0.5 \text{ mole}$$

$$X_A = \frac{2}{3} \quad X_B = \frac{1}{3}$$

$$P_A = P_A^0 X_A$$

$$P_A = 90 \times \frac{1}{1.5}$$

$$= 60 \text{ mm of Hg}$$

$$P_B = P_B^0 \times X_B$$

$$P_B = \frac{51 \times 0.5}{1 + 0.5} = 51 \times \frac{1}{3} = 17 \text{ mm of Hg.}$$

$$P_{\text{Total}} = P_A^0 \times X_A + P_B^0 \times X_B$$

$$P_{\text{Total}} = \frac{30}{90} \times 2 \frac{2}{3} + \frac{17}{51} \times \frac{1}{3}$$

$$= 60 + 17 = 77 \text{ mm of Hg.}$$

IDEAL SOL

* Which obeys Raoult's Law

Example:

- 1) Toluene + Benzene.
- 2) Chloroethane + Bromoethane.
- 3) n-Hexane + n-Heptane.

i) $P_T = P_A + P_B$

ii) $P_A = P_A^0 X_A$; $P_B = P_B^0 X_B$

iii) $\Delta H_{mix} = 0$

iv) $\Delta V_{mix} = 0$

v) Interaction b/w A-B are equal to A-A & B-B type interaction,

* Graph: Same as Raoult's Law

Non-Ideal Sol

* Don't Obey's Raoult's Law.

* Positive Deviation

i) $P_{Total} > P_A^0 X_A + P_B^0 X_B$

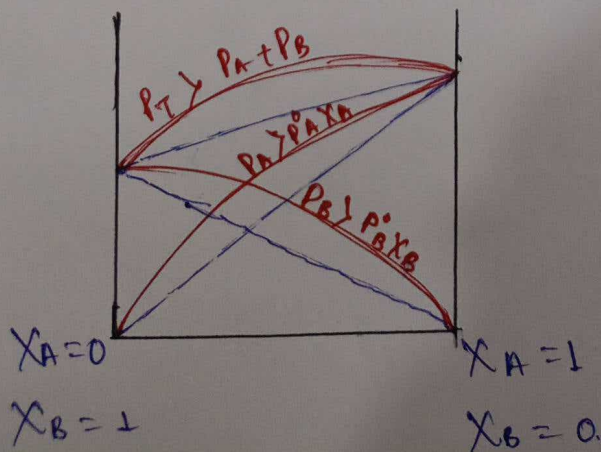
ii) $P_A > P_A^0 X_A$; $P_B > P_B^0 X_B$

iii) $\Delta H_{mix} > 0$

iv) $\Delta V_{mix} > 0$

v) Interaction b/w A-B are weaker than A-A & B-B interaction,

Graph:



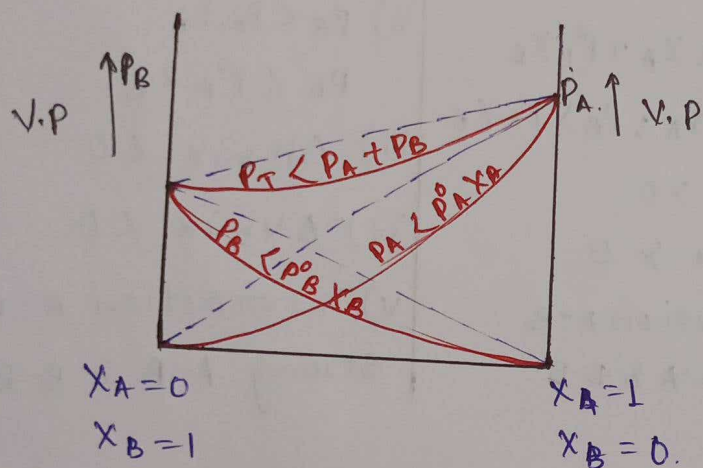
* Negative Deviation.

- i) $P_{\text{Total}} < P_A + P_B$.
- ii) $P_A < P_A^\circ X_A$; $P_B < P_B^\circ X_B$.
- iii) $\Delta H_{\text{mix}} < 0$
- iv) $\Delta V_{\text{mix}} < 0$.
- v) Interaction b/w A-B is always stronger than A-A & B-B interactions.

Example:

- 1) Chloroform + Acetone
- 2) HNO_3 + Water
- 3) Phenol + Aniline.

Graph.



Azotropic Sol

A mixture at fixed temperature its composition are same in liquid phase or in gaseous phase, they are of the two types.

Minimum Boiling Point	Maximum Boiling Point
Eg: $\text{C}_2\text{H}_5\text{OH} + \text{H}_2\text{O}$ 95%, 5% at 65°C	Eg: $\text{HNO}_3 + \text{H}_2\text{O}$ 68%, 32% at 398K
→ Minimum boiling azeo show high +ve deviation in Raoult's law	→ Maximum boiling azeo show high -ve deviation in Raoult's law

Non-Ideal Solution.

Ideal Solution.	Positive Deviation	Negative Deviation.
Obey's Raoult's law 1) $P_T = P_A^0 X_A + P_B^0 X_B$ 2) $P_A = P_A^0 X_A, P_B = P_B^0 X_B$ 3) $\Delta H_{\text{mix}} = 0$ 4) $\Delta V_{\text{mix}} = 0$ 5) Interaction A-B Same as A-A & B-B	Don't obey Raoult's law. i) $P_T > P_A^0 X_A + P_B^0 X_B$ ii) $P_A > P_A^0 X_A, P_B > P_B^0 X_B$ iii) $\Delta H_{\text{mix}} > 0$ iv) $\Delta V_{\text{mix}} > 0$ v) Interaction A-B weaker A-A & B-B	i) $P_T < P_A^0 X_A + P_B^0 X_B$ ii) $P_A < P_A^0 X_A$ $P_B < P_B^0 X_B$ iii) $\Delta H_{\text{mix}} < 0$ iv) $\Delta V_{\text{mix}} < 0$ v) Interaction A-B Strong A-A & B-B

Q. Which one is not correct mathematical equation for Dalton's law of partial pressure? Here P is total pressure of gaseous mix. [NEET 2022]

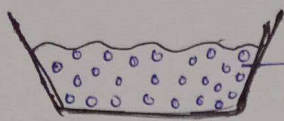
a) $P = n_1 \frac{RT}{V} + n_2 \frac{RT}{V} + n_3 \frac{RT}{V}$

b) $P_i = X_i P$ where P_i = partial pressure of gas X_i mole fraction of gas in gaseous mix.

c) $P = X_i P_i^0$, where P_i , partial pressure of gas in gaseous mixture P_i^0 , pressure of gas in pure state.

d) $P = P_1 + P_2 + P_3$

Pure solvent are called Relative lowering in V.P.



Water + solute non volatile
non-electrolyte.

$$P_{\text{total}} = P_A^\circ X_A + P_B^\circ X_B$$

Non-volatile liquid

$$P_A^\circ = 0$$

$$P_{\text{total}} = P_B^\circ X_B$$

$$P_{\text{total}} = P_B^\circ X_B = P_B$$

$$P_B = P_B^\circ X_B$$

$$\therefore X_B = 1 - X_A$$

$$P_B = P_B^\circ (1 - X_A)$$

$$P_B = P_B^\circ - P_B^\circ X_A$$

$$P_B^\circ - P_B = P_B^\circ X_A$$

$$P_B^\circ - P_B = \text{low in V.P.}$$

$$\Delta P = P_B^\circ X_A$$

$$\frac{\Delta P}{P_B^\circ} = X_A$$

NOTE: If P_B° not given
take 760 torr, 760 mm of Hg
or 1 atm

Relative low in V.P.

$$\frac{\Delta P}{P_B^\circ} = \frac{n_A}{n_A + n_B}$$

If solution are very
very dilute solute.

Very very less:

$$n_A \ll n_B$$

$$\frac{\Delta P}{P_B^\circ} = \frac{n_A}{n_B}$$

$$\frac{\Delta P}{P_B^\circ} = \frac{W_A \times M_{WB}}{W_B \times M_{WA}}$$

$$M_{WA} = \frac{W_A \times M_{WB} \times P_B^\circ}{W_B \times \Delta P}$$

M_{WA} = Molar mass of solute

W_A = weight of solute

M_{WB} = Molar mass of solvent

P_B° = V.P of pure solvent.

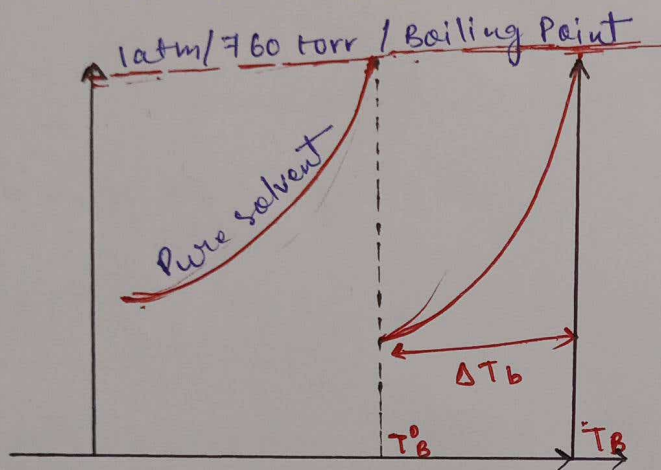
ΔP = Lowering in V.P = $P_B^\circ - P_B$

W_B = weight of solvent.

ii) Elevation In Boiling Point:

When we dissolve non-volatile non electrolyte solute in any liquid their boiling point increases because their vapour pressure decreases. This is called Elevation in Boiling point.

The elevation in boiling point is directly proportional to the molality of the solution which is present in the solution.



→ mix : Non volatile
Non electrolyte
solute.

$$\Delta T_b = K_b \cdot m$$

$$\Delta T_b = K_b \cdot \frac{W_A \times 1000}{M_{WA} \times W_B}$$

Colligative Properties to
find molar mass of solute.

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

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

Elevation in B.P

$$\Delta T_b \propto m \leftarrow \text{Molality}$$

$$\Delta T_b = K_b m$$

→ Molal elevation const.

→ Elevation const.

→ Ebullisicopic const.

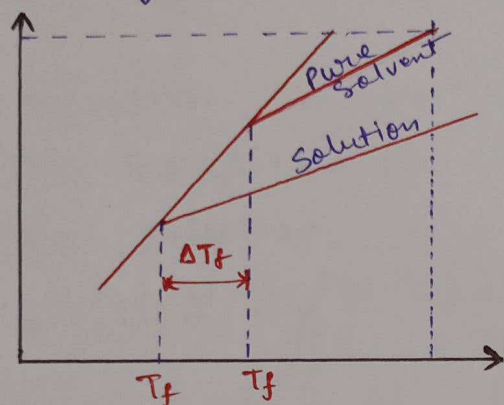
$$K_b = 0.52 \text{ water}$$

$$\Delta T_b = K_b m = \frac{\Delta T_b}{m} \frac{^\circ\text{C}}{\text{mol/kg of solute}}$$

$$K_b \text{ unit} - ^\circ\text{C mol}^{-1} \text{ kg of solute}$$

iii) Depressing In Freezing Point.

When we mix non-volatile, non-electrolyte solute in any solvent vapour pressure should be decreased this is because of lowering in vapour pressure so freezing point also decreases. In that case:-



* Water $K_f = 1.86$.

$$K_f = \frac{R(T_f^0)^2}{1000 \times L}$$

$$K_f = \frac{R(T_f^0)^2 M_w}{1000 \Delta H_f} \quad \text{Latent heat.}$$

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

$$\Delta T_f \propto m; T_f^0 > T_f.$$

$$\Delta T_f = K_f \frac{W_A \times 1000}{M_{wA} \times W_B.}$$

$$M_{wA} = K_f \frac{W_A \times 1000}{\Delta T_f \times W_B.}$$

K_f = • Molal depression const
• Depression const
• Cryoscopic const.

M_{wA} = Molar mass of solute.

W_A = Weight of solute

W_B = Weight of solvent.

ΔT_f = Depression in Freezing Point

iv) OSMOSIS

Movement of water molecules from high concentration (H_2O more) to low concentration (H_2O less) of solvent through SPM.

→ The flow of solvent through SPM (Semi Permeable Membrane) is called osmosis.

OSMOTIC PRESSURE

The pressure that just stops the flow of solvent is called osmotic pressure.

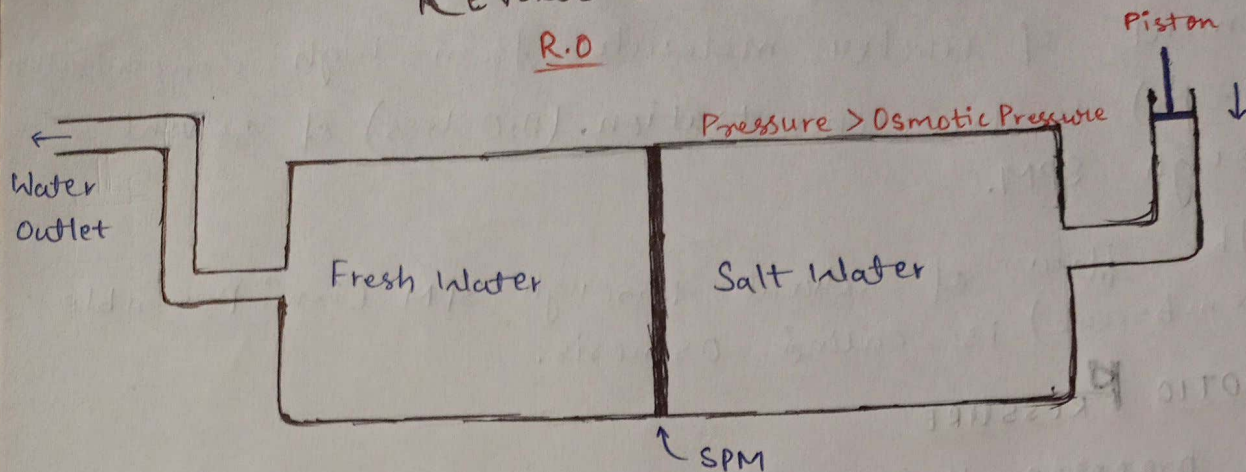
If we increase pressure we get fresh water ($P > \pi$) that extra pressure is called reverse pressure and the process is called reverse osmosis.

Natural SPM - cellulose (Plant cell wall), Pig bladder.

Artificial SPM - Cellaphane.

REVERSE OSMOSIS

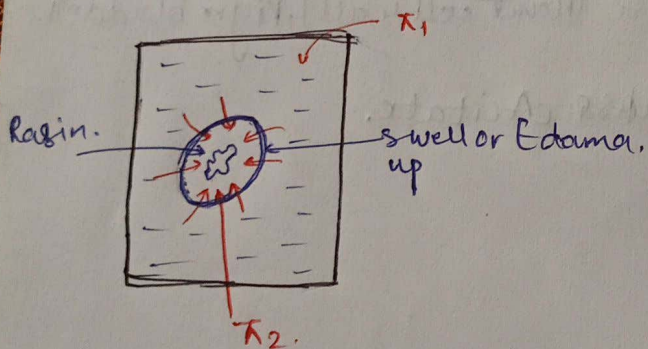
R.O



> On the Basis of Osmotic Pressure Solution are of 3 types:

- 1) Hypotonic
- 2) Hypertonic
- 3) Isotonic.

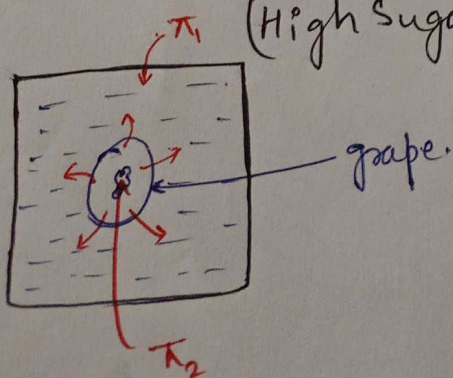
1) Hypotonic: A solution concentration is lower than a concentration of other solution



$$\pi_1 < \pi_2$$

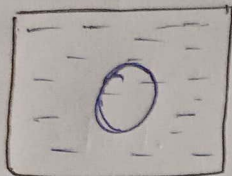
2) Hypertonic: Concentration are higher than the other concentration.

(High Sugar + Water)



$$\pi_1 > \pi_2$$

3) Isotonic Solution: Both concentration are same.
(sugar + water)



$$\pi_1 = \pi_2$$

Only for Isotonic solution:
($\pi_1 = \pi_2$)

$$C_1 \cancel{RT} = C_2 \cancel{RT}$$

$$C_1 = C_2$$

$$\frac{n_1}{V_1} = \frac{n_2}{V_2}$$

$$\frac{w_1 \times 1000}{Mw_1 \times V_1} = \frac{w_2 \times 1000}{Mw_2 \times V_2}$$

$$\frac{w_1}{w_2} = \frac{V_1}{V_2} \times \frac{Mw_1}{Mw_2}$$

If solutions are same.

$$\frac{w_1}{w_2} = \frac{Mw_1}{Mw_2}$$