

Ch-2 Solution

Date _____

Solution: Solution is a mixture of Solvent or Solute.

$$\text{Solutions} = \text{Solvent} + \text{Solute}$$

& Solutions have two types:- 1) Homogeneous Homogeneous mixture

2) Heterogeneous mixture

but in the Solution chapter we only learn ~~to~~ Homogeneous mixture

Homogeneous mixture :- it means composition and properties are uniform throughout the mixture

Solutions are homogeneous mixture of two or more components in which the composition and properties will remain same throughout the mixture.

Solvent: Generally, the component of that is present in the largest quantity is known as solvent. It is also defined as a physical state of solution.

Solute: Components present in the solution other than solvent.

Binary Solutions: One Solute & One Solvent are present

Ex:- $(\text{NaCl} + \text{H}_2\text{O})$ { where H_2O = Solvent }
 { $\text{NaCl} \rightarrow$ Solute }

NOTE: Anoxia: The absence of dissolved oxygen in a body of water

When oxygen levels are at zero the condition is called Anoxia
Special

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Types of solution	Solute	Solvent	common example.
Gaseous Solutions	Gas	Gas	Mixture of oxygen & nitrogen Gas
	Liquid	Gas	chloroform mixed with nitrogen Gas
	Solid	Gas	camphor in nitrogen Gas
Liquid	Gas	Liquid	Oxygen dissolved in water
	Liquid	Liquid	Ethanol dissolved in water
	Solid	Liquid	Glycose dissolved in water
Solid	Gas	Solid	Solution of hydrogen in palladium
	Liquid	Solid	Amalgam of Hg with sodium
	Solid	Solid	cu dissolved in gold

Concentration Terms of Solution

1) Mass percentage : w/w (weight by weight)

$$\text{Mass percentage} = \frac{\text{wt of Solute}}{\text{wt of Solution}} \times 100$$

eg NaCl is 20% of 100gm saline salt. Find the wt of NaCl.

$$20\% = \frac{\text{wt of NaCl}}{100} \times 100$$

$$\text{wt of NaCl} = 20 \text{ gm}$$

→ Volume percentage (V/V)

$$\text{Volume percentage} = \frac{\text{volume of compound}}{\text{volume of solution}} \times 100$$

eg

Oxygen is 20% ab 100ml saline salt find volume of O₂ in Salt?

$$20\% = \frac{\text{volume ab O}_2 \text{ compon}}{100} \times 100$$

$$\text{volume ab O}_2 \text{ compon} = 20 \text{ ml}$$

→ Mass by volume percentage (w/v) : used in medicine and pharmacy

$$\text{mass by volume \% of a compound} = \frac{\text{mass of Solute}}{\text{volume of Solution}} \times 100$$

→ Parts per million (PPM) : ~~if it is used when Solute~~
~~Solute is in trace~~ quantity is very - very small.

$$\text{PPM} = \frac{\text{No of parts of compound}}{\text{Total no of particle in solution}} \times 10^6$$

→ Mole fraction (X) : ~~Note : sum of mole fraction of all the components of a~~
~~solution is unity (1)~~

$$\text{Mole fraction} = \frac{\text{no of moles of the component}}{\text{Total no of moles in the solution}}$$

$$X_A + X_B = 1$$

→ for a binary mixture (having component A and B) if the no. of moles ab A and B are n_A & n_B respectively

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The mole fraction of A & B will be

$$\chi_A = \frac{n_A}{n_A + n_B}$$

$$\chi_B = \frac{n_B}{n_A + n_B}$$

Now:

$$\chi_A + \chi_B = 1$$

$$\frac{n_A + n_B}{n_A + n_B} = 1$$

$$\frac{(n_A + n_B)}{(n_A + n_B)} > 1$$

$$\frac{1}{(n_A + n_B)} < 1$$

$$\text{LHS RHS } (\text{Prove})$$

Molarity (M)

$$\frac{\text{no. of mole Solute}}{\text{Volume (in lit) of Solution}}$$

[SI unit = mol/dt]

$$\boxed{\text{Molarity} = \frac{\text{no. of mole Solute}}{\text{Volume (in lit) of Solution}}}$$

$$\text{but if, } \boxed{\frac{\text{no. of mole Solute}}{\text{Volume (in ml) of Solt}} \times 1000}$$

Molality (m):

[SI unit = mol/kg]

$$\text{molality (m)} = \frac{\text{mole of Solute}}{\text{mass of Solvent (kg)}}$$

but if

$$\frac{\text{no. of mole Solute}}{\text{mass of Solvent (g)}} \times 1000$$

Main advantage of Molality over molarity :-

Molarity Molality does not change with change in temp. while. Molarity decreases with rise in temp. This is because volume depends on Temperature ($V \propto T$) but mass doesn't.

Q.2.1 Calculate the mass percentage of benzene (C_6H_6) and carbon tetrachloride (CCl_4) if 88g of benzene is dissolved in 122g of carbon tetrachloride.

Ans

$$\text{benzene } (C_6H_6) = 88$$

$$\text{Carbon tetrachloride} = 122\text{g}$$

$$\text{Total mass of Solution} = 122 + 88 = 210\text{g}$$

$$\text{So mass percentage of benzene}$$

$$= \frac{\text{mass of } C_6H_6}{\text{Total mass of Solt}} \times 100$$

$$\frac{88}{210} \times 100 = \frac{80}{18} = 15.6\% \text{ Ans}$$

$$\text{mass percentage of } CCl_4 = \frac{\text{mass of } CCl_4}{\text{Total mass of Solt}} \times 100$$

$$\frac{122}{210} \times 100 = \frac{122}{18} = 89.7\% \text{ Ans}$$

Q.2.2 Calculate the mole fraction of benzene in solution containing 30% by mass in carbon tetrachloride.

Ans mole fraction = $\frac{\text{Number of moles of the component}}{\text{total number of moles of all components}}$

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$$\text{Mole of benzene} = \frac{\text{Given mass}}{\text{molar mass}} = \frac{30}{78} = 0.384 \text{ mol}$$

$$\text{Mole of } b\text{-C}_6\text{H}_4 = \frac{\text{Given mass}}{\text{molar mass}} = \frac{30}{152.76} = 0.19605 \text{ mol}$$

χ_2 benzene mole of benzene (C_6H_6)

Total no of mole of salt

$$= \frac{0.384}{0.384 + 0.1960} = \frac{0.384}{0.5804} = \frac{0.384 \times 92.96}{0.5804 \times 92.96} = [0.6599] A$$

(Q23) Calculate the molarity of each of the following

Solution: (a) 30g $Co(NO_3)_2 \cdot 6H_2O$ in 4.3L of solution.

$$\text{Ans} \quad Co(NO_3)_2 \cdot 6H_2O = \frac{12 \times 62.96 + 2 \times 96}{152 \times 102} = 0.291$$

$$= 59 + 2(14 + 48) + 6 \times 10 \\ = 59 + 2(62) + 60 \\ = 59 + 124 + 60 = 243$$

$$\text{Mole of } Co(NO_3)_2 \cdot 6H_2O = \frac{\text{Given mass}}{\text{molar mass}} = \frac{30}{243} = 0.123$$

$$\text{Molarity of } Co(NO_3)_2 \cdot 6H_2O = \frac{30 \times 1000}{4.3 \times 1000} \times \frac{0.123 \times 1000}{1000} \\ = [0.023] M A$$

(Q23) calculate (a) Molality (b) Molarity. ~~10~~ mass = 20g

$$\text{Ans} \quad \text{Molality} = \frac{\text{No. of moles of sol}}{\text{mass of sol}}$$

(Ex 2.1) calculate the mole fraction of ethylene glycol ($C_2H_6O_2$) in a solution containing 20% d. ($C_2H_6O_2$) by mass.

$$\text{Ans} \quad A \quad C_2H_6O_2 = \frac{24 + 6 + 32}{2 + 16} = 62 \text{ g mol}^{-1}$$

$$\text{Moles of } C_2H_6O_2 = \frac{20}{62} = 0.32 \text{ mol}$$

$$\text{Moles of Water} = \frac{80}{18} = 4.44 \text{ mol}$$

Mole fraction = $\frac{\text{no. of mole component}}{\text{Total no. of mole of solution}}$

$$\chi_{C_2H_6O_2} = \frac{0.32}{4.44} = [0.0672] A$$

$$\chi_{H_2O} = \frac{4.44}{4.44 + 0.32} = [0.93] A$$

(Ex) calculate the molarity of a solution containing 5g of NaOH in 450 mL solution.

$$\text{Ans} \quad NaOH = 23 \times 16 \times 1 = 40 \text{ g mol}^{-1}$$

$$\text{Molarity} = \frac{\text{no. of moles of component} \times 1000}{\text{volume of soln (in ml)}}$$

$$= \frac{0.12 \times 1000}{450 \times 1000} = [0.267] L^{-1} A$$

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Q Calculate molality of 2.5g of ethanoic acid (CH_3COOH) in 25g of benzene.

$$\text{Molality} = \frac{\text{moles of Solute}}{\text{mass of Solvent (g)}} \times 1000$$

$$\begin{aligned}\text{Moles of ethanoic acid } (\text{CH}_3\text{COOH}) &= \frac{\text{Given mass}}{\text{molar mass}} = \frac{2.5}{60.05} = 0.041 \\ \text{Molar mass} &= 60.05 \\ &= 0.041 \text{ moles}\end{aligned}$$

$$\text{CH}_3\text{COOH} = 12 + 3 + 12 + 32 + 1 = 60 \text{ g/mol}$$

$$\text{Molality} = \frac{\text{moles of Solute}}{\text{mass of Solvent (g)}} \times 1000$$

$$\begin{aligned}0.041 &\times 1000 = 41 \text{ g} \\ 75 - 41 &= 34 \text{ g} \\ \frac{41}{75} &= 0.54 \text{ m}\end{aligned}$$

Solubility: Solubility of a substance is its maximum amount that can be dissolved in a fix amount of solvent at a specified temperature.

→ Solubility depend upon the → temperature Pressure.

→ Best condition of solubility Solubility →

more means	Temp \propto $\frac{1}{\text{Pressure}}$
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High temp.
low pressure
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→ Solubility also depend upon another nature of solute and solvent

[nature is a polar or non-polar]

As we known that like dissolves in like e.g. Sodium chloride (NaCl) and sugar dissolve in readily in water but naphthalene and anthracene dissolve readily in benzene but sodium chlorided (NaCl) and sugar don't.

Saturated Solution: A solution in which no more solute can be dissolved at the same temperature and pressure is called Saturated Solution.

Unsaturated Solution: A solution in which more solute can be dissolved at the same temperature and pressure is called unsaturated solution.

Dissolution: When a solid is added to solvent some solute dissolves and its concentration increases in solution. This process is known as dissolution.

Crystallisation: Some solute particles in solution collide with the solid solute particles and get separated out of solution. This process is known as crystallisation.

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Effect of temperature ! It depend upon de chateliers principle.

So mix the gas in water

$P \propto$ Solubility & Temperature constant

→ Temperature : if temperature $\uparrow \propto$ \downarrow solubility
 means pressure \propto solubility

→ In general if in a nearly Saturated Solution
 The dissolution process is endothermic ($\Delta_{sol} H > 0$)

→ the solubility should increase with rise in temp.

→ If is exothermic ($\Delta_{sol} H < 0$) the solubility should decrease.

Effect of pressure ! General no effect of
 Solubility of Solid and liquid
 because these both are incompressible.
 but it is effect on gas because gas is
 compressible.

Solubility of Solid in liquid:

→ Temperature : → For endothermic process, Temperature increase, solubility of solid in liquid increase

→ For exothermic process, Temperature (\uparrow), solubility of solid in liquid \downarrow .

* Polar dissolve polar & non-polar dissolve non-polar
 Polar don't dissolve non-polar (H₂O + oil)

Solubility of gases in liquid:

$T \uparrow \propto \downarrow$ it is ideal condition
 $P \downarrow$ Special

Henry Law ! It is a quantitatively relation b/w pressure and solubility of a gas.

→ It is only valid for solubility of gases.

→ The solubility of a gas in a liquid is directly proportional to the partial pressure of the gas present above the surface of liquid or solution.

$P \propto$ Solubility (Temp. constant)
 \rightarrow mole fraction of gas

→ Mole fraction of gas in the solution is proportional to the partial pressure of the gas over the solution.

$P \propto X$

$P = K_H X$, where K_H = Henry law constant

→ That higher the value K_H at a given pressure, the lower is the solubility of the gas in the liquid.

$$P = K_H X$$

Mole
fraction

$$X = \frac{P}{K_H}$$

$$\left[\text{mean } \frac{1}{X} \propto \frac{1}{K_H} \right]$$

$K_H \uparrow \rightarrow \downarrow \text{Solubility}$
 $T \uparrow \rightarrow \downarrow \text{Solubility}$

$$[K_H \propto T]$$

The Henry's Constant Signifies that:-

- It is directly proportional to temperature.
- It has different values for different gases at same temperature. That means is a function of nature of gases.

→ Application of Henry's Law:-

- To increase the Solubility of CO_2 in soft drinks and Soda water the bottle is sealed under high pressure.

Such divers must cope with high concentrations of dissolved gases while

- At high altitudes, the partial pressure of oxygen is less than that at the ground level. Low blood oxygen causes anoxia.

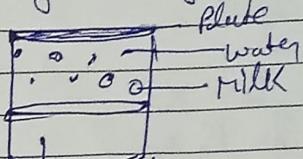
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→ Mole fraction

NOTE :- Vapour non-volatile \rightarrow form vapour of solvent

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Vapour pressure of liquid Solutions :- For liquid Solute Solution the Solvent must be liquid and the Solvent must be volatile but Solute may or may not be volatile.

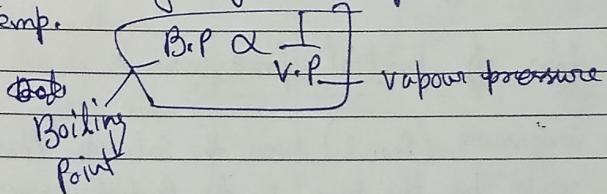


It is a mixture of milk and water

NOTE:- If we take an enclosed vessel then the liquid present in that vessel will evaporate and attain equilibrium b/w liquid face and gas face.

→ # Vapour pressure: The partial pressure of vapours in equilibrium with pure solid or pure liquid at a given temp.

Liquid having high vapour pressure boils at low Temp.



→ Boiling point: The temp. at which vapour pressure of a liquid is equal to external pressure.

Vapour pressure of liquid-liquid Solution:-

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Raoult's law:-

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According to Raoult's law for a solution of volatile liquids, the partial vapour pressure of each component of the solution is directly proportional to the solution is directly its mole fraction present in solution.

$$P_A \propto X_A$$
$$P_A = P_A^o X_A$$

P_A^o = Vapour pressure of pure component at the same temp.

P_A = Partial pressure of component A vapour

X_A = Mole fraction of A in liquid solution.

According to Raoult's law

Component A

$$P_A = P_A^o X_A$$

Similarly Component - B

$$P_B = P_B^o X_B$$

Dalton's law of partial pressure:

The total pressure (P_{total}) over the solution phase in the container will be the sum of the partial pressures of the components of the solution.

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

∴ mole fraction of A, B and nth = 1 means,

$$X_A + X_B + \dots + X_n = 1$$

$$\begin{aligned} P_{\text{total}} &= P_A + P_B \\ &= P_A^o X_A + P_B^o X_B \\ &= P_A^o X_A + P_B^o (1 - X_A) \end{aligned}$$

$$P_A^o X_A + P_B^o - P_B^o X_A$$

$$(P_A^o X_A - P_B^o X_A) + P_B^o$$

$$X_A (P_A^o - P_B^o) + P_B^o$$

$$P_{\text{total}} = X_A (P_A^o - P_B^o) + P_B^o$$

Prove

⇒ Components components A and B respectively in the vapour phase then, using Dalton's law of partial pressure.

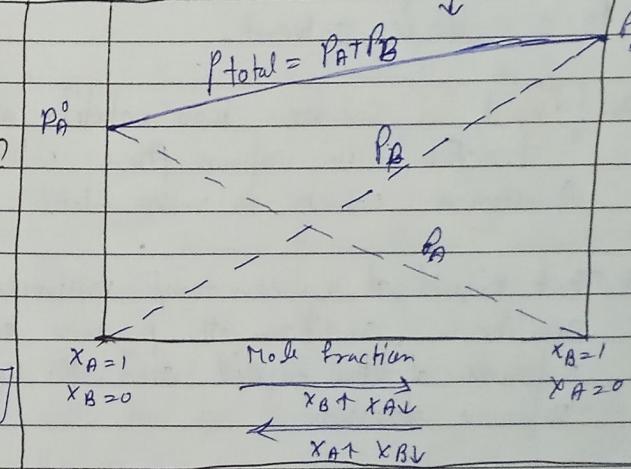
$$\begin{array}{l} \text{Partial pressure } P_A = Y_A P_{\text{total}} \\ \text{Partial pressure } P_B = Y_B P_{\text{total}} \end{array}$$

Linear graph b/w total P_{total} and mole fraction

Question: When does pressure due to any component gets max?

Ans: when its value of mole fraction becomes 1 (unity).

$$X_A + X_B + \dots + X_n = 1$$



* At equilibrium, vapour phase will be always rich in the component which is more volatile.

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Raoult's Law as a Special Case of Henry's Law.

→ According to Raoult's law $\rightarrow P_a = P^0 X_a = P = P^0 X$

According to Henry's law $\rightarrow P_a = K_h X_p \Rightarrow P = K_h X$

by comparing both equation means
Henry's and Raoult's law because $P = P_a$ Partial
pressure

$$P^0 X = K_h X$$

$$\text{so } K_h = P^0$$

then Raoult's law becomes Special Case of Henry's
law.

Vapour pressure of Solution of Solid in
liquid.

→ by adding The vapour pressure of Solution decreases
decreases when a non-volatile solution is added
to a volatile solvent.

→ If we add a solution two volatile liquid then the mole
fraction in vapour phase will be higher for the
substance which is more volatile.

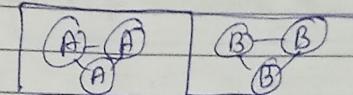
→ That liquid at a given temp. vapourises and under
equilibrium conditions the pressure and exerted by the
vapour of the liquid over the liquid phase is called
vapour pressure.

Ideal and non-Ideal Solutions

Liquid-Liquid Solution can be classified into ideal and
non-ideal Solutions on the basis of Raoult's law.

Ideal Solution: Those Solution which follow the obey
the Raoult's law for entire range of
concentration are known as ideal Solution

→ in Ideal Solution interaction b/w particles of
two component is equal to the interactions b/w pure
components



Important $\rightarrow A-A = B-B = A-B$ bond

→ Vapour pressure of the Solution equals to vapour
pressure of these component

→ On mixing: There is no enthalpy and
volume change.

$$\Delta H_{\text{mix}} = 0$$

$$\Delta V_{\text{mix}} = 0$$

Example n-hexane n-heptane
butanol bromoethane, chloroethane

chloroethane, benzene and toluene.

Non-Ideal Solution: Those Solution which don't obey
Raoult's law for entire range of
concentration are known as non-Ideal Solution.

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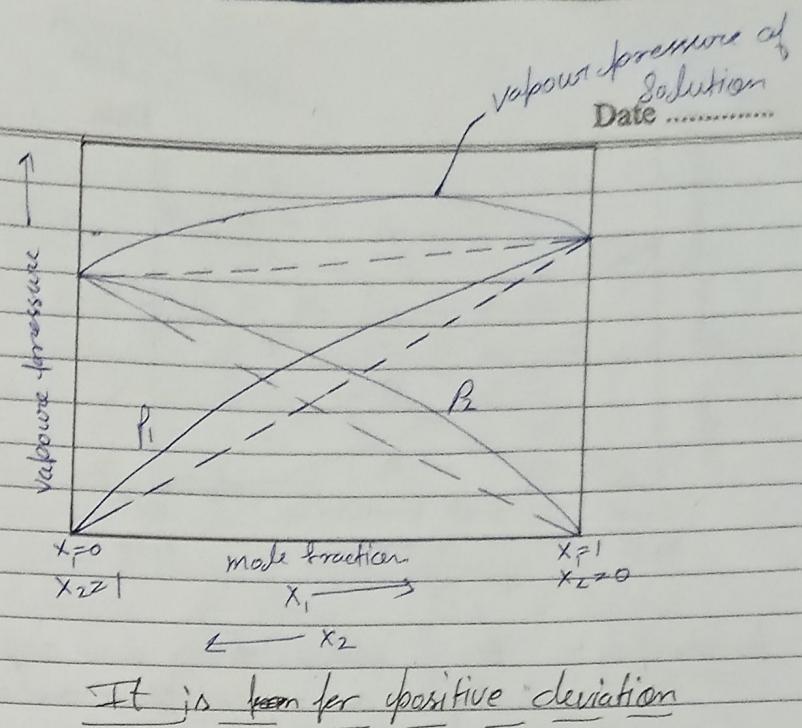
The vapour pressure of such a solution is either higher or lower than that predicted by Raoult's law.

⇒ non-ideal solution are two types :-

1) Positive deviation from Raoult's law :- vapour pressure of A-TS is higher than vapour pressure of A-A and B-B that means interaction b/w A-B A-B is weaker than A-A and B-B.

$$(↓)(↑) \text{v.p.}(A-B) \propto \frac{1}{x_1 x_2}$$

* interaction of (A-B)



2) Negative deviation from Raoult's Law :-

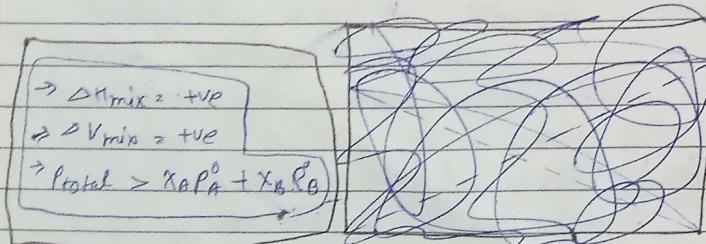
A-B vapour pressure lower than A-A and B-B that means Interaction b/w A-B is higher than A-A and B-B.

Ex:- Phenol and carbon
chloroform and acetone

* Force of interaction b/w components is ~~weaker~~^{stronger} than pure components

$$\begin{aligned} &\rightarrow \Delta H_{mix} = -ve \\ &\rightarrow \Delta V_{mix} = -ve \\ &\rightarrow P_{total} < (P^0 x_A + P^0 x_B) \end{aligned}$$

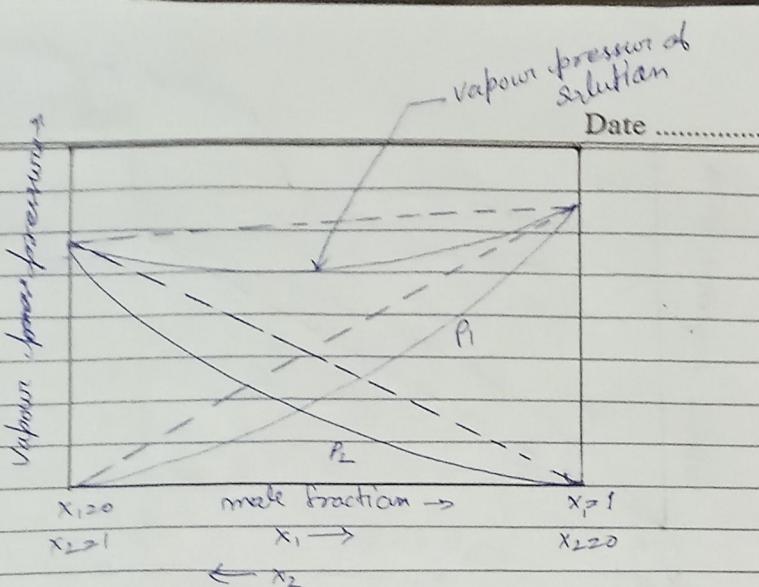
Eg:- ethanol and acetone



⇒ Force of interaction b/w components is weaker than pure components.

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Azeotropes: Binary mixtures having same composition in liquid and vapour phase and boil at a constant Temp. [$x_A = y_A$ & $x_B = y_B$]

✗ Azeotropes can't be separated into its components by fractional distillation.

⇒ There are two types of Azeotropes :-

1) Minimum boiling point azeotropes:- The Solution which show large positive deviation from Raoult's law form minimum boiling azeotropes at a specific composition.

Ex:- Ethanol + water
 $C_2H_5OH + H_2O$

2) Maximum Boiling azeotropes:- The Solution that shows large negative deviation from Raoult's law form maximum boiling azeotropes at a specific composition.

Ex:- Nitric acid + water
 $HNO_3 + H_2O$

→ colligative property ←

The properties of Solution which depend only on number of particles of the Salute.

→ Four colligative property :

(i) Relative lowering of vapour pressure

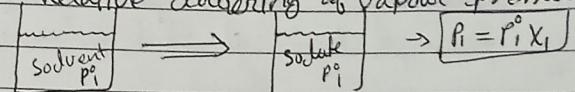
(ii) Depression of Freezing point of Solvent

(iii) Elevation of Boiling point of Solvent.

(iv) Osmotic pressure of Solution.

NOTE:- Whenever we add non-volatile Salute in the volatile Solvent so Total Vapour pressure of Solution will decrease.

† Relative lowering of vapour pressure



$$\frac{\Delta P}{P_i^o} = \frac{P_i^o - P_i}{P_i^o} = \frac{P_i^o - P_i^o x_i}{P_i^o} = \frac{P_i^o (1 - x_i)}{P_i^o} = x_i$$

Relative lowering:- $\frac{\Delta P}{P_i^o} = \frac{P_i^o x_2}{P_i^o} = x_2$

$$\frac{\Delta P}{P_i^o} = x_2$$

P_2^o vapour pressure
of pure Solvent

relative lowering of vapour pressure and it equal to the mole fraction of the Solvent Salute.

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$$\frac{P_i^0 - P_i}{P_i^0} = \frac{x_2}{n_1 + n_2} \quad [\text{since } x_2 = \frac{n_2}{n_1 + n_2}]$$

$$\frac{P_i^0 - P_i}{P_i^0} = \frac{n_2}{n_1 + n_2} \quad [\therefore n_2 \ll n_1]$$

$$\text{So, } \frac{P_i^0 - P_i}{P_i^0} = \frac{n_2}{n_1} \quad [\text{no. mole} = \frac{\text{Given mass}}{\text{molar mass}} = \frac{w}{M}]$$

$$\frac{P_i^0 - P_i}{P_i^0} = \frac{w_2}{M_2} \frac{M_1}{w_1}$$

Now

$$\frac{P_i^0 - P_i}{P_i^0} = \frac{w_2 M_1}{M_2 w_1}$$

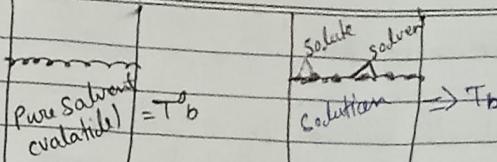
Hence where w_1 and w_2 are the given mass and M_1 and M_2 are the molar mass of the Solvent and Solute.

Elevation of boiling point of solvent

Tempres Temp. at which vapour pressure of liquid becomes equal in external pressure at the Surface of liquid is called boiling point of liquid at that pressure.

→ If $P_{ext} = 1\text{ atm}$, then the B.P. is called Normal B Point.
 → If $P_{ext} = 1\text{ torr}$, then the B.P. is called Standard Boiling Point.

NOTE:- On adding nonvolatile Solute in the volatile Solvent So the Boiling point of the new Solution will increase in comparison volatile Solvent.



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

Molarity $\Rightarrow \frac{\text{Mol of solute}}{\text{mass (kg) solvent}}$

* for dilute Solutions

$$\Delta T_b \propto m \quad \text{Molarity}$$

$$\Delta T_b = K_b m$$

K_b = B.P elevation constant
 m = Molarity

$$\text{then, } \Delta T_b = K_b m$$

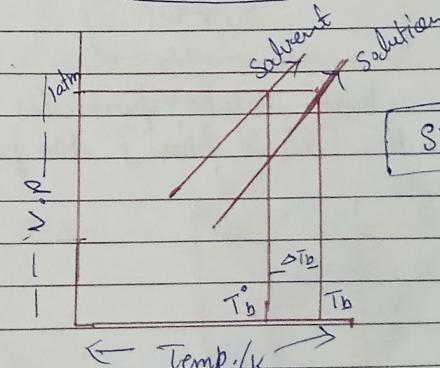
$$\Delta T_b = K_b = \frac{n_2}{\text{wt of } n_1 (\text{g})} \times 1000$$

n_1	n_2
↓	↓
Salvent	Solute

$$\Delta T_b = K_b = \frac{w_2 \times 1000}{w_1 \times M_2} - h_2$$

$$\Delta T_b = K_b = \frac{w_2 \times 1000}{w_1 \times M_2}$$

w_1 = wt of Solvent taken (g)



SI unit of K_b = K kg mol^{-1}

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Depression of Freezing Point :-

On adding non-volatile Solute in a volatile Solvent the freezing of new Solution will decrease.

$$\Delta T_f = T_f^o - T_f$$

{ where T_f = Freezing Point of Solution }
 or T_f^o = Freezing Point of Solvent

$\frac{n}{1}$
 ↓
 Solvent Solute

$$\Delta T_f \propto m$$

$$T_f^o - T_f = K_f m$$

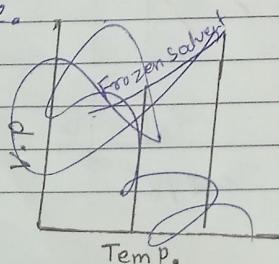
$$T_f^o - T_f = K_f = \frac{w_2 \times 1000}{M_2 \times w_1 (g)}$$

$$M_2 = \frac{K_f \times 1000 \times w_2}{w_1 (g) \times \Delta T_f}$$

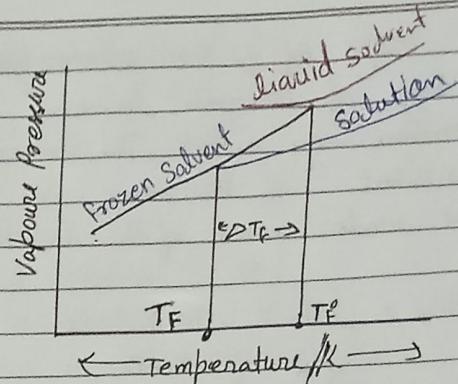
If we find mass of any solute by using Depression of Freezing point

$$\Delta T_f = \frac{K_f w_2 \times 1000}{M_2 \times w_1}$$

NOTE :- All non-volatile Solute particles always remain in Solution [liquid phase]. No present in Solid/vapour phase.



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Question : 45g of ethylene glycol ($C_2H_6O_2$) is mixed with 600g of water. calculate (a) the freezing point depression and (b) the Freezing Point of the Solution.

Given $w_1 = 600g$
 $w_2 = 45g$

$$\text{mass of } C_2H_6O_2 (M_2) = 62 \text{ mol}$$

$$K_f = 1.86$$

(a) find Freezing Point ΔT_f

$$\Delta T_f = K_f \times \frac{w_2 \times 1000}{M_2 \times w_1}$$

$$\Delta T_f = 1.86 \times \frac{45g \times 1000}{600 \times 62 \times 10^{-3}} = \frac{27.9}{12.4} = 2.2 \text{ K}$$

$$(b) \Delta T_f = 2.2$$

$$T_f^o = 273.15$$

$$\Delta T_f = T_f^o - T_f$$

$$2.2 = 273.15 - T_f$$

$$T_f = 273.15 - 2.2$$

$$T_f = 270.95 \text{ K}$$

Spiral

Question 1.00g of a non-electrolyte Solute dissolved in 50g of benzene lowered the Freezing Point of benzene by 0.40K. The freezing point depression constant of benzene is $5.12 \text{ K Kg mol}^{-1}$. Find the molar mass of the Solute.

$$\text{Ans} \quad M_2 = \frac{5.12 \times 1.00 \times 1000}{256 \times 0.40 \times 50}$$

$$= \frac{5.12 \times 100}{256 \times 8}$$

$$= 25.6 \text{ g mol}^{-1}$$

So the molar mass of the Solute = 25.6 g mol^{-1}

Osmotic pressure: (i) Osmotic defined as flow of Solvent from higher concentration to lower concentration with respect to solvent.

(ii) It is defined as flow of solute from lower concentration to higher concentration of solute.

Osmotic pressure: This pressure that just stops the flow of solvent is called osmotic pressure.

* The flow of the solvent from its side to solution side across a semipermeable membrane can be stopped if some extra pressure is applied on the solution.

Osmotic Pressure (Π) \propto molarity (c)

$$\Pi = CRT$$

$$\Pi = \frac{n_2 RT}{V}$$

where, V = volume of Solution (in lt)

$$\Pi = \text{osmotic pressure}$$

$$n_2 \rightarrow \text{Moles of Solute (wz/me)}$$

$$T = \text{Temp.}$$

$$R = \text{Gas constant}$$

$$V = \text{volume of Solution (lt)}$$

$$\Pi = w_2$$

$$(M.E.P)$$

$$\Pi = \frac{w_2 \cdot RT}{M_2 \cdot V}$$

$$M_2 = \frac{w_2}{M_2}$$

→ Osmotic pressure is used to determine molar mass of macro molecules like Proteins, polymers.

$$M_2 = \frac{w_2 RT}{\Pi V}$$

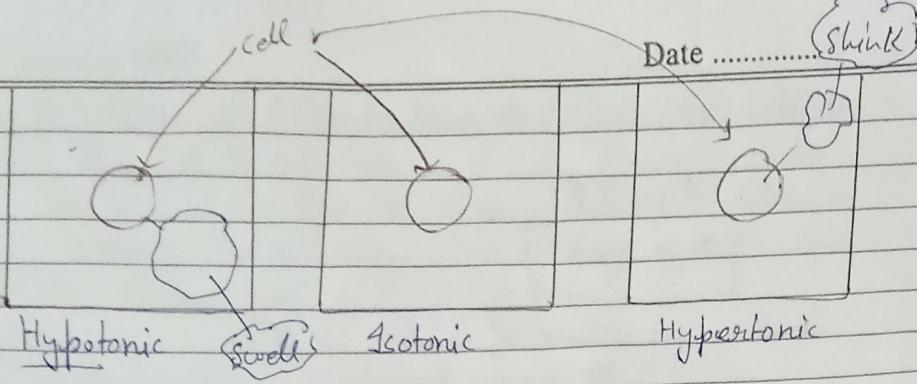
$$k_b = \frac{RT^2}{1000(\Delta H)_{\text{vap}}}$$

, where m = mass of solvent

$$k_f = \frac{RT^2}{1000(\Delta H)_{\text{fusion}}}$$

, where m = mass of solvent

Iso tonic Solution: Two Solution having same osmotic pressure at a given temp.



cell < solute
Solvent > cell

Equilibrium
Solute = cell solute
Solvent = cell solvent

solute > cell solute
Solvent < cell solvent

Hypotonic Swells Isotonic

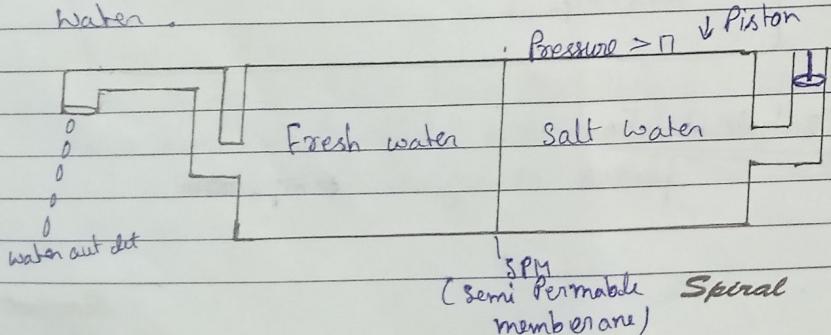
Hyper tonic

* Solvent flow
higher to lower

* Solute flow
lower to higher

Reverse osmosis: The directions of osmosis can be reversed if a pressure ~~slightly~~ larger than the osmotic pressure is applied to the Solution Side. That is, now the pure Solvent flows out of the Solution through the ~~Semi permeable~~ Semipermeable membrane. This ~~phenomenon~~ phenomenon is called reverse osmosis (OR).

* Reverse osmosis is used in desalination of Sea Water.



Date Shrink

Date

→ Cellulose acetate is ~~permeable~~ permeable to water but impermeable to impurities and ions present in sea water. These days many countries use desalination plants to meet their potable water requirements.

Abnormal Molar masses :-

Abnormal Molar masses :-

→ Molar mass either higher or lower than the expected normal value.

→ When the molar molecular mass of a substance determined by studying any of the colligative properties comes out to be different than the theoretically expected values, the substance is said to show ~~abnormal~~ abnormal molecular mass.

Abnormal Molar masses are observed

1) When the solution is non-ideal

2) When the Solute undergoes association in the solution

3) When the Solute undergoes dissociation in the solution.

→

Van't Hoff factor: - (i): It helps as to determine the extent of association and dissociation.

i = normal molar mass
Abnormal molar mass

Spiral

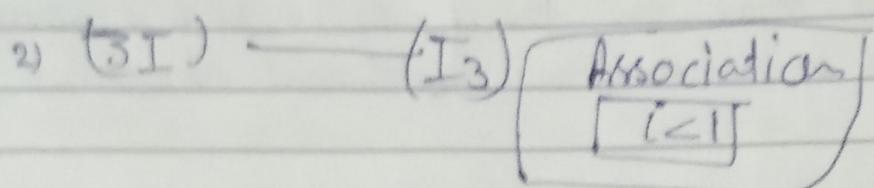
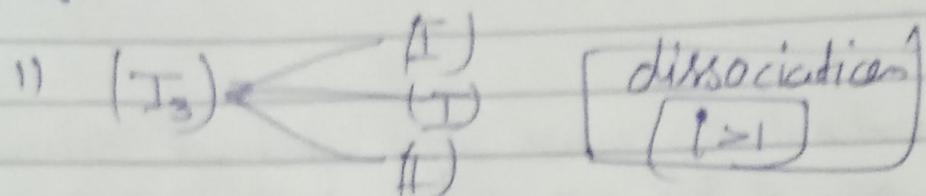
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PTG

1. Observed colligative property
calculated colligative property

$\text{t} = \frac{\text{Total no. of moles of particles after association/dissociation}}{\text{no. of moles of particles before association/dissociation}}$

Eg of association and dissociation



NOTE: Difference b/w ideal or non-ideal

ideal solutions

non-ideal solutions

1) It follows Raoult's law

1) It does not follow Raoult's law.

2) $\Delta H_{\text{mix}} = 0, \Delta V_{\text{mix}} = 0$

2) $\Delta H_{\text{mix}} \neq 0, \Delta V_{\text{mix}} \neq 0$

① They can be separated by fractional distillation.

3) They can't be separated by fractional distillation.

a process of purification

Special

Q1 Differentiate b/w molality and Molality of solution.

How can we change molality value into molality value.

~~Ans~~ Molarity is the number of moles of Solute dissolved per Litre of solution, whereas molality is the number of moles of Solute dissolved per Kg of solvent.

$$m = \frac{M \times 1000}{1000 \times d - M \times M.wt}$$

[d = density of soln]