Super Short Tricky Chemistry By
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Conceptual Notes for NEET/JEE/Boards

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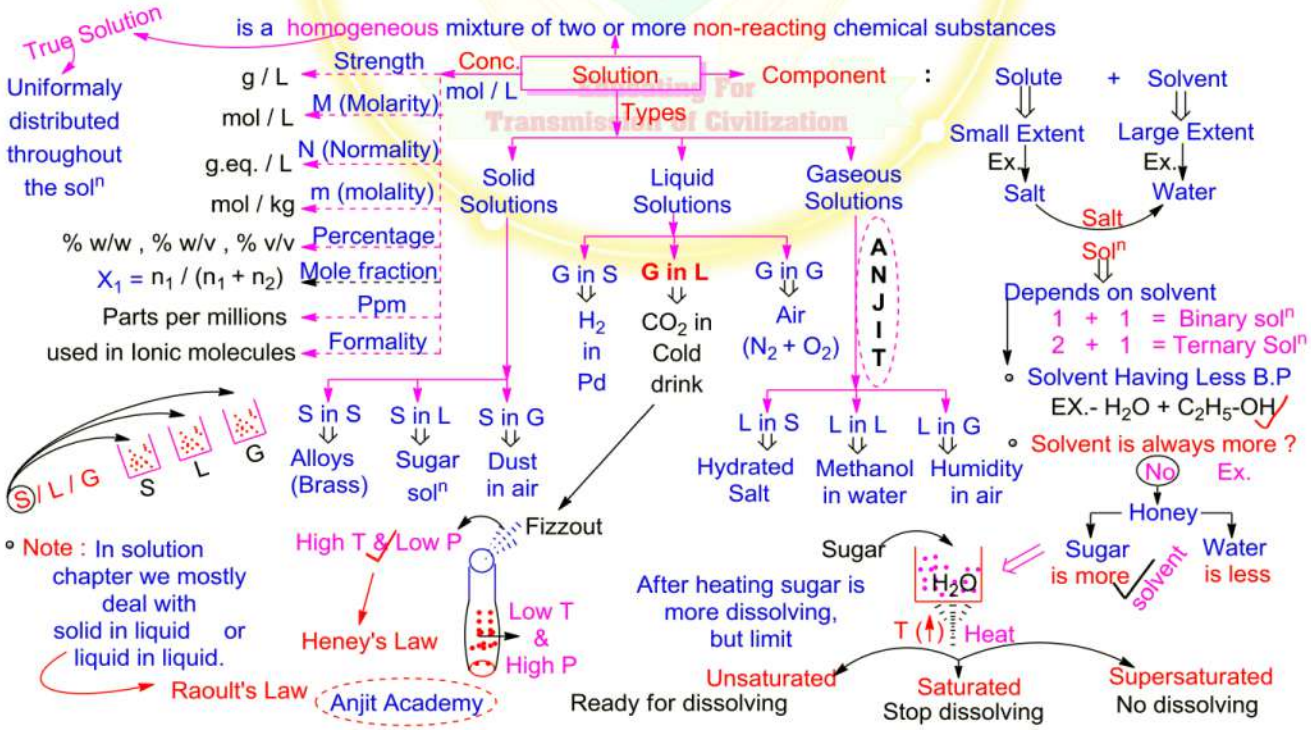
1. Introduction



- **Characteristics of Solution :**
  - It is a homogeneous mixture.
  - Formation of solution is a physical change but not a chemical change.
  - Solute cannot be separated from solution by filtration.
- **Types of Solution** : Based on nature of Solvent -
  - Aqueous Solutions (Solvent is water)
  - Non-Aqueous Solutions (Solvent is other than H_2O)
  - If alcohol is solvent, then they are alcoholic solutions.
  - If Ether is solvent, then they are ethereal solutions.
  - If liq. Ammonia is solvent, then they are Ammonical solutions.

o **Dilute Solution:** The solution containing relatively smaller quantity of solute compared to that of solvent.

o **Concentrated Solution:** The solution which contain relatively large solute, in a definite quantity of the sol^{n}.

2. Concentration of Solution

2.1 Molarity (M) : mol/L

$$M = \frac{n}{V} = \frac{w}{M \times V_{\text{in litre}}} = \frac{W \times 1000}{M \times V_{\text{in cc}}}$$

- Molarity changes with temperature of the solution. Increase in temperature decreases the molarity.
- It is the most convenient method to express concentration of the solution.
- On dilution molarity decreases.

Molar Solution	-----	1M
Semi molar Solution	-----	0.5M
Deci molar Solution	-----	0.1M
Centi molar Solution	-----	0.01M
Milli molar Solution	-----	0.001M

o **Molarity of Mixture (Same solutes):**

$$VM = V_1M_1 + V_2M_2 + ---- \qquad = \frac{Total\ moles}{Total\ volume}$$

$$M = \frac{V_1M_1 + V_2M_2 + ----}{V}$$

2.2 Molality (m) : mol / kg

- No. of moles (n) of solute present per kg of solvent.

$$m = \frac{n}{W_{\text{in kg}}} = \frac{w}{M \times W_{\text{in kg}}} = \frac{w}{M \times W_{\text{in g}}(\text{solvent})} \times 1000$$

- It is independent of temperature since no volume factor is involved in the equation.

2.3 Mole fraction (x) :

- It is the ratio of no. of moles of one component to the total no. of moles present in the solution.

For a system having two components A and B.

$$X_A = \frac{n_A}{n_A + n_B}, X_B = \frac{n_B}{n_A + n_B} \quad \therefore \boxed{X_A + X_B = 1}$$

- Mole fraction is also independent of temperature.

2.4 % Concentration :

$$\%\ w/w = \frac{\text{weight of solute(g)}}{\text{weight of solution (g)}}$$

$$\%\ w/v = \frac{\text{gram of solutes}}{\text{vol. of solution in mL}} \times 100$$

- % by weight is independent of temperature while % by vol., % by strength or strength are temp. dependent.

2.5 Strength of solution in g/L :

Weight of solute (in gram) per litre (1000mL) of solution.

Ex. 10% (w/v) sucrose solution then specify its conc. in gm/L

100 mL ..... 10 gm

$\therefore$ 1000 mL ..... $\frac{10}{100} \times 1000$ = 100 gm/L

2.6 PPM (Parts per Million): It is the mass of the solute present in million parts by mass of the solution.

$$ppm = \frac{Mass\ of\ solute \times 10^6}{Mass\ of\ solution}$$

(a) $\text{ppm (w/w)} = \frac{\text{wt. of solute(in gm)}}{\text{wt. of solution (in gm)}} \times 10^6$

(b) $\text{ppm (w/v)} = \frac{\text{wt. of solute(in gm)}}{\text{vol. of solution (in mL)}} \times 10^6$

(c) $\text{ppm (moles/moles)} = \frac{\text{moles of solute}}{\text{moles of solution}} \times 10^6$

2.7 Normality: g.eq. / V(L)

It is number of gram equivalents of solute dissolved per litre of solution.

- No. of equivalents per litre of solution $= \frac{\text{no. of equivalents of solute}}{\text{volume of solution (in L)}}$
- No. of equivalents = normality × volume (L) or (Normality = n × molarity)
- Equivalent mass = $\frac{\text{Molar mass}}{\text{n – factor}}$
- No. of eq. = $\frac{\text{Mass of the species}}{\text{equivalent mass}} = \frac{\text{Mass of the species}}{\frac{\text{Molar mass}}{\text{n – factor}}}$

'n' factor

(i) For oxidizing/reducing agents :
no. of e^- involved in oxidation/reduction half reaction per mole of oxidising agent/reducing agent.

e.g. : $5e^- + 8H^+ + MnO_4^- \rightarrow Mn^{2+} + H_2O$; n-factor= 5

(ii) For acid/base reactions :
no. of H^+ ions displaced/OH^- ions displaced per mole of acid/base.

e.g. : NaOH n - factor = 1, & H_2SO_4 n - factor = 2

(iii) For salt :

$$\left.\begin{array}{c} n = \text{Total charge on cations} \\ \text{or} \\ \text{total charge on anions} \end{array}\right\} \text{Simple salts}$$

e.g. $Al_2(SO_4)_3$

n-factor = charge on the cation = 2×3 = 6

- Normality decreases as temperature increases.

2.8 Formality (F): This is the concentration unit for ionic-compounds which dissolve in a polar solvent to give pair of ions. It is almost the same as molarity.

$$\text{Formality} = \frac{\text{moles of substance added to solution}}{\text{volume of solution (in litres)}}$$

o **Relation between Molarity and Normality :** $N = M \times n$

o **Relation between Molality and Molarity:**

$$m = \frac{1000 \times M}{(1000 \times d) - (M \times MW_{solute})}$$

3. Solubility of Gas in Liquid

o **Factors Influencing the Solubility of a Gas in liquid :**

- **Nature of the Gas :** Easily liquiefiable gases are more soluble. or polar gas (like- CO_2, HCl, NH_3) are highly soluble in water as compare to Non-polar gas (like- O_2, N_2, H_2 etc) " Like dissolve Like "

Eg : CO_2 is more soluble than O_2 and H_2

- **Nature of Solvent:** Gases capable of forming ions in aqueous solution are more soluble in water than in other solvents. 'or' Solvent have less B.P.

Eg : HCl, NH_3etc.

- **Effect of Temperature :** Solubility decreases with rise of temp. at constant pressure.

i.e, Solubility $\propto \frac{1}{T} \propto P$ Only in case of Gas.

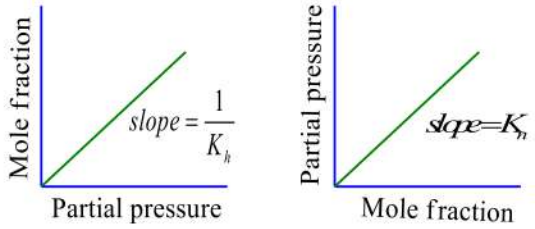
- **Effect of Pressure of the Gas 'or' Henry's law :**

The most commonly used form of Henry's law states that " the partial pressure of the gas in vapour phase (p) is proportional to the mole fraction of the gas (x) in the

solution" i.e, $P_A \propto X_A \quad \Rightarrow P_A = K_H X_A$

Here, K_H is the Henry' s law constant.

Expression Compare with Straight line eqⁿ, Y = mx + C



- Henry' Law is applicable for Only Low Pr. & High Temp.
- I.e., K_H (↑) ⇒ T(↑) but, we know, ⇒ T(↑) ↔ $Solubility$ (↓)
- Hence, Higher value of KH then Lower Value of solubility of gas in liquid.

o **Limitations of Henry's Law:**

i) pressure is not very high
ii) temperature is not very low
iii) gas not highly soluble
iv) gas do not form any compound with solvent
v) gas does not undergo dissociation

o **Application of Henry's law:**

- To increase solubility of CO_2 in soft drinks and soda water the bottle is sealed under high pressure.
- Sea divers use air diluted with He (11.7% He, 56.2% N_2 and 32.1% O_2) to avoid a condition known as 'bends' to cope up with high 'P' under water.
- At high altitudes, when partial pressure of O_2 is less, it leads to a condition known as 'Anoxia'.

4. Concept of Vapour Pressure

o **Vaporization (or) Evaporation:** of a liquid is **Endo. process**

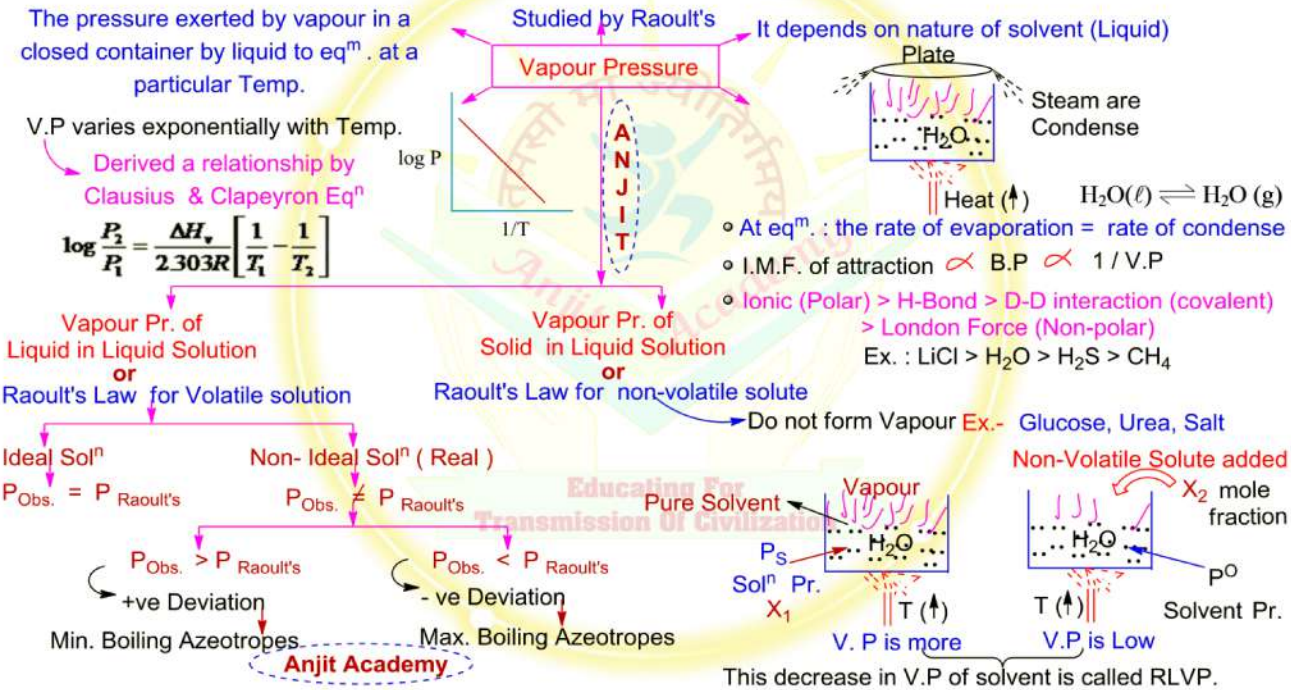
o **Vapour Pressure:** Vaporization increases with surface area & temperature.

o **Boiling Point :**

- It is the temperature at which vapour pressure of a liquid becomes equal to its Atmospheric pressure.
- Volatile liquids have high Vapour Pressure and low Boiling Point.

Eg:- Ether, Methyl alcohol, acetone, benzene, Carbon tetrachloride, Carbon disulphide.

- Non volatile liquids have low vapour pressure and high boiling point. **Eg:** - H_2O, Aniline, Nitrobenzene

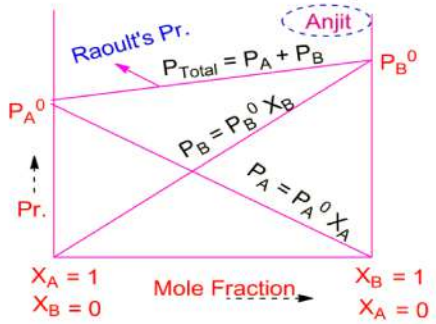


This decrease in V.P of solvent is called RLVP.

$P = p_A + p_B = p^0_A X_A + p^0_B X_B = (1 - X_B)\, p^0_A + p^0_B X_B$

$P_{Total} = (p^0_B - p^0_A) X_B + p^0_A \qquad [X_A + X_B = 1]$

'or' $P_{Total} = (p^0_A - p^0_B) X_A + p^0_B$ Compre with Y = mx +C



4.1 Raoult's Law for a solution having non volatile solute:

Vapour Pr. of Solution(P_S) = Vap. Pr. solvent = $X_1 . P^0$

Hence, $P_S = X_1 . P^0 \Rightarrow \frac{P_S}{P^0} = x_1 \Rightarrow 1 - \frac{P_S}{P^0} = 1 - x_1$

$\Rightarrow \frac{P^0 - P_S}{P^0} = x_2 = \frac{n_2}{n_1 + n_2}$ $\boxed{X_{solute} = \frac{P^\circ - P_s}{P^\circ}}$

$x_{solute} \rightarrow$ mole fraction of solute in solution
$P^\circ \rightarrow$ V.P. of pure solvent
$P_s \rightarrow$ V.P. of solution

i.e, Relative lowering of vapour pressure is equal to the mole fraction of solute in the solution. .

4.2 Raoult's Law for liquid-liquid solution or Raoult's Law :

" Vapour pressure of a component in the solution is equal to mole fraction of that component and multiplied with the vapour pressure of that component in pure state."

For two components *A* and *B* in liquid solution.

$p_A = p^0_A X_A$ & $p_B = p^0_B X_B$

Total pressure ; Apply Dalton's Law of Partial Pressure

o **Limitations:**

- It is applicable for very dilute solutions (Volatile liq.) only.
- It is applicable for solutions containing solutes, which neither associate nor dissociate.
- It is applicable for Homogenous mixture only.

4.3 Ideal Solutions for Volatile Liquid :

I) The solution which obey Raoult's law at all temperatures and concentrations.

$p_A = p^0_A X_A$ & $p_B = p^0_B X_B$ Hence, $P = p_A + p_B$

II) $\Delta H_{mix.} = 0$ i.e. no heat is evolved or absorbed when components are mixed to form the solution.

III) $\Delta V_{mix.} = 0$ i.e. no change in vol. on mixing of two comp.

IV) $\Delta U = 0$ & $\Delta S > 0$

V) $P_{Observed} = P_{Raoult's}$

VI) In ideal solution the A -B intermolecular interactions are the same as A -A and B -B inter molecular interactions.

VII) In an ideal solution of two components say and, all cohesive forces (A-A, B-B and A-B) must be identical.

VIII) They do not form Azeotrope's.

- Two liquids on mixing will form an ideal solution if following conditions be satisfied:-
  - Both have similar structures
  - Both have similar molecular sizes
  - Both have identical intermolecular forces strictly there is no attraction and repulsions
- The following pairs almost behave as ideal solutions
  a) Benzene & toluene
  b) ethyl bromide & ethyl chloride
  c) n - Heptane & n- hexane
  d) Chlorobenzene & bromobezene
  e) ethylene chloride & ethylene bromide.

4.4 Non-Ideal Solution : And those which do not obey Raoult's law form non-deal solution.

I) Showing Positive Deviations : For such solutions-

I) $p_A > p^0_A X_A$ & $p_B > p^0_B X_B$ Hence, $P > p_A + p_B$

II) $\Delta H_{mix.} > 0$ i.e. no heat is evolved or absorbed when components are mixed to form the solution.

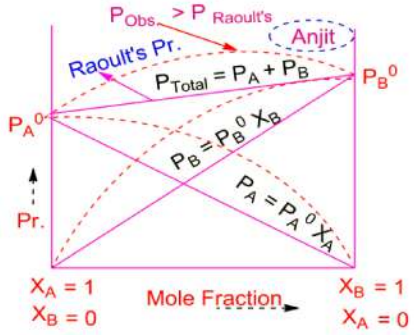
III) $\Delta V_{mix.} > 0$ i.e. no change in vol. on mixing of two comp.

IV) $\Delta U > 0$

V) $P_{Observed} > P_{Raoult's}$

VI) A- B inter - molecular interactions are weaker than A-A and B-B intermolecular interactions.

VII) Minimum Boiling Azeotrope's.



Examples:

a) Carbon tetrachloride +benzene
b) Carbon tetrachloride + chloroform
c) Carbon tetrachloride + Toluene
d) Acetone + Carbon disulphide
e) Acetone +Ethyl alcohol
f) Acetone + Benzene
g) Methyl alcohol + Water
h) Ethyl alcohol + Water

II) Showing Negative Deviations: For such solutions

(a) A -B intermolecular interactions are stronger than A-A and B-B intermolecular interactions .

Examples:

a) Acetic acid + Pyridine
b) Phenol + Aniline
c) HCl + Water
d) HNO_3 + Water

5. Azeotropic Mixtures

A mixtures of two liquids which has constant boiling point and their composition throughout the distillation.

def. Azeotropes

They are formed by non-ideal solutions.

Greek word: a + Zein + O + tropes

No to boil to change

No change in boiling

Constant Boiling Mixture

Types

Minimum boiling azeotropes

- are the mixture of two liquids, whose boiling points is less than either of the two pure components.
- They are formed by non-ideal solution showing positive deviation.
- Ex.- ethanol (95.5%) + water (4.5%) mixture boiling at 351.15 K.

Maximum boiling azeotropes

- are the mixtures of two liquids, whose boiling points are more than either of the two components.
- They are formed by non-ideal solution showing negative deviation.
- Ex.- HNO_3(68%) + water (32%) mixture boiling at 393.5 K

6. Colligative Properties (C.P)

A colligative property are the those properties of ideal solution, which depends only on the number of solute particle and do not depend on the nature of solute, are called colligative properties.

- Solute are Non-volatile in nature.
- **C.P** ∝ No. of particles.
  ∝ No. of molecules
  ∝ No. of ions (In the solution of electrolytes)
  ∝ No. of moles of solute
  ∝ Mole fraction of solute
- There are four colligative properties of solution:
  (i) RLVP, $\frac{P^\circ - P_s}{P^\circ} = \chi_{solute}$.
  (ii) Osmotic pressure, π = CRT.
  (iii) Elevation of boiling point, $\Delta T_b = k_b m$.
  (iv) Depression in freezing point, $\Delta T_b = k_f m$.

(i) Relative lowering of Vapour Pressure (RLVP) :

Experimentally relative lowering in Vapor pressure = mole fraction of the non volatile solute in solution.

- When the sol^n do not dilute (if conc. of the solute is > 5%)
$$\frac{P^0 - P_S}{P^0} = \frac{n_2}{n_2 + n_1}$$
- Very dilute (if conc. of the solute is upto 5%)
$$\frac{P^0 - P_S}{P^0} = \frac{n_2}{n_1} = molality \times \frac{M_{solvent}}{1000}$$
- Conc. and dilute (Dilute as well as Conc. solution) :

$$\text{RLVP} = \frac{P - P_s}{P} = X_{\text{Solute}} = \frac{n}{n+N}$$

$$\Rightarrow \frac{P}{P - P_s} = \frac{n+N}{n} = 1 + \frac{N}{n}$$

$$\Rightarrow \frac{N}{n} = \frac{P}{P - P_s} - 1 = \frac{P - P + P_s}{P - P_s} = \frac{P_s}{P - P_s}$$

$$\Rightarrow \frac{P - P_s}{P_s} = \frac{n}{N}$$

$$\Rightarrow \frac{P - P_s}{P_s} = \frac{w}{m} \times \frac{M}{W} = \frac{w}{m} \times \frac{M}{W} \times \frac{1000}{1000}$$

$$= \frac{w}{m} \times \frac{1000}{W} \times \frac{M}{1000}$$

$$\Rightarrow \frac{P - P_s}{P_s} = (\text{molality}) \times \frac{M}{1000}$$

M = Mol. wt. of solvent

n = no. of moles of solute

N = no. of moles of solvent

(ii) Osmotic pressure :

➢**Note: Diffusion :** Spontaneous flow of particles from high concentration region to lower concentration region is known as diffusion.

➢**Osmosis :** The spontaneous flow of solvent particles from solvent side to solution side 'or' It is a process in which solvent molecules pass through a semipermeable membrane (SPM) from solution of low concentration side to high concentration side solution, is known as Osmosis.

➢**Reverse Osmosis:**

When a pressure higher than that of osmotic pressure is applied in the solution, is called reverse osmosis.
It used in desalination of sea water

➢**SPM :** A membrane which allows only solvent particles to move across it.

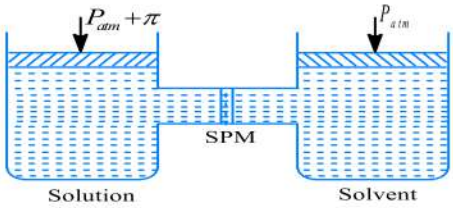
(a) **Natural semi permeable membrane :** Animal/plant cell membrane formed just below the outer skins.

(b) **Artificial semi permeable membranes :** A copper ferrocyanide. $Cu_2[Fe(CN)_6]$

➢**Osmotic pressure :** The min. excess pressure that has to be applied on the solution to prevent the entry of the solvent into the solution, through a semipermeable membrane, is called O.P.

Definition : The external pressure which must be applied on solution side to stop the process of osmosis is called osmotic pressure of the solution.

$P_{ext.}$ must be applied on the higher conc. side.



➢**Determination : Barkley–Hartley method:**

For cal. of O.P. $\pi \propto C$ conc. (molarity) & $\pi \propto T$

hence, $\pi = CRT$

R (ideal gas) constant = 8.314 J mol^{-1}. K^{-1}

$\pi = CRT = \frac{n}{V} RT$ (just like ideal gas equation)

$\Rightarrow \pi V = nRT$ ⇒ van't Hoff equation for dilution solutions

➢**Determination of M.M from O.P expression:**

$\pi V = nRT$ = wt/M.wt RT ⇒ M. wt. = $\frac{dRT}{\pi}$

- Applicable only to dilute solution.
- R = 0.0821 L-atm/K-mol

➢**Type of solutions :**

(a) isotonic solutions : Two sol^n having same O.P.

$\pi_1 = \pi_2$ (at same temp.)

Ex- 0.85% NaCl solutions is found to be isotonic with blood.

(b) Hyper tonic solutions : If $\pi_1 > \pi_2$

Ist solution is hypertonic solution w.r.t. 2nd solution

When placed in hypertonic solutions , cells contract in size (plasmolysis). When excess of fertilizers (like urea) are applied , plasmolysis takes place and plants dry up (wilt).

(c) Hypotonic solutions : 2nd sol^n is hypotonic w.r.t. Ist sol^n

When placed in hypotonic solutions, cells swell and burst (haemolysis)

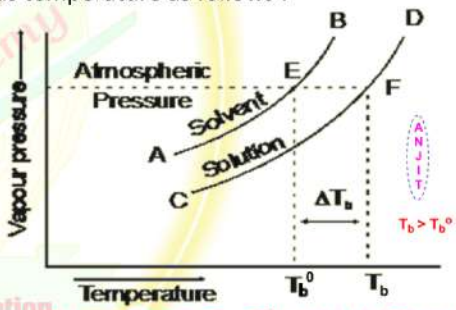
(iii) Elevation in boiling point:

Boiling point of a Liquid : The temperature at which vapour pressure of a liquid becomes equal to the external pressure present at the surface of the liquid is called b.p. of liquid at that pressure.

The property of rise in boiling point when some non volatile solute is added.

We know that the vapour pressure of the solution is lower than that of the pure solvent and vapour pressure increases with increase in temperature.

Alternatively, the elevation in boiling point may be explained on the bais of plots of vapour pressure versus temperature as follows :



The difference $\Delta T_b = T_b - T_b^0$, is called Elevation in B.P.

$\Rightarrow \Delta T_b = K_b \times \text{molality} = K_b \times \frac{w_2 \times 1000}{M_2 \times M_1}$

- K_b is dependent on property of solvent and known as molal elevation constant of solvent 'or' known as ebullioscopic constant .
- M_2= Mol. mass of non-ionic (non-electrolyte) solute
- Units: $\frac{\Delta T_b}{\text{molality}} = \frac{K}{\text{mol/kg}} = K\ \text{kg mol}^{-1}$
- for $K_b = \frac{R T_b^2}{1000} \times \frac{M_1}{\Delta_{vap}.H}$ ⇒ Value less than 1.
- for Water K_b = 0.52 K-Kg/mol.

(iv) Depression in freezing point :

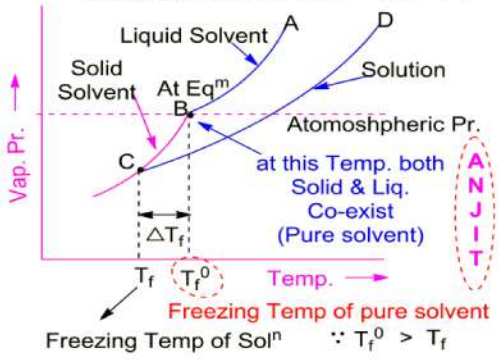
Freezing point : Temperature at which vapour pressure of solid becomes equal to v.p. of liquid is called freezing point of liquid or melting point of solid.

The property of decrease in freezing point when some non-volatile solute is dissolved. The depression in freezing point is given by ΔT_f

We know that vapour pressure of the solution is less than that of the pure solvent. As freezing point is the temperature at which the vapour pressure of the liquid and the solid phase are equal, therefore for the solution, this will occur at lower temperature (lower the

temperature lower the vapour pressure).

The graph explains this. $\Delta T_f = T°f - Tf$



Freezing Temp of Soln $\because T_f^0 > T_f$

$\Delta T_f = k_f.m$

k_f = **Molal depression constant.** or **cryoscopic constant .**

- for $K_f = \frac{R T_f^{0\,2}}{1000} \times \frac{M_1}{\Delta_{vap}.H}$
- for Water K_f = 1.86 K-Kg/mol.

Application Of Depression in freezing point :

1. In Melting antifreeze Solution: Adding Ethylene glycol (OH-CH_2-CH_2-OH) to water in car radiator to hill station.

2. Melting of ICE on roads: by adding NaCl or $CaCl_2$.

7. Abnormal Molecular Masses

When the calculated molecular mass of colligative properties is different from expected value is known as abnormal molecular mass.

It depends upon -

- Solution should be non-ideal.
- When solute undergo either dissociation or Association of Solution.
- The actual extent of dissociation/ association can be expressas a correction factor known as vant Haff factor (*i*).
- $i = \frac{Observed\ Colligative\ Prop.}{Calculated\ Colligative\ Prop.} = \frac{Cal.\ Molar\ mass}{Observed\ molar\ mass} = \frac{Total\ no.\ of\ solute\ after\ Association/dissociation}{Total\ no.\ of\ solute\ before\ Association/dissociation}$

i > 1 ⇒ Dissociation

I < 1 ⇒ Association

i = 1 ⇒ neither dissociation nor association.

7.1 Van't Hoff factor and degree of dissociation:

If a molecule of solute on dissociation gives **n** ions (no. of dissociated moles) & α is the degree of dissociation then,

	$(A)_n$	⟶	nA
Initial mole	1 mole		0
dissociation change	$-\alpha$ mole		$+ n\alpha$ mole
Equilibrium mole	$(1-\alpha)$ mole		$n\alpha$ mole

Total number of moles after dissociation of 1 mole of A

$= [(1 - \alpha) + n\alpha]$ mole $= 1 + \alpha(n - 1)$ mole

⇒ Van't Hoff factor (*i*) $= \frac{1+\alpha(n-1)}{1} =$ **$1 + (n - 1)\alpha$**

or ⇒ $\alpha = \frac{i-1}{n-1}$

- For Strong Electrolyte (100% dissolve) ⇒ All type of Salt, Strong Acid or Strong Base. then, ⇒ $\alpha = 1$ So, **i = n**
- For Strong Electrolyte (< 100% dissolve) ⇒ weak Acid or weak Base. then, ⇒ Use the Formulae.

7.2 Van't Hoff factor and degree of association :

If a solute A forms associated molecules A_n and α is the degree of association then,

	nA	⟶	A_n
Initial mole	1 mole		0
Associated change	$-\alpha$ mole		$+\alpha/n$ mole
Equilibrium mole	$(1-\alpha)$ mole		$+\alpha/n$ mole

Total number of moles after association 1 mole of A

$= (1 - \alpha) + (\alpha/n)$ mole $= 1 + (1/n - 1)\alpha$ mole

Van't Hoff factor (*i*) = **$1 + (1/n - 1)\alpha$**

7.3 Colligative properties in terms of Von't Hoff Factor:

Always multiply with ***i*** **:**

- $\frac{P - P_s}{P_s} \times i \times (molality) \times \frac{M}{1000}$
- $\pi = i \times CRT$
- $\Delta T_b = i \times K_b \times molality$
- $\Delta T_f = i \times k_f.m$

Solved Problems

Ex.1 Which solution will have the highest boiling point?

(A) 1 (M) $C_6H_{12}O_6$ solution (B) 1 (M) NaCl solution

(C) 1 (M) $BaCl_2$ solution (D) 1 (M) $CO(NH_2)_2$ soln

Sol.(C) As the no. of particles is highest for the 1(M) $BaCl_2$ after complete ionisation, therefore, elevation of boiling pt. will be highest for this solution.

Ex.2 Which of the following 0.1(M) aqueous solution will have lowest boiling point ?

(A) K_2SO_4 (B) NaCl (C) Urea (D) Glucose

Sol.(C) As the number of particles is the highest on complete dissociation of K_2SO_4. Hence boiling point is highest for K_2SO_4. As glucose and urea is not dissociated in solution hence boiling point is lower for these two solutions.

Ex.3 Which one of the following pairs of solution can we expect to be isotonic at the same temperature-

(A) 0.1(M) urea and 0.1(M) NaCl

(B) 0.1(M) urea and 0.2(M) $MgCl_2$

(C) 0.1(M) NaCl and 0.1(M) Na_2SO_4

(D) 0.1(M) $Ca(NO_3)_2$ and 0.1(M) Na_2SO_4

Sol.(D) As the no. of ionic species produced after complete dissociation of 0.1(M) $Ca(NO_3)_2$ and 0.1(M) Na_2SO_4 are only same.

Ex.4 When 1 mole of a solute is dissolved in 1kg of H_2O, boiling point of solution was found to be 100.5ºC. K_b for H_2O is -

(A) 0.5 (B) 100 (C) 100.5 (D) 95.5

Sol.(A) $\Delta T_b = K_b \times m$, m = 1 $\therefore K_b = \Delta T_b = 100.5 - 100 = 0.5$

Ex.5 Which of the following aqueous solution has osmotic pressure nearest to that an equimolar solution of $K_4[Fe(CN)_6]$?

(A) Na_2SO_4 (B) $BaCl_2$

(C) $Al_2(SO_4)_3$ (D) $C_{12}H_{22}O_{11}$

Sol.(C) As the no. of species obtained after the complete dissociation of $Al_2(SO_4)_3$ is same to the no. of species obtained after complete dissociation of $K_4[Fe(CN)_6]$.

Ex.6 The osmotic pressure of a solution at 0ºC is 4 atm. What will be the osmotic pressure at 546K under similar conditions ?

(A) 4 atm (B) 2 atm (C) 8 atm (D) 1 atm

Sol.(C) $\pi = CRT$, T = 273, π = 4

$\therefore C = \frac{\pi}{RT} = \frac{4}{R \times 273}$ When, T = 546 K

$\therefore \pi = CRT = \frac{4}{R \times 273} \times R \times 546 = 8$ atm

Ex. 7 pH of a 0.1 (M) mono basic is found to be 2. Hence

osmotic pressure at given temperature T is -

(A) 0.1 RT (B) 0.11 RT (C) 1.1 RT (D) 0.01 RT

Sol.(B) $HA \rightleftharpoons H^+ + A^-$ $C(1+\alpha)$

$C(1-\alpha)$ $C\alpha$ $C\alpha$

$[H^+] = 10^{-2}$ $[A^-] = 10^{-2}$

$[HA] = 0.1 - 10^{-2} = 0.09$

$C(1-\alpha) = 0.09$ hence, $(1-\alpha) = \frac{0.09}{0.1} = 0.9$

$\alpha = 1 - 0.9 = 0.1$

$\therefore \pi = C(1+\alpha)RT = 0.1\,(1.1)\,RT = 0.11\,RT$

Ex.8 $PtCl_4 . 6H_2O$ can exist as a hydrated complex 1 molal aqueus solution has depression in freezing point of 3.72º. Assume 100% ionisation and K_f (H_2O) = 1.86º mol^{-1} kg, then complex is -

(A) $[Pt(H_2O)_6]Cl_4$ (B) $[Pt(H_2O)_4Cl_2]\,Cl_2\,2H_2O$

(C) $[Pt(H_2O)_3Cl_3]$,Cl $3H_2O$ (D) $[Pt(H_2O)_4Cl_4]4H_2O$

Sol.(C) $(\Delta T_f)_{cal} = K_f \times m \Rightarrow (\Delta T_f)_{cal} = 1.86 \times 1 = 1.86$

$i = \frac{(\Delta T_f)_{obs}}{(\Delta T_f)_{cal}} = \frac{3.72}{1.86} = 2 = 1 + (n-1)\alpha$

Hence $\alpha = 1$, $\therefore$ $n = 2$

$\therefore$ Two species will be produced from single species which is only possible for $[Pt(H_2O)_3Cl_3]Cl,3H_2O$

Ex.9 The freezing point of an 0.08 (m) $NaHSO_4$ is – 0.345ºC. Calculate the percentage of HSO_4^- ions that transfer a proton to water to form SO_4^{2-} ion.

$K_f(H_2O) = 1.86\ mol^{-1}kg$

Sol. $NaHSO_4 \rightleftharpoons Na^+ + HSO_4^-$

$H_2O + HSO_4^- \rightleftharpoons H_3O^+ + SO_4^{2-}$

$NaHSO_4 \rightleftharpoons Na^+ + H^+ + SO_4^{2-}$

$i = \frac{\Delta T_f}{K_f \times m} = \frac{0.345}{1.86 \times 0.08} = 2.3185$

$i = 1 + (3-1)\alpha = 1 + 2\alpha$ $\therefore$ $2\alpha = 1.3185$

or $\alpha = 0.65925$

$\therefore$ percentage of HSO_4^- that transfer proton to water = 65.925

Multiple Choice Questions

Q.1 When the depression in freezing point is carried out then equilibrium exist between-

(A) Liquid solvent and solid solvent

(B) Liquid solute and solid solvent

(C) Liquid solute and solid solute

(D) Liquid solvent and solid solute

Q.2 Aqueous solutions of 0.004 M Na_2SO_4 and 0.01 M Glucose are isotonic. The degree of dissociation of Na_2SO_4 is –

(A) 25% (B) 60% (C) 75% (D) 85%

Q.3 13.44 gm of $CuCl_2$ is dissolved in 1 kg of water. Determine the elevation in boiling point of the solution. K_b = 0.5 K Kg mol^{-1}. Molecular wt. of $CuCl_2$ = 134.4

(A) 0.16 (B) 0.052 (C) 0.1 (D) 0.5

Q.4 When 20 g of naphthoic acid ($C_{11}H_8O_2$) is dissolved in 50g of benzene (K_f = 1.72 K kg mol^{-1}), a freezing point depression of 2K is observed. The van't Hoff factor (i) is–

(A) 0.5 (B) 1 (C) 2 (D) 3

Q.5 The Henry's law constant for the solubility of N_2 gas in water at 298 K is 1.0×10^5 atm. The mole fraction of N_2 in air is 0.8. The number of moles of N_2 from air dissolved in 10 moles of water at 298 K and 5 atm pressure is-

(A) 4.0×10^{-4} (B) 4.0×10^{-5}

(C) 5.0×10^{-4} (D) 4.0×10^{-6}

Q.6 For a dilute solution, Raoult's law states that-

(A) The lowering of vapour-pressure is equal to the mole-fraction of solute

(B) The relative lowering of vapour-pressure is equal to the mole fraction of solute

(C) The relative lowering the vapour-pressure is proportional to the amount of solute in solution

(D) The vapour-pressure of the solution is equal to the mole-fraction of solvent

Q.7 A molal solution is one that contains one mole of a solute in-

(A) 1000 g of the solvent (B) 1 L of the solvent

(C) 1 L of the solution (D) 22.4 L of the solution

Q.8 When mercuric iodide is added to the aqueous solution of potassium iodide

(A) freezing point is raised

(B) freezing point is lowered

(C) freezing point does not change

(D) boiling point does not change

Q.9 Which of the following 0.1 M aqueous solution will have the lowest freezing point ?

(A) Potassium sulphate (B) Sodium chloride

(C) Urea (D) Glucose

Q.10 The freezing point of equimolal aqueous will be highest for :

(A) $C_6H_5NH_3Cl$ (aniline hydrochloride)

(B) $Ca(NO_3)_2$

(C) $La(NO_3)_3$

(D) $C_6H_{12}O_6$(glucose)

Q. 11 The molecular weight of benzoic acid in benzene as determined by depressing in freezing point method corresponds to –

(A) ionization of benzoic acid

(B) dimerization of benzoic acid

(C) trimerization of benzoic acid

(D) salvation of benzoic acid

Q.12 Azeotropes are –

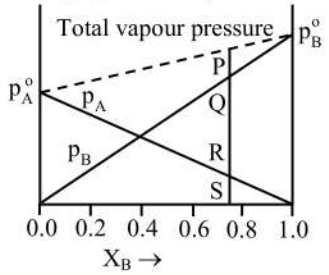
(A) liquid mixtures which distill unchanged in composition

(B) liquids which can mix with each other in all proportions

(C) solids which form solid solutions of definite composition

(D) gases which can be separated

Q.13 Consider the following vapour-pressure composition graph SP is equal to –



(A) PQ + RS (B) PQ + QR + RS
(C) SR + SQ (D) PQ + QR

Q.14 Which of the following solutions are expected to be isotonic with respect to 6% (W/V) solution of urea ?
(A) 18% solution of glucose
(B) 1 M solution of NaCl
(C) 1 M solution of sucrose
(D) 1 M solution of CH_3COOH

Q.15 Which of the following solutions exhibit positive deviation from Raoult's law ?
(A) $H_2O + C_2H_5OH$ (B) $C_6H_6 + C_2H_5OH$
(C) $H_2O + HCl$ (D) $CHCl_3+(CH_3)_2CO$

Q.16 For which of the following solutes 'i' is greater than 1 ?
(A) Urea (B) Sucrose
(C) Sodium chloride (D) Sodium sulphate

Q.17 When a solution containing non-volatile solute is diluted with water,
(A) its vapour pressure increases
(B) its osmotic pressure increases
(C) its boiling point increases
(D) its freezing point increases

Q.18 For a solution containing non-volatile solute, the relative lowering of vapour pressure is 0.2. If the solution contains 5 moles in all, which of the following are true ?
(A) Mole fraction of solute in the solution is 0.2
(B) No. of moles of solute in the solution is 0.2
(C) No. of moles of solvent in the solution is 4
(D) Mole fraction of solvent is 0.2

Q.19 Consider following solutions :
I. 1 M aq. glucose
II. 1 M aq. sodium chloride
III. 1 M benzoic acid in benzene
IV. 1 M ammonium phosphate
(A) all are isotonic solutions
(B) III is hypotonic of I, II, IV
(C) I, II, IV are hypertonic of III
(D) IV is hypertonic of I, II, III

Q.20 5.3% (W/V) Na_2CO_3 solution and 6.3% (W/V) $H_2C_2O_4.2H_2O$ solution have same –
(A) Molality (B) Molarity
(C) Normality (D) Mole fraction

Match the items of column A to those of column B:

Q.21

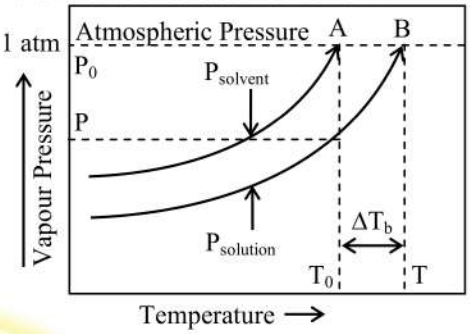
	Column I		Column II
(A)	Relative lowering of	(P)	Mole fraction of V.P. solute
(B)	For electrolyte $CaSO_4$	(Q)	i = 1
(C)	For ideal Solution	(R)	i > 1
(D)	For $NaHCO_3$	(S)	i = 3

Q.22 For an ideal binary liquid solution of A & B. P_A^0 = pure vapour pressure of A. P_B^0 = pure vapour presure of B. X_A = mole fraction of A in liquid phase. Y_A = mole fraction of A in vapour phase.

	Column I		Column II
(A)	$P_A^0 > P_B^0$	(P)	$X_A = Y_A$
(B)	Azeotropic mixture	(Q)	$X_A < Y_A$
(C)	Equimolar mixture of A & B with $P_A^0 < P_B^0$	(R)	$X_B < Y_B$
(D)	Equimolar mixture of A & B with $P_A^0 = P_B^0$	(S)	$Y_B > Y_A$

Passage - I (Q. 23 to 25)

Figure explains elevation in boiling point when a non-volatile solute is added to a solvent.



Q.23 Given that ΔT_b is the elevation in boiling point of the solvent in a solution of molality 'm' then $\lim_{m\to 0}\left(\frac{\Delta T_b}{m}\right)$ is equal to –
(A) K_b (molal elevation constant)
(B) L_y (latent heat of vaporisation)
(C) ΔS (entropy change)
(D) X (mole fraction of solute)

Q.24 Elevation in b.p. of an aqueous urea solution is 0.52º. (K_b = 0.52º mol^{-1} kg). Hence, mole fraction of urea in this solution is –
(A) 0.982 (B) 0.0567 (C) 0.943 (D) 0.018

Q.25 A complex of iron and cyanide ions is 100% ionised at 1 m (molal) If its elevation in b.p. is 2.08º. (k_b = 0.52) then complex is –
(A) $K_3[Fe(CN)_6]$ (B) $Fe(CN)_2$
(C) $K_4[Fe(CN)_6]$ (D) $Fe(CN)_4$

Ans Key

1-A	2-C	3-A	4-A	5-A	6-B	7-A	8-A
9-A	10-D	11-B	12-A	13-B,C	14-A,C	15-A,B	16-C,D
17-A,D	18-A,C	19-B,C,D	20-B,C				

21. (A) ⟶ (P) (B) ⟶ (R) (C) ⟶ (Q) (D) ⟶ (R,S)
22. (A) ⟶ (Q) (B) ⟶ (P) (C) ⟶ (R,S) (D) ⟶ (P)
23. A **24.** D **25.** A

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☎आपका परिश्रम + हमारा मार्गदर्शन = निश्चित सफलता☎
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