SOLUTIONS & COLLIGATIVE PROPERTIES

Concentration Terms

i. **A** or **1** = Solvent,
B or **2** = Solute,
C or **3** = Solution

ii. **W** = Weight,
V = Volume
d = density

iii. $W_C = W_A + W_B$

iv. $W_A = W_1$ = Weight of solvent

✡ Concentration of Solution

i. **Conc. of Solution** = Conc. of Solute

$$= \frac{\text{no -of moles of solute}}{\text{Volume of solution}}$$

ii. Methods of expressing concentration of solution.

$$\text{M, N, m, } \%\frac{W}{W}, \%\frac{W}{V}, \text{X, PPb, PPm, strength}$$

Molarity and Normality (A = Solvent, B = Solute, C = Solution)

✡ Molarity (M)

i. $M = \dfrac{n_B}{V_C \text{ lt}}$

ii. $M = \dfrac{W_B}{M.W_B} \times \dfrac{1}{V_C(\text{lt})}$

iii. $M = \dfrac{W_B}{M.W_B} \times \dfrac{1000}{V_C(M)}$

iv. $M = \dfrac{\text{no - of solute molecules}}{N_A} \times \dfrac{1000}{V_C \text{ ml.}}$

v. **no – of moles of solute = $M \times V_C$ (lt)**

vi. **no – of millimoles of solute = $M \times V_C$ (ml)**

vii. **Wt of solute = $W_B = n_B \times M.W_B$**

viii. **1 Molar = 1 M = 1 mol/lt**
Decimolar = 0.1 M = M/10
Centimolar = 0.01 M = M/100
Millimolar = 0.001 M = M/1000
Semi molar = 0.5 Md = M/2
Penti molar = 0.2 M = M/5
Deca molar = 10 M.

✡ Normality (N)

i. $N = \left(\dfrac{\text{no - of gm. eq of solute}}{\text{Vol. of solute (lt)}}\right)$

ii. $N = \dfrac{W_B}{E_B} \times \dfrac{1000}{V_C \text{ ml}}$

(E = Gram equivalent weight)

iii. **no – of gm. eq of solute = N × V_C (lt)**

iv. **No – of millieq. of solute = N × V_C (ml)**

v. **Unit : gm. eq./lt**

Note : First find molarity then find normality

$$N = M \times V.f$$

Molality, Mole Fraction and Strength (A = Solvent, B = Solute, C = Solution)

✡ Molality (m)

i. $m = \dfrac{n_B}{W_A(\text{kg})}$

ii. $m = \dfrac{n_B}{M.W_B} \times \dfrac{100}{W_A(\text{gm})}$

iii. **1 molal = 1 m = 1 mole/kg**
Decimolal = 0.1 m = m/10

✡ Mole fraction (x)

i. If a mixture or solution contains three components of moles n_1, n_2 & n_3.

ii. If x_1, x_2, x_3 are mole fraction of each components.

iii. Let $N = n_1 + n_2 + n_3$ = Total moles

iv. $x_1 = \dfrac{n_1}{N}, \; x_2 = \dfrac{n_2}{N}, \; x_3 = \dfrac{n_3}{N}$

v. $x_1 + x_2 + x_3 = 1$

∴ Sum case of mole frection on = **1**

vi. **In case of binary solution**

$$x_A = \frac{n_A}{n_A + n_B} \; ; \qquad x_B = \frac{n_B}{n_A + n_B}$$

$x_A + x_B = 1$

✡ Strength in gm/lt (S) :

i. $S = \dfrac{W_B(\text{gm})}{V_A \text{lt}}$

ii. W_B = (S) (V_C lt)

By RAJESH SHAH

Percentage, PPM, PPb, PPT
(A = Solvent, B = Solute, C = Solution)

i. %by weight (% W/W)

$$\boxed{\% \frac{W}{W} = \frac{W_B}{W_C} \times 100}$$

$(W_C = W_A + W_B)$

ii. % Wt by Vol. %W/V or W/V%

$$\boxed{\% \frac{W}{V} = \frac{W_B}{V_C} \times 100}$$

iii. % Vol. by Vol. (%V/V)

- It is applicable for **liquid** in **liquid** type of solution.
- Let V_A, V_B, V_C = Vol. of solvent, solute and solution.
- If $V_C = V_A + V_B$ = Ideal sol.
  $V_C < V_A + V_B$ = Non Ideal –ve deviation
  $V_C > V_A + V_B$ = Non Ideal +ve deviation.
- $$\boxed{\% \frac{V}{V} = \frac{V_B}{V_C} \times 100}$$

✡ PPM, PPb, PPT

i. These are used to express the conc. of very dilhte solution and conc. of gaseous pollutant.

ii. In case of solids in liquid solution.

- **no – of PPM** $= \frac{W_B}{W_C} \times 10^6$
- **no – of PPb** $= \frac{W_B}{W_C} \times 10^9$
- **no – of PPT** $= \frac{W_B}{W_C} \times 10^{12}$
- Ex : **100 PPM** Sugar solution means **100 gm** of sugar preseat in **10^6 gm** of solution.

iii. In case of gas in gas solution.

$$\text{no – of PPM} = \frac{V_B}{V_C} \times 10^6$$

Ex : **100 PPM of CO_2** in air is **100** ml of **CO_2** preseat in every **10^6** ml of air mixture.

Interconversion of Concentration Terms
(A = Solvent, B = Solute, C = Solution)

i. $M = \dfrac{\% \frac{W}{V} \times 10}{M.W_B}$

ii. $M = \dfrac{\% \frac{W}{W} \times d_C \times 10}{MW_B}$

iii. $M = \dfrac{S(gm/lt)}{MW_B}$

iv. $N = M \times V.f$

v. $S(gm/lt) = \% \frac{W}{V} \times 10$

vi. $\% \frac{W}{V} = \% \frac{W}{W} \times d_C$

vii. In case of binary solution.

- $X_B = \dfrac{m}{m + \left(\frac{1000}{M.W_A}\right)}$ (For any sol.)
- In case of aqueous solution.

$$\boxed{X_B = \frac{m}{m + 55.5}}$$

viii. $\boxed{\frac{d_C}{M} = \frac{1}{m} + \frac{M.W_B}{1000}}$ or $\boxed{m = \frac{1000 \times M}{(1000 \times d) - (M \times MW_{solute})}}$

But in case of very dilute solution, $M = m \times d_C$

ix. **When % W / W of solute is given**

$$m = \frac{\%\ W/W}{M_2} \times \frac{1000}{(100 - \% w/w)}$$

x. **Relation bet^n molarity & mole fraction**

$$M = \frac{X_{Solute} \times 1000 \times d_c}{(X_{Solute} \times M.W_{Solute}) + (X_{Solvent} \times M.W_{Solvent})}$$

Note:

- In case of aq. solution or density of solvent ≥ 1
  Then concentration of **1 M > 1 ml**
- If density of solvent < 1
  Then concentration of **1 M < 1 m**

Concept of Dilution

i.

Before Dilution (B / D)	After Dilution (A / D)
M_1	M_2
N_1	N_2
V_1	V_2

ii. On dilution, amount of **solute constant**

M × V = no of moles of **solute = constant**

N × V = no of gm.eq of **solute = constant**

iii. $$\boxed{\begin{aligned}M_1V_1 = N_2V_2\\ N_1V_1 = N_2V_2\end{aligned}}$$

iv. $V_2 - V_1$ = volume of solvent added for dilution.

v. $$\frac{V_2}{V_1} = \frac{M_1}{M_2} = \frac{N_1}{N_2} = \text{N.T.D.}$$

(N. T. D = No of time of dilution)

Mixing of Solutions of non reacting solutes

i.

Sol^n 1	**Sol^n** 2
M_1	N_2
N_1	N_2
V_1	V_2

ii. If M_R, N_R = Resultant molarity and normality of mixture of solution 1 and 2.

iii. $$M_R = \boxed{\frac{\text{Total moles of solute}}{\text{Total Vol. of solution}}}$$

$$M_R = \boxed{\frac{M_1V_1 + M_2V_2}{V_1 + V_2}}$$

iv. $$N_R = \boxed{\frac{\text{Total gm. eq of solution}}{\text{Total Vol. of sol.}}}$$

$$N_R = \boxed{\frac{N_1V_1 + N_2V_2}{V_1 + V_2}}$$

v. If the above two solutions are mixed and then diluted to **vol. (V)** then

- $$M_R = \boxed{\frac{M_1V_1 + M_2V_2}{V}}$$
- $$N_R = \boxed{\frac{N_1V_1 + N_2V_2}{V}}$$
- Volume of **H_2O** added for dilution

  $= V - (V_1 + V_2)$

Mixing of Solutions of reacting solutes

✡ Mixing of Solutions of reacting solutes

i. **Ex :** of reacting solutes

- **Acid – Base**
- **Oxidising agent + Reacing agent**

ii. Consider of mixture of Acid and Base

-

Acid	Base
N_a	N_b
V_a	V_b

- If $N_aV_a > N_bV_b$, then

  $$N_R = [H^+] = \left(\frac{N_aV_a - N_bV_b}{N_b + V_b}\right)$$

- If $N_bV_b > N_aV_a$, then

  N_R = Resultant Normality of unreacted (U.R) Base.

  $$N_R = [OH^-] = \left(\frac{N_bV_b - N_aV_a}{V_a + V_b}\right) \qquad M_R = \left(\frac{N_R}{V.f}\right)$$

- If $N_aV_b = N_bV_b$, then

  Nature of solution = neutral

  N_R = Resultant normality of solution

  = normality of salt formed

  $$N_R = \left(\frac{\text{no. of eq. of salt formed}}{\text{Total volume}}\right) = \frac{x}{V_a + V_b}$$

  no of eq. of salt formed = $x = N_aV_a = N_bV_b$

Henry's Law

i. Statement :

Solubility of gas $\propto$ Partial Pressure of gas

ii. **Let S =** Molar solubility mole/lt

$$S = \frac{n(g)}{V_C lt}$$

n(g) = no of moles of gas in dissolved state.

iii. $\boxed{P_{(g)} = K_H S_{(g)}}$

K_H = Henry's constant.

iv. The value of K_H depends on nature of gas, nature of solvent, temp and pressure.

v. **Soulbility of gas** $\propto \frac{1}{K_H}$

$\propto$ **I. M. F**

$\propto$ T_C

$\propto$ **Liquification of gas**

$\propto \frac{a}{b}$ (a, b = vanderwaal const.)

$\propto$ **Pressure of gas**

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

v. The Henry's formula depends on unit of K_H

Step I : Check the unit of K_H

Step II : Apply the related formula.

Unit of K_H	Henry's Formula
mole lt^{-1} atm^1	$S_{(g)} = K_H.P_{(g)}$
atm lt $mole^{-1}$	$P_{(g)} = K_H.S_{(g)}$
atm gm^{-1}	$P_{(g)} = K_H.m_{(g)}$
atm^{-1}	$x_{(g)} = K_H.P_{(g)}$
gm atm^{-1}	$m_{(g)} = K_H.P_{(g)}$

vi. Effect of temp. on Solubility of solid in liquid

- Solubility $\propto \frac{1}{\text{Temp.}}$ (Exothermic dissolution)

  Ex.: **Na_2SO_4, Ce_2SO_4**
- Solubility $\propto$ Temp. (Endothermic dissolution)

  Ex.: **NH_4 NO_3, $NaNO_3$, KNO_3, KBr**
- Solubility of **NaCl, KCl & NaBr** increases **slightly** with increase in temperature.
- The salt which are more soluble at high temperature are recrystallised first
- Crystalisation of

$KNO_3 > NaNO_3 > NaBr > KBr > KCl > NaCl > Na_2SO_4$

Colligative Properties (C. P.)

i. **C. P.** are the properties of dilute solution containing non – volatile solute **(N.V. S)**

ii. The values of **C. P.** depends on No. of solute particles but do not depends on nature of solute particles.

iii. The solute particles may be covalent molecule or ions

eg. **2** mole glucouse and **1** mol **NaCl** have same no of solute particles.

iv. **C. P.** are used to calculate the molecular weight of non volatile solute.

v. **C. P. are**

a) **RLVP** b) ΔT_b

c) ΔT_f d) π

vi. On addition of **N.V. S** to volatile solvent, then **V. P** of solvent decreases. This is called lowering of **V.P.**

P° = V. P. of **solvent**

P^S = V. P. of **solvent + N. V. S**

= V. P. of **solution**

vii. **$P^\circ > P^S \Rightarrow P^\circ - P^S > o$ (+ve)**

viii. Lowering in **V. P = $\Delta P = P^\circ - P^S$**

ix. **R. L. V. P. =** $\frac{P^\circ - P^S}{P^\circ}$

x. **% Lowering in V.P. =** $\frac{P^\circ - P^S}{P^\circ} \times 100$

Relative lowering in vapour pressure (RLVP)

vi. Raoult's law for a solution containing N.V.S.

Statement of Raoult's law

$$\boxed{\frac{P^\circ - P^S}{P^\circ} = i.\times_B}$$

$$\boxed{\frac{P^\circ - P^S}{P^\circ} = i.\frac{W_B}{M.W_B} \times \frac{M.W_A}{W_A}}$$

vii. Ostwald – walker method to find RLVP

- On passing dry air into solution bulb and then into solvent bulb.
- Then dry air absorbs the water vapour of the solution and solvent bulb.
- Then there is loss in weight of solution & solvent bulb.
- **W_1 =** Loss in weight of solution bulb.
- **W_2=** Loss in weight of solvent bulb.
- **W_3=** Gain in weight of **$CaCl_2$** tube.

$$\boxed{W_3 = W_1 + W_2}$$

- $\frac{P^0 - P^S}{P^0} = \left(\frac{W_2}{W_1+W_2}\right) = \frac{W_2}{W_3}$

viii. Raoult's Law for a Mixture of volatile liquids

- Consider mixture two Volatile liquids (A) & (B)
- **In the mixture of A & B.**

a) In solution phase (Raoult's Law) :

$$P_A = P_A^o X_A \text{ , } P_B = P_B^o X_B$$

$$\therefore \ P_T = P_A^o X_A + P_B^o X_B$$

$$P_T = P_A + P_B$$

b) **In vapour phase (Dalton's Law) :**

$$P_A = P_T . Y_A = P_A^o X_A$$

$$P_B = P_T . Y_B = P_B^o X_B$$

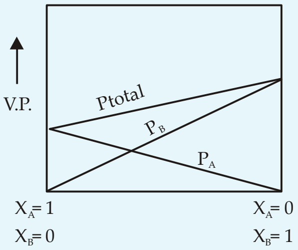
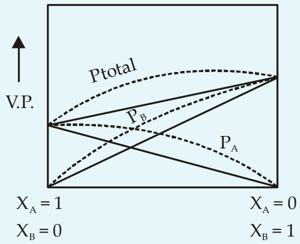
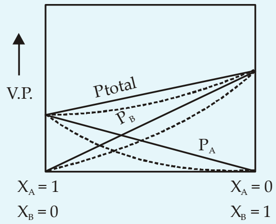
- **P_A, P_B =** Parital pressure of **A & B**

$P_A°$, $P_B°$ = V.P. of pure component of **A & B**

X_A, X_B = Mole fraction of **A & B** in **liq. state**

Y_A, Y_B = Mole fraction of **A & B** in **Vap. state**

Ideal & Non-Ideal solution

Ideal	Non ideal +ve deviations	Non ideal –ve deviations
It **Obeys Raoults** law. **ΔV mix = 0, ΔH mix = 0** **$\Delta S_{mix} > 0$, $\Delta G < 0$** **Attractions of A–A = B–B = A–B** **$P_A = P_A{}^0X_A$** and **$P_B = P_B{}^0X_B$**	It **Do not Obeys Raoults** law. **ΔV mix > 0, ΔH mix > 0** **$\Delta S_{mix} > 0$, $\Delta G < 0$** **Attractions of A–B < Avg. of B–B & A–A** **$P_A > P_A{}^0X_A$** and **$P_B > P_B{}^0X_B$**	It **Do not Obeys Raoults** law. **ΔV mix < 0, ΔH mix < 0** **$\Delta S_{mix} > 0$, $\Delta G < 0$** **Attractions of A–B > Avg. of B–B & A–A** **$P_A < P_A{}^0X_A$** and **$P_B < P_B{}^0X_B$**
Ex. **a. Methanol + ethanol** **b. Ethyl bromide + methyl bromide** **c. Benzene & toluene** **d. n-heptane + N-Hexane** **e. CCl_4;+ benzene** 	**Ex.** **a. Acetone + Ethanol** **b. Acetone + CS_2** **c. Acetone + C_6H_6** **d. $H_2O + CH_3OH$** **e. $H_2O + C_2H_5OH$** **f. CCl_4 + toulene** **g. $CCl_4 + CHCl_3$** **h. $CCl_4 + CH_3OH$** 	**Ex.** **a. Acetone + Aniline** **b. Acetone + $CHCl_3$** **c. CH_3OH+CH_3COOH** **d. $H_2O + HNO_3$** **e. $CHCl_3$+C_2H_5O–C_2H_5** **f. H_2O + HCl** **g. CH_3COOH+Pyridine** **h. $CHCl_3$ +**  

Azeotropic Mixture

- Azeotrope is a binary mixture having same composition in **liquid** & **vapour phase** & **boil** at a constant temperature.
- These mixtures are **formed by only Non-ideal** solutions.
- **They are of two types**

a) **Minimum boiling azeotrope** are formed by the solutions with show **positive deviation** from **Raoult's law.**

b) **Maximum boiling azeotrope** are formed by the solutions with how **negative deviation** from **Raoult's law.**

- Components of azeotropic mixture **can not** be separated by **fractional distillations**.

Note :

1. V.P. Do not depend on

i) Amount of liquid
ii) Size of vessel
iii) Surface area of liquid

2. V.P. Depend on

i) Nature of liquid
ii) Temp.

Abnormal C. P. & Van't hoff factor(i)

i. $$\boxed{i = \frac{A.C.P}{N.C.P}}$$

ii. $$i = \left(\frac{\text{no- of Solute partices After Association or Dissociation}}{\text{no - of Solute partices Before Association Dissociation}}\right)$$

iii. $$i = \frac{(M.W)_T}{(M.W)_E}$$

(M.W.)$_T$ = Theoritical or calculated or actual **M.W**

(M.W.)$_E$ = Experimeated or observed **M. W**

A.C.P. = Abnormal colligative property or observed colligative property.

N.C.P. = Normal colligative property or calculated colligative property

iv. In case of dissociation

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

n = no – of partices formed from **1** particles of solute.

v. In case of Association.

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

n = no–of particle associatiate to from one particle.

Boiling point elevation(ΔT_b)

- On addition of **N.V.S** to a volatile solvent, then **V. P.** of volatile Solvent, decreases, Hence **B.P** of Solvent Increases. This is called **B.P** elevation **(ΔT_b)**
- $\boxed{\Delta T_b = i.\,K_b.m}$

  K_b = Ebulliosopic or mole B.P elevation constant.
- **$\Delta T_b = T_s - T_0$**

  T_0 = B.P of solvent

  T_S = B.P of solvent **+ N.V.S = B.P.** of solution
- Unit of **K_b = °C kg mole^{-1}**

  = K. kg mol^{-1}

  = K mol^{-1}
- **B. P.** of liquids ∝ **($P_2 - P_1$)**

  P_1 = Vapour Pressure of liquid

  P_2 = Atmospheric Pressure
- **B. P.** of solution ∝ concentration of solute.
- **B. P.** of solution ∝ **ΔT_b.**

$$\boxed{K_b = \frac{RT_0^2 M_A}{1000 \times \Delta H_{vap}}}$$

$$K_b = \frac{RT_0^2 M_A}{1000 \times \Delta H_{vap}}$$

- **ΔH_{vap}** = Heat of Vapourisation = amount of heat reguired to vapourise **1** mole of lig. at its **B.P**
- **L_{vap}** = Latent heat of Vapourisation

  = amount of heat required to vapourise 1 mole of solvent.
- $\boxed{\Delta H_{vap} = L_{vap} \times M_A}$

T_0 = B. P of solvent.

R = Gas constant.

Freezing point Depression (ΔT_f)

i. On Addition of **N.V.S.** to a volatile solvent, **F. P.** of **Solvent** decreases. This is called **F. P.** depression.

ii. $\boxed{\Delta T_f = T_o^f - T_s^f}$

T_o^f **= F. P of pure Solvent**

T_s^f **= F. P of pure Solvent + N.V. S**

= F. P. of Solution.

iii. $\boxed{\Delta T_f = i.K_f.m}$

K_f **=** Cryoscopic const. or molal **F. P.** dep. const.

iv. $\boxed{\text{F.P of liquid} \propto \text{its V.P}}$

v. Among two or many solutions

$$\text{F. P. of solution} \propto \text{V. P} \propto \frac{1}{\text{Conc of solution}}$$

vi. $\Delta T_f \propto$ **Conc** of solute.

vii. $\boxed{K_f = \frac{R.(T_f^0)^2 M_A}{1000 \times \Delta H_{Fus}}}$

$\boxed{K_f = \frac{R.(T_f^0)^2}{1000 \times L_{Fus}}}$

T_f^0 **= F. P** of solvent.

M_A **=** M. **W** of solvent in **gm**.

viii. ΔH_{Fus} = amount of heat required to fuse one mole solid to liquid at its **melting point**.

ix. L_{Fus} = Lateat heat of Fusion = Amount of heat required to fuse 1 gm of solid to liquid at its **M.P.**

$\boxed{\Delta H_{Fus} = L_{vap} \times M.W_A}$

Osmotic Pressure (π)

i. **O. P =** Pressure applied from the solution side to stop osmotic.

ii. If the pressure applied is more then **O. P,** then solvent flow from solution to pur. solvent. This is called reverse Osmosis **(R.O)**

iii. $\pi = i\,M\,R\,T$

iv. O. P of Dilution :

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B/D	A/D
π_1 V_1	π_2 V_2

$\boxed{\pi_1 V_1 = \pi_2 V_2}$

- $V_2 - V_1$ **=** Volume of water added for **Dilution**.

v. O. P. of mixing for Non reacting solute :

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Sol-1	Sol-1	Mixture
π_1 V_1	π_2 V_2	$\pi_R \neq \pi_1 + \pi_2$ $V = V_1 + V_2$

- $\boxed{\pi_R = \frac{\pi_1 V_1 + \pi_2 V_2}{V}}$
- **If molaritis of solution are given :**

Sol-1	Sol-1	Mixture
M_1 V_1 i_1	M_2 V_2 i_2	$M_R = ?$

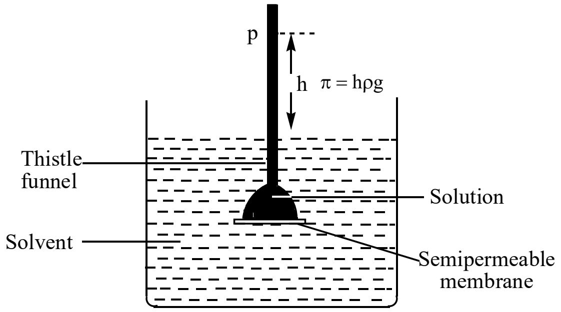
- $M_R = \left(\frac{i_1 M_1 V_1 + i_2 M_2 V_2}{V_1 + V_2}\right)$
- $\boxed{\pi = (M_R)(R)(T)}$

vi. Abe Nollet Experiment :

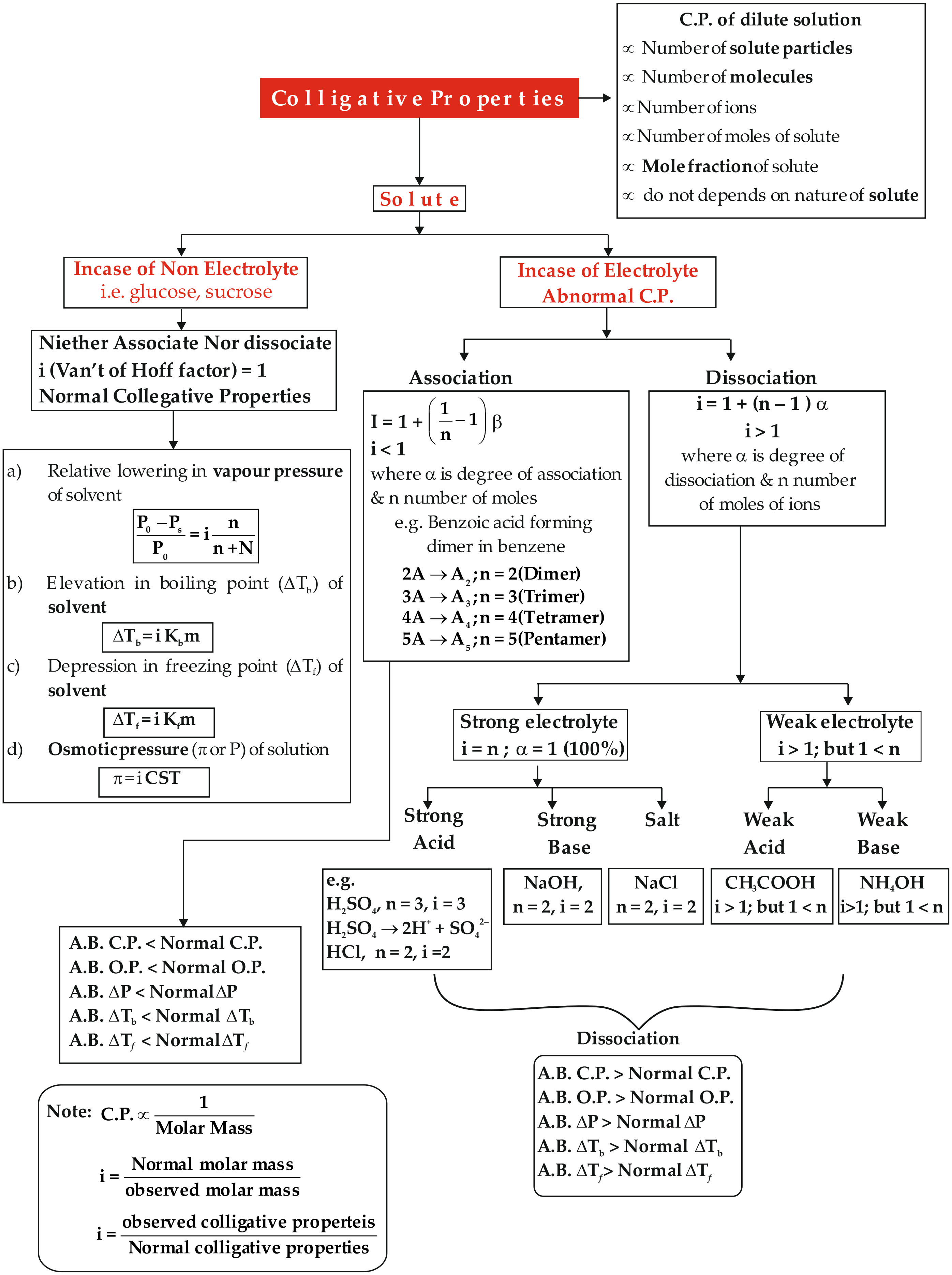
- $\boxed{\pi = h\,d\,g}$

h = Rise in height of liquid
d = Density of solution
g = Acceleration due to gravity.

- This experiment do not calculate, accurate osmotic pressure because density of solution changes wrt. height.



Phenomenon of osmosis



Colligative Properties

C.P. of dilute solution
∝ Number of **solute particles**
∝ Number of **molecules**
∝ Number of ions
∝ Number of moles of solute
∝ **Mole fraction** of solute
∝ do not depends on nature of **solute**

Solute

Incase of Non Electrolyte
i.e. glucose, sucrose

Niether Associate Nor dissociate
i (Van't of Hoff factor) = 1
Normal Collegative Properties

a) Relative lowering in **vapour pressure** of solvent

$$\boxed{\frac{P_0 - P_s}{P_0} = i\frac{n}{n+N}}$$

b) Elevation in boiling point (ΔT_b) of **solvent**

$$\boxed{\Delta T_b = iK_bm}$$

c) Depression in freezing point (ΔT_f) of **solvent**

$$\boxed{\Delta T_f = iK_fm}$$

d) **Osmotic pressure** (π or P) of solution

$$\boxed{\pi = iCST}$$

Incase of Electrolyte
Abnormal C.P.

Association

$$I = 1 + \left(\frac{1}{n} - 1\right)\beta$$

i < 1

where α is degree of association & n number of moles

e.g. Benzoic acid forming dimer in benzene

$2A \rightarrow A_2 ; n = 2$ **(Dimer)**
$3A \rightarrow A_3 ; n = 3$ **(Trimer)**
$4A \rightarrow A_4 ; n = 4$ **(Tetramer)**
$5A \rightarrow A_5 ; n = 5$ **(Pentamer)**

A.B. C.P. < Normal C.P.
A.B. O.P. < Normal O.P.
A.B. ΔP < Normal ΔP
A.B. ΔT_b < Normal ΔT_b
A.B. ΔT_f < Normal ΔT_f

Dissociation

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

i > 1

where α is degree of dissociation & n number of moles of ions

Strong electrolyte
$i = n ; \alpha = 1$ **(100%)**

Strong Acid
e.g.
H_2SO_4, n = 3, i = 3
$H_2SO_4 \rightarrow 2H^+ + SO_4^{2-}$
HCl, n = 2, i = 2

Strong Base
NaOH,
n = 2, i = 2

Salt
NaCl
n = 2, i = 2

Weak electrolyte
i > 1; but 1 < n

Weak Acid
CH_3COOH
i > 1; but 1 < n

Weak Base
NH_4OH
i>1; but 1 < n

Dissociation

A.B. C.P. > Normal C.P.
A.B. O.P. > Normal O.P.
A.B. ΔP > Normal ΔP
A.B. ΔT_b > Normal ΔT_b
A.B. ΔT_f > Normal ΔT_f

Note: $\text{C.P.} \propto \frac{1}{\text{Molar Mass}}$

$$i = \frac{\text{Normal molar mass}}{\text{observed molar mass}}$$

$$i = \frac{\text{observed colligative properteis}}{\text{Normal colligative properties}}$$

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