Solution

Introduction:—

A homogenous mixture of 2 or more components is called as a solution.

- Solution = Solute + Solvent
  ⇓ ⇓
  Lesser amount Larger amount

* 1 Solute + 1 Solvent ⇒ Binary solution.

⇒ Physical state of a solution can be solid, liquid and gas.
⇒ Physical state of solvent & solution is same.

* On the basies of amount of solute:—
Dilute & Concentrated solution.

Concentration Terms:—

(i) Normality (N):—

No. of equivalents (gram equivalents) of solute present in 1L of solution.

$$\boxed{\text{Normality} = \frac{\text{No. of equivalents of solute}}{\text{Vol}^n \text{ of sol}^n (L)}}\ *$$

$$= \frac{\text{Mass of solute (g)}}{\underset{(g\,eq^{-1})}{\text{Eq. wt of solute}} \times \text{Vol}^n \text{ of sol}^n (L)}$$

Unit = eqL^{-1} or $geqL^{-1}$ or N

Eg:— 2N (normal) NaOH sol^n

2 eq. of NaOH in 1L sol^n

② Molarity (M):—

No. of moles of solute present in 1L of solution.

$$\text{Malarity} = \frac{\text{Moles of solute}}{\text{Vol}^n\text{ of sol}^n\text{ (L)}} = \frac{\text{Mass of solute (g)}}{\text{Molar Mass of solute (g mol}^{-1}) \times \text{Vol}^n\text{ of sol}^n\text{ (L)}}$$

Unit ⇒ Mol L^{-1} or M

Eg:- 2M (molar) NaOH Sol^n

⇒ 2 moles of NaOH in 1L Sol^n

③ Molality (m):—

No. of moles of solute present in 1kg. of solvent.

$$\text{Molality} = \frac{\text{Moles of solute}}{\text{Mass of solvent (kg)}}$$

Unit = mol kg^{-1} or m

Eg:- 2m (molal) NaOH Sol^n

⇒ 2 moles of NaOH in 1kg solvent

④ Strength (S):—

Mass of solute (in g) present in 1L of sol^n

$$\text{Strength (S)} = \frac{\text{Mass of solute (g)}}{\text{Vol. of Sol}^n\text{ (L)}}$$

Unit ⇒ gL^{-1}

Eg:- 2gL^{-1} NaOH Sol^n

⇒ 2g NaOH in 1L sol^n.

$$S = \frac{\text{Mass of solute}}{\text{Molar Mass of solute} \times \text{Vol of Sol}^n} \times \text{Molar mass of Solute}$$

$$\boxed{\begin{array}{l} S = M \times \text{molar mass of solute} \\ S = N \times \text{Equivalent mass of solute} \end{array}}$$

⑤ Mole fraction (x) :—

Ratio of moles of component to the total no. of moles of all components present in a solution.

A = Solvent ; B = Solute

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

⟹ Sum of mole fraction of all components present in a solution is equal to 1.

$$\therefore \boxed{x_A + x_B = 1}$$

⟹ $\boxed{0 < \underset{\Downarrow}{x} < 1}$

mole fraction of any component present in a solution.

⟹ Unitless quantity

⟹ $\boxed{\frac{x_B}{x_A} = \frac{n_B}{n_A}}$

⑥ In terms of Percentage :—

(A) Mass percentage (w/w) :— Mass of solute (in g) present in 100g of solution.

$$\boxed{\% \, w/w = \frac{\text{Mass of solute (g)}}{\text{Mass of Sol}^n \text{(g)}} \times 100}$$

Eg:— 10% w/w NaOH Solⁿ
⇒ 10g NaOH in 100g Solⁿ.

Ⓑ Volume percentage (V/V) :—
Vol. of solute (in mL) present in 100mL of solution.

$$\boxed{\% \, V/V = \frac{\text{Vol. of Solute(mL)}}{\text{Vol. of Sol}^n \text{(mL}} \times 100}$$

Eg:— 10% V/V ethanol Solⁿ
⇒ 10mL ethanol 100mL Solⁿ.

Ⓒ Mass by volume (w/v) :—
Mass of solute (in g) present in 100mL of solution.

$$\boxed{\% \, w/v = \frac{\text{Mass of Solute (g)}}{\text{Vol. of Solution (mL)}} \times 100}$$

Eg:— 10% w/v glucose Solⁿ.
⇒ 10g glucose in 100mL Solⁿ.

⑦ Parts per million (PPM) :—
⇒ It is used to express the conc. where solute is present in tarce amounts.
Eg:— water & Air pollution.

⇒ No. of parts of solute presents in 10^6 parts of solution. *

$$\boxed{\text{PPM} = \frac{\text{No. of parts of solute}}{\text{No. of parts of solution}} \times 10^6}$$

Note:—

PPM can be expressed in terms of w/w, v/v & w/v.

⑧ Formality (F) :—

No. of gram formula mass unit of solute present in 1L of solution.

$$\boxed{\text{Formality} = \frac{\text{No. of formula units of solute}}{\text{Vol. of Solution (L)}}}$$

$$\boxed{\text{Formality} = \frac{\text{Mass of solute (g)}}{\text{formula mass of solute} \times \text{Vol. of soln (L)}}}$$

Eg:— $\underset{Mw = 58.5g}{\underbrace{NaCl}} \xrightarrow{H_2O} \underset{fw = 58.5g}{\underbrace{Na^+ + Cl^-}}$

$\underset{Mw = 60g}{\underbrace{2CH_3COOH}} \xrightarrow{C_6H_6} \underset{fw = 120g}{\underbrace{(CH_3COOH)_2}}$

⑨ Volume Strength of solution :—

Volume of O_2 (in L) produced at STP/NTP by the decomposition of 1L of H_2O_2 soln is known as volume strength of H_2O_2 solution.

Relation b/w vol. strength of H_2O_2 soln with M, N, S & % w/v :

Let, vol. strength of H_2O_2 soln be 'X' V

↳ It means that 'X' L of O_2 is produced at STP/NTP by the decomposition of 1L of H_2O_2 soln.

$$2H_2O_2(l) \longrightarrow 2H_2O(l) + O_2(g)$$

$$1\text{ Mol of } O_2 \longrightarrow 2\text{ mol of } H_2O_2$$

$$\frac{x}{22.4}\text{ mol of } O_2 \longrightarrow \frac{2x}{22.4} = \frac{x}{11.2}\text{ mol of } H_2O_2$$

① Molarity

$$M = \frac{\text{moles of solute}}{\text{Vol}^n\text{ of Soln (L)}} = \frac{x}{11.2\times1}$$

$$\therefore \boxed{M = \frac{x}{11.2}}$$

(II) $N = M \times v.f. \Rightarrow \frac{x}{11.2} \times 2$

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

V.f. of $H_2O_2 = 2$

(III) Strength = N × Eq.wt of solute

$$\therefore \boxed{S = \frac{x}{5.6} \times 17}$$

$$\text{Eq.wt} = \frac{\text{Molar mass}}{\text{V.f.}} = \frac{34}{2} = 17.$$

(IV) $\text{Strength} = \frac{\text{Mass of solute (g)}}{\text{Vol. of Soln (mL)}} \times 1000$

$$\therefore S = \%\ w/v \times 10$$

$$\boxed{\%\ w/v = \frac{x}{5.6} \times \frac{17}{10}}$$

$$2H_2\overset{-1}{O_2} \longrightarrow 2H_2\overset{-2}{O} + \overset{0}{O}$$

$$\boxed{\text{v.f.} = \frac{\text{Change in O.N.}}{\text{per atom}} \times \frac{\text{No. of atoms undergoing}}{\text{the change in one molecules}}}$$ **

$$\text{v.f.} = 1 \times 2 = 2$$

Relation b/w various concentration terms :—

① Mole fraction (x) & Molality (m) :—

$$\frac{x_{solute}}{x_{solvent}} = \frac{n_{solute}}{n_{solvent}} = \frac{n_{solute} \times M_{solvent} \times 1000}{W_{solvent} \times 1000}$$

$$\boxed{\frac{x_{solute}}{x_{solvent}} = \frac{m \times M_{solvent}}{100}}$$

$M_{solvent} \Rightarrow$ Molar Mass of solvent

② Molality (m) & Molarity (M) :—

'M' molar soln $\Rightarrow$ M moles of solute present in 1000mL of soln

Density ~~of~~ soln = 'd' gmL^{-1}

$$W_{solvent} = W_{soln} - W_{solute}$$
$$= (d \times Vd)_{soln} - (M \times M_{solute})_{solute}$$

$$\text{Molality} = \frac{\text{Moles of solute}}{\text{Mass of solvent (kg)}} = \frac{\text{Moles of solute}}{\text{Mass of solvent (g)}} \times 1000$$

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

M_{solute} = Molar mass of solute

③ Molarity (M) & % w/w :—

$$\boxed{M = \frac{10 \times d\,(\%\ w/w)}{\text{Molar mass of solute}}}$$

④ Normality (N) & w/w

$$\boxed{N = \frac{10 \times d \times (\%\ w/w)}{\text{Equivalent mass of solute}}}$$

d = density of soln in gmL^{-1}

Note:— The conc. terms like molarity, Normality, % w/v are temp. dependent whereas the conc. terms like molality, mole fraction, % w/w etc. are temp. independent because volume depends on temp. but mass does not depends on temp.

Law of Dilution:—

(Addn of Solvent)

$$\downarrow C = \frac{\boxed{n} \Longrightarrow \text{Const}}{V \uparrow}$$

Before dilution = After dilution

$$M_iV_i = M_fV_f$$

$$N_iV_i = N_fV_f$$

Law of mixing :—

Ⓐ Homogenous mixture :

$$\underbrace{N_R}_{\Downarrow} = \frac{N_1V_1 + N_2V_2}{V_1+V_2}$$

Normality of resultant solⁿ

Ⓑ Heterogenous Mixture :

(i) Complete Neutralisation :—

$$N_AV_A = N_BV_B$$

$$\underbrace{N_R}_{\Downarrow} = \frac{N_AV_A}{V_A+V_B} = \frac{N_BV_B}{V_B+V_B}$$

Normality of resultant solt solⁿ

(ii) Incomplete Neutralisation :—

$$\underbrace{N_R}_{\Downarrow} = \frac{N_AV_A - N_BV_B}{V_A+V_B} \; ; \; \underbrace{N_R}_{\Downarrow} = \frac{N_BV_B - N_AV_A}{V_A+V_B}$$

Normality of resultant acidic solⁿ ; Normality of resultant basic solⁿ

Ques. ① 20gm NaOH is present in 250mL aq. solution having a density of 1.2gm/mL then find out M, m, N mole fraction of solute and strength of solⁿ.

ⓐ $$M = \frac{20/40}{\frac{250}{1000}}$$

$$= 2M$$

ⓑ $$N = M \times v.f$$
$$= 2 \times 1$$
$$= 2N$$

ⓒ $W_{soln} = d \times Vol^n$

$= 1.2\,g\,mL^{-1} \times 250$

$= 300g$

$W_{solv} = W_{soln} - W_{solute}$

$= 300 - 20$

$= 280g$

$$m = \frac{20/40}{\frac{280}{1000}}$$

$= 1.7m$

ⓓ $$X_{solute} = \frac{20/40}{\frac{20}{40} + \frac{280}{18}}$$

$$= \frac{0.5}{0.5 + 15.5}$$

$= 0.03$

ⓔ $$\text{Strength} = \frac{20}{250/1000}$$

$= 80\,g\,L^{-1}$

Ques ②. 24.4g benzoic acid is dissolved in benzene to preparied 2L soln if benzoic acid exist as a dimer in benzene then find out F and molarity of soln. (Benzoic acid M.W = 122)

$$M = \frac{24.4/122}{2} = \underline{0.1M}$$

$$2C_6H_5COOH \longrightarrow \underbrace{(C_6H_5COOH)_2}_{FW = 244g}$$

$M.W = 122g$

$$\text{formality} = \frac{24.4/244}{2}$$

$= 0.05F$

Ques ③. Calculate the molarity of 700ml water.

Mass of H_2O = $d \times vol$

$= 1\,g\,mL^{-1} \times 700\,mL$

$= 700g$

$$M = \frac{700/18}{700/1000} \Rightarrow \frac{1000}{18} = \underline{55.5M}$$

Ques④ Calculate the mole fraction of a solute in 1 molal aq. solⁿ.

Ques⑤ The mole fraction of solute in water 0.2 then find out the molality of solⁿ.

Ans ④ 1 Molal aq. solⁿ = 1 mol solute in $\underset{1000g}{1kg}$ Solvent

$$x_{solute} = \frac{n_{solute}}{n_{solute}+n_{solvent}}$$

$$= \frac{1}{1+\frac{1000}{18}} = \frac{1}{56.5} = 0.017$$

~~Ans ⑤~~ OR

$$\frac{x_{solute}}{x_{solvent}} = \frac{m \times M_{solvent}}{1000}$$

$$\frac{x_{solute}}{1-x_{solute}} = \frac{1\times 18}{1000} = 0.017$$

Ans ⑤

$$\frac{0.\cancel{2}}{0.\cancel{8}_4} = \frac{m\times 18}{1000}$$

$$m = \frac{1000}{4\times 18} = 13.8m$$

OR

$$\frac{x_{solute}}{x_{solvent}} = \frac{n_{solute}}{n_{solvent}}$$

$$\frac{0.2}{0.8} = \frac{1}{4} = \frac{n_{solute}}{n_{solvent}}$$

$$m = \frac{\text{moles of Solute}}{\text{Mass of Solvent (kg)}}$$

$$m = \frac{1}{4\times 18}\times 1000$$

$$= \frac{1000}{72}$$

$$= 13.8m$$

Ans (5.)

OR

$x_{solute} = 0.2 = \frac{n_{solute}}{n_{solute} + n_{solvent}}$

$0.2 = \frac{1}{\left(1 + \frac{n_{solvent}}{n_{solute}}\right)}$

$1 + \frac{n_{solvent}}{n_{solute}} = \frac{1}{0.2} = 5$

$\frac{n_{solvent}}{n_{solute}} = 4$

$m = \frac{n_{solute}}{w_{solvent}(g)} \times 1000$

$m = \frac{n_{solute}}{\left(\frac{w_{solvent}}{M_{solvent}}\right) \times M_{solvent}} \times 1000$

$m = \frac{n_{solute} \times 1000}{n_{solute} \times M_{solvents}}$

$= \frac{1}{4} \times \frac{1000}{18}$

$= 13.8 m.$

Ques Calculate the wt. of ~~H~~HNO_3 (70% pure) that must be dissolved in 250mL soln. to prepare a 2M soln.

moles of $HNO_3 = M \times Vol. (L)$

$= 2 \times \frac{250}{1000} = \frac{1}{2}$ mol.

Mass of HNO_3 = moles × Molar mass

$= \frac{1}{2} \times 63 = 31.5g$

HNO_3 ~~70%~~ Sample is 70% pure

70g $HNO_3 \longrightarrow$ 100g Sample

$31.5g \longrightarrow \frac{100}{70} \times 31.5$

$= 45g$

Ques Calculate M and m of 30% w/w Urea soln having a density of 1.2g /per mL.

~~$M = \frac{30/60}{70/100}$~~

~~$= \frac{3}{6} \times \frac{10}{7} = 30$~~

$m = \frac{30/60}{70/100} = \underline{7.1m}$

Vol. of soln = $\frac{\text{Mass}}{\text{density}} = \frac{100g}{1.2gmL^{-1}}$

$= \frac{1000}{12}$

$M = \frac{30/60}{1000/12} \times 1000$

$= \underline{6M}$

Ques. 40% w/v 150mL ammonium chloride soln is added to 25% w/v 300mL ammonium chloride then find out % w/v of mixture.

$\% \frac{w}{v} = \frac{\text{Mass of Solute}}{\text{Vol. of Soln (mL)}} \times 100$

$40 = \frac{w_1}{150} \times 100 \Rightarrow w_1 = 60g$

$25 = \frac{w_2}{300} \times 100 \Rightarrow w_2 = 75g$

$\% w/v = \frac{(w_1 + w_2)}{(V_1 + V_2)} \times 100$

$= \frac{60+75}{150+300} \times 100$

$= 30\%$

Ques 98% w/w H_2SO_4 soln has a density of 1.2 gm/cm^3 then find out the required volume of this soln to prepare 4L of 3M H_2SO_4 soln

→ $M = \frac{10 \times \cancel{98} \times 1.2 \times 10^{-3}}{\cancel{98}}$

$= 12\ \text{mol}$

$M_i V_i = M_f V_f$

$12 \times V_1 = 3 \times 4$

$V = \underline{1\ L}$

OR

Moles of $H_2SO_4 = M \times \text{Vol. (L)}$

$= 3 \times 4 = 12\ \text{mol}$

Mass of $H_2SO_4 = 12 \times 98$

$= 1176\ g$

$98\,g\ H_2SO_4 \longrightarrow 100\,g$ solⁿ

$1176\,g\ H_2SO_4 \longrightarrow \frac{100}{98} \times 1176$

$= 1200\,g$ solⁿ

Vol. of solⁿ $= \frac{\text{mass}}{\text{density}} = \frac{1200\,g}{1.2\,g\,cm^{-3}} = \frac{1000}{1000\,cm^3}$

$\boxed{= 1\,L}$

Ques The mole fraction of ethanol in water is 0.25 then determine the % by mass of ethanol in the solⁿ.

~~$x_{ethanol} = \frac{n_{ethanol}}{n_{ethanol} + n_{water}}$~~

~~$0.25 = \frac{n_{ethanol}}{}$~~

$$\frac{x_{C_2H_5OH}}{x_{H_2O}} = \frac{0.25}{0.75} = \frac{1}{3} = \frac{n_{C_2H_5OH}}{n_{H_2O}}$$

$$\% \frac{w}{w} = \frac{1 \times 46}{(1 \times 46) + (3 \times 18)} \times 100$$

$= 46\%$

Ques: 4000g sample of hard water contains 12mg $CaCO_3$ then determine the conc. of PPM

$$PPM = \frac{12\times10^{-3}}{4000}\times10^{6}$$

$$= 3\,ppm$$

Ques. Calculate the volume strength of H_2O_2 solⁿ If the strength of H_2O_2 is 3.4g/L

$$S = \frac{x}{5.6}\times17$$

$$3.4 = \frac{x}{5.6}\times17$$

$$x = \frac{3.4\times5.6}{17}$$

$$\boxed{x = 1.12V}$$

Ques. Calculate M, N, % w/v and Strength of 10V H_2O_2 Solⁿ.

$0.89 \times 2 = 1.78$

$$M = \frac{100}{112}$$

$$= 0.89M$$

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

$$= 0.89\times2$$

$$= 1.78N$$

$$\%\ w/v = \frac{X}{5.6}\times\frac{17}{10}$$

$$= 3.03\%$$

$$S = \frac{x}{5.6}\times17$$

$$= 30.3\,g\,L^{-1}$$

Ques. Calculate the no. of moles and the O_2 gas at STP produces by the decomposition of 1.12L of 10V H_2O_2.

1L of H_2O_2 solⁿ $\longrightarrow$ 10 L O_2 gas at STP

1.12L of H_2O_2 $\longrightarrow$ 10×1.12

$= 11.2$L O_2 gas at STP.

Moles of $O_2 = \frac{11.2}{22.4} = 0.5$ mol.

mass of $O_2 = 0.5 \times 32$

$= 16g$

OR

$M = \frac{x}{11.2} = \frac{10}{11.2} M$

Moles of $H_2O_2 = M \times$ Vol. (L)

$= \frac{10}{11.2} \times 1.12$

$= 1$ mol

$2H_2O_2 \longrightarrow 2H_2O + O_2$

Ques. Calculate the strength of H_2SO_4 solⁿ in gram/L if 12mL is complectly neutralisyed by 15mL of N/10 NaOH.

$N_A V_A = N_B V_B$

$N_A \times 12 = \frac{1}{10} \times 15$

$N_A = \frac{1}{8} N$

$S = N \times$ Eq. wt of Solute

$= \frac{1}{8} \times \frac{98}{2}$

$= 6.125 g/L$

Ques① Calculate the volume of water added to 200mL semi-molar HCl soln to converted into demimolar soln.

Ques.② Calculate the volume of water which should be added to a mixture containing 750mL 2M HCl and 250mL 6M HCl to prepare a mixture having of a molarity 2.5M.

Ques ①

$M_1V_1 = M_fV_f$

$\frac{1}{2}\times 200 = \frac{1}{10}\times V_f$

$V_f = 1000\,mL$

∴ Req. Vol. of H_2O $= 1000 - 200$ $= 800\,mL$

Ques ②

$M_1V_1 = M_fV_f$

$M_1V_1 + M_2V_2 = M_fV_f$

$(2)(750) + (6)(250) = (2.5)(V_f)$

$V_f = \frac{3000}{2.5} = 1200\,mL$

∴ Req Vol. of H_2O $= 1200 - 1000$ $= 200\,mL$

Ques Calculate the M of Nitrate ion when 0.1M $Al(NO_3)_3$ and 0.2M $Pb(NO_3)_2$ are mixed in the volume ratio 1:2.

$V_1 : V_2$

$1 : 2$

$V_1 = 1V\,L$

$V_2 = 2V\,L$

$Al(NO_3)_3 \longrightarrow Al^{+3} + 3NO_3^-$

$0.1V\,mol \longrightarrow 0.3\,V\,mol$ of NO_3^-

$Pb(NO_3)_2 \longrightarrow Pb^{+2} + 2NO_3^-$

$0.4\,mol \longrightarrow 0.8V\,mol.$ of NO_3^-

$$M \text{ of } NO_3^- = \frac{0.3V + 0.8V}{V + 2V}$$

$$= \frac{1.1V}{3V} = 0.366\,M$$

Ques. 1.575g of $(COOH)_2 \cdot xH_2O$ is dissolved in 250mL solⁿ. On titration 16.6mL of this solⁿ is completely neutralised by 25mL of N/15 NaOH solution then determine the value of water of crystalisation x.

$$N_A V_A = N_B V_B$$

$$N_A (16.6) = \left(\frac{1}{15}\right)(25)$$

$$N_A = 0.1N$$

$$\text{Normality} = \frac{\text{Mass of solute}}{\text{Eq. wt of solute} \times \text{Vol. of solⁿ (L)}}$$

$$0.1 = \frac{1.575}{\left(\frac{90+18x}{2}\right) \times \left(\frac{250}{1000}\right)}$$

$$0.1 = \frac{1.575 \times 4 \times 2}{90+18x}$$

$$0.1 = \frac{12.6}{90+18x}$$

$$90+18x = \frac{12.6}{0.1} = 126$$

$$18x = 126 - 90$$

$$18x = 36$$

$$\boxed{x = 2}$$

Date ________ Page ____

★ Note :—

If $d_{soln} = 1 gmL^{-1}$ or $d_{soln} < 1 gmL^{-1}$

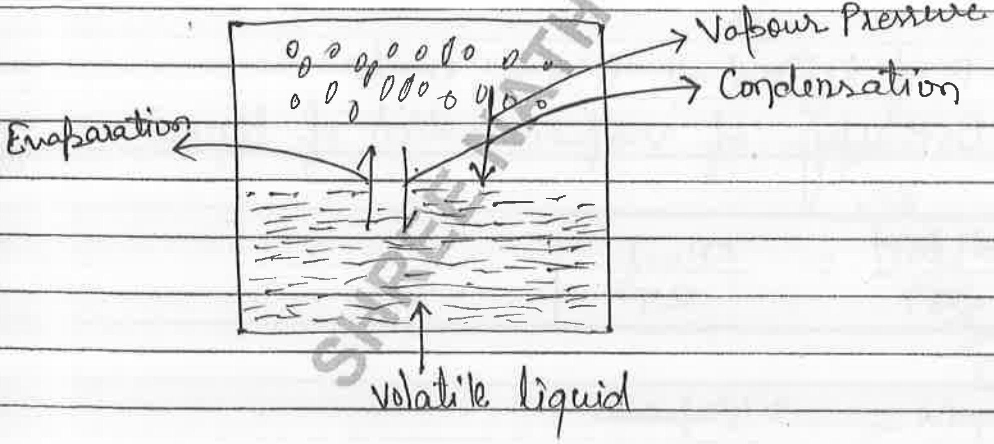
$\boxed{m > M}$ (for same soln)

When density is not given, then this only will be the answer because density is considered to be almost 1gmL.

⇒ If $d_{soln} > 1 gmL^{-1}$

$m > M$; $m = M$, $m < M$

Vapour Pressure in liquid :—



At eqm ⇒ Rate of evaporation = Rate of condensation.

$$\text{Liquid} \rightleftharpoons \text{Vapour}$$

At const. temp, pressure exerted by the vapour of a volatile liquid on its own surface, when liquid & vapour are in eqm is known as vapour pressure of liquid.

$\Rightarrow$ factors affecting V.P. of liquid :—

(i) Nature of liquid $\Rightarrow$ IMF (weak) $\downarrow$ = More vapours are formed $\Rightarrow$ V.P. $\uparrow$

(ii) Temperature $\Rightarrow T\uparrow \Rightarrow$ K.E of molecules $\uparrow \Rightarrow$ IMF $\downarrow \Rightarrow$ More vapours are formed $\Rightarrow$ V.P. $\uparrow$

Clausius – Clapeyron Equation :—

The effect of temp on V.P. of liquid is given by Clausius – Clapeyron eqn as follow—

$$\boxed{\log_{10}\left(\frac{P_2}{P_1}\right) = \frac{\Delta H_{vap}}{2.303R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right)}$$

P_1 & $P_2 \Rightarrow$ V.P. of liquid at T_1 & T_2 temp.

$\Delta H_{vap.} \Rightarrow$ Enthalpy of vapourisation of liquid.

$$\boxed{\frac{d(\ln P)}{dT} = \frac{\Delta H_{vap.}}{RT^2}}$$

$$\text{Liquid} \rightleftharpoons \text{Vapour}$$

At T_1 temp. $P_1 = K_{P_1}$

At T_2 temp. $P_2 = K_{P_2}$

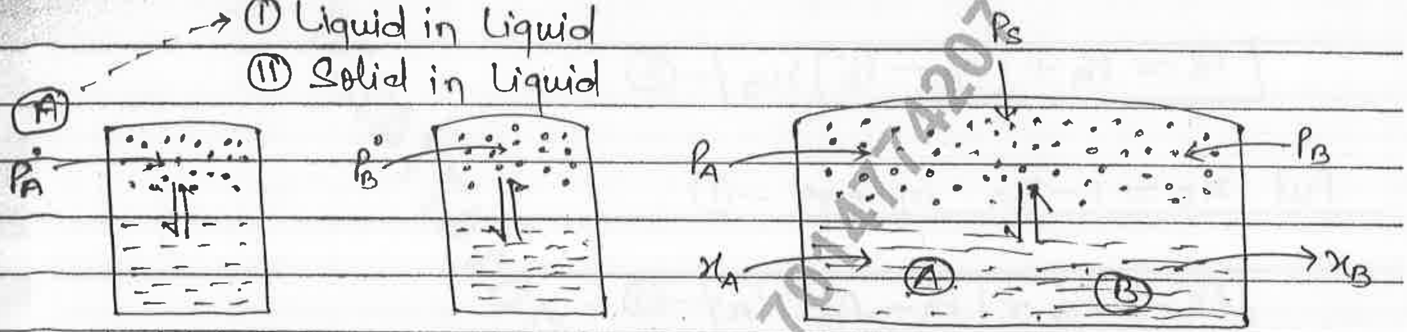
★ **Note:—** ① More volatile liquid has higher V.P.

② V.P. of liquid $\propto \dfrac{1}{\text{B.Pt. of liquid}}$

③ V.P. of pure liquid does not depends on amount of liquid and shape & size of vessel.

Raoult's law:—

(I) Liquid in Liquid
(II) Solid in Liquid



Volatile liquid A Volatile liquid B Solⁿ of volatile liquids

Liq.A Liq.B

V.P. in liquid state ⇒ P_A° & P_B°

Mole fraction in solⁿ ⇒ x_A & x_B

Partical V.P. in solⁿ ⇒ P_A & P_B

⇒ Acc. to Raoult's law, for a solⁿ of volatile liquids, at const. temp. the partical V.P. of a component is directaly proportional to the mole fraction of that component in solution.

∴ for liquid A

$P_A \propto x_A$

$\boxed{P_A = P_A^\circ x_A}$

for liquid B

$P_B \propto x_B$

$\boxed{P_B = P_B^\circ x_B}$

⇒ Acc. to dalton's law

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

$$\boxed{P_S \text{ or } P_{Total} = P_A^\circ x_A + P_B^\circ x_B} \text{ — ①}$$

Put $x_A = 1 - x_B$ in eqⁿ ①

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

$$P_s = P_A^\circ - P_A^\circ x_B + P_B^\circ x_B$$

$$\boxed{P_s = P_A^\circ + (P_B^\circ - P_A^\circ) x_B} \text{ — ②}$$

Put $x_B = 1 - x_A$ in eqⁿ — ①

$$\boxed{P_s = P_B^\circ + (P_A^\circ - P_B^\circ) x_A} \text{ — ③}$$

F <u>Graphical Representation</u> :—

From eqⁿ ②

$$P_s = (P_B^\circ - P_A^\circ) x_B + P_A^\circ$$

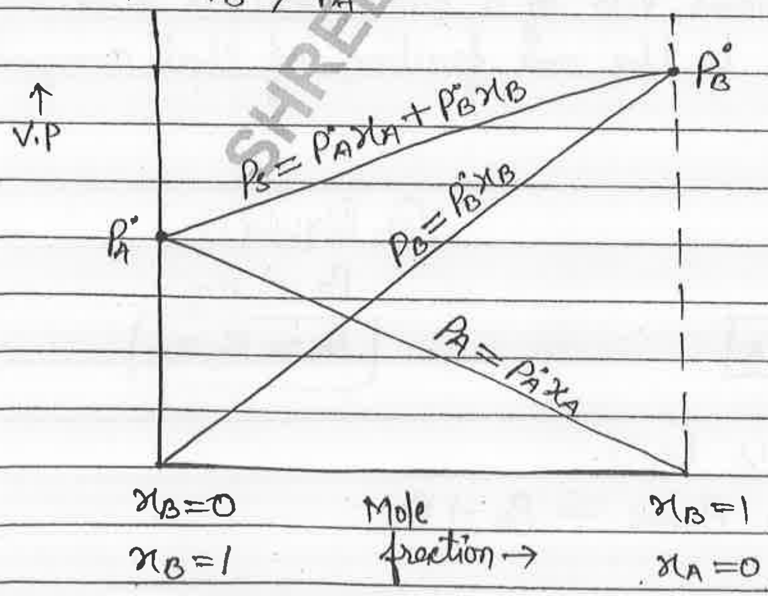
$$y = m \quad x \quad + c$$

Slope can be ⊕ive or ⊖ive

⇓ $P_A^\circ > P_A^\circ$ ⇓ $P_A^\circ > P_B^\circ$

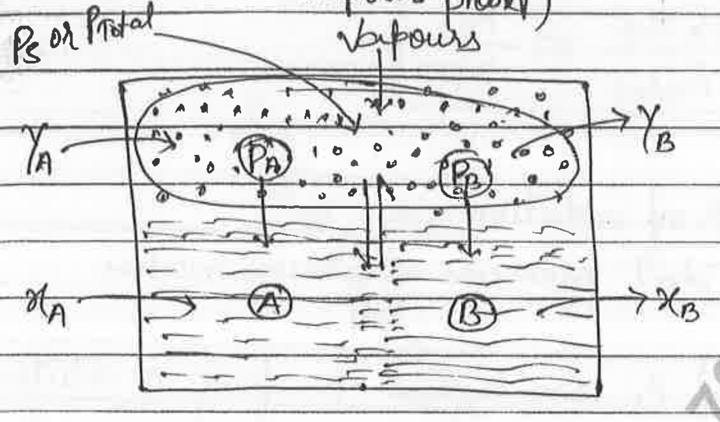
Assume B is more volatile than A.

∴ $P_B^\circ > P_A^\circ$



Relation b/w Raoult's law and Dalton's law :—

(Used for determing mole fraction of components in vapour phase)



x_A & x_B = Mole fraction ~~of~~ in liquid phase.

Y_A & Y_B = Mole fraction in vapour phase.

⇒ Acc. to Dalton's law (Only for gases)

Partical pressure of a gas = Mole fraction of gas × Total Pressure

$$P_A = Y_A \times P_{Total} \text{ —— ①}$$

$$P_B = Y_B \times P_{Total} \text{ —— (II)}$$

⇒ Acc. to Raoult's law (Only for solutions)

Partical V.P. of a component = V.P. of pure Component × Mole fraction of Component in solution

$$P_A = P^{\circ}_A \times x_A \text{ —— (III)}$$

$$P_B = P^{\circ}_B \times x_B \text{ —— (IV)}$$

Eqⁿ ① = Eqⁿ ③

$$Y_A \times P_{Total} = P^{\circ}_A \times x_A$$

$$\boxed{Y_A = \frac{P^{\circ}_A x_A}{P_{Total}} = \frac{P_A}{P_{Total}}}$$

$$Eq^n ② = Eq^n ④$$

$$Y_B \times P_{total} = P^\circ_B \times x_B$$

$$\boxed{Y_B = \frac{P^\circ_B x_B}{P_{Total}} = \frac{P_B}{total}}$$

P_{Total} = V.P. of solution OR
Total pressure of gaseous mixture.

Ques 3 mole of A and 2 mole of B are mixed to form a solution If the V.P. of A & B are 60 & 80 mm of Hg respectively then find out the V.P. of soln and the mole fraction of A and B in V.P.

Soln —

(I) $P_S = P^\circ_A x_A + P^\circ_B x_B$

$= \frac{60 \times 3}{\cancel{5}} + \overset{16}{\cancel{80}} \times \frac{2}{\cancel{5}}$

$= 36 + 32$

$= 68 \text{ mmHg}$

(II) $Y_A = \frac{P^\circ_A x_A}{P_{Total}}$

$= \frac{(60 \times 3/5)}{68}$

$= \frac{36}{68} = \boxed{\frac{9}{17}}$

$Y_B = \frac{P^\circ_B x_B}{P_{total}} = \frac{(80 \times \frac{2}{5})}{68} = \frac{32}{68} = \boxed{\frac{8}{17}}$

Ques. The V.P. of a solution of two liquid A and B is 600 torr If the mole fraction of ~~x~~ A in Vapour phase is 0.4 and in liquid phase is 0.6 then find out the V.P. of A & B in pure state.

$Y_A = 0.4$; $Y_B = 0.6$

$X_A = 0.6$; $X_B = 0.4$

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$$y_A = \frac{P_A^\circ x_A}{P_{total}} \qquad y_B = \frac{P_B^\circ x_B}{P_{total}}$$

$$0.4 = \frac{P_A^\circ(0.6)}{600} = \boxed{P_A^\circ = 400\,\text{torr}} \qquad 0.6 = \frac{P_B^\circ(0.4)}{600}$$

$$\boxed{P_B^\circ = 900\,\text{torr.}}$$

Ques. The V.P. of a solution containing 1 mole of A and 1 mole of B is 500 mm Hg when 2 mole of B are further added to a solution then its V.P. increased by 50 mm Hg. then determine V.P. of A & B in pure state.

Solu:—

$$P_S = P_A^\circ x_A + P_B^\circ x_B$$

$$500 = P_A^\circ\left(\tfrac{1}{2}\right) + P_B^\circ\left(\tfrac{1}{2}\right)$$

$$1000 = P_A^\circ + P_B^\circ \text{ —— ①}$$

B futher added

$$550 = P_A^\circ\left(\tfrac{1}{4}\right) + P_B^\circ\left(\tfrac{3}{4}\right)$$

$$2200 = P_A^\circ + 3P_B \text{ —— ②}$$

$$P_A^\circ = 400\,\text{mm Hg}$$

$$P_B^\circ = 600\,\text{mm Hg}$$

Ques. The V.P. of a sol^n containing two voltalile liquid A & B is repsterented by $P_S(\text{torr}) = 254 - 119x_A$ where x_A is mole faction of A in solu^n then find out value of P_A° & P_B°.

Solu^n:—

$$P_S(\text{torr}) = 254 - 119x_A \text{ —— (I)}$$

$$P_S = P_B^\circ + (P_A^\circ - P_B^\circ)\,x_A \text{ —— (II)}$$

$$P_B^\circ = 254\,\text{torr}$$

$$P_A^\circ - P_B^\circ = -119\,\text{torr}$$

$P_A^\circ - 254 = -119$

$P_A^\circ = 135$ torr

OR

for Pure liquid A

$x_A = 1;\ x_B = 0$

$P_s = P_A^\circ = 254 - 119(1)$

$= 135$ torr

for Pure liquid B

$x_B = 1;\ x_A = 0$

$P_s = P_B^\circ = 254 - 119(0)$

$= 254$ torr

Que. An aq. solution containing 28% w/w of liquid A (Mwt=140) has a V.P. of 160 mmHg then find out V.P. of Pure liq. A if the V.P. of water is 150 mmHg.

28% w/w = 28 g of A in 100 g soln.

$\text{Moles of A} = \frac{28}{140} = 0.2\ \text{mol}$

$\text{Moles of } H_2O = \frac{72}{18} = 4\ \text{mol}$

$P_s = P_A^\circ x_A + P_B^\circ x_B$

$160 = P_A^\circ \left(\frac{0.2}{4.2}\right) + (150)\left(\frac{4}{4.2}\right)$

$\boxed{P_A^\circ = 360\ \text{mmHg}}$

[illegible]

Ques. The V.P. of A and B is 520 & 1000 mm Hg respectivily If the mixture of A and B boils at 80°C temp. then determine mole % of A in mixture.

Solⁿ. :—

B.P. ⇒ The temp at which the V.P. of liquid becomes equal to atmospheric pressure.

$$P_S = P_A^\circ x_A + P_B^\circ x_B$$

$$P_S = P_B^\circ + (P_A^\circ - P_B^\circ)x_A$$

$$760 = 1000 + (520 - 1000)x_A$$

$$(760 - 1000) = (-480)x_A$$

$$-240 = -480\,x_A$$

$$x_A = \frac{-240}{-480}$$

$$= 0.5$$

mole % = mole fraction × 100

= 0.5 × 100

= 50%

Ques. The V.P. of liquid P and Q are 200 & 100 mm Hg respecti. then determine composition of P and Q in vapour phase which in contain with equimolar solⁿ of the two component

$$P_S = P_A^\circ x_A + P_B^\circ x_B$$

$$= 200 \times \frac{1}{2} + 100 + \frac{1}{2}$$

$$= 150\,\text{mmHg}$$

$Y'_A = \frac{P'_A x_A}{P_{Total}}$ $\qquad$ $Y'_B = \frac{Y_B x_B}{P_{Total}}$

$= \frac{200 \times \frac{1}{2}}{150}$ $\qquad$ $= \frac{100 \times \frac{1}{2}}{150}$

$= \frac{2}{3} = 0.66$ $\qquad$ $= \frac{1}{3} = 0.33$

i.e. 66% $\qquad$ i.e. 33.3%

ues. The ratio of V.P. of A and B in pure state is 1:2 and the ratio of moles A and B in solution is also 1:2 then find out the mole ~~of~~ of A in the vapour phase.

$$\frac{P'_A}{P'_B} = \frac{1}{2} \; ; \; \left(\frac{n_A}{n_B}\right)_{soln} = \frac{1}{2} = \frac{x_A}{x_B}$$

$$\frac{Y_A}{Y_B} = \frac{P'_A x_A}{P'_B x_B} = \frac{1}{2} \times \frac{1}{2} = \frac{1}{4} = \left(\frac{n_A}{n_B}\right)_{vapour}$$

$$Y_A = \frac{1}{1+4} = \underline{0.2}$$

) Solid in Liquid Solutions :—

Solvent ⇒ A (Volatile solid) $\qquad$ Solute ⇒ B (Non-volatile solid)

$P^\circ_A = P^\circ \Rightarrow$ V.P. of pure Solvent $\qquad$ $P^\circ_B = 0$

$$P_S = P'_A x_A + \underbrace{P'_B x_B}_{0}$$

$$\therefore P_S = P'_A x_A$$

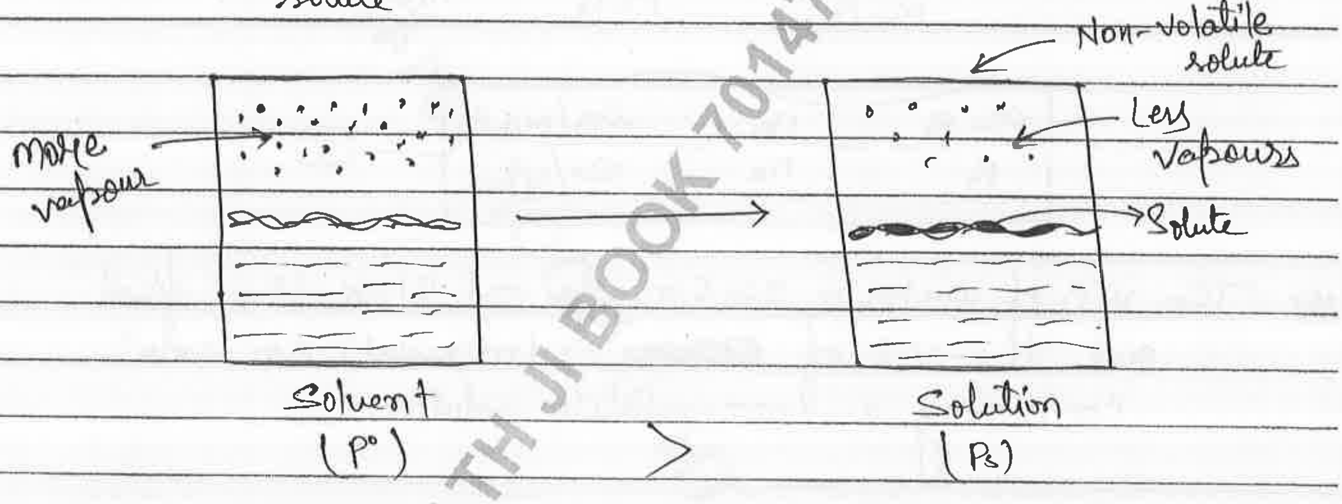
$$\boxed{P_s = P^\circ \times x_{solvent}}$$

↳ V.P. of solution of contain non-volatile solute

$$\underset{\sim\sim}{P_s} \propto \underset{\sim\sim}{x_{solvent}}$$

V.P. of soluⁿ Containing non-volatile solute

Mole fraction of Solvent



From eqⁿ ① ⇒

$$\frac{P_s}{P^\circ} = x_{solvent} = 1 - x_{solute}$$

$$x_{solute} = 1 - \frac{P_s}{P^\circ} = \frac{P^\circ - P_s}{P^\circ}$$

$$\therefore \boxed{\frac{P^\circ - P_s}{P^\circ} = x_{solute} = \frac{n_B}{n_A + n_B}} \text{ —— ②}$$

$P^\circ - P_s = \Delta P$ ⇒ Lowering in V.P.

$\frac{P^\circ - P_s}{P^\circ} = \frac{\Delta P}{P^\circ}$ ⇒ Relative lowering in V.P. (RLVP)

From eqn ②

$$\frac{P^\circ}{P^\circ - P_s} = \frac{n_A + n_B}{n_B} = \frac{n_A}{n_B} + 1$$

$$\frac{P^\circ}{P^\circ - P_s} - 1 = \frac{n_A}{n_B}$$

$$\frac{P^\circ - (P^\circ - P_s)}{P^\circ - P_s} = \frac{P_s}{P^\circ - P_s} = \frac{n_A}{n_B}$$

$$\boxed{\frac{P^\circ - P_s}{P_s} = \frac{n_B}{n_A} = \frac{w_B/M_B}{w_A/M_A}} \quad ③$$

Ques. The V.P. of water is 92.5 mm Hg at 310K then find out the V.P. of 1m(molal) aq. soln containing a non-volatile solution.

~~$P_s = P^\circ \times x_{solvent}$~~

~~$= 92.5 \times$~~

1 molal of aq. soln

1 mole solute in 1 kg Solvent

1000 g H_2O

$$P_s = P^\circ \times x_{solvent}$$

$$= 92.5 \times \frac{(1000/18)}{\left(1 + \frac{1000}{18}\right)}$$

$$= 92.5 \times \frac{55.5}{56.5}$$

$$= 90.8 \text{ mm Hg}$$

Ques. The V.P. of aq. solution of glucose is 750mm Hg at 373K then determine

P°

B.P. of H_2O

① L.V.P.

(ii) RLVP

(iv) m of solution.

(iii) mole fraction of glucose

①

Solvent = $H_2O \Rightarrow 760$ mm Hg

$$L.V.P. = P^\circ - P_s$$
$$= 760 - 750$$
$$= 10 \text{ mm Hg}$$

② $RLVP = \frac{P^\circ - P_s}{P^\circ}$

$$= \frac{10}{760} = \frac{1}{76}$$

(iii) $RLVP = x_{\text{solute}} = \frac{1}{76}$
glucose

(iv) $\frac{x_{\text{solute}}}{x_{\text{solvent}}} = \frac{x_{\text{solute}}}{1 - x_{\text{solute}}} \Rightarrow \frac{1/76}{1 - 1/76} = \frac{1/76}{75/76} = \frac{1}{75}$

$$\frac{x_{\text{solute}}}{x_{\text{solvent}}} = \frac{1}{75} = \frac{n_{\text{solute}}}{n_{\text{solvent}}}$$

$$m = \frac{1}{75 \times 18} \times 1000$$

$$= \underline{0.74m}$$

Ques. The V.P of pure Benzene is 0.850 bar If a solution is prepared by dissolving 0.5g of a non volatile solute in 39g. of benzene. then the V.P. of soln is found to be 0.845 bar then determine the must of non-volatile solute

$$\frac{0.850 - 0.845}{0.845} = \frac{\omega_B}{M_B} \times \frac{M_A}{\omega_B}$$

$$\frac{0.850 - 845}{0.845} = \frac{0.5}{M_B} \times \frac{\cancel{78}^{2}}{\cancel{39}}$$

$$\frac{0.005}{0.845} = \frac{1}{m_B}$$

$$\boxed{m_B = 169 g\,mol^{-1}}$$

Ques. How much mass of a non-volatile solute (mw = 40) needs to be dissolved in 114 g of Octane to reduce its V.P. to 80%.

Let:- $P^\circ = 100$; $P_s = 80$

$$\frac{P^\circ - P_s}{P_s} = \frac{\omega_B}{m_B} \times \frac{M_A}{\omega_A}$$

$$\frac{100 - 80}{80} = \frac{\omega_B}{40} \times \frac{\cancel{114}}{\cancel{114}}$$

$$\boxed{\omega_B = 10g}$$

Ques 18g glucose and 34.2g sugar are dissolved in 72g of H_2O in the V.P. of pure water is 30 mmHg then determine the V.P. of solution.

$$n_{glucose} = \frac{18}{180} = 0.1 mol$$

$$n_{sugar} = \frac{34.2}{342} = 0.1 mol$$

$n_{solute} = 0.1 + 0.1 = 0.2\,mol$

$n_{solvent} = n_{H_2O} = \frac{72}{18} = 4\,mol$

$P_s = P^\circ \times x_{solvent}$

$= 30 \times \frac{4}{4.2}$

$= 28.5$ mmHg

Ques A solution containing 30g Non-volatile solute in 90g water has a V.P. 21.85 mm Hg. If 18g of water is added to the solution then V.P. of solution becomes 22.15 mm Hg then find out the V.P. of water and molecular wt. of solute.

P = 24
MW = 67.8

$P_{H_2O} = P^\circ = x$

$n_{solute} = y$

$P_s = P^\circ \times x_{solvent}$

$21.85 = x \cdot \times \frac{5}{(5+y)}$

$y = \frac{30}{M}$

$M = \frac{30}{y}$

$21.85(5) + 21.85y = 5x$ — (I)

$22.15 = x \times \frac{6}{6+y}$

$22.15(6) + 22.15y = 6x$ — (II)

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F Colligative Properties of Dilute solutions :—

Colligative Properties depends on relative no. of solute particles present in solution.

→ Concentration of solution

→ Does not depends on nature of solute

Volatile solvent = A

Non-volatile solute = B

① Relative Lowering in V.P. :—

Acc. to Raoult's law,

$$\text{RLVP} \Rightarrow \boxed{\frac{P^\circ - P_s}{P^\circ} = x_{solute} = \frac{n_B}{n_A + n_B}} \Rightarrow \text{for concentrated Solution}$$

for Dilute solution ⇒ $n_A >>> n_B$

$\therefore (n_A + n_B) \simeq n_A$

$$\therefore \boxed{\frac{\Delta P}{P^\circ} = \frac{P^\circ - P_s}{P^\circ} = \frac{n_B}{n_A}} \Rightarrow \text{for dilute Solutions}$$

for dilute solⁿ

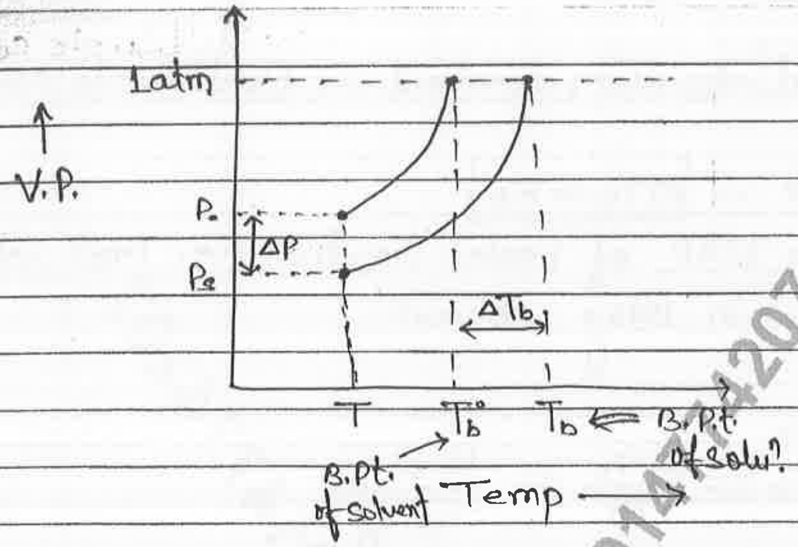
$$\boxed{\Delta P \propto \frac{n_B}{n_A}}$$

② Elevation in Boiling point :—

- Boiling point is the temp. at which —

V.P. of liquid = Atmospheric pressure

⇒ When atmospheric pressure is 1atm then boiling point is known as Normal B.P.



$$EIBP \Longrightarrow \boxed{\Delta T_b = T_b - T_b^\circ} = \left(\text{B.Pt of Solution}\right) - \left(\text{B.Pt. of pure solvent}\right)$$

From graph,

$$\Delta T_b \propto \Delta P \text{ —— (I)}$$

$$\Delta P \propto \frac{n_B}{n_B} \text{ —— (II)}$$

From eqn (I) & (II)

$$\Delta T_b \propto \frac{n_B}{n_A}$$

$$\Delta T_b \propto \frac{n_B \times M_A}{W_A}$$

For a particular solvent

$$M_A = \text{Constant}$$

$$\therefore \Delta T_b \propto \frac{n_B}{W_A}$$

$$\Delta T_b \propto m$$

$$\boxed{\therefore \Delta T_b = K_b \cdot m = K_b \cdot \frac{W_B \times 1000}{m_B \times W_A(g)}}$$

K_b = Molal elevation constant or Ebulliscopic constant

⇒ If $m=1$ ⇒ ∴ $\boxed{\Delta T_b = K_b}$

K_b is EIBP of 1 molal solution i.e. 1 mol solute in 1000g solvent

⇒ Unit of K_b

$$K_b = \frac{\Delta T_b}{m} = \frac{K \text{ or } {}^\circ C}{mol\,Kg^{-1}}$$

$$= \boxed{\begin{array}{l} K\,Kg\,mol^{-1} \text{ or } K\,m^{-1} \\ = {}^\circ C\,Kg\,mol^{-1} \text{ or } {}^\circ C\,m^{-1} \end{array}}$$

K_b = depends only on nature of solvent

$$\boxed{K_b = \frac{M\times R\times T_b^{\circ 2}}{1000\times \Delta H_{vap}} = \frac{R\times T_b^{\circ 2}}{1000\times L_{vap.}}}$$

~~R = const~~ R = Conc. constant.

M = Molar mass of solvent

T_b° = Boiling point of pure solvent

$\Delta H_{vap.}$ = Enthalpy of vapourisation per mol. of solvent

$L_{vap.}$ = Latent heat of vapourisation per g of solvent.

* 1 mol solvent = M g of solvent ⟶ $\Delta H_{vap.}$

1g of solvent ⟶ $\frac{\Delta H_{vap.}}{M} = L_{vap.}$

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

$\Delta H_{vap.}$ ⇓ $kJ\,mol^{-1}$ or $kcal\,mol^{-1}$

$L_{vap.}$ ⇓ $kJ\,g^{-1}$ or $kcal\,g^{-1}$

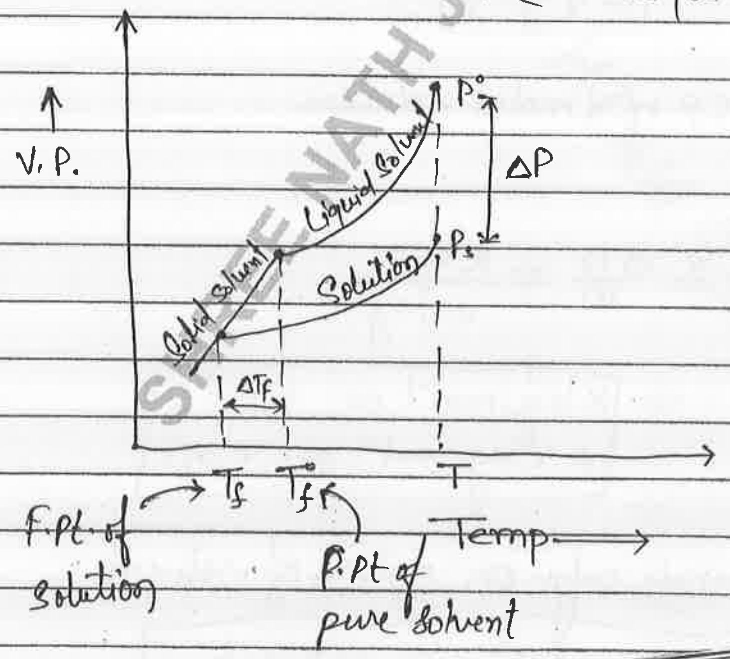
M ⇓ $g\,mol^{-1}$

③ Depression in freezing point :—

⇒ Freezing is the temp. at which the solid phase, liquid phase. of a substance are in dynamic equillibrium with each other i.e. the temp. at which —

$$\boxed{\text{V.P. of solid phase} = \text{V.P. of liquid phase}}$$

$$\text{Solid} \rightleftharpoons \text{liquid}$$



= A solution will freeze when the V.P. of solution will becomes equal to V.P. of pure solid Solvent.

DIFP. ⇒ $\boxed{\Delta T_f = T_f^\circ - T_f} = \left(\begin{array}{c}\text{f. pt. of}\\ \text{pure solvent}\end{array}\right) - \left(\begin{array}{c}\text{f. pt. of}\\ \text{solution}\end{array}\right)$

from graph :—

$$\Delta T_f \propto \Delta P \propto \frac{n_B}{n_A} \propto m$$

$$\therefore \boxed{\Delta T_f = K_f \cdot m = K_f \cdot \frac{w_B \times 1000}{m_B \times w_A(g)}}$$

m = molality of solution

K_f = Molal depression constant

or

Cryoscopic constant

If $m = 1 \Rightarrow \therefore \boxed{\Delta T_f = K_f}$

⇒ K_f is DIFP of 1 molal solution

⇒ Unit of K_f

$$K_f = \frac{\Delta T_f}{m} = \frac{K \text{ or } ^\circ C}{mol\ kg^{-1}}$$

$$= \boxed{\begin{array}{l} K\,kg\,mol^{-1} \text{ or } K\,m^{-1} \\ ^\circ C\,kg\,mol^{-1} \text{ or } ^\circ C\,m^{-1}\end{array}}$$

⇒ K_f depend only on nature of solvent

$$\boxed{K_f = \frac{M \times R \times T_f^{\circ 2}}{1000 \times \Delta H_{fus}} = \frac{R \times T_f^{\circ 2}}{1000 \times L_{fus}}}$$

R = Gas constant

M = Molar mass of solvent

T_f = freezing point of pure solvent

ΔH_{fus} = Enthalpy of fusion per mol of solvent

L_{fus} = latent heat of fusion per g of solvent.

$$\boxed{\Delta H_{fus} = L_{fus.} \times M}$$

Note :—

① Ostwalds Process is ~~for~~ used for determing elevation in B. Pt.

(ii) Beckmann's therma meter is used for determing depression in freezing point.

(iii) Compher is the best solvent for determine the molar mass of solute using DIFP. because of its high Kf value. ($39.70\ K\,m^{-1}$)

(iv) for $H_2O \Rightarrow K_f = 1.86\ km^{-1}$

$K_b = 0.52\ Km^{-1}$

Ques. 6g Urea is dissolved in 100g of H_2O then determine the Boling point and freezing point of the solu^n.

$$m = \frac{6/60}{\frac{100}{1000}} = 1$$

$$\Delta T_b = K_b \cdot m$$
$$= 0.52 \times 1$$
$$= 0.52K$$

$$T_b - T_b^{\circ} = 0.52$$
$$T_b = 0.52 + T_b^{\circ}$$
$$= 0.52 + 373 = 373.5K$$

$\Delta T_f = K_f \cdot m = 1.86 \times 1 = 1.86\,K$

$T_f^\circ - T_f = 1.86$

$T_f = T_f^\circ - 1.86 = 273 - 1.86$

$= 271.4\,K$

Ques. The freezing point of an aqous solution containing a non-volitile solute is -0.465 °c then find out Boiling ~~of~~ point of solution.

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

$= 0 - (-0.465)$

$= 0.465$ °C or K

$$\frac{\Delta T_b}{\Delta T_f} = \frac{K_b \cdot \cancel{m}}{K_f \cdot \cancel{m}}$$

$$\frac{\Delta T_b}{0.465} = \frac{0.52}{1.86}$$

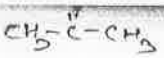
$\Delta T_b = 0.13$

$T_b - T_b^\circ = 0.13$

$T_b = 0.13 + T_b^\circ$

$= 0.13 + 373$

$= 373.13\,K$



$CH_3-\overset{\|}{C}-CH_3$

<u>Ques.</u> In car radiato 8l water is mixed with 2L methanol (d = 0.8g/ml) then determine the lowest temp at which the vehicle can be parked outdoor without freezing of the water of radiator.

Mass of methanol

$CH_3OH = d \times vol.$

$= 0.8 gmL^{-1} \times 2000$

$= 1600g$

$d_{H_2O} = 1 gmL^{-1}$

mass of $H_2O = d \times vol.$

$= 1 gmL \times 800 mL$

$= 8000g.$

$\Delta T_f = k_f . m$

$= 1.86 \times \left(\frac{1600 \times 1000}{32 \times 8000} \right)$

$\Delta T_f = 11.625°C$

$T_f^\circ - T_f = 11.625$

$T_f = T_f^\circ = -11.625$

$= 0 - 11.625$

$= -11.625°C$

<u>Ques</u> A solution containing 1.4g of acetone in 100gm benzene frees at ~~[illegible]~~ 277.12K another solution containing 2.8g. of solid A in 100g benzene freess at 277.76K then determine the molecular wt of Solid A If the freezing point of benzene is 278.40K.

$\Delta T_{f_1} = T_f^\circ - T_f$

$= 278.40 - 277.12$

$= 1.28K$

$\Delta T_{f_2} = T_f^\circ - T_f$

$=$ ~~2780~~ $278.40 - 277.76$

$= 0.64K$

$$\frac{\Delta T_{f_1}}{\Delta T_{f_2}} = \frac{\cancel{K_f} \times m_1}{\cancel{K_f} \times m_2}$$

$$\frac{\overset{2}{\cancel{1.28}}}{\cancel{0.64}} = \frac{\frac{1.4 \times \cancel{1000}}{58 \times \cancel{100}}}{\frac{2.8 \times \cancel{1000}}{M \times \cancel{100}}}$$

$$2 = \frac{1.4}{58} \times \frac{M}{2.8}$$

$$M = 58 \times 4 = 232\ g\,mol^{-1}$$

Ques. The V.P. of water and the V.P. of an aqeous solution Cantaing a non-volatile solute is 20 and 19.64 MM Hg respec-tivily. then determing the Boiling point of solution.

$$\frac{\frac{P^\circ - P_s}{P_\circ}}{\Delta T_b} = \frac{\frac{n_B}{n_A}}{K_b \times m}$$

$$\frac{\frac{20-19.64}{20}}{\Delta T_b} = \frac{\cancel{\frac{n_B \times n_A}{w_A}}}{K_b \times \frac{n_B}{w_{A(g)}} \times 1000}$$

$$\frac{0.36}{20 \times \Delta T_b} = \frac{18}{0.52 \times 1000}$$

$$\Delta T_b = 0.52$$

$$\cancel{\Delta T}\ T_b - T_b^\circ = 0.52$$

$$T_b = 0.52 + T_b^\circ$$

$$= 0.52 + 100$$

$$= 100.52^\circ C$$

Que. Calculate the freezing point of an aqous solution containing 5% Urea and 10% glucose by mass. (PC).

$n_{urea} = \frac{5}{60} = \frac{1}{12}$ mol ; $n_{glucose} = \frac{10}{180}$

$= \frac{1}{18}$ mol

$n_{solute} = \frac{1}{12} + \frac{1}{18} = \frac{5}{36}$ mol

$W_{solvent} = 100 - (5+10)$
$= 85g$

$\Delta T_f = K_f \times m = 1.86 \times \frac{5 \times 1000}{36 \times 85}$

$\Delta T_f = 3.04°C$

$T_f° - T_f = 3.04$

$T_f = T_f° - 3.04$

$= 0 - 3.04$

$T_f = -3.04°C$

Que. Calculate the mass of sucrose that should be disolved in 100g of water in order to prepair a solution having a difference of 105°C b/w its Boiling point and freezing point. (~~Kb~~ for H_2O $K_f = 1.8\,K\,m^{-1}$
$K_b = 0.5\,K\,m^{-1}$)

$\Delta T_b = T_b - T_b°$ — ①

$\Delta T_f = T_f° - T_f$

$T_f = T_f° - \Delta T_f$ — ⑪

$T_b - T_f = 105$

$(\Delta T_b + T_b^\circ) - (T_f^\circ - \Delta T_f) = 105$

$(\Delta T_b + \Delta T_f) + (T_b^\circ - T_f^\circ) = 105$

$K_b \cdot m + K_f \cdot m + 100 = 105$

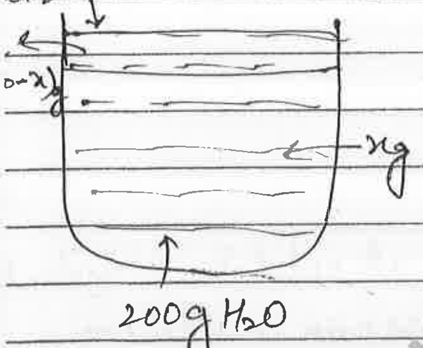
$(K_b + K_f) m = 5$

$(0.5 + 1.8) \frac{w \times 1000}{342 \times 100} = 5$

$\boxed{w = 74.3g}$

Ques. Calculate the mass of ice that will be seperated on cooling on solution upto $-9.3°C$ that contains 50g ethylene glycol in 200g water.

CH_2-OH
$|$
CH_2-OH



$\Delta T_f = K_f \cdot m$

$T_f^\circ - T_f = K_f \cdot m$

$0 - (-9.3) = 1.86 \times \left(\frac{50 \times 1000}{62 \times x}\right)$

$9.3 = 1.86 \times \frac{50 \times 1000}{62 \times x}$

$x = 161.3g$

Mass of ice seperated out $= 200 - x \Rightarrow 200 - 161.3$
$= 38.7g$

#④ Osmotic Pressure :—

Osmosis → Osmosis is the process in which the spontaneous net flow of solvent occurs through semi-permiable membrane from solvent side (or lesser conc. soln) towards solution (more conc. soln) till equillium is attained. i.e. Net flow of solvent becomes zero.

* SPM:— It appear to be a continious sheet but consist of sub-microscopic hollow that allows the passage of smaller partical of solvent but ^ passage of solute.

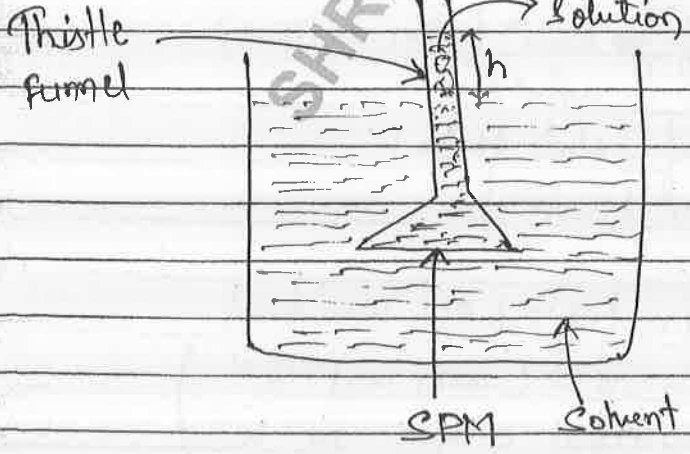
Eg:— Animal membrane
Vegetable membrane
Parchement
Cellophone, Copper ferrocynide $(Cu_2[Fe(CN)_6)]$
Cellose Acetate

※ Osmotic Pressure:—

The mini. external pressure that must be applied on the solution side to just stop the process of Osmosis is known as osmotic pressure.

OR

It is the hydrostatic pressure develop in vertical column when solvent and solution are seprated by SPM.



Osmotic Pressure = Hydrostatic Pres

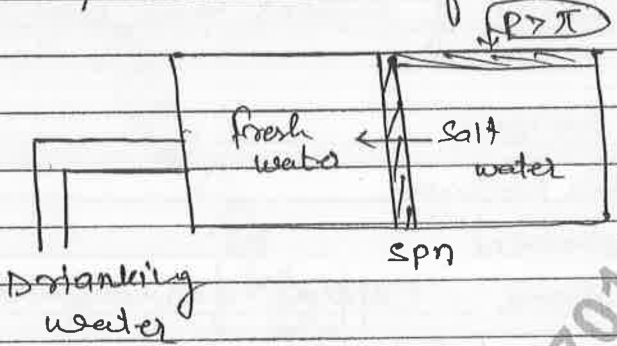
$$\boxed{\pi = dgh}$$

d = density of soln
g = Acc due to gravity
h = Increase in the level of solution in thistle funnel.

Reverse Osmosis :—

↳ When a pressure greater than osmotic pressure is applied on the solu^n then ~~pressur~~ precess of osmosis is reversed and is known as reverse osmosis.

⇒ Used in desalination of sea water.



Vant Hoff law for Dilute sutions.

Acc. to this the gas equation that is $PV=nRT$ can be used for dilute solutions when the pressure of gas is repliced by Osmotic pressure of solution.

for gas ⇒ $PV = nRT$

$\downarrow$

for dilute solu^n ⇒ $\boxed{\pi V = nRT}$

π = O.P. of ~~g~~ solu^n (atm or bar)

V = Vol. of solu^n (L)

n = Moles of solute (mole)

T = Temp. (Kelvin)

R (or S) = Gas (or Solution) constant

(0.0821 L atm $mol^{-1} K^{-1}$

0.0831 L bar $mol^{-1} K^{-1}$)

As, $\pi V = nRT$

$$\pi = \left(\frac{n}{V}\right)RT$$

$$\boxed{\pi = CRT}$$

At const. T

$$\pi \propto C$$

$$\boxed{\frac{\pi_1}{\pi_2} = \frac{C_1}{C_2}}$$

Isotonic solution :—

↳ Solution having same osmotic pressure at a given temp.

Solu^n ① and Solu^n ⑪

π_1 & C_1 $\qquad$ π_2 & C_2

$$\therefore \boxed{\pi_1 = \pi_2}$$

$C_1RT = C_2RT$ (at given temp)

$$C_1 = C_2$$

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

Hypertonic and Hypotonic Solutions :—

Solu^n ① and Solu^n ⑪

π_1 & C_1 $\qquad$ π_2 & C_2

If $\pi_1 > \pi_2 \implies C_1 > C_2$

Solu^n ① $\implies$ Hypertonic (High O.P.)

Solu^n ⑪ $\implies$ Hypotonic (Low O.P.)

Note →

(i) Berkely-Hartley's Method & funnel experimental are used for determing osmotic pressure of solⁿ

(ii) 0.9% w/v Nacl Solution is isotoic with blood.
Ns → Normal Saline solution.

(iii) Osmotic pressure is the best method for determing the molar mass of polymer, Portein and other macromoleculy because its magnetude is large and it can be easily measured at room temp.

Ques Calculate the osmotic pressure of 5% ~~o~~ solution of cane sugar at 27°C
% w/v

$$\cancel{\pi}\ \pi V = nRT$$

$$\pi\left(\frac{100}{1000}\right) = \frac{5}{342}(0.0821)(300)$$

$$\pi = \frac{50 \times 24.6}{342} = 3.6\ \text{atM}$$

Note :- In the question of osmotic pressure % solution is considered as % w/v solⁿ and in the question of ~~ad~~ all other colligative properties % solⁿ is considered as % w/w solⁿ.

Ques. At a certain temp. 1L solution containing 36g of glucose has an osomotic pressure of 6 bar If the osmotic pressure of solⁿ is found to be

1.5 bar at the same temp. then determine the conc. of solution.

$$\pi \propto C$$

$$\frac{\pi_1}{\pi_2} = \frac{C_1}{C_2}$$

$$\frac{6}{1.5} = \frac{36/180 \times 1}{C_2}$$

$$4 = \frac{0.2}{C_2}$$

$$C_2 = 0.05M$$

Ques. Determine the osmotic pressure of 2m sucrose solⁿ having a density of 1.4gml at 27°C temp

2mol sucrose in 1kg solvent

Mass of solⁿ = 1000 + (2×342)

= 1684g

$$\text{Vol. of sol}^n = \frac{\text{mass}}{\text{density}} = \frac{1684 g}{1.4 g mL^{-1}}$$

$$= \frac{1684}{1.4} mL$$

$$M = \frac{2 \times 1000}{\frac{1684}{1.4}} = \frac{2800}{1684} = 1.66M$$

$$\pi = CRT$$

$$= 1.66 \times 0.821 \times 300$$

$$= 40.8 \text{ atm}$$

Note :—

If density of solution is not given in the question, then assume,

$$\boxed{M \simeq m}$$

Ques. The freezing point aqeous solution of urea is ~~-62°c~~ $-0.62°c$ then find out O.P. of the soln at 300K temp.

$$\Delta T_f = T_f^\circ - T_f$$
$$= 0 - (-0.62)$$
$$= 0.62°C \text{ or } K$$

$$\frac{\Delta T_f}{\pi} = \frac{K_f \cdot \cancel{m}}{\cancel{M}RT}$$ As dsoln is not given $\Rightarrow \therefore M \simeq m$

$$\frac{0.62}{\pi} = \frac{1.86}{0.821 \times 300}$$

$$\pi = 8.2 \text{ atm.}$$

Ques. A 5% solution of urea is isotonic with 2% of solution of non-electrolyte at a given temp. then determine the molecular wt of non-electrolyte.

$$\pi_1 = \pi_2$$
$$C_1 = C_2$$
$$\frac{n_1}{V_1} = \frac{n_2}{V_2}$$
$$\frac{5/60}{100/1000} = \frac{2/M}{100/1000} \Rightarrow M = 24 g\ mol^{-1}$$

Ques. A staight line graph ~~is~~ ploted b/w π and conc. (gcc^{-1}) at 27°c has a slope of 4.5×10^{-3} then find out the molar mass of solute in the solun.

$$\pi V = nRT$$

$$\pi = \left(\frac{w}{MV}\right)RT$$

$$\pi = \left(\frac{RT}{M}\right)\frac{w}{V} \quad w \Rightarrow g,\ V \Rightarrow L$$

$$\pi = \left(\frac{1000RT}{M}\right)\frac{w}{V} \quad w \Rightarrow g,\ V \Rightarrow cc$$

$$y = m \cdot x$$

$$\text{Slope} = \frac{1000RT}{M} = 4.5 \times 10^{-3}$$

$$= \frac{1000 \times 0.821 \times 300}{4.5 \times 10^{-3}}$$

$$M = 5.4 \times 10^{8}\ g\,mol^{-1}$$

Ques O.P. of 100mL solun at 27°c is 12 atm If x mL of water added and solun is heated upto 327°c then O.P. becomes 8 atm. then find out x.

$$\frac{\pi_1 V_1}{\pi_2 V_2} = \frac{\cancel{n_1} \cancel{R} T}{\cancel{n_2} \cancel{R} T_2}$$

$n_1 = n_2$

becoz on adding H_2O there is no effect on moles of solute.

$$\frac{12 \times 100}{8 \times (100 + x)} = \frac{300}{600}$$

$$\boxed{x = \cancel{1}200\,mL}$$

Ques. A 10g mixture glucose of Urea ~~is~~ present in 250mL of solun shown the O.P. of 7.4atm at 27°c then determine the wt of glucose & Urea in the mixture.

$$\pi V = nRT$$

$$\pi = \frac{nV}{RT} = \frac{(7.4)\left(\frac{250}{1000}\right)}{(0.821)(300)}$$

$$n = 0.075\,\text{mol}$$

$$\frac{x}{60} + \frac{10-x}{180} = 0.075$$

$$\frac{3x+10-x}{180} = 0.075$$

$$10+2x = 13.5$$

$$\boxed{x = 1.75\,g}$$

Mass of Urea = x g = 1.75 g

Mass of glucose = (10 − x) g = 8.25 g

Abnormal Colligative properties:—

1 mol Urea $\xrightarrow{\text{in } H_2O}$ 1 mol Urea in solution.

1 mol NaCl $\xrightarrow{\text{in } H_2O}$ 1 mol Na^+ + 1 mol Cl^-

58.5g

2 mol ions in solution

58.5g ⇒ 1 mol → 29.5g

1 mol $CH_3COOH \xrightarrow{\text{in } C_6H_6} \frac{1}{2}(CH_3COOH)_2$

$\frac{1}{2}$ mol dimer in solution.

60g ⇒ 1 mol → 120g

↳ When a solute undergoes assocation or dissociation in solu^n then it shows abnormal or observed or expermental colligative properties.

When a solute does not undergoes dissociation or association in solution then i shows normal or Calculated or theortial colligative properties.

Vant Hoff Factor (i) :—

It gives a relative b/w normal & abnormal C.P.

$$\boxed{i = \frac{\text{Abnormal (observed) C.P.}}{\text{Normal (Calculated) C.P.}}}$$

$$C.P. \propto n_{solute} \propto \frac{1}{\text{Molar mass of solute}}$$

$$i = \frac{\text{Total no. of moles of solute after dissociation/Assocication}}{\text{— '' — '' — Before — '' — ''}}$$

$$i = \frac{\text{Normal (Calculated) Molar Mass}}{\text{Abnormal (observed) Molar mass}}$$

Modified formula's of C.P. for dissocia^n/Assoc(„)ia^n of solute in solution :—

$$\text{Observed C.P.} = i \times \text{Calculated C.P.}$$

$$\frac{P^\circ - P_s}{P^\circ} = i \times \frac{n_{solute}}{n_{solvent}}$$

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

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

$$\boxed{\pi = i \times CRT}$$

Possible Values of 'i' :—

$i = 1 \Rightarrow$ Neither association nor dissciation of solute takes places.

Eg:— Non-electrolytes like Urea, Sugar, glucose etc.

$i > 1 \Rightarrow$ for Dissciation of solute

Eg:— NaCl, KCl, in H_2O

$i < 1 \Rightarrow$ for Association of solute

Eg:— CH_3COOH, C_6H_5COOH in C_6H_6

Calculation of 'i'

Case I :— for Dissociation

$\Rightarrow i > 1$ because no. of moles of solute $\uparrow$ses

$\Rightarrow$ Observed C.P > Calculated C.P.

$\Rightarrow$ Observed molar mass < Calculated molar mass.

$$\Rightarrow A_xB_y \longrightarrow xA^{+y} + yB^{-x}$$

Initially 1 mol

After dissⁿ $\Rightarrow (1-\alpha) \qquad x\alpha \qquad y\alpha$

$\Rightarrow$ Total no. of moles after dissⁿ $= 1-\alpha + x\alpha + y\alpha$

$$= 1-\alpha + \underbrace{(x+y)}_{n}\alpha$$

$$= 1-\alpha + n\alpha$$

$$i = \frac{\text{Total moles of solute after dissociation}}{\text{———"——— Before ———"———}}$$

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

$(x+y) = n \Rightarrow$ Total no. of moles of ions given by 1mol of solute. (i.e. electrolyte)

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

α = Degree of dissociation

Note :- For strong electrolyte, If 'α' is not given, then consider $\alpha=1$ i.e. 100% $\Rightarrow \therefore \boxed{i=n}$

Eg:- $CaCl_2 \longrightarrow Ca^{+2} + 2Cl^-$

If $\alpha = 100\%$ $i = n \Rightarrow 3$

$Al_2(SO_4)_3 \longrightarrow 2Al^{+3} + 3SO_4^{-2}$

If $\alpha = 100\%$ $i = n = 5$

$K_4[Fe(CN)_6] \longrightarrow 4K^+ + [Fe(CN)_6]^{4-}$

If $\alpha = 100\% \Rightarrow i = n = 5$

If $\alpha = 50\% \Rightarrow i = 1+(5-1)(0.5)$
$= 3$

Case II Association

$\Rightarrow$ $i < 1$ because no. of moles of solutes ↓ses.

$\Rightarrow$ Observed C.P. < Calculated C.P.

$\Rightarrow$ Observed molar mass > Calculated molar mass.

	$\Rightarrow nA \longrightarrow$	A_n
Initially	1 mol	—
After assoⁿ	$(1-\beta)$	β/n

$\Rightarrow$ Total no. of moles after association $= 1 - \beta + \beta/n$

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

$$i = \frac{\text{Total no. of solute after association}}{\text{——''—— Before ——''——}}$$

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

β = Degree of association

n = No. of moles of solute association.

$\left\{ \begin{array}{l} \text{Dimer } n = 2 \\ \text{Trimer } n = 3 \end{array} \right\}$

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

Note:— If 'β' is not given then consider β=1 i.e. 100% $\Rightarrow \boxed{i = 1/n}$

Q. Calculat the O.P. of 0.1 molar N_2SO_4 solution at 300 K temp If N_2SO_4 is 60% ionised.

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

$i = 1 + (3-1)\,0.6$

$= 2.2$

$\pi = i \times CRT$

$= 2.2 \times 0.1 \times 0.0821 \times 300$

$= 5.4$ atm.

Ques. In 500 cm^3 water 3g of acetic acid is added If 25% of the acid is dissociated then find out the dipression in freezing point.

Solu^n:—

$$i = 1 + (n-1)\alpha$$
$$= 1 + (2-1)(0.25)$$
$$= 1.25$$

$d_{H_2O} = 1 g mL^{-1}$
$1 cm^3 = 1 mL = 1g$

$$\Delta T_f = i \times K_f \cdot m$$
$$= 1.25 \times 1.86 \times \left(\frac{3 \times \overset{2}{\cancel{1000}}}{60 \times \cancel{500}}\right)$$
$$= 0.23°C \text{ or } K$$

Ques. Calculate the B.P. of a solution prepaired by dissolving 0.61g of benzoic acid in 50g carbon disulphite (CS_2) assuming that acid undergoes 80% ~~[illegible]~~ dimension

Given:- (B.P. of CS_2 = 46.2 °C, K_b of CS_2 = 2.5 °C m^{-1})

$$i = 1 + \left(\frac{1}{n} - 1\right)\beta$$
$$= 1 + \left(\frac{1}{2} - 1\right)(0.8)$$
$$= 0.6$$

$$\Delta T_b = i \times k_b \cdot m$$
$$= 0.6 \times 2.5 \times \left(\frac{0.61 \times 1000}{122 \times 50}\right)$$
$$= 1[illegible]$$
$$= 0.15°C \text{ or } K$$

$$T_b - T_b^\circ = 0.15$$
$$T_b = 0.15 + T_b^\circ$$
$$= 0.15 + 46.2$$
$$= 46.35°C$$

Ques. Calculate the O.P. of 0.1M weak monobasic acid solution, having pH equal to 2 at 300K temp.

Solu^n:— $C = 0.1M$ or N

$pH = 2 \Rightarrow (H^+) = 10^{-2}N$

$(H^+) = C\alpha$

$\alpha = \frac{(H^+)}{C} = \frac{10^{-2}}{10^{-1}} = \underline{0.1}$

$i = 1+(n-1)\alpha$
$= 1+(2-1)0.1$
$= 1.1$

$\pi = i \times CRT$
$= 1.1 \times 0.1 \times 0.0821 \times 300$
$= \underline{2.7\,atm.}$

Ques. 7.2% glucose solution is isotonic with 1.17% Sodium chloride (NaCl) solution at a given temp. then find out the degree of dissociation NaCl.

$\pi_1 = \pi_2$

$i_1 \times C_1 \cancel{RT} = i_2 \times C_2 \cancel{RT}$

$i_1 \times C_1 = i_2 \times C_2$

$1 \times \frac{7.2 \times 1000}{180 \times \cancel{100}} = i_2 \times \frac{1.17 \times 1000}{58.5 \times \cancel{100}}$

$i_2 = 2$

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

$2 = 1+(2-1)\alpha$

$\underline{\alpha = 1 \text{ i.e. } 100\%}$

Que 11g Brarium Nitratie is added to 100g water to prepaired a solu^n that boils at 100.44°C temp. then find out the degree of Ionision of Barium Nitrate.
(~~mol~~ molecular wt. of $Ba(NO_3)_2 = 260$)

$$\Delta T_b = i \times k_b \cdot m$$

$$T_b - T_b^\circ = i \times 0.52 \times \frac{11 \times 1000}{260 \times 100}$$

$$100.44 - 100 = i \times \frac{0.52 \times 11}{26}$$

$$0.44 = i \times \frac{0.52 \times 11}{26}$$

$$0.44 = i \times 0.22$$

$$i = \frac{0.44}{0.22} = \underline{2}$$

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

$$2 = 1 + (3-1)\alpha$$

$$1 = 2\alpha$$

$$\alpha = \tfrac{1}{2} = 0.5 \text{ i.e. } 50\%$$

Que Arrange the following solution in increasing Order of their B.P., f.pt, V.P, ΔT_b, ΔT_f, RLVP, LVP and O.P of solution.

(A) 0.05 molar $NaNO_3$ (aq.) $= 2 \times 0.05 = 0.1$
(B) 0.06 molar $(NH_4)_3PO_4$ $= 4 \times 0.06 = 0.24$
(B) 0.8 molar glucose (aq.) $= 1 \times 0.8 = 0.8$
(D) 0.01 molar $Al_2(SO_4)_3$ (aq.) $= 5 \times 0.01 = 0.05$

$$\frac{1}{(V.P)_{sol.}} \propto \frac{P^\circ - P_s}{P^\circ} = i \times \frac{n_{solute}}{n_{solvent}} \Rightarrow \Delta P = P^\circ - P_s \Rightarrow \downarrow P_s = P^\circ - \Delta P \uparrow$$

$$(B.P.)_{sol.} \propto \Delta T_b = i \times K_b \cdot m \Rightarrow \Delta T_b \Rightarrow T_b - T_b^\circ \Rightarrow \uparrow T_b = \uparrow \Delta T_b + T_b^\circ$$

$$\frac{1}{(F.P)_{sol.}} \propto \Delta T_f = i \times K_f \cdot m \Rightarrow \Delta T_f \Rightarrow T_f^\circ - T_f \Rightarrow \downarrow T_f = T_f^\circ - \Delta T_f \uparrow$$

$$\propto \pi = i \times CRT$$

$$O.P. \propto i \times C$$

$$(B.P)_{sol.} \propto i \times C$$

$$(F.P.)_{sol.} \;\&\; (V.P)_{sol} \propto \frac{1}{i \times C}$$

As α is not given $\Rightarrow \therefore \alpha = 1$

As $d_{sol.}$ is not given $\Rightarrow \therefore M \simeq m$.

* RLVP, LVP, ΔT_b, $\Delta T_f \Rightarrow d<a<b<c$

* $(B.P)_{sol.}$ & $(O.P)_{sol.} \Rightarrow d<a<b<c$

* $(F.P.)_{sol^n}$ & $(V.P)_{sol^n} \Rightarrow c<b<a<d$

Ques. 1g of monobasic acid 100g water loweres the freezing point by 0.186°c If 0.2g of same acid requires 16mL of N/10 NaOH solution for complecte newtralization then find out degree of dissociation of acid.

Soln:-

Eq. of acid = Eq. of base

moles × v.f. = N × vol.(L)

$$\frac{0.2}{M} \times 1 = \frac{1}{10} \times \frac{16}{1000}$$

$$M = \frac{2000}{16} = \underline{125\,g\,mol}$$

$$\Delta T_f = iK_f \cdot m$$

$$0.186 = i \times 1.86 \times \frac{1 \times 10\cancel{0}\cancel{0}}{125 \times 1\cancel{0}\cancel{0}}$$

$$i = \frac{125}{100} = 1.25$$

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

$$1.25 = 1 + (2-1)\alpha$$

$$\alpha = 0.25$$

i.e. 25%

Date 27/09

Henry's law :—

This law states that at const Temp. the solubility ~~in~~ of a gas in a liquid is directly proportional to the Partical pressure of the gas present above the surface of the liquid or gas.

If the solubility of a gas is expressed in term of mole fraction then the Henry law can be stated as follow:—

The partical pressure of a gas in vapour ~~gas~~ phase is proportional to the mole fraction of the gas in the solution.

$$P \propto X$$

$$\boxed{P = K_H \cdot X}$$

P = partical pressure of gas in vapour phase
X = mole fraction of gas in solution
K_H = Henry's ~~law~~ Constant

Units of K_H = Unit of Pressure
⟹ K_H depends on nature of gas & temp.
⟹ On ↑sing temp, K_H also ↑ses ∴ solubility ↓ses

★ It is due to this reason that aquatic species are more comfortable in cold water as compair to warm water.

★ At constant temp. the mass of a gas dissolved in a given vol. of solvent is directly proportional to the pressure at which it is in equillibrium with the solution.

$$m \propto p$$

$$* \boxed{\frac{m_1}{m_2} = \frac{P_1}{P_2}}$$

Note :—

① Rault's law is a special case of Henry's law.

(II) Henry's law is not applicable ~~for~~ when a gas Undergoes any chemical raiection with a Solvent.

(III) Henry law is not applicable when a gas associate or dissocite in solvent.

Ques. If N_2 gas is babbled through water at 293K then How many millimoley of N_2 gas would dissolve in 1L of water assuming that N_2 exerts a partical pressure of 0.98 bar given that K_H of N_2 at 293K is 76.48K bar.

$$P_{N_2} = K_H \cdot X_{N_2}$$

$$X_{N_2} = \frac{P_{N_2}}{X_H} = \frac{0.987}{76.48} \times 10^{-5}$$

$$= 1.3 \times 10^{-5}$$

$$\frac{n_{N_2}}{n_{N_2} + n_{H_2O}} = 1.3 \times 10^{-5}$$

$$(\text{As } n_{N_2} <<< n_{H_2O})$$

$$\frac{n_{N_2}}{n_{H_2O}} = 1.3 \times 10^{-5}$$

$$\frac{n_{N_2}}{55.5} = 1.3 \times 10^{-5}$$

$$n_{N_2} = 55.5 \times 1.3 \times 10^{-5}$$

$$= 72.1 \times 10^{-5} \text{ mol}$$

$$= 72.1 \times 10^{-5} \times 10^{3}$$

$$= 0.72 \text{ mmol}$$

Ques. The value of k_H for the solubility of N_2 in water at 298K is 1×10^5 atm. If the mole fraction of N_2 in air is 0.8 then Calculate the no. of mole of Nitrogen from air dissolved in 10 mole of water at 298 K and 5 atm pressure of air.

Partical Pressure = Mole fraction × Total Pressure

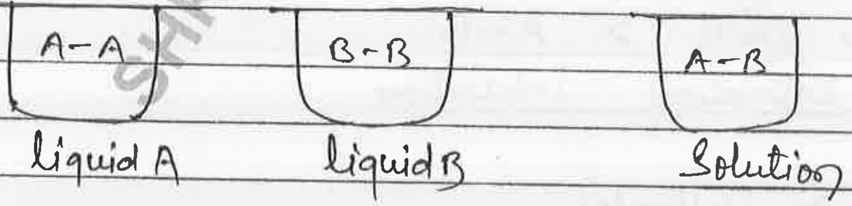
$$P_{N_2} = 0.8 \times 5$$
$$= 4 atm$$

$$P_{N_2} = k_H \cdot \chi_{N_2}$$
$$4 = 10^5 \times \frac{n_{N_2}}{10}$$
$$4\times10^{-5} = \frac{n_{N_2}}{10}$$
$$\boxed{n_{N_2} = 4\times10^{-4} mol}$$

Ideal & Non-ideal Solutions :-

① Ideal Solution :-

The solution that obey Rault's law at all conc. and all temp. are known as ideal solution.



⇒ A–A = B–B = A–B
Interaitions Interactions Interactions

⇒ $\Delta H_{mix} = 0$ (No extra heat is absorbed or released)

⇒ $\Delta V_{mix} = 0$ ($V_{sol} = V_{solute} + V_{solvent}$)

⟹ Observed V.P. == Calculated V.P.
(Experimental) (Theoritical)

⟹ Observed B.P. == Calculated B.P.

$$\boxed{V.P. \propto \frac{1}{B.P}}$$

Eg:- Benzene + Tolaene
Bromoethane + Chloroethane
N-Hexane + N-Heptane.

Note:—

- Liquid having same molecular structure and same polarity (can form ideal solution. Partically No solution is ideal.
Rault's law is only applicable for ideal solution.

(II) Non-Ideal Solutions:—

(A) It shows positive deviation from Rault law:—

⟹ A–A == B–B > A–B
Interactions Interactions Interactions

⟹ $\Delta H_{mix} > 0$ (Endo)

⟹ $\Delta V_{mix} > 0$ ($V_{sol.} > V_{solute} + V_{solvent}$)

⟹ Observed V.P. > Calculated V.P. $\left[\begin{array}{l} P_A > P_A^\circ x_A \,; \\ P_B > P_B^\circ x_B \end{array} \right.$
(Experimental) (Theartical)

$P_S > P_A^\circ x_A + P_B^\circ x_B$

⇒ Observed B.P. < Calculated B.P.

$$\boxed{V.P. \propto \frac{1}{B.P.}}$$

Eg:— Ethanol & Acetone
CS_2 & Acetone

Ⓑ Non-ideal Solution showing negative deviation from Rault's law :—

⇒ $A-A = B-B < A-B$

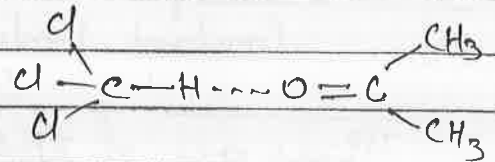
⇒ $\Delta H_{mix} < 0$ (Exo)

⇒ $\Delta V_{mix.} < 0$ ($V_{sol.} < V_{solue} + V_{solvent}$)

⇒ Observed V.P. < Calculated V.P $\left[\begin{array}{l} P_A < P_A^\circ x_A \\ P_B < P_B^\circ x_A \\ P_s < P_A^\circ x_A + P_B^\circ x_B \end{array}\right]$

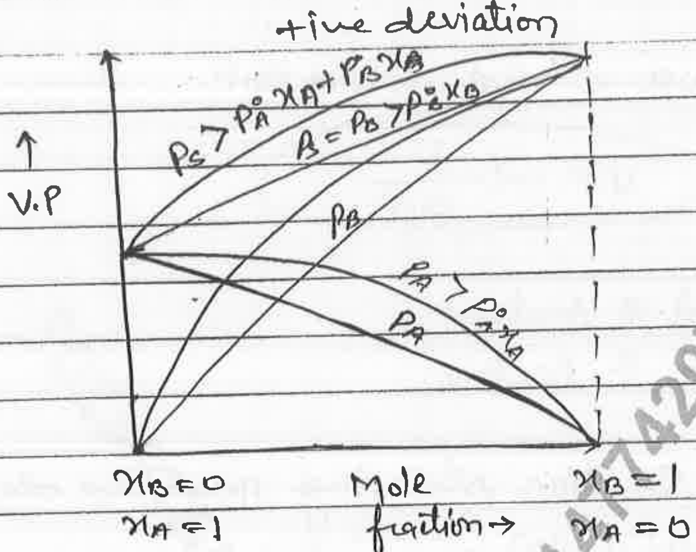
⇒ Observed B.P. > Calculated B.P.

Eg:— Phenol & Aniline
Chloroform & Acetone.



Note:—
For both ideal & Non-ideal solun

$$\left[\begin{array}{l} \Delta S_{mix} > 0 \\ \Delta G_{mix} < 0 \end{array}\right]$$



Azotropes/Azeotropic mixtures :—

A binnary mixture of two volitile liquids having same composition in vapour and liquid phase and boils at const. temp. are known as azotropes.

The component of such mixture cannot be seperated by fractional distilation because they boils at constant temp and hence they are also known as Constant boiling mixture.

There are of two types :-

① Mini boiling Azotropes :—

The solution that show large +ive deviation from Rault's law forms mini boiling azotropes at a specific composition.

The boiling point of ~~a~~ mixture is less than the B.P. of each component in pure state.

Eg :- ~~Ethanol~~ Ethanol and water

95.6% 4.4% } By mass

$\Downarrow$ $\Downarrow$

B.P. = 351.5K 373K

B.P. of Solution = 351K

Maximum Boiling Azeotrope :—

Negative deviation.

The solution that shows (-)ive deviation from Rault's law from max. boiling azeotrope at a specific composition.

Eg:— HNO_3 + H_2O

68% 32% } By Mass

$\Downarrow$ $\Downarrow$

B.P. = 356K 373K

B.P. of Solution ⟹ 393.5K

Ques 10mL of liquid A (B.P. = 368K) and 10mL of liquid B (B.P. = 415K) are mixed to obtained 19.92mL of a constant boiling mixture than the B.P. of a solution will be.

(i) < 368 K

(ii) > 368K but < 415K

(iii) > 415K

(iv) Unpredictable

$Vol._{sol.} < V_{solute} + V_{solvent}$

$19.92 < 10 + 10$

-ive deviation ⟹ Maxm Boiling Azotrops.

#1
-49

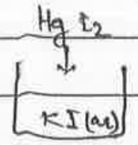
$$\frac{\Delta T_b}{\Delta T_f} = \frac{k_b \cdot m}{K_f \cdot m}$$

$$\frac{0.15}{\Delta T_f} = \frac{0.512}{1.86} \times \frac{m}{m/2}$$

$a = 59$
$T = 273.15K$

(103) KNO_3 = Strong electrolite
$i = 2$
CH_3COOH = week electrolite

x#1
(114)



$$2KI_{(aq)} + HgI_2 \longrightarrow K_2(HgI_4)$$

$\underbrace{2K^+ + 2I^-}$
4 mole ions.

$\downarrow$
$\underbrace{2K^+ + (HgI_4)^{2-}}$
3 mole ions.

$n_{solute} \downarrow$
$\Delta T_f \downarrow$
$\Delta T_f \uparrow$

EX#2
(44=2)

EX#2
4= 20

EX#2
(23) $(\Delta T_b)_x > (\Delta T_b)_y$

$i_x \cdot \cancel{k_b m} > i_y \cancel{k_b m}$

(45) $N = \frac{1/49}{100/000} = \frac{10}{49}$

Solid State

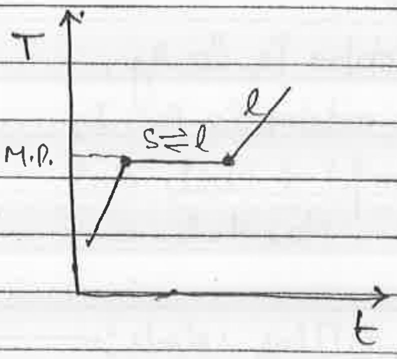
★ It is branch of chemistry that deals with varius types of solids, arrangement of constituent particles resulting in varey structure / properties and defects in solid state.

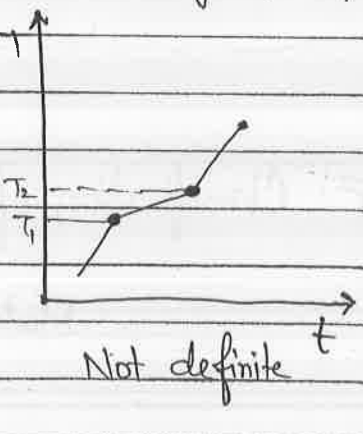
★ Under the given condition of Pressure and Temp. the Characteries properties are as follow:—

(i) They have diffinite shape, mass and Volume
(ii) Intermolecular distance are short.
(iii) Intermolecular forces are strong.
(iv) Their contitutent particles i.e. atoms, molecules or ions have fixed positions and they can only oscillate their mean positions.
(v) They are incompressible and rigid.

Classification of Solids:—

Property	Crystalline	Amorphous
① Shape	Definite geometrical shape	Irregular shape
Ⅱ Melting point	Sharp M.pt.	No sharp M.pt. They gradually soften over a range of temp.
Ⅲ Heat of fusion	Definite	Not definite





(IV) Clevage Properties	When cut into pieces with a sharp edaged tool then newly ~~genti~~ genrated surfaces are plain & Smooth.	Newly generated Surface area irregular.
(V) Anisotropy → The value of same physical properties when measured along diff. dir^n comes out to be diff. in the same crystal due to diff. arrangement of particles in diff. directions is known as Anisotropy.	Anisotropic in Nature	Isotropic in Nature
(VI) Nature	True solids	Pseudosolids or Supercooled liquids.
(VII) Order of arrangement of Constitents particles	Large range Order	Short range Order
(VIII) Examples	Metal ⇒ Fe, Cu, Ag, Non-metal ⇒ S_8, P_4, I_2 Compd. ⇒ NaCl, ZnS Napthelene	Glass, Plastic, Rubber Amorphous Si photovoltaic Sunlight → Electricity

Classification of Crystalline solids:—

On the basis of interactions b/w the particles

· Molecules, Metallic, Covalent and Ionic

Some important Terminology :—

① Crystal Lattice / Space Lattice :—

A regular three dimensional arrangement Constitent particles in space d is known as Crystal lattice.

- There are only 14 unique lattices which are known as BRAVAIS.

Ⓘⓘ Lattice point / Lattice site :—

The point at which a constituent particles i.e. atom, molecules and ions is present in space is known as lattic point.

ⒾⒾⒾ Unit Cell :—

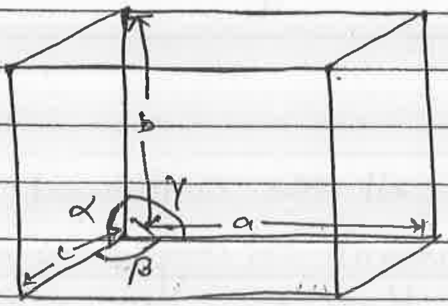
The smollest portion of a crystal lattice which when ~~repit~~ repeated varies directions creats the entire lattice is known as unit cell.

- All unit cell are identical in crystal lattice.

⇒ Parameter of a unit cell

① Dimensions along the edges = a, b, c [Edge length or Axial distance]

Ⓘⓘ Angle b/w the edges = α, β, γ [Axial angle]



Unit Cell

Classification of Unit Cell :—
On the basis of position of particles in unit Cell.

- These are of 2 types:—

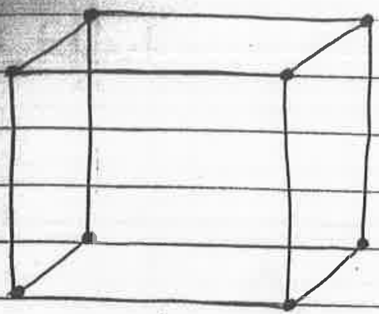
Ⓐ Primitive / Simple unit cell
When constituent particles are present only at corner position of a unit cell then it is known as primitive unit cell

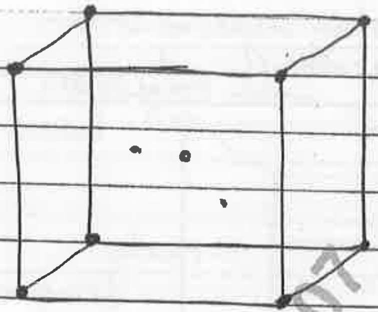
Ⓑ Centred Unit
When one or more constituent particles are present at any other position other then corner along with those present at corners are known as centred Unit.

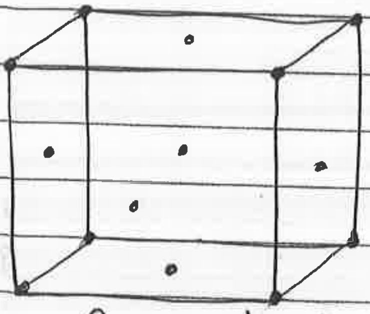
(i) Body Centred :—
In such a unit cell consitituent particles are present at the body centred along with those out at corners.

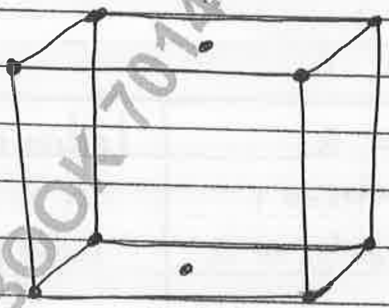
(ii) Face Centred :—
In such a unit cell the constituent particles are present at each face centred along with those present at corners.

(iii) End Centred :—
In such a unit cell the contituent particles are present are present at any two opposite face centres along with those present at their Corners.


Primitive


Body Centred

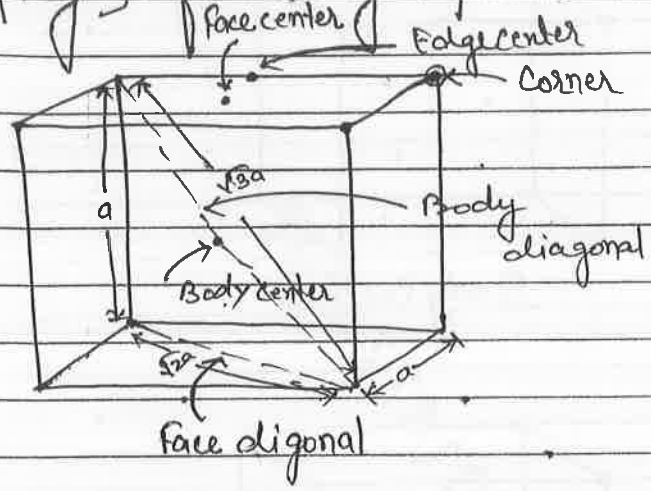

face centred


End Centred

II On the basis of parameter of unit cell :—
7 types:—

Crystal System	Edge length OR Axial distances	Axial Angle.
(i) Cubic P, B, F	$a = b = c$	$\alpha = \beta = \gamma = 90^\circ$
(ii) Tetergonal P, B	$a = b \neq c$	$\alpha = \beta = \gamma = 90^\circ$
(iii) Orthorhombic P, B, F, E	$a \neq b \neq c$	$\alpha = \beta = \gamma = 90^\circ$
(iv) Rhombohedral (Trigonal) P	$a = b = c$	$\alpha = \beta \neq \gamma \neq 90$
(v) Hexagonal P	$a = b \neq c$	$\alpha = \beta = 90^\circ, \gamma = 120^\circ$
(vi) Monoclinic P, E	$a \neq b \neq c$	$\alpha = \gamma = 90^\circ, \beta \neq 90$
(vii) Triclinic P	$a \neq b \neq c$	$\alpha \neq \beta \neq \gamma \neq 90$

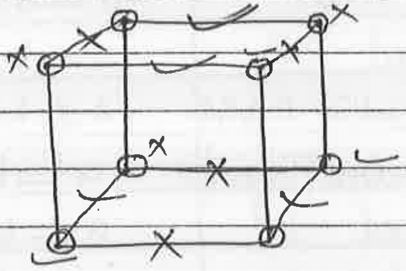
Analysis of cubic system :—



No. of corners = 8
No. of body center = 1
No. of face center = 6
No of edge center = 12

Lattice point in a Cubic unit cell

No of face diagonals = 12
No. of body diagonals = 4
~~No. of~~
Length of face diagonal = $\sqrt{2}a$
Length of body diagonal = $\sqrt{3}a$
Volume of cubic unit cell = a^3
where, a = edge length of cubic unit cell



Alternate corners = 4
Alternate faces = 2
Alternate edges = 4
Distance b/w two adjectance face center = $\frac{a}{\sqrt{2}}$
Distance b/w two adjecent edge center = $\frac{a}{\sqrt{2}}$

Date 03/10/19 Page

#. Effective No. of atoms in a unit Cell (z) :—

For a unit cell,

$$z = \Sigma x_i$$

where, x_i ⇒ effective no. of atoms at a particular lattice point in a unit cell.

For a particular lattice point,

x = Total no. of atoms at that lattice point. X Effective contribution of an atom at that lattice point in a unit cell.

⇒ Effective contribution of an atom at various lattice points in a cubic unit cell.

Corner $= \frac{1}{8}$ face centre $= \frac{1}{2}$

Body centre $= 1$ Edge centre $= \frac{1}{4}$

Determination of formula of a compound :—

If a compound contains elements A, B, C & D then its formula will be —

$$A_{Z_A} \; B_{Z_B} \; C_{Z_C} \; D_{Z_D}$$

where,

Z_A, Z_B, Z_C, Z_D } effective no. of atoms in a unit cell of that elements.

Ques. In solid cubic lattice A atoms are present at all corner and body center. and 'B' atoms are present all all face centre then find out the simplest formula of the solid atom.

$Z_A = 8 \times \frac{1}{8} + 1 \Rightarrow 2$

$\boxed{A_2B_3}$

$Z_B = 6 \times \frac{1}{2} \Rightarrow 3$

Ques. In a cubic structure A atoms are arranged in FCC and B atoms are at every edge center and C atoms are at Body center then find out the simplast formula of soild.

~~$Z_A = 8 \times \frac{1}{8}$ [illegible]~~

$Z_A = \left(8 \times \frac{1}{8}\right) + \left(6 \times \frac{1}{2}\right) = 4$

$Z_B = \left(12 \times \frac{1}{4}\right) = 3$ $\boxed{A_4B_3C_1}$

$Z_C = 1 \times 1 = 1$

Ques In solid cubic lattice A atoms are present at all corners B atoms at alternat face center and C atoms at alternates Edge centre then find out simplast formula.

$Z_A = 8 \times \frac{1}{8} = 1$

$\boxed{ABC}$

$Z_B = 2 \times \frac{1}{2} = 1$

$Z_C = 4 \times \frac{1}{4} = 1$

Ques. In a solid cubic lattice A occupies corners B occupied 50% face center and c occupied 25% edge center then find out formule of the solid.

$Z_A = 8 \times \frac{1}{8} = 1$

$Z_B = 3 \times \frac{1}{2} = 3/2$

$Z_C = \underset{\substack{\uparrow \\ 12 \text{ of } 25\%}}{3} \times \frac{1}{4} = \frac{3}{4}$

$A_1 B_{3/2} C_{3/4}$ multipled by 4.

$\boxed{A_4 B_6 B_3}$

Ques In a cubic stucture A atoms are arrenged in BCC and B atoms are ~~atom~~ at every edge center and C atoms are at alternate face center then find out simplest formule if atoms are removed along any body diagonal.

$Z_A = \left(8 \times \frac{1}{8}\right) + (1 \times 1) \Rightarrow 2 \Rightarrow 6 \times \frac{1}{8} = \frac{3}{4}$

$Z_B = 12 \times \frac{1}{4} = 3 \quad \Rightarrow 3$

$Z_C = 2 \times \frac{1}{2} = 1 \quad \Rightarrow 1$

$A_{3/4} B_3 C_1$

$\boxed{A_3 B_{12} C_4}$

Ques for a ~~crite~~ crystile the unit cell parameter are as follow:- a = 4.2A°, b = 4.2A°, C = 5A° then determine the crystile will be-

① Tetragonal
(ii) Orthorhobic
(iii) Hexgonal
✓ ~~(iv)~~ Either ① or ③

Ques. 1 In a solid cubic lattice A atoms are present at all corner, B atoms are at all face center. If one of the A atoms is removed from corner then the formula will be –
A_7B_{24}

Ques ② In a cubic structure A atoms are present at every corner. B atom at every face center. and C atoms at every edge center then find the simplece of the solid if all atoms are removed any one face.
$A_1B_5C_4$

Ans ① $Z_A = 8\times\frac{1}{8} = 1 \quad 7\times\frac{1}{8} = \frac{7}{8}\times 8 = 7$

$Z_B = \left(6\times\frac{1}{2}\right) = 3 \quad 3\times 8 = 24$

$\boxed{A_7B_{24}}$

Ans ② $Z_A = \left(8\times\frac{1}{8}\right) = 1;\ \cancel{4}\times\frac{1}{\cancel{8}} = \frac{1}{2}\times 2 = 1$

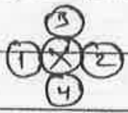
$Z_B = 5\times\frac{1}{2} = \frac{5}{2};\ \frac{5}{\cancel{2}}\times\cancel{2} = 5$

$Z_C = 12\times\frac{1}{4} = 3;\ 8\times\frac{1}{4}\ 2\times 2 = 4$

$\boxed{A_1B_5C_4}$

Co-odination number :—

the number of nearest neighbours that are touching to a particles is known as co-ordination no.



$C.N = 4$

Packing fraction or packing efficiency :—

It is define as the fraction of volume of a unit cell occupied by ~~unit~~ atom

$$\text{Packing fraction} = \frac{\text{Vol. occupied atoms in a unit cell}}{\text{Vol. of unit cell}}$$

$$\boxed{P.f. = \frac{Z \times \frac{4}{3}\pi r^3}{\text{Vol. of unit cell}}}$$

$$\%\ \text{Packing} = PF \times 100$$

$Z \Rightarrow$ effective no. of atoms in a unit cell

$r \Rightarrow$ Atomic radius

For a cubic unit cell,

$$\text{Vol. of cubic unit cell} = a^3$$

where, $a \Rightarrow$ edge length of cubic unit cell.

Void fraction :—

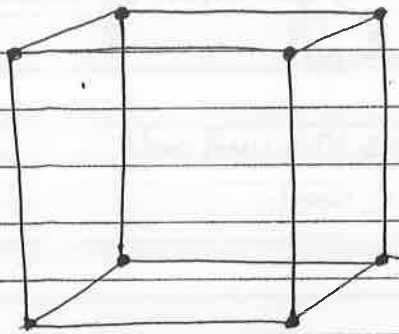
It is define as the fraction of Vol. of a unit cell that is unoccupied.

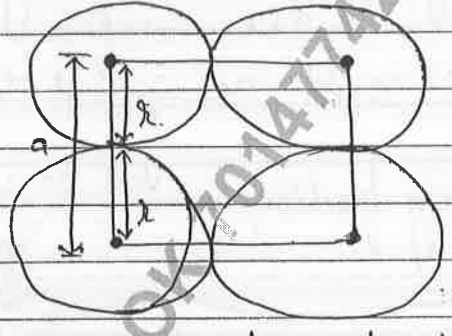
$$\boxed{Vf = 1 - Pf}$$

Types of Cubic system :—

① Primitive / Simple cubic (sc) :—

Similar atom are present at all corner in such a manner that each corner atoms is toching to its adjecent atom.





(One face of sc)

⇒ Effective no. of atoms in a unit cell $(z) = \left(8 \times \frac{1}{8}\right) = 1$

⇒ Co-ordination No. = 6

⇒ Relation b/w edge length (a) & atomic radius (r)

$$2r = a \Rightarrow \therefore \boxed{r = \frac{a}{2}}$$

⇒ Packing fraction

$$Pf = \frac{z \times \frac{4}{3}\pi r^3}{\text{Vol. of unit cell}} = \frac{1 \times \frac{4}{3}\pi\left(\frac{a}{2}\right)^3}{a^3} = 0.524$$

% Pf = 52.4%

% Vf = 47.6%

② Body centred Cubic (BCC) :—

Similar atom are present at all corner along with body center in such a manner that all corner atoms are touching to the body center atom and Non- of the corner atoms are touching each other.

⇒ Effective no. of atoms in a unit cell $= (Z) = \left(8 \times \frac{1}{8}\right) + (1+1) = 2$

⇒ Co-ordination No. = 8

⇒ Relation b/w edge length (a) & atomic radius (r)

$4r = \sqrt{3}a \therefore \Rightarrow \boxed{r = \frac{\sqrt{3}}{4}a}$

⇒ Packing fraction

$$Pf = \frac{2 \times \frac{4}{3}\pi\left(\frac{\sqrt{3}a}{4}\right)^3}{a^3} = \frac{\sqrt{3}\pi}{8} = 0.68$$

$$\% Pf = 68\%$$

$$\% V.f = 32\%$$

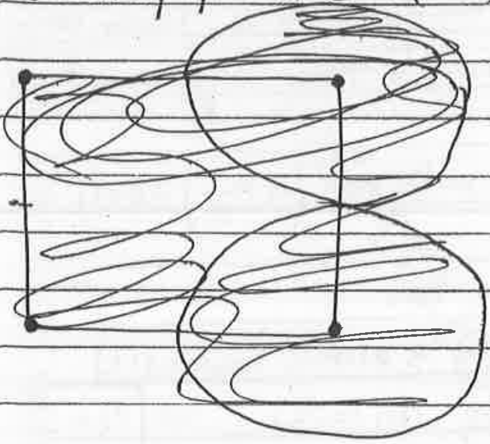
③ Face centred Cubic (FCC) :—

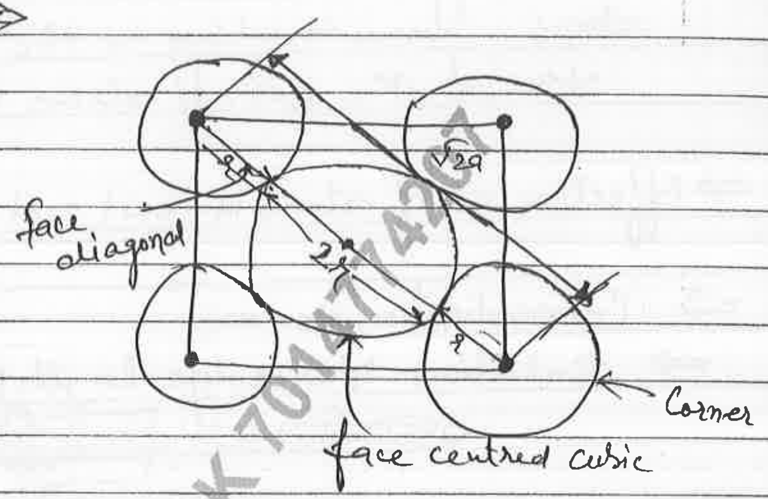
Similar atom are present at all the corner and each face centred in such manner that each face centred atom is teaching to all the corner atoms of its face and adjacent face centre atoms but it does not touches to the opp. face centre atom. (Non of the corner atoms are touching to each other)

⇒ Effective no. of atoms in a unit cell $(z) = \left(8 \times \frac{1}{8}\right) + \left(6 \times \frac{1}{2}\right) = 4$

⇒ Co-ordination no. = 12

⇒ Relation b/w a & r ⇒





$$4r = \sqrt{2}a \Rightarrow \therefore r = \frac{\sqrt{2}a}{4} \Rightarrow \therefore \boxed{r = \frac{a}{2\sqrt{2}}}$$

⇒ Packing Fraction

$$PF = \frac{2 \times \frac{4}{3}\pi r^3}{\text{Vol. of unit cell}} = \frac{4 \times \frac{4}{3}\pi\left(\frac{a}{2\sqrt{2}}\right)^3}{a^3}$$

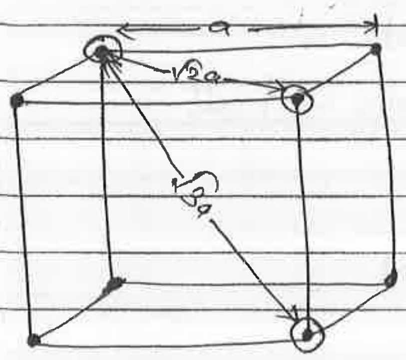
$$= \frac{\pi}{3\sqrt{2}} = 0.74.$$

% PF = 74%

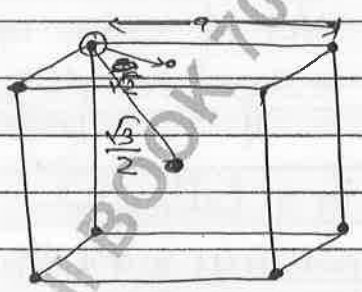
% Vf = 26%

Nearest Neighbours:—

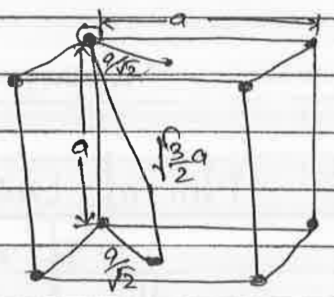
Unit Cell	Nearest		Next Nearest		Next to Next Nearest.	
	Distance	Number	Distance	Number	Distance	Number
SC	a	6	$\sqrt{2}a$	12	$\sqrt{3}a$	8
BCC	$\frac{\sqrt{3}}{2}a$	8	a	6	$\sqrt{2}a$	12
FCC	$\frac{a}{\sqrt{2}}$	12	a	6	$\sqrt{\frac{3}{2}}a$	24 $(\underline{3\times 8})$



SC



BCC



FCC

Density of unit Cell :—

$$\text{Density of unit cell} = \text{Density of Crystal}$$

$$\text{Density of Unit cell} = \frac{\text{Mass of unit Cell}}{\text{Vol. of unit cell}}$$

$$\therefore \text{Mass of Unit Cell} = \text{Effective no. of atoms in a unit cell} \times \text{Mass of one atom.}$$

$$= Z \times m$$

$$= Z \times \frac{M}{N_A}$$

$$\therefore \boxed{\text{Density} = \frac{Z \times M}{N_A \times a^3}}$$

M = Molar mass of substance $(g\,mol^{-1})$
N_A = Avogadro No.
Z = Effective no. of atoms in a unit cell.

a^3 = Vol. of cubic unit cell
where, a = edge length of cubic unit cell.

No. of unit cells in a lattice :-

If, no. of particles in a lattice = N
then,

No. of SC unit cells = N
No. of BCC unit cells = $\frac{N}{2}$
No. of FCC unit cells = $\frac{N}{4}$

eg. Ni metal crystallisoes in FCC lattice if the edge length of unit cell of Ni crystal is 350 PM then determine the atomic radius of Ni metal.

$$4r = \sqrt{2}a$$

$$r = \frac{a}{2\sqrt{2}} = \frac{340}{2(1.4)} = 121\,\text{pm}$$

Ques. Cs crystalliare in bcc lattice with the nearest distance of 1.73A' b/w the atom then find out the edge length of the unit cell in pm.

$$\frac{\cancel{\sqrt{3}}}{2} a = \cancel{1.73} A^\circ$$

$$a = 2 A^\circ$$

$$a = 2 \times 10^{-10} m \times 10^{-12}$$

$$\boxed{a = 200 pm.}$$

Ques. K crystallisare in Bcc arrangement then find out the mass of K sample containing 3.01×10^{24} unit cell.

No. of Bcc unit cell $= 3.01 \times 10^{24}$

No. of atoms $= 3.01 \times 10^{24} \times 2$

$= 6.02 \times 10^{24}$ atoms

moles of K-atoms $= \frac{6.02 \times 10^{24}}{6.02 \times 10^{23}}$

$= 10$ mol

mass of K-sample = moles × molar mass

$= 10 \times 39$

$= 390 g$

Ques. An element M (Molar mass 100g/mol) having fcc structure then Calculate the No. of unit cells present in 10g of sample of element.

moles $= \frac{10g}{100g} = 0.1$ mole

No. of atoms $= 0.1 \times N_A$

$= 6 \times 10^{22}$ atoms

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$$\text{No. of FCC unit Cells} = \frac{N}{4}$$

$$= \frac{6\times10^{22}}{4} = \underline{1.5\times10^{22}}$$

Ques A metal 'A' (Molar mass = 100g/mole) Crystallisare in BCC lattile ~~If~~ the edge length of a unit ~~[illegible]~~ Cells is 400pm then determine the density of the unit cell in g/cm³

$a = 400\,pm = 400\times10^{-12}\,m$

$4\times10^{-10}\,m = \underline{4\times10^{-8}\,m}$

$$d = \frac{Z\times M}{N_A\times a^3}$$

$$= \cancel{\frac{2\times100}{6\times10^{23}\times400\times10^{-8}}}$$

$$= \frac{2\times100}{6\times10^{23}\times(4\times10^{-8})^3}$$

$$= \frac{200}{6\times10^{23}\times64\times10^{-24}}$$

$$= \frac{2000}{384} = \underline{5.2g\ cm^3}$$

Ques. 1. Na metal crystallisare in BCC lattice if the radius of Na ~~the~~ atom is found to be 160pm then determine the edge length of a unit cell of Na-crystal.

Ques 2. an element (Molar mass = 75g/mole) crystallisare in cubic form with a density 2g/cm³ If the edge length of the unit cell 5A° then find out the atomic radius of the element in A°.

① $4r = \sqrt{3}a$

$a = \frac{4r}{\sqrt{3}}$

$a = \frac{4(160)}{1.73}$

$a = 370pm$

② $d = \frac{Z \times M}{N_A \times a^3}$

$2 = \frac{Z \times 75}{6\times10^{23} \times (5\times10^{-8})^3}$

$Z = 2 \Rightarrow BCC$

$4r = \sqrt{3}a$

$r = \frac{\sqrt{3}a}{4} = \frac{1.73\times5}{4}$

$r = 2.16 A°$

Ques. The density of an element (molar mass = 60 g mol⁻¹) having a fcc structure is 6.23 g/cm⁻³ then find out the edge length of unit cell. (in cm)

$d = \frac{Z \times M}{N_A \times a^3}$

$6.23 = \frac{4 \times 60}{6\times10^{23} \times a^3}$

$6.23 = \frac{\cancel{240}\ 40}{\cancel{6}\times10^{23} \times a^3}$

$a^3 = \frac{\cancel{240}\ 40}{\cancel{6}\times10^{23} \times 6.23}$

$= \frac{240}{36\times10^{23}}$

$= \frac{40\times10^{-23}}{6.23}$

$a^3 = 6.4\times10^{-23}$

$a = (64\times10^{-24})^{1/3}$

$= 64\times10^{-24} \times \frac{1}{3}$

$= 4\times10^{-8} cm$

Ques. An element having fcc structure has the edge length of 200pm. If 200g of element have 24×10^{23} atom then, find out its density.

$$d = \frac{Z \times m}{a^3} = \frac{4 \times 200}{24 \times 10^{23} \times (2 \times 10^{-8})^3}$$

$$= \frac{800}{24 \times 10^{23} \times 8 \times 10^{-24}}$$

$$= \frac{1000}{24} = 41.67 \, g \, cm^{-3}$$

Closed Packed Structures:—

Arrangement of particles is done to get max^m packing fraction and mini. void fraction.

All real structure are 3-D structure that can be build up in the following step:—

① 1-D Closed packing (Single layer single row):— This packing is formed by placing the sphere in a single row touching to each other.

C.N = 2

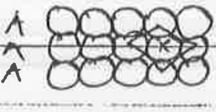
② 2-D Closed packing (Single layer multiple rows):—

* It is 2 types:—

Ⓐ Square Closed packing :-

Type ⇒ AAA - - -

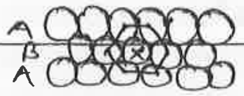
C.N. = 4



Void = Square (b/w 4 particles)
$Pf = 52.4\%$; $Z = 1$

→ This packing is formed by placing the square of second row in the same aliment with the sphere of 1st row both horizontialy and ~~bex~~ vertically.

③ Hexagonal Closed Packing :—



Type = ABAB ....
C.N. = 6
Void = Triangular (b/w 3 particles)
apex up & apex down
$Pf = 60.4\%$; $Z = 3$

→ This packing is formed by placing the sphere of second row at the depression of second row.

③ 3-D Closed Packing (Multiple layers Multiple rows) :—

Types of Packing	Types of arreng. of particles	Unit Cells	Void	C.N.	Z	P.F.
1.) Square Closed	AAA...	Simple Cubic	Cubical	6	1	52.4%
2.) Hexagonal Closed (HCP)	ABAB...	Hexagonal	Tetrahedral & Octahedral	12	6	74%
3.) Cubic Closed (CCP)	ABCABC...	FCC	Tetrahedral & Octahedral	12	4	74%

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★ ↳ A 3-D Closed packed structure is formed by a successive placing of 2-D closed packed layer over layer over one another.

Ⓐ Square Closed Packing:-

Type = AAA....

C.N. = 4+1+1 = 6

Unitcell = Simple cubic

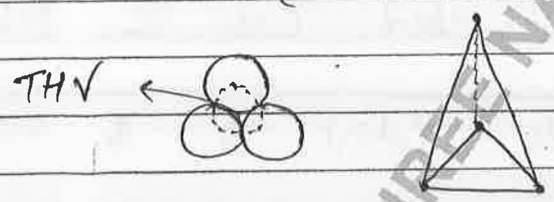
Void = Cubical (b/w 8 particles)

Z = 1 ; P.F. = 52.4%

↳ This packing is formed by the successive placing of 2-D square closed paked layer in the same allment both Horizontally and vertically.

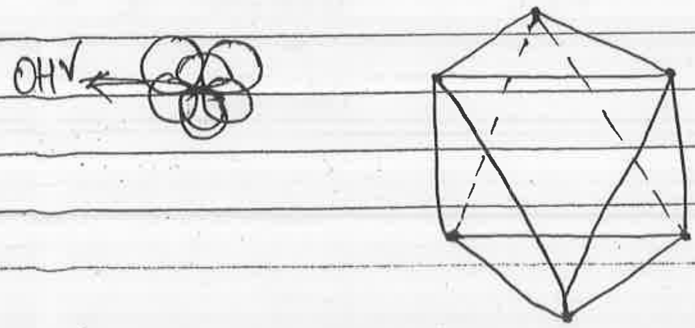
Note:—

① Tetrahedral void (b/w 4 particles)



When a triangula void is covered by a atoms its reslult in the formation of tetrahedral void.

⑪ Octahedral void (b/w 6 particles)



→ When a triangular void is covered by another triangular void in opposite oriantation then it result in the formation of Octahedral void.

Note* No. of THV & OHV in a unit cell

No. of THV = 2Z (2 voids per atom)

No. of OHV = Z (1 voids per atom.

(B) Hexagonal close Packing:—

Layer-I A. 2-D hexagonal closed packed layer ⇒ layer A

Point a ⇒ Centre of atoms in 1st layer.

Point b ⇒ Triangular voids of 1st layer.
(apex up or down)

Layer-II A similar 2-D hexagonal closed packed layer is placed at the depressions of 1st layer.

Different aligment from 1st layer ⇒ layer B

Point b ⇒ THV of 1st layer;

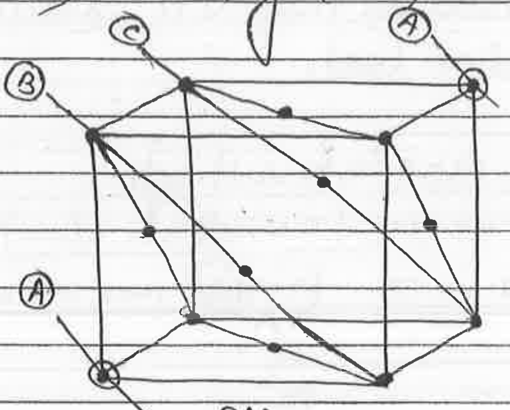
Point 'a' ⇒ 'THV' of 2nd layer; Point c ⇒ OHV of 1st & 2nd layer.

Layer-III A similar 2-D hexagonal closed layer can be placed in 2 ways:—

(I) Covering THV ⇒ 'a' Voids ⇒ same aligment with 1st layer ⇒ ABAB.... ⇒ HCP.

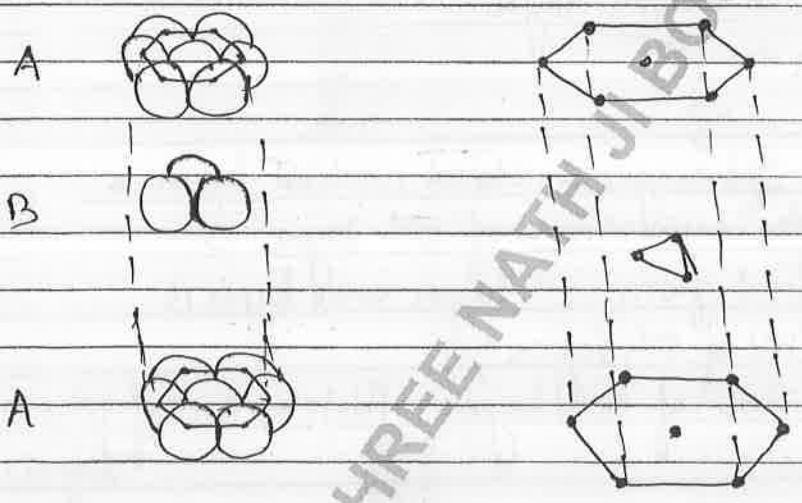
(II) Covering OHV ⇒ 'C' voids ⇒ Diff alignment from 1st and 2nd layer. ⇒ ABCABC ⇒ CCP or FCC pack

✶ Cubic Closed Packing (CCP) :—



FCC

Hexagonal Closed Packing (HCP) :—



Hexagonal Unit cell
- →12 Corners ⇒ each shared in 6 unit cells
- →8 faces ⇒ —"— 2 —"—
- →18 edges
  - →12 edges ⇒ each shared 4 in unit cell
  - 6 side edge ⇒ —"— 3 —"—

In HCP

- → 12 atom at all corners
- → 2 atom at faces
- → 3 atom ~~at~~ within the unit cell

$Z(HCP) = \left(12 \times \frac{1}{6}\right) + \left(2 \times \frac{1}{2}\right) + \left(3 \times 1\right) = 6$

No of THV per unit cell $= 12$; No. of OHV per unit cell $\Rightarrow 6$

C.N. $= 12$

Volume of hexagonal unit cell = Base Area × Height

Height $= 2a\sqrt{\frac{2}{3}}$

Base area $= \frac{6\sqrt{3}}{4} a^3$

$\boxed{a = 2r}$

PF = 74%

Locations of voids in FCC :—

For FCC $\Rightarrow Z = 4$

$\therefore$ No of THV per unit cell $= 8$

$\therefore$ No. of OHV per unit cell $= 4$

THV

$\Rightarrow$ Each THV is present at a distance of $\frac{\sqrt{3}}{4}a$ on the body diagonal from the corner.

$\Rightarrow \therefore$ Two THV are present on each body diagonal.

So, Total no. of THV $= 2 \times 4$

$= \textcircled{8}$

OHV

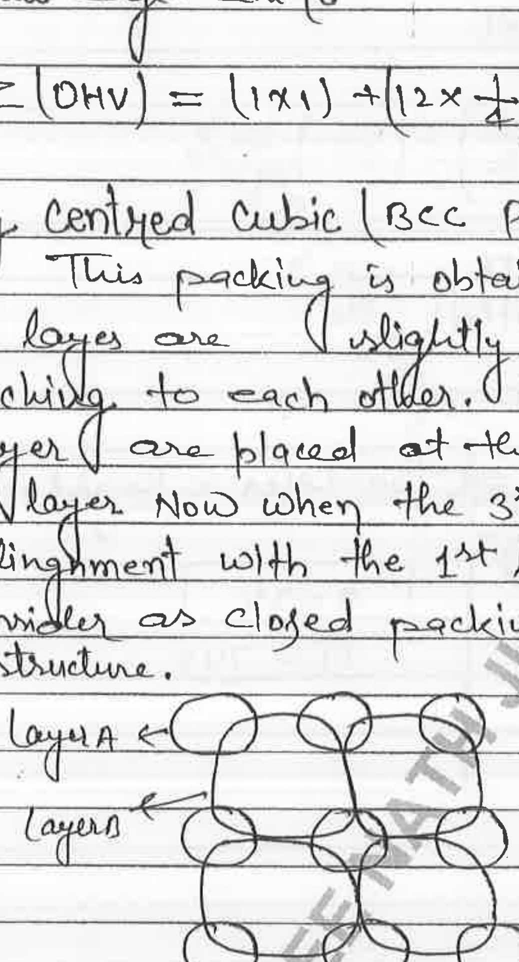
⇒ One at body centre

⇒ At all edge centre

$$Z(OHV) = (1\times1) + (12\times\frac{1}{4}) = 4$$

Body Centred Cubic (BCC Packing) :—

This packing is obtained when the spheres of first layer are slightly opened up & none of these are touching to each other. Now, the sphere of second layer are placed at the hollow ~~sphere~~ spaces of 1st layer. Now when the 3rd layer is placed it is in same allignment with the 1st layer this packing is Not consider as closed packing due to its opened up structure.



Types = ABAB ----

Pf = 68%

Z = 2

C.N. = 8

Que WOF option is correct regarding the cubic closed packing.

① 11th & 19th layer are identical

~~②~~ 7th & 13th layer are "

~~③~~ 8th & 12th " " "

④ All

A	B	C
1	2	3
4	5	6
−7	8	9
10	11	12
−13	14	15
16	17	18

Ques. In a closed packed structure x atom are arreanged in CCP y atom in every tetrahedral void and z atom in every Octahedral then determine the formula If all atoms are removed along any one body diagonal.

CCP or fcc

$$Z(x)=\left(8\times\frac{1}{8}\right)+\left(6\times\frac{1}{2}\right)=4 \Rightarrow \left(6\times\frac{1}{8}\right)+\left(6\times\frac{1}{2}\right)=\frac{3}{4}+3=\frac{15}{4}$$

$$Z(y)=\left(4\times2\times1\right)=8 \Rightarrow (3\times2)=6$$

$$Z(z)=(1\times1)\left(12\times\frac{1}{4}\right)=4 \Rightarrow \cancel{0+}\ 12\times\frac{1}{4}=3$$

$$x_{\frac{15}{4}}\,Y_6\,Z_3$$

$$\boxed{x_5\,Y_8\,Z_4}$$

Ques. In solid oxide oxide ions are arreanged in CCP then Cation of A occupy $\frac{1}{6}$th of THV and cation of B occupy $\frac{1}{3}$rd of OHV. find the formula of oxides.

$$Z(O)=\left(8\times\frac{1}{8}\right)+\left(6\times\frac{1}{2}\right)=4$$

$$Z(A)=\left(8\times\frac{1}{6}\right)=\frac{4}{3}$$

$$Z(B)=4\times\frac{1}{3}=\frac{4}{3}$$

$$A_4\,B_{4/3}\,O_{4/3} \qquad \boxed{ABO_3}$$

$$\cancel{A_2\,B_4\,C_4}$$

Ques In a compound B atom are arrenged in HCP packing and A atom are present in $2/3^{th}$ of OHV then determine the formula of compd.

$Z(B) = 6$

$Z(A) = 6 \times \frac{2}{3} = 4$

$A_4B_6 \Rightarrow \underline{A_2B_3}$

Ques In a solid AB_2O_4 oxides ions are in CCP cations of A are in OHV and cations of B are equally distributed b/w THV and OHV then find out %age occupency of both the voids.

$Z(O) = 4 \Rightarrow CCP$

$Z(A) = 1 \Rightarrow OHV$

$Z(B) = 2 \rightarrow 1\,THV,\ 1\,OHV$

No. of OHV occupied per unit cell = 2

" THV " = 1

$\% OHV = \frac{2}{4} \times 100\% = 50\%$

$\% THV = \frac{1}{8} \times 100$

$= 12.5\%$

Ques A metal crystallies in HCP structure then determine the total No. of voids present in 0.5 mole of metal.

No. of atoms $= 0.5 \times N_A$

$= 0.5 \times 6 \times 10^{23}$

$= 3 \times 10^{23}$ atoms

∴ As we known,

2THV are present per atom.

1 OHV is —— " ——

∴ Total THV $= 2\times 3\times10^{23} = 6\times10^{23}$

Total OHV $= 1\times3\times10^{23} = 3\times10^{23}$

$$\underbrace{6\times10^{23} + 3\times10^{23}}_{9\times10^{23}}$$

Structure of Ionic Crystal :—

* An ionic crystal is made by the packing of cations & anions.

* larger ions (usally ions) form the closed paked structure that is lattice and the small ions (usally cations) occupy the void spaces.

* Co-ordinational no. of an ion = No. of nearest oppositely charged ions touching to that ions.

* The type of void occupied by the small ions depends upon the parameter known as limiting radius ratio which is given as follow.

* L.R.R. ⇒ $\boxed{x = \frac{r}{R}}$ → r: Radius of smaller ions; R: Radius of layer ion

$x < 1$ ⇒ Always

Usually, $x = \frac{r^+}{R^-}$

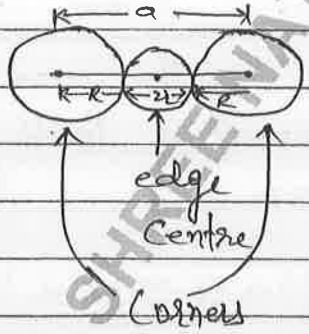
# Limiting Radius Ratio (x)	C.No.	Types of void.
$0.155 \leq x < 0.225$	3	Triangular
$0.225 \leq x < 0.414$	4	Tetrahedral
$0.414 \leq x < 0.732$	6	Octahedral
$0.732 \leq x < 1$	8	Cubical.

Rock Salt Type
(NaCl Crystal)

$\Rightarrow Cl^- \Rightarrow$ forms FCC
$\Rightarrow Na^+ \Rightarrow$ All OHV
} Vice-versa

$\Rightarrow Z(Cl^-) = 4$
$\Rightarrow Z(Na^+) = 4$
$\Rightarrow Z(NaCl) = 4Na^+ + 4Cl^-$
$= 4NaCl$
$= 4$ formula units

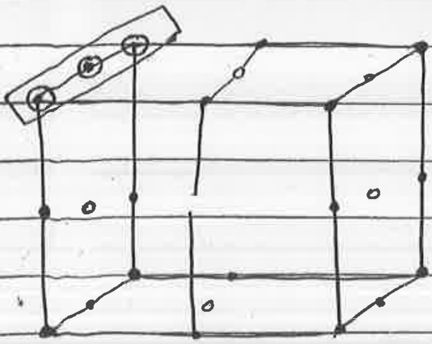
C.No. $(Cl^-) = 6$
C.No. (Na^+) 6



$$2r + 2R = a$$

$$\therefore \boxed{r + R = \frac{a}{2}}$$

$(r+R) \Rightarrow$ Interionic distance b/w 2 oppositely charged ions



o = Cl^-
• $\Rightarrow Na^+$

$\boxed{\frac{r}{R} = 0.414}$ for OHV

Example from Modules

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② CsCl Crystal

⇒ Cl^- ⇒ Forms SC (at all corners) } vice versa
⇒ Cs ⇒ At cubic void (at body centre) }

*Note:-

It appears to be BCC

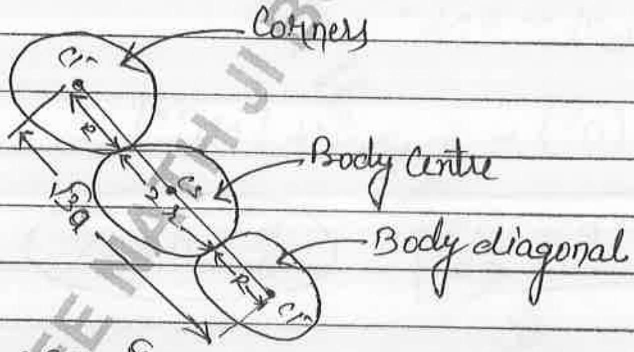
⇒ $Z(Cl^-) = \left(8 \times \frac{1}{8}\right) = 1$

$Z(Cs^+) = (1 \times 1) = 1$

$Z(CsCl) = 1Cs^+ + Cl^- = 1\,CsCl = 1$

⇒ $C.N.(Cl^-) = 8$

$C.N.(Cs^+) = 8$



$2r + 2R = \sqrt{3}a$

∴ $\boxed{r + R = \frac{\sqrt{3}}{2}a}$ $\boxed{\frac{r}{R} = 0.732}$

For cubic void

Example from module

③ CaF_2 Crystals (flourite structure):-

Ca^{+2} = forms fcc

F^- = All 8 THV

$\Rightarrow Z(Ca^{+2}) = 4 \; ; \; Z(F^-) = 8$

$Z(CaF_2) = 4Ca^{+2} + 8F^-$

$= 4CaF_2 = \underline{4}$

$\Rightarrow C.N(Ca^{+2}) = 8 \; ; \; C.N.(F^-) = 4$

$\Rightarrow \boxed{r + R = \frac{\sqrt{3}}{4}a} \quad \boxed{\frac{r}{R} = 0.225}$

for THV

④ Na_2O Crystal (Anti-Flourite Strucutre):—

$\Rightarrow O^{2-}$ = forms FCC

Na^+ = All THV

$\Rightarrow Z(O^{2-}) = 4 \; ; \; Z(Na^+) = 8$

$Z(Na_2O) = 8Na^+ + 4O^{2-}$

$\Rightarrow C.N.(O^{2-}) = 8 \; ; \; C.N.(Na^+) \; 4$

$\Rightarrow \boxed{r + R = \frac{\sqrt{3}}{4}a} \quad \frac{r}{R} = 0.225$

For THV

⑤ ZnS Crystal (Zinc Blende Structure)

Sphalerite

$S^{2-} \Rightarrow$ forms FCC

Zn^{+2} = Alternate THV (50% THV)

$\Rightarrow Z(S^{2-}) = 4$

$Z(Zn^{+2}) = 8 \times \frac{1}{2} = 4$

$Z(ZnS) = 4Zn^{+2} + 4S^{2-}$

$= 4ZnS$

$= \underline{4}$

$C.N.(S^{2-}) = 4$

$C.N(Zn^{+2}) = 4$

$\boxed{r + R = \frac{\sqrt{3}}{4}a}$ Example from module

Note:—

The structure of diamond is similar to ZnS crystal i.e. the carbon atom in diamond forms fcc lattice and also occupy alternate THV.

$$2(\text{Diamond}) = \left(8 \times \frac{1}{8}\right) + \left(6 \times \frac{1}{2}\right) + \left(8 \times \frac{1}{2}\right) = 8$$

$\boxed{\frac{\sqrt{3}}{4}a = 2r \ (C\text{-atom})}$ PF = 34%

$CN(C) = 4$

⑥ ZnS Crystal (Wurtzite structure):—

S^{2-} = form HCP

Zn^{+2} = Alternate THV (50% THV)

$Z(S^{-2}) = 6$

$Z(Zn^{+2}) = 12 \times \frac{1}{2} = 6$

$$Z(ZnS) = 6Zn^{+2} + 6S^{-2}$$
$$= 6ZnS$$
$$= \underline{6}$$

$C.N.(S^{-2}) = 4$

$C.N.(Zn^{+2}) = 4$

Note:—

For all ionic crystal

$$d = \frac{Z \times M}{N_A \times a^3}$$

$$PF = \frac{\text{Vol. of Cations} + \text{Vol. of anions}}{\text{Vol. of unit Cell}}$$

$$PF = \frac{Z \times \frac{4}{3}\pi(r^+)^3 + Z \times \frac{4}{3}\pi(r^-)^3}{\text{Vol. of unit Cell}}$$

Note:-

Effect of Pressure and Temperature on C.N.

On ↑sing P ⟹ C.N. ↑ses
On ↑sing T ⟹ C.N. ↓ses

Ques ① A solid crystal AB has NaCl structure If radius of anion is 200pm then determine radius of cation.

Solnⁿ:— $\frac{r}{R} = 0.414 \Rightarrow$ for OHV

$$\frac{r^+}{r^-} = 0.414 \Rightarrow r^+ = 0.414 \times r^-$$
$$= 0.414 \times 200$$
$$= 82.8\text{pm}$$

Ques.. The edge length of CsCl crystal is 390pm If the radius of cation is 150pm then determine ~~the~~ radius anions.

~~$\frac{r}{R} = 390\text{pm}$~~ ~~$\frac{r}{R}$~~ 0.

$$r + R = \frac{\sqrt{3}}{2} a$$

$$r^+ + r^- = \frac{\sqrt{3}}{2} a$$

$$150 + r^- = \frac{\sqrt{3} \times 390}{2}$$

$$\boxed{r^- = 187\ pm}$$

Que. Two ions A^+ & B^- have a radius of 86 pm and 200pm respectivily in a closed packed crystal of AB Compd. then determine the C.N. of cation.

$$\frac{r}{R} = \frac{86}{200} \Rightarrow 0.43 \Rightarrow OHV$$

$$\boxed{C.N. = 6}$$

Defects or Imperfections in solids :—

The irregularity in the arrangement of constituent particles is known as defects or imperfections in solids.

for Crystalline substance at absolute zero kelvin temp. the entropy and defects are zero but with a increase in temp. both increases.

Due to presence of extra cations at interstitial site :-

$$ZnO \xrightarrow{Heating} Zn^{+2} + \frac{1}{2} O_2(g) + 2e^-$$

$$\boxed{Zn_{(1+x)}O}$$

Ques Nacl lattic is dopped with 10^{-5} moles% SrCl then find No. of vaccency that will be creadited in 58.5 g of Nacl

Sol^n:-

$$\text{Moles of NaCl} = \frac{58.5}{58.5} = 1\text{ mol}$$

$$\text{Moles of SrCl} = \frac{1\times10^{-5}}{100} = 10^{-7}\text{ mol}$$

$$\text{No. of } Sr^{+2} \text{ ions} = 10^{-7}\times N_A = \text{No. of cationic vacancies,}$$
$$= 6.62\times10^{16}$$

Ques An oxides of Fe has a formula $Fe_{0.93}O$ then find out the % age of Fe that exists in Fe^{+3} in the compound.

Solu^n:-

$$Fe_{0.93}O = Fe_{93}O_{100}$$
→ 93 ions of Fe
→ 100 ions of O

Let, No. of Fe^{+2} ions = x

—— " —— Fe^{+3} ions = $(93-x)$

Oxidation of medthod :-

$$(+2)x + (+3)(93-x) + (-2)100 = 0$$
$$2x + 279 - 3x - 200 = 0$$
$$x = 79$$

$$\text{No. of } Fe^{+3} \text{ ions} = 93 - x$$
$$= 93 - 79$$
$$= 14.$$

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$\%$ of Fe^{+3} ions $= \frac{14}{93} \times 100$

$= 15\%$

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Atomic Structure

★ Anode ray particle are +ively charged gaseous ions.

★ Proton was discovered when

	P	e^-	n
e/m	9.6×10^{7} C/kg	1.76×10^{11} C/kg	0

Representation of a atom:

A = Mass No. = {No. of (Proton + neutron)} = No. of nucleons.

X

Z = Atomic No. = no. of protons

- For a neutral atom = no. of e^- = no. of P = Z.
- for a ion = no. of e^- = Z − (charge on ions)
- No. of neutrons = A − Z
- Mass no. is a always a whole no & it cannot be fractional.

* Atomic mass of element can be fractional as it is the avg. of isotopic masses.

* Atomic no. is a unique identity of every element and it fixed & definite.

* An atom & its ion differ in no. of e^-.

Ques. If A^{3-} no. of ~~ae~~ e^- are 18 and mass no. of 31 then determine the atomic no., No. of neutrons and & the no. of e^- present in A^{+2}.

No. of e^- = Z − (charge on ion)

$18 = Z - (-3)$

$\underline{Z = 15}$

no. of 'n' $= A - Z$

$= 31 - 15$

$= \underline{16}$

No. of e^- in A^{+2} = Z − (charge)

$= 15 - (2)$

$= \underline{13}$

Ques The mass of X and Y having same atomic No. are 208 and 210 respectivily. If X has 126 neutron in its nucleus then find out the no. of neutrons in Y & its atomic No.

$^{208}_{Z}X \quad ^{210}_{Z}Y$

no. of 'n' in X = 126

$A - Z = 126$

$208 - Z = 126$

$Z = 82$

No. of 'n' in Y $= A - Z$

$= 210 - 82$

$= 128$

Ques If in ^{18}O atom mass of proton is ~~dob~~ double the mass neutron made 1/4th and mass of e^- is trippled Calculate the %age ~~of~~ in atomic mass.

$M_p \simeq m_n \simeq 1$ amu

$m_e = 0.00055$ amu

$m_e \simeq \frac{1}{1837} \times m_p$

$^{16}_{8}O \Rightarrow \frac{p}{8} \quad \frac{n}{8} \quad \frac{e^-}{8}$

Originally $= 8\times1 \quad 8\times1 \quad - \quad = 16$ amu

final $= 8\times2 \quad 8\times\frac{1}{4} \quad - \quad = 18$ amu

$$\%\ \text{Change} = \frac{\text{Change in value}}{\text{Initial value}} \times 100$$

$$= \frac{2}{16}\times100 = \boxed{12.5\%}$$

Ques. Assuming that the mass of ^{12}C atom is 150 unit then under this assumption what will be the mass of 'N' atom.

$^{12}_{6}C$ atom $= 12$ amu $= 150$ unit

$1 \text{ amu} = \frac{150}{12}$ unit

$^{14}_{7}N$ atom $= 14$ amu $= 14\times\frac{150}{12}$

$= 175$ units

Ques. X^+, Y^{+2} and Z^- are isoelectronic of CO_2 then pick out the correct sequence of proton in them.

(I) $Y^{+2} < X^+ < Z^-$

(II) $Z^- < X^+ < Y^{+2}$

(III) $X^+ < Y^{+2} < Z^-$

(IV) $X^+ \neq Y^{+2} \neq Z^-$

$CO_2 = 22e^-$

No. of e^- in $X^+ = 22$

$Z - (\text{charge}) = 22$

$Z - (1) = 22$

$X^+ \Rightarrow Z = 23$

$Y^+ \Rightarrow Z \Rightarrow 24$

$Z^- \Rightarrow Z = 21$

Ques. Atom $_7X$, $_8Y$, $^{18}_{9}Z$ are such that Y is isodiaphers of X and Z is an isotone of Y. then find out the A of X and Y

Solⁿ.:—

$_7X \quad _8Y \quad ^{18}_{9}Z$

No. of 'n' in Z = A − Z

= 18 − 9 = 9

Mass No. of 'Y' = n + P

= 9 + 8

= 17

(n − P) value in Y = 9 − 8

= 1

(n − P) for X = 1

n − P = 1

n − 7 = 1

n = 8

Mass no. of X = n + 7

= 8 + 7

= 15

Ques. An element M as three isotope whose isotopic mass are 11, 12, 13 respectivily If there present occurreance in nature is 85%, 50%, 5% respectivily then calculate the avg. atomic wt. of M.

Solⁿ.:—

$$\text{avg. atomic wt.} = \frac{(11\times85)+(12\times10)+(13\times5)}{100}$$

$$= \frac{935+120+65}{100}$$

$$= \frac{1120}{100} = 11.2$$