MOLE CONCEPT

Mole Concept

moles

case ① If weight is given

$$\boxed{n = \frac{w}{M.W}}$$

Q find moles of 4 gm of CH_4?

$$n = \frac{4}{16} = \frac{1}{4}$$

Mole Concept

moles

atoms, molecules, ions

case ② If no. of entities are given

$$\boxed{n = \frac{N}{N_A}}$$

Q find moles of 3.01×10^{22} molecules of urea?

$$n = \frac{N}{N_A}$$

$$n = \frac{\cancel{3.01} \times \cancel{10^{22}}}{\cancel{6.02} \times \cancel{10^{23}}}$$

2 10

$$n = \frac{1}{20}$$

Mole Concept

moles

Case ③ If volume at STP is given

$$\boxed{n = \frac{V_{(L)}}{22.4}}$$

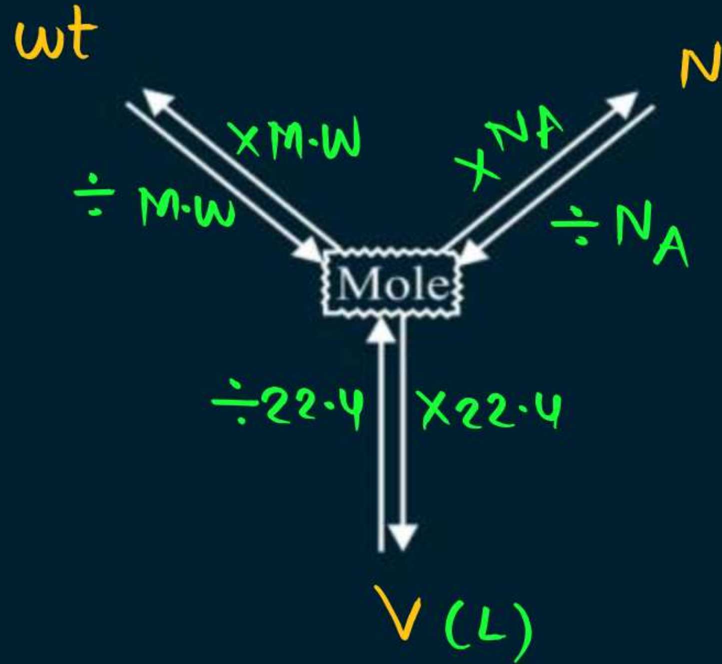
Q find moles of 67.2 L O_2 at S.T.P ?

$$n = \frac{V_{(L)}}{22.4}$$

$$n = \frac{67.2}{22.4}$$

$$n = 3$$

Mole Calculation (Y Map)



% Composition

$CaCO_3$

$$\boxed{\%\ \text{Compo of Element} = \frac{\text{A.W of Element} \times \text{No. of atoms}}{\text{M.W of Compound}} \times 100}$$

$$\%\ \text{`Ca'} = \frac{40 \times 1}{100} \times 100 = 40\%$$

$$\%\ \text{`O'} = \frac{16 \times 3}{100} \times 100 = 48\%$$

$$\%\ \text{`C'} = \frac{12 \times 1}{100} \times 100 = 12\%$$

Q find % of 'C', 'H' and 'O' in glucose?

$C_6H_{12}O_6$?

$M.W = 12 \times 6 + 12 \times 1 + 16 \times 6$

$= 72 + 12 + 96$

$= 180$

$$\% \text{ 'C'} = \frac{12 \times 6}{180} \times 100 =$$

$$\% \text{ 'H'} = \frac{1 \times 12}{180} \times 100 =$$

$$\% \text{ 'O'} = \frac{16 \times 6}{180} \times 100 =$$

Density

Two types → Absolute density

Two types → Relative density

Case ① for solids and liq

① Absolute density (A.D) $d = \frac{mass}{volume}$ (gm/mL)

② Relative density (R.D) $R.D = \frac{\text{density of substance}}{\text{density of water at } 4^\circ C}$

Specific gravity

unit less

MI* density is 2 gm/mL
the specific gravity = 2

Case ② for gases

① Absolute density $d = \frac{PM}{RT}$

$PV = nRT$

$P \times V = \frac{w}{M} \times RT$

$PM = \frac{w}{V} \times RT$

$PM = d \times RT$

$d = \frac{PM}{RT}$

P = Pressure (atm)

d = density (gm/L)

R = gas const $0.082 \frac{L\text{-}atm}{mol\text{-}K}$ $\left(\frac{1}{12}\right)$

T = Temp (K)

② Relative density (R·D) ÷ density of a gas w.r.t another gas at const temp and presure.

$$d = \frac{PM}{RT}$$

$$\boxed{\frac{d_1}{d_2} = \frac{M_1}{M_2}}$$

$d \propto M$ (at const P, T)

Vapour density (V·D) ÷ The density of gas w.r.t H_2 gas at const P and T

$$V \cdot D = \frac{M_1}{M_{H_2}} = \frac{M_1}{2}$$

n = moles

d = density

V.D = vapour density

M = molecular wt

w = weight

N = No. of entities

A.D = Absolute density

R.D = Relative density

Q find density of CH_4 w.r.t O_2 at const P, T ?

$$R.D = \frac{16}{32} = \frac{1}{2}$$

Q find V.D of SO_2 ?

$$V.D = \frac{64}{2} = 32$$

Q find density of SO_2 w.r.t CH_4 at const P, T ?

$$R.D = \frac{\cancel{6}4}{1\cancel{6}} = 4$$

Average Atomic weight

for isotopes

Isotope 1	% abundance ✓	AW ✓
Isotope 2	" ✓	" ✓
Isotope 3	" ✓	" ✓

$$\boxed{\text{Avg At. wt} = \frac{\%\,\text{abund}_1 \times A.W_1 + \%\,\text{abun}_2 \times A.W_2 + \%\,\text{abund}_3 \times AW_3}{100}}$$

Q. Find avg. atomic wt.

Isotopes	% abundance
Cl^{35}	75%
Cl^{37}	25%

$$\text{Avg At wt} = \frac{75 \times 35 + 25 \times 37}{100} = 35.5$$

Mean molar mass for gaseous mix.

gas 1
+
gas 2
+
gas 3

$$\text{Mean molar mass} = \frac{\overbrace{n_1 M_1}^{w_1} + \overbrace{n_2 M_2}^{w_2} + \overbrace{n_3 M_3}^{w_3}}{n_1 + n_2 + n_3}$$

Q. Find mean molar mass

Gas	mole %
O_2	16
N_2	80
CO_2	3
SO_2	1

$$\text{Mean molar mass} = \frac{16 \times 32 + 80 \times 28 + 3 \times 44 + 1 \times 64}{16 + 80 + 3 + 1}$$

$$= 29.48$$

Limiting Reagent (or Reactant)

The reagent (or Reactant) which is consume first in a chemical Rxn is called L.R

Q find L.R if 3 moles of A are reacted with 9 moles of B accn to the Rxn.

Given moles	3	9		0
	1 A	+	2 B	$\longrightarrow$ 3 C (Rxn should be balance)
moles Reacted	$\frac{3}{1}$		$\frac{9}{2}$	
	$\boxed{3}$		4.5	

A is L.R

Q

Given moles: 4, 6

$2SO_2 + 1O_2 \longrightarrow 2SO_3$

L.R ?

moles reacted

$\frac{4}{2}$ $\frac{6}{1}$

$\boxed{2}$ 6

SO_2 is L.R

Q

Given moles: 5.6, 3.2

$1H_2 + \frac{1}{2}O_2 \longrightarrow H_2O$

L.R ?

moles reacted

$\frac{5.6}{1}$ $\frac{3.2}{\frac{1}{2}}$

$\boxed{5.6}$ 6.4

H_2 is L.R

Q. 4 moles of N_2 is reacted with 9 moles of H_2 to form NH_3

Given moles	4	9	0
	$1N_2$ +	$3H_2$ →	$2NH_3$.
moles reacted	$\frac{4}{1}$	$\frac{9}{3}$	
	4	$\boxed{3}$	
moles remaining	$(4-3)\times 1$	0×3	3×2
	1	0	6

H_2 is L.R

After rxn

$n_{N_2} = 1$

$n_{H_2} = 0$

$n_{NH_3} = 6$

1. Moles of NH_3 formed

$$n_{NH_3} = 6$$

2. weight of NH_3 formed

$$w_{NH_3} = 6 \times 17 =$$

3. molecules of NH_3 formed

$$N_{NH_3} = 6 \times N_A$$

4. Volume of NH_3 produced at S.T.P

$$V = 6 \times 22.4$$

5. moles of excess reactant left

$$n_{N_2} = 1$$

6. wt of excess reactant left

$$w_{N_2} = 1 \times 28$$

7. molecules of excess reactant left

$$N_{N_2} = 1 \times N_A$$

8. Volume of excess reactant left at S.T.P

$$V_{N_2} = 1 \times 22.4$$

Q 4 moles of SO_2 is reacted with 5 moles of O_2 accn to the Rxn

moles given	4	5		
	$2SO_2$ +	$1O_2$	$\longrightarrow$	$2SO_3$
moles reacted	$\frac{4}{2}$	$\frac{5}{1}$		
	$\boxed{2}$	5		
				2×2
moles remaining	0×2	$(5-2) \times 1$		
	0	3		4

1. Moles of SO_3 formed

$n_{SO_3} = 4$

2. weight of SO_3 formed

$w_{SO_3} = 4 \times 80$

3. molecules of SO_3 formed

$N_{SO_3} = 4 \times N_A$

4. Volume of SO_3 produced at S.T.P

$V_{SO_3} = 4 \times 22.4$

5. moles of excess reactant left

3

6. wt of excess reactant left

$$w_{O_2} = 3 \times 32$$

7. molecules of excess reactant left

$$N_{O_2} = 3 \times N_A$$

8. Volume of excess reactant left at S.T.P

$$V_{O_2} = 3 \times 22.4 \text{ L}$$

$C_xH_y + \left(x+\frac{y}{4}\right)O_2 \longrightarrow xCO_2 + \frac{y}{2}H_2O$

Stoichiometry (Balanced chemical Rxn)

1) C
2) H
3) O

$$1CH_{4(g)} + 2O_{2(g)} \longrightarrow 1CO_{2(g)} + 2H_2O_{(g)}$$

① 1 mol of CH_4 is reacted with 2 moles O_2 to form 1 mol of CO_2 and 2 moles of H_2O.

② 16 gm CH_4 is reacted with 2×32 gm O_2 to form 1×44 gm of CO_2 and 2×18 gm H_2O

$C_xH_y + (x + \frac{y}{4})O_2 \longrightarrow xCO_2 + \frac{y}{2}H_2O$

Stoichiometry (Balanced chemical Rxn)

1) C
2) H
3) O

$1CH_{4(g)} + 2O_{2(g)} \longrightarrow 1CO_{2(g)} + 2H_2O_{(l)}$

(3) N_A molecules of CH_4 is reacted with $2N_A$ molecules of O_2 to form N_A molecules of CO_2 and $2N_A$ molecules of H_2O.

(4) 1×22.4 L CH_4 is reacted with 2×22.4 L O_2 to form 1×22.4 L of CO_2

Q find the no. of moles of CO_2 produced by the Complete combustion of 2.5 moles of propane?

$$C_3H_8 + 5O_2 \longrightarrow 3CO_2 + 4H_2O$$

$$1 \text{ moles} \longrightarrow 3 \text{ mol}$$

$$2.5 \text{ moles} \longrightarrow 3 \times 2.5 \text{ mol}$$

L.R	Stoichio.
$A + B \longrightarrow$	$A + B \longrightarrow$
Information of A & B is given	Information of A or B

Q. Calculate weight of residue obtained when 1 mol $CaCO_3$ is strongly heated.

Residue

$$CaCO_{3(s)} \longrightarrow \underset{\uparrow\ \text{Residue}}{CaO_{(s)}} + CO_{2(g)}$$

1 mol   1 mol

$$\begin{array}{r} 40 \\ 16 \\ \hline 56 \end{array}$$

$n_{CaO} = 1$

$\frac{w_{CaO}}{56} = 1$

$w_{CaO} = 56$ gm

Q. How many Ltr. O_2 at NTP required for complete combustion of 2 moles of C_5H_{10}

$$C_5H_{10} + \frac{15}{2}O_2 \longrightarrow 5CO_2 + 5H_2O$$

1 mol $\quad \frac{15}{2}$ mol

2 mol $\quad \frac{15}{2} \times 2$ mol

2 mol $\quad$ 15 mol

$n_{O_2} = 15$

V_{O_2} at NTP $= 15 \times 22.4$ Ltr

Q. How many moles of O_2 are needed to produce 5 mole of Fe_2O_3 ?

$$\overset{?}{} \qquad \checkmark \qquad n_{O_2} = \frac{15}{2}$$

$$4Fe + 3O_2 \rightarrow 2Fe_2O_3$$

$3\,mol \qquad 2\,mol$

$\frac{3}{2}\,mol \qquad 1\,mol$

$\frac{3}{2} \times 5\,mol \qquad 5\,mol$

Empirical and molecular formula

Element	% composition given	A.w	$\frac{\%}{Aw}$	Simplest ratio	Simplest whole no. ratio
C	40.6	12	$\frac{40.6}{12} = 3.38$	$\frac{3.38}{3.38} = 1$	$1 \times 2 = 2$
H	5	1	$\frac{5}{1} = 5$	$\frac{5}{3.38} = 1.5 = \frac{3}{2}$	$\frac{3}{2} \times 2 = 3$
O	54.4	16	$\frac{54.4}{16} = 3.4$	$\frac{3.4}{3.38} = 1$	$1 \times 2 = 2$

$E.F = C_2H_3O_2$

If M.W. of compound is 118, then find molecular formula.

$$M.F = (E.F)_n = (C_2H_3O_2)_2 = C_4H_6O_4$$

$$n = \frac{M.F.W}{E.F.W}$$

M.F.W → molecular formula wt.

E.F.W → Empirical formula wt.

$$n = \frac{118}{59}$$

$$n = 2$$

$C_2H_3O_2$

$$E.F.W = 12\times2 + 1\times3 + 16\times2$$
$$= 24 + 3 + 32$$
$$= 27 + 32$$
$$= 59$$

Concentration terms

Solution = solute + solvent
(Sol^n) (B) (A)

① Molarity (M) ÷ The no. of moles of solute present in 1 L of the sol^n.

$$\boxed{M = \frac{n_B}{V_{sol^n}(L)}}$$

Temp dependent

② molality (m) ÷ The no. of moles of solute present in 1 kg of the solvent

$$\boxed{m = \frac{n_B}{W_{A\,(kg)}}}$$

Temp independent

③ mole fraction (chi) (χ) ÷ The no. of moles of a component divided by total moles

$$\boxed{\chi_A = \frac{n_A}{n_A + n_B}} \quad \boxed{\chi_B = \frac{n_B}{n_A + n_B}} \quad \boxed{\chi_A + \chi_B = 1}$$

Temp independent

④ $\% \frac{w}{w} \Rightarrow x \% \frac{w}{w} \Rightarrow$ x gm solute is present in 100gm of sol^n.

$$\boxed{\% \frac{w}{w} = \frac{w_B}{w_{sol^n}} \times 100}$$ Temp. independent

⑤ $\% \frac{w}{v} \Rightarrow x \% \frac{w}{v} \Rightarrow$ x gm solute is present in 100 mL of sol^n

$$\boxed{\% \frac{w}{v} = \frac{w_B}{V_{sol^n (mL)}} \times 100}$$ Temp dependent

⑥ $\% \frac{v}{v} \Rightarrow x \% \frac{v}{v} \Rightarrow$ x mL Solute is present in 100 mL of sol^n

$$\boxed{\% \frac{v}{v} = \frac{V_{B (mL)}}{V_{sol^n (mL)}} \times 100}$$ Temp dependent

Relation b/w conc^n terms

① * Relation b/w M (Molarity) and $\boxed{\% \frac{w}{w}}$ (x)

$$\boxed{M = \frac{10 x d}{M.W_B}}$$

M = Molarity

$x = \% \frac{w}{w}$

d = density (gm/mL or gm/cc)

$M.W_B$ = Molecular wt of solute

Relation b/w concⁿ terms

② Relation b/w m and x

$$\boxed{m = \frac{x_B}{x_A} \times \frac{1000}{MW_A}}$$

m = molality

x_B = mole fraction of solute

x_A = " " " solvent

MW_A ** = molecular wt of solvent

Relation b/w conc^n terms

③ Relation b/w m and M

$$\boxed{M = \frac{md}{1 + \frac{m\, MW_B}{1000}}}$$

M = Molarity

m = molality

d = density (gm/mL)

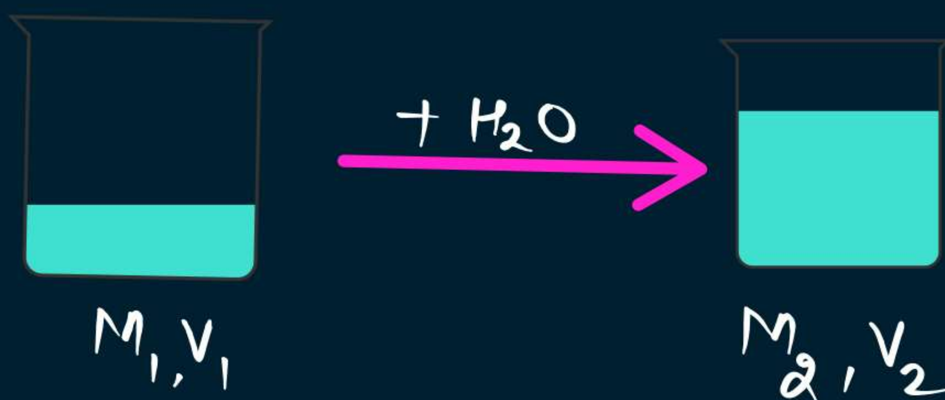
MW_B = molecular wt of Solute

Molarity in diff. cases

Case ① Molarity on dilution

$$n_i = n_f$$

$$\boxed{M_1 V_1 = M_2 V_2}$$



Molarity in diff. cases

Case ② molarity on mixing

1	2
M_1	M_2
V_1	V_2

$$\boxed{M_{Mix} = \frac{|M_1V_1 \pm M_2V_2|}{V_1+V_2}}$$

Jab dono acid ho ya base ho

Jab ek acid & doosra base ho

Q. Find molarity on mixing 200mL of 1M HCl + 100 mL of 0.5M HCl

$$M_{mix} = \frac{M_1V_1 + M_2V_2}{V_1+V_2}$$

$$= \frac{1 \times 200 + 0.5 \times 100}{300}$$

$$= \frac{250}{300}$$

$$= \frac{5}{6}$$

60

Q. Density of 2M CH_3COOH is 1.2 gm/mL.

Find 1) $\% \frac{w}{w}$ 2) m 3) x_{solute} (B)

1) $M = \frac{10 \times d}{MW_B}$

$2 = \frac{10 x \times 1.2}{60}$

$x = \frac{2 \times 60}{10 \times 1.2} = 10$

$(10\% \frac{w}{w}\ CH_3COOH)$

2) $M = \frac{md}{1 + \frac{m MW_B}{1000}}$

$2 = \frac{m \times 1.2}{1 + \frac{m \times 60}{1000}}$

$m = 1.8$

3) $m = \frac{x_B}{x_A} \times \frac{1000}{MW_A}$

$1.8 = \frac{x_B}{1 - x_B} \times \frac{1000}{18}$

$1.8 = \frac{x_B}{1 - x_B} \times 55.5$

$x_B = \frac{1}{31}$

Q. 6.022×10^{22} molecules of a compound 'X' has mass 10 gm. What is the molarity of sol^n containing 5 gm of 'X' in 2L.

$$N_X = 6.022 \times 10^{22}$$

$$\omega_X = 10\, gm$$

$$n = \frac{\omega_X}{MW_X} = \frac{N_X}{N_A}$$

$$\frac{10}{MW_X} = \frac{\cancel{6.022} \times 10^{\cancel{22}}}{\cancel{6.022} \times 10^{\cancel{23}}_{10}}$$

$$MW_X = 100$$

$$n_X = \frac{5}{100} = \frac{1}{20}$$

$$M_X = \frac{1}{\frac{20}{2}}$$

$$\boxed{M_X = \frac{1}{40}}$$

Volumetric strength of H_2O_2

'x' volume H_2O_2

1 L H_2O_2 gives 'x' L O_2 at STP accⁿ to the Rxn

$$n_{H_2O_2} = \frac{2x}{22.4}$$

$$n_{H_2O_2} = \frac{x}{11.2}$$

$$2H_2O_2 \longrightarrow 2H_2O + O_2$$

2 mol	1 moL
2 mol	1×22.4 L
$\frac{2}{22.4}$ mol	1 L
$(2x/22.4)$	'x' L

$$\text{Molarity } (M) = \frac{n_{H_2O_2}}{V_{H_2O_2}(L)}$$

$$\boxed{x = 11.2 \times M}$$

$$M = \frac{\frac{x}{11.2}}{1}$$

x = volumetric strength

M = molarity

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

Q find M of 10 volume H_2O_2?

$$x = 11.2 \times M$$

$$10 = 11.2 \times M$$

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

Q. Find % $\frac{w}{w}$ of 5.6 V H_2O_2 (d = 1 gm/mL, M.W. of H_2O_2 = 34)

$x = 11.2 \times M$

$M = \frac{5.6}{11.2}$

$M = \frac{1}{2}$

$M = \frac{10 x d}{MW_B}$

$\frac{1}{2} = \frac{10 \times x \times 1}{34}$

$x = \frac{34}{2 \times 10}$

$x = 1.7$

$\boxed{1.7\ \%\ \frac{w}{w}\ H_2O_2}$

% free SO_3

Oleum $(SO_3 + H_2SO_4)$

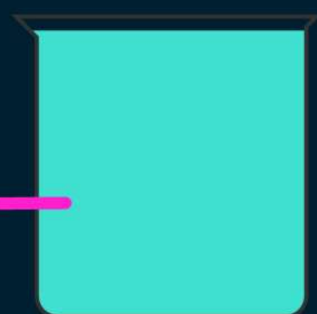
[118 % Oleum]

$$\% \ SO_3 \text{ or } \% \text{ free } SO_3 = \frac{80}{100} \times 100 = 80\%$$

$$100 \text{ gm oleum} + 18 \text{ gm } H_2O \longrightarrow 118 \text{ gm } H_2SO_4$$

$(\underbrace{H_2SO_4}_{20gm} + \underbrace{SO_3}_{80gm})$

H_2O



$H_2SO_4 + SO_3$

$$\underset{\substack{1\,mol \\ 80\,gm}}{SO_3} + \underset{\substack{1\,mol \\ 18\,gm}}{H_2O} \longrightarrow H_2SO_4$$

y % oleum sample $\quad (y > 100)$

100 gm oleum is reacted with $\underbrace{(y-100)}$ gm H_2O to give y gm H_2SO_4

$\downarrow$

$SO_3 + H_2SO_4$

$$\left[W_{H_2SO_4} = 100 - W_{SO_3} \right]$$

$$SO_3 + H_2O \longrightarrow H_2SO_4$$

1 mol	1 mol
80 gm	18 gm
$\frac{80}{18}$ gm	1 gm
$\frac{80}{18}(y-100)$	$(y-100)$

$$\% \text{ free } SO_3 = \frac{\frac{80}{18}(y-100)}{100} \times 100$$

$$\boxed{\% \text{ free } SO_3 = \frac{80}{18}(y-100)}$$

Q. An oleum sample is labelled as 109% . Find %free SO3 ?

$$\% \text{ free } SO_3 = \frac{80}{18}(y-100)$$

$$= \frac{80}{18}(109-100)$$

$$= \frac{80}{18} \times 9$$

$$= 40 \%$$

% PURITY

50gm 10gm
Comp + impurity

Sample

60 gm

$$\%\ purity = \frac{w_{comp}}{w_{sample}} \times 100$$

Q. 20 gm $MgCO_3$ sample decomposes on heating to give CO_2 and 8 gm MgO. Find % purity of $MgCO_3$ in sample.

$\cancel{w_{MgCO_3} = 20}$

$w_{sample} = 20\,gm$

$w_{MgCO_3} + w_{impurity} = 20\,gm$

$$MgCO_3 \longrightarrow MgO + CO_2$$

1 mol	1 mol
84 gm	40 gm
$\frac{84}{40}$ gm	1 gm
$\frac{84}{\cancel{40}_5} \times \cancel{8}$ gm	8 gm
$\frac{84}{5}$ gm	8 gm

$w_{MgCO_3} = \frac{84}{5}$, $w_{sample} = 20\,gm$

$$\%\ Purity = \frac{84}{5 \times 20} \times 100$$

$$= 84\ \%$$

$$\boxed{\%\ purity\ of\ MgCO_3 = 84\ \%}$$

PRACTICE

Q. Find $\underline{\underline{x_B}}$ of $\underbrace{\text{1 molal aq}}$ solⁿ ?

$m = 1$

$x_B = ?$

$$m = \frac{x_B}{x_A} \times \frac{1000}{MW_A}$$

$$1 = \frac{x_B}{x_A} \times \frac{1000}{18}$$

$$\frac{18}{1000} = \frac{x_B}{1 - x_B}$$

$$\frac{1}{55.5} = \frac{x_B}{1 - x_B}$$

$$1 - x_B = 55.5 x_B$$

$$1 = 56.5 x_B$$

$$\boxed{x_B = \frac{1}{56.5}}$$

Q. A sol^n of H_2SO_4 is $\underbrace{98\%}$ $\underbrace{H_2SO_4}$ by mass & has density 1.8 gm/mL. $\underbrace{\text{Volume of acid}}_{V_1}$ required to make $\underbrace{\text{1 Ltr}}_{V_2}$ of $\underbrace{\text{0.1M}}_{M_2}$ H_2SO_4 solution is?

$$M_1 = \frac{10 x d}{MW_B}$$

$$= \frac{10 \times 98 \times 1.8}{98}$$

$$= 18$$

$$18 \times V_1 = 1 \times 0.1$$

$$V_1 = \frac{0.1}{18}$$

Q. How many moles of $PbCl_2$ will be formed from a reaction b/w 6.5 gm PbO & 3.2 gm HCl?

$$PbO + 2HCl \rightarrow PbCl_2 + H_2O$$

$$\frac{6.5}{223} \quad \frac{3.2}{36.5}$$

$$1\,PbO + 2\,HCl \longrightarrow 1\,PbCl_2 + H_2O$$

$$n_{PbO} = \frac{6.5}{223} =$$

$$n_{HCl} = \frac{3.2}{36.5} =$$

$$\frac{6.5}{1\times 223} \quad \frac{3.2}{2\times 36.5}$$

$$\boxed{\frac{6.5}{223}} \quad \frac{3.2}{73}$$

$$n_{PbCl_2} = \frac{6.5}{223}$$

Q A solution of HNO_3 of density 1.4 g/mL and 63% w/w. Determine the molarity of HNO_3 solution.

$$M = \frac{10 \times d}{MW_B} = \frac{10 \times 63 \times 1.4}{63} = 14$$

Q A 5.2 molal aqueous solution of methyl alcohol, CH_3OH, is supplied. What is the mole fraction of methyl alcohol in the solution

AIEEE-2011

a. 0.086

b. 0.050

c. 0.100

d. 0.190

$m = 5.2$

$$m = \frac{x_B}{x_A} \times \frac{1000}{MW_A}$$

$$5.2 = \frac{x_B}{1-x_B} \times \frac{1000}{18}$$

$$\frac{5.2}{55.5} = \frac{x_B}{1-x_B}$$

Q The concentrated sulphuric acid that is peddled commercially is 95% H_2SO_4 by weight. If the density of this commercial acid is 1.834 g cm^{-3}, the molarity of this solution is :-

a. 17.8 M

b. 15.7 M

c. 10.5 M

d. 12.0 M

AIEEE-2012

$$M = \frac{10 \times d}{MW_B} = \frac{10 \times 95 \times 1.834}{98} =$$

Q The density of a solution prepared by dissolving 120 g of urea (mol. Mass = 60 u) in 1000 g of water is 1.15 g/mL. The molarity of this solutions is

Solute

Solvent

a. 2.05 M

b. 0.50 M

c. 1.78 M

d. 1.02 M

AIEEE-2012

$$x = \% \frac{w}{w} = \frac{w_B}{w_{sol^n}} \times 100$$

$$= \frac{120}{112\cancel{0}} \times 10\cancel{0}$$

$$= \frac{1200}{112}$$

$$M = \frac{10 \times x \times d}{MW_B}$$

$$= \frac{10 \times 1200 \times 1.15}{112 \times 60} =$$

Q The ratio of number of oxygen atoms (O) in 16.0 g ozone (O_3), 28.0 g carbon monoxide (CO) and 16.0 g oxygen (O_2) is :
(Atomic mass : C = 12, O = 16 and Avogadro's constant $N_A = 6.0 \times 10^{23}$ mol^{-1})

AIEEE 2012 (Online)

× a. 3 : 1 : 1

b. 1 : 1 : 2

× c. 3 : 1 : 2

✓ d. 1 : 1 : 1

1) $N = \frac{w}{MW} \times N_A$

$N = \frac{16}{48} \times N_A$

$N = \frac{N_A}{3}$

No. of atoms $= \frac{N_A}{3} \times 3 = N_A$

2) $N = \frac{w}{MW} \times N_A$

$N = \frac{28}{28} \times N_A = N_A$

No. of atoms $= N_A \times 1 = N_A$

3) $N = \frac{16}{32} \times N_A$

$N = \frac{N_A}{2}$

No. of atoms $= \frac{N_A}{2} \times 2$

$= N_A$

Q The density of 3M solution of sodium chloride is 1.252 g mL^{-1}. The molality of the solution will be (molar mass, NaCl = 58.5 g mol^{-1})

JEE (Main-Online) 2013

a. 2.18 m

b. 3.00 m

c. 2.60 m

d. 2.79 m

$$M = \frac{md}{1 + \frac{m\,MW_B}{1000}}$$

$$3 = \frac{m \times 1.252}{1 + \frac{m \times 58.5}{1000}}$$

$$3 = \frac{m \times 1.252 \times 1000}{1000 + 58.5\,m}$$

$m =$

Q 10 mL of 2(M) NaOH solution is added to 200 mL of 0.5 (M) of NaOH solution. What is the final concentration?

a. 0.57 M

b. 5.7 M

c. 11.4 M

d. 1.14 M

JEE (Main-Online) 2013

$$M_{mix} = \frac{2\times 10 + 0.5\times 200}{210} = \frac{20+100}{210} = \frac{120}{210} = \frac{12}{21}$$

Q Number of atoms in the following samples of substances is the largest in :

a. 127.0g of iodine I_2

b. 48.0g of magnesium Mg

JEE (Main-Online) 2013

c. 71.0g of chlorine Cl_2

d. 4.0g of hydrogen H_2

$$n = \frac{w}{MW} = \frac{N}{N_A}$$

$$\boxed{N = \frac{w}{MW} \times N_A}$$

A) $w_{I_2} = 127$ gm

$$N = \frac{127}{254} \times N_A$$

$$N = \frac{N_A}{2}$$

No. of atom $= \frac{N_A}{2} \times 2 = N_A$

No. of atom

B) $N = \frac{48}{24} \times N_A = 2N_A$

c) $N = \frac{71}{71} \times N_A = N_A$

No. of atom $= 2N_A$

d) $N = \frac{4}{2} \times N_A = 2N_A$

No. of atoms $= 2N_A \times 2$

$= 4N_A$

weight

Q The amount of $BaSO_4$ formed upon mixing 100 mL of 20.8% $BaCl_2$ solution with 50 mL of 9.8% (w/v) H_2SO_4 solution will be : $\left(\frac{w}{v}\right)$
(Ba = 137, Cl = 35.5, S = 32, H = 1 and O = 16)

a. 33.2 g

b. 11.65 g ✓

c. 23.3 g

d. 30.6 g

JEE (Main-online)-2014

$\frac{9.8}{2}$ gm H_2SO_4 in $\frac{100\text{ mL}}{2}$

$$\overset{0.1}{BaCl_2} + \overset{0.05}{H_2SO_4} \rightarrow BaSO_4 + 2HCl$$

$$\frac{0.1}{1} \quad \frac{0.05}{1} \quad \boxed{0.05}$$

$w_{BaCl_2} = 20.8$ gm

$w_{H_2SO_4} = \frac{9.8}{2} = 4.9$

$n_{BaCl_2} = \frac{20.8}{208} = 0.1$

$n_{H_2SO_4} = \frac{4.9}{98} = 0.05$

$n_{BaSO_4} = 0.05$

$w_{BaSO_4} = 0.05 \times 233$

$=$

Q The ratio of masses of oxygen (O_2) and nitrogen (N_2) in a particular gaseous mixture is 1 : 4. The ratio of number of their molecule is :

a. 1 : 8

b. 3 : 16

c. 1 : 4

d. 7 : 32

JEE (Main)-2014

$O_2 \rightarrow 1$

$N_2 \rightarrow 2$

$$\frac{\omega_1}{\omega_2} = \frac{1}{4}$$

$$\frac{N_1}{N_2}$$

$$n = \frac{\omega}{MW} = \frac{N}{N_A}$$

$$N \propto \frac{\omega}{MW}$$

$$\frac{N_1}{N_2} = \frac{\omega_1}{\omega_2} \times \frac{M.W_2}{M.W_1}$$

$$= \frac{1}{4} \times \frac{28}{32}$$

$$= \frac{7}{32}$$

Q The molecular formula of a commercial resin used for exchanging ions in water softening is $C_8H_7SO_3Na$ (Mol. W.t 206). What would be the maximum uptake of Ca^{2+} ions by the resin when expressed in mole per gram resin ?

a. $\frac{2}{309}$

b. $\frac{1}{412}$

c. $\frac{1}{103}$

d. $\frac{1}{206}$

JEE (Main)-2015

$n_{Ca^{2+}}$ per gram of Resin $= \frac{1}{412}$

$$2C_8H_7SO_3Na + Ca^{2+} \longrightarrow (C_8H_7SO_3)_2Ca + 2Na^+$$

2 mol | 1 mol

2×206 gm | 1 mol

1 gm | $\frac{1}{412}$ mol

Q The most abundant elements by mass in the body of a healthy human adult are : Oxygen (61.4%) ; Carbon (22.9%), Hydrogen (10.0%) ; and Nitrogen (2.6%). The weight which a 75 kg person would gain if all ^1H atoms are replaced by ^2H atoms is

JEE (Main)-2017

a. 15 kg

b. 37.5 kg

c. 7.5 kg

d. 10 kg

$$\omega_1 = \frac{75 \times 10}{100} = 7.5\,kg$$

$$\omega_2 = 7.5 \times 2 = 15\,kg$$

$$\text{wt gain} = \omega_2 - \omega_1 = 15 - 7.5 = 7.5\,kg$$

Q 1 gram of a carbonate (M_2CO_3) on treatment with excess HCl produces 0.01186 mole of CO_2. the molar mass of M_2CO_3 in g mol^{-1} :

JEE (Main)-2017

a. 1186

b. 84.3

c. 118.6

d. 11.86

$$M.W_{M_2CO_3} = 2a + 12 + 16\times 3 = 2a + 60 = 2\times 12.1 + 60 = 84.2$$

$A.W_M = a$

$$\underset{1\text{ mol}}{M_2CO_3} + 2HCl \longrightarrow 2MCl + \underset{1\text{ mol}}{CO_2} + H_2O$$

$$\frac{1}{2a+12+16\times 3} \qquad \frac{1}{2a+60} = 0.01186 \qquad \frac{1}{2a+60}\text{ mol}$$

$$a = 12.1$$

Q The ratio of mass percent of C and H of an organic compound ($C_xH_YO_z$) is 6 : 1. If one molecule of the above compound ($C_xH_YO_z$) contains half as much oxygen as required to burn one molecule of compound C_xH_Y completely to CO_2 and H_2O.
The empirical formula of compound $C_xH_YO_z$ is :

JEE (Main)-2018

a. C_2H_4O

b. $C_3H_4O_2$

c. $C_2H_4O_3$

d. $C_3H_6O_3$

Q 5 moles of AB_2 weight 125×10^{-3} kg and 10 moles of A_2B_2 weight 300×10^{-3} kg. The molar mass of $A(M_A)$ and molar mass of $B(M_B)$ in kg mol^{-1} are

2019 Main, 12 April I

a. $M_A = 10 \times 10^{-3}$ and $M_B = 5 \times 10^{-3}$

b. $M_A = 50 \times 10^{-3}$ and $M_B = 25 \times 10^{-3}$

c. $M_A = 25 \times 10^{-3}$ and $M_B = 50 \times 10^{-3}$

d. $M_A = 5 \times 10^{-3}$ and $M_B = 10 \times 10^{-3}$

$n_{AB_2} = 5$

$w_{AB_2} = 125 \times 10^{-3}$ kg

$n_{A_2B_2} = 10$

$w_{A_2B_2} = 300 \times 10^{-3}$ kg

$$n = \frac{w}{MW}$$

$$10 = \frac{300 \times 10^{-3}}{2a + 2b}$$

$$5 = \frac{125 \times 10^{-3}}{a + 2b}$$

$$2a + 2b = 30 \times 10^{-3}$$

$$a + b = 15 \times 10^{-3} \quad \text{—} \ (2)$$

$$a + 2b = 25 \times 10^{-3} \ \text{—} \ (1)$$

$(1) - (2) \qquad b = 10 \times 10^{-3}$

from (2)

$$a + 10 \times 10^{-3} = 15 \times 10^{-3}$$

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

Q The minimum amount of $O_2(g)$ consumed per gram of reactant is the reaction (Given atomic mass : Fe = 56, O = 16, Mg = 24, P = 31, C = 12, H = 1)

2019 Main, 10 April II

a. $C_3H_8(g) + 5O_2(g) \rightarrow 3CO_2(g) + 4H_2O(l)$ 1 gm $C_3H_8 \rightarrow \frac{5\times32}{44}$ gm O_2

44 $\quad$ 5×32

b. $P_4(s) + 5O_2(g) \rightarrow P_4O_{10}(s)$ 1 gm $P_4 \rightarrow \frac{5\times32}{124}$ gm O_2

124 gm $\quad$ 5×32

c. $4Fe(s) + 3O_2(g) \rightarrow 2Fe_2O_3(s)$ 1 gm Fe $\rightarrow \frac{3\times32}{4\times56}$ gm O_2

4×56 $\quad$ 3×32

d. $2Mg(s) + O_2(g) \rightarrow 2MgO(s)$

2×24 $\quad$ 32 gm

1 gm $\rightarrow \frac{32}{2\times24}$ gm O_2

Q For a reaction,

$N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$, identify dihydrogen ($H_2$) as a limiting reagent in the following mixtures.

2019 Main, 09 April I

a. 56 g of N_2 + 10g of H_2

$a = \frac{56}{28} = 2$ $\quad b = \frac{10}{2} = 5$

b. 35 g of N_2 + 8 g of H_2

c. 14 g of N_2 + 4 g of H_2

d. 28 g of N_2 + 6g of H_2

$$\overset{a}{N_2} + 3\overset{b}{H_2} \longrightarrow 2NH_3$$

$$\frac{a}{1} \qquad \frac{b}{3}$$

$$\frac{2}{1} > \frac{5}{3}$$

Q The percentage composition of carbon by mole in methane is

2019 Main, 08 April II

a. 75%

b. 20%

c. 25%

d. 80%

CH_4

$$\left[\frac{12}{16}\times 100 = 75\% \ \frac{w}{w}\right]$$

75 gm 'c' in 100 gm CH_4

Q The volume strength of 1 M H_2O_2 is
(Molar mass of H_2O_2 = 34 g mol^{-1})

2019 Main, 12 Jan II

a. 16.8

b. 22.4

c. 11.35

d. 5.6

$x = 11.2 \times M$

$x = 11.2 \times 1$

Q A solution of sodium sulphate contains 92 g of Na^+ ions per kilogram of water. The molality of Na^+ ions in that solution in mol kg^{-1} is.

2019 Main, 09 Jan I

a. 16

b. 4

c. 132

d. 8

$w_{Na^+} = 92\ gm$

$w_{H_2O} = 1\ kg$

$m_{Na^+} = \frac{n_{Na^+}}{w_{H_2O(kg)}} = \frac{92}{23}$

Q A compound H_2X with molar weight of 80 g is dissolved in a solvent having density of 0.4 g mL^{-1}. Assuming no change in volume upon dissolution, the molality of a 3.2 molar solution is

$\underbrace{V_{sol^n} = V_{solvent}}= V_A$

JEE adv-2014

$$\text{molality} = \frac{n_B}{W_{A(kg)}}$$

$$MW_{H_2X} = 80$$

$$\text{Molarity} = \frac{n_B}{V_{sol^n(L)}}$$

$$\text{molality} = \frac{3.2 \times V_{sol^n(L)}}{W_{A}(kg)}$$

$$3.2 = \frac{n_B}{V_{sol^n(L)}}$$

$$= \frac{3.2 \times V_{A(L)}}{W_{A}(kg)}$$

$$n_B = 3.2 \times V_{sol^n(L)}$$

$$m = \frac{3.2}{\frac{W_A(kg)}{V_A(L)}}$$

$$\frac{Kg}{L} = \frac{1000g}{1000mL} = \frac{g}{mL}$$

$$m = \frac{3.2}{0.4}$$

$$\boxed{m = 8}$$

Q 29.2% (w/W) HCl stock solution has density of 1.25g mL^{-1}. The molecular weight of HCl is 36.5 g mol^{-1}. The volume (mL) of stock solution required to prepare a 200 mL solution 0.4 M HCl is

JEE adv-2012

$x = 29.2\ \%\ w/w$

$d = 1.25\ gm/mL$

$MW_B = 36.5$

$$M_1 = \frac{10 \times x d}{MW_B}$$

$$M_1 = \frac{10 \times 29.2 \times 1.25}{36.5} = 10$$

$$M_1 V_1 = M_2 V_2$$

$$10 \times V_1 = 0.4 \times 200$$

$$V_1 = 8\ mL$$

Q Dissolving 120 g of urea (mol. Wt 60) in 1000g of water gave a solution of density 1.16 g/mL. The molarity of the solution is

JEE adv-2011

a. 1.78 M

b. 2.00 M

c. 2.05 M

d. 2.22 M

Done

Q Given that the abundances of isotopes ^{54}Fe, ^{56}Fe and ^{57}Fe are 5%, 90% and 5% respectively, the atomic mass of Fe is :

JEE adv-2009

a. 55.85

b. 55.95

c. 55.75

d. 56.05

$$\text{Avg At wt} = \frac{54 \times 5 + 56 \times 90 + 57 \times 5}{100} = 55.95$$