MOLE CONCEPT

① State Gray-Lussac's Laco of Combining Volumes.

Ans: When Gases react, they do so in volumes which bears a simple whole no. ratio to one another and to the volumes of Products formed if gaseous

② What volume of oxygen is required to burn completely 90dm³ of butane under similar conditions of temperature and pressure

Ans

$$2C_4H_{10} + 13O_2 \longrightarrow 8CO_2 + 10H_2O$$

2 vol 13 vol

2 vol of butane requires 13 vol of O_2

So 90 dm³ " " " $\frac{13}{2} \times 90$ dm³ of O_2

③ In a container, 20ml of N_2 and 30ml of H_2 are mixed. Find the volume of resultant mixture.

Ans

$$N_2 + 3H_2 \rightleftharpoons 2NH_3$$

1 vol 3 vol 2 vol

Watch Mole Concept Video for Numericals

1 vol N_2 Combines with 3 vol H_2

So 20ml N_2 " " 60ml H_2 ⟶ But we don't have this much H_2

Change Approach

3 vol of H_2 Combines with 1 vol of H_2

So 30ml of H_2 " 10ml of N_2 ⟶ we have this much N_2

$$1N_2 + 3H_2 \rightleftharpoons 2NH_3$$

~~30ml~~ ~~10ml~~

10ml 30ml 20ml

Resulting mixture ⟶ 20ml of NH_3 is formed

10ml of unreacted N_2

State Avagadro's Law.

Ans: Under similar conditions of temperature and pressure, equal volume of all gases contains equal no of molecules

(5) A vessel contains 'X' number of molecules of H_2 gas. How many molecules of N_2 gas will be present under similar conditions.

Ans 'X', Avagadros Law Equal volume of all gas ⟶ Equal molecule

(6) The volumes of gases A, B, C, D are in ratio 1:2:2:4. Under similar conditions, which sample contains maximum no. of molecules.

Ans D more volume ⟹ more molecules, Avagadro's Law

(7) Complete the table (Under similar conditions)

Gas	Volume	Molecules
Cl_2	10	———
N_2	20	x
NH_3	20	———
SO_2	5	———

Ans $Cl_2 \rightarrow x/2$

$NH_3 \rightarrow x$

$SO_2 \rightarrow x/4$

(8) Define the term vapour density.

Ans: It is defined as the ratio of mass of a certain volume of a gas to the mass of an equal volume of H_2 under same conditions.

(9) How to solve Mass/Volume/Molecules/Atom Numericals

[WATCH VIDEO] (Highly Recommended for Mole Concept)

How is Vapour Density related to Molecular Mass?

Ans: $V.D_. = \frac{\text{Molar Mass}}{2}$

(11) How to Solve Mole Concept Numericals :-

See Notes Attached: Solved Numericals of Mole Concept OR VIDEO.

Types of Numerical Based on Mole Concept

The vapour density of CO_2 [C=12, O=16] is-

Ans $V.D. = \frac{\text{Molar Mass}}{2} = \frac{12+16\times2}{2} = 22$ (no units)

② How to find no. of mole?

Ans no. of mole $= \frac{\text{mass given}}{\text{Molar Mass}}$ no of mole $= \frac{\text{Volume given (At STP)}}{22.4L}$

no. of mole $= \frac{\text{molecules given}}{6.022\times10^{23}}$

③ Calculate the volume of 320g of SO_2 at STP [S=32, O=16]

Ans: no of moles $= \frac{\text{Mass given}}{\text{Molar Mass}} = \frac{320}{32+16\times2} = 5$

no of moles $= \frac{\text{volume (At STP)}}{22.4L}$

$5 = \frac{\text{volume}}{22.4L} \Rightarrow$ **volume = 5 × 22.4L** Ans

④ The mass of 5.6 dm^3 of a certain gast at STP is 12g. Calculate the Molecular Mass of gas.

Ans no of moles $= \frac{\text{volume given}}{22.4\,L\,(\text{or}\,dm^3)} = \frac{5.6}{22.4} = \frac{1}{4}$

no of moles $= \frac{\text{mass given}}{\text{Molecular Mass}}$

$\frac{1}{4} = \frac{12}{M}$ **M = 48g**

Calculate the no. of moles and the no. of molecules present in 1.4g ethylene gas. What is the volume occupied by the same amount of ethylene? What is vapour density of ethylene?
[C=12, H=1]

Ans: ethylene C_2H_4

$$\text{no of moles} = \frac{\text{mass given}}{\text{Molecular Mass}} = \frac{1.4}{12\times2+1\times4} = \frac{1.4}{28} = \frac{0.1}{20} = \frac{1}{20}$$

$$\text{no of moles} = \frac{\text{molecules}}{6.022\times10^{23}} \Rightarrow \frac{1}{20} = \frac{\text{molecules}}{6.022\times10^{23}}$$

$$\Rightarrow \text{molecules} = \frac{6.022\times10^{23}}{20}$$

$$\text{no of moles} = \frac{\text{volume given}}{22.4L} \Rightarrow \frac{1}{20} = \frac{\text{volume}}{22.4L}$$

$$\Rightarrow \text{volume} = \frac{22.4L}{20}$$

$$V.D. = \frac{\text{Molar Mass}}{2} = \frac{12\times2+1\times4}{2} = 14$$

(6) Calculate the mass of i) 10^{22} atoms of S ii) 0.1 mole of CO_2
[S=32, C=12, H=1, O=16]

Ans: i) $$\text{no of moles} = \frac{\text{Atoms}}{6.022\times10^{23}} = \frac{10^{22}}{6022\times10^{23}}$$

$$\text{no of moles} = \frac{\text{mass}}{\text{Molar Mass}} = \frac{\text{mass}}{32}$$

$$\frac{10^{22}}{6.022\times10^{23}} = \frac{\text{mass}}{32}$$ Calculate mass

ii) $$\text{no of moles} = \frac{\text{mass}}{\text{Molar Mass}}$$

$$0.1 = \frac{\text{mass}}{12+16\times2} \Rightarrow \text{mass} = 0.1\times44 = 4.4g$$

Percentage Composition:

HCl

H = 1

Cl = 35.5

HCl

H = 1, Cl = 35.5

H% = $\frac{\text{mass of H}}{\text{total mass}}$

% of H = $\frac{\text{mass of H}}{\text{molecular mass}}$ = $\frac{1}{36.5} \times 100$

% of Cl = $\frac{\text{mass of Cl}}{\text{molecular mass}}$ = $\frac{35.5}{36.5} \times 100$

% of N in ammonia NH_3

N = 14 H = 1

% of N = $\frac{14}{17} \times 100$

$MgSO_4 \cdot 7H_2O$

$= 24 + 32 + 64 + 7(16 + 2)$

$= 24 + 32 + 64 + 126$

$= 246$

Mg = 24
S = 32
O = 16
H = 1

Find percentage of Oxygen and Nitrogen in Ammonium Nitrate

NH_4NO_3

$$\% \text{ of } N = \frac{2 \times 14}{14 + 4 + 14 + 48} \times 100 = \frac{28}{80} \times 100$$

Calc. the percentage of sodium in sodium aluminium fluoride.

Na_3AlF_6 Na = 23, Al = 27, F = 19

$$\% \text{ of } Na = \frac{3 \times 23}{3 \times 23 + 27 + 6 \times 19} \times 100$$

Determining empirical formula

Elements	% Comp	At. Wt.	At. Ratio = %/At. wt.	Sim. ratio of atom
N	42%	14	$\frac{42}{14} = 3$	$\frac{3}{3} = 1$
O	48%	16	$\frac{48}{16} = 3$	$\frac{3}{3} = 1$
H	9%	1	$\frac{9}{1} = 9$	$\frac{9}{3} = 3$

Empirical Formula = NOH_3

WCSE - 2011

E	% Comp	At. Wt	A.R. % / wt	S.R.
C	12.67	12	$12.67/12 = 1.05$	1
H	2.13	1	$2.13/1 = 2.13$	2
Br	85.11	80	$85.11/80 = 1.06$	1

~~CH_2Br - Molecule~~

Emp. form = CH_2Br

V.D. = 94

$$V.D. = \frac{\text{Molecular Mass}}{2}$$

$$188 = \text{Mol. Mass}$$

$$n = \frac{\text{Mol. mass}}{\text{emp. mass}}$$

$$n = \frac{188}{94} = 2$$

Mol. for = $n \times$ Emp. form

= $2 \times CH_2Br$

= $C_2H_4Br_2$

JCSE - 2009

E	% Comp	At. Wt	A.R.	S.R.
N	87.5	14	$\frac{87.5}{14}$ (60.5)	$\frac{6.25}{6.25} = 1$
H	12.5%	1	12.5	$\frac{12.5}{6.25} = 2$

M.M. 37

NH_2 = Emp. form

Emp. mass = 14 + 2 = 16

~~Mol. mass = n × Emp. mass~~

~~37 =~~

$$n = \frac{\text{molecular mass}}{\text{emp. form mass}}$$

$$= \frac{37}{16} = 2.3 \approx 2$$

Mol. form = 2 × NH_2

= N_2H_4