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Mole : Mole is an amount of substance that has ~~or~~ as many species (atoms/molecules / ions / electrons / protons / neutron etc) as atoms present in 12 g of C-12 isotope.

$$1 \text{ mole} = 6.022 \times 10^{23} = N_A$$

mass of 1 atoms of C-12 = $1.992648 \times 10^{-23} \text{ g}$
(spectroscopic)

$1.992648 \times 10^{-23} \text{ g}$ of C-12 has = 1 atom

$$1 \text{ g of C-12 has} = \frac{1}{1.992648 \times 10^{-23}} \text{ atoms}$$

$$12 \text{ g of C-12 has} = \frac{1}{1.992648 \times 10^{-23}} \times 12$$

$$= 6.022 \times 10^{23} \text{ atoms}$$

calculation of mole :- 3 type

Type - I If mass is given

no. of mole, $n = \frac{\text{mass given (g)}}{\text{molar Mass}}$

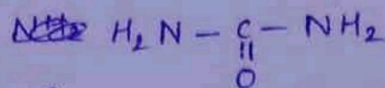
$$n = \frac{W}{M}$$

Ques Find no. of moles in

① 12 g of H_2 $n = \frac{W}{M}$ $n = \frac{12 \text{ g}}{2 \text{ g/mol}} = 6 \text{ mol}$

② 2 g of H $n = \frac{2}{1} = 2 \text{ mol}$

③ 4 g of He $n = \frac{4}{4} = 1 \text{ mol}$



- (4) 180 g of urea $n = \frac{180 \text{ g}}{60 \text{ g/mol}} = 3 \text{ mol}$
- (5) 13.2 g of CO_2 $n = \frac{13.2}{44} = \frac{33}{110} = 0.3$
- (6) 24 mg of O_3 $n = \frac{24 \times 10^{-3}}{48} = 0.5 \times 10^{-3} = 5 \times 10^{-4}$
- (7) 1.6 kg of SO_2 $n = \frac{1.6 \times 10^3}{64} = \frac{1}{40} \times 10^3$
 $= 0.25 \times 10^2$
 $= 25 \text{ mol}$

$$\begin{array}{r} 32 \\ 32 \\ \hline 64 \end{array}$$

Ques Find mass of

- (1) 4 mol of NH_3
 $n = \frac{W}{M}$ $M = 14 + 3 = 17$
 $4 = \frac{W}{17}$
 $W = 17 \times 4 = 68 \text{ g}$

- (2) 0.25 mole of He
 $W = M \times n$
 $= 4 \times 0.25 = 1 \text{ mole g}$

- (3) 5 m mole of CO_2
 $W = M \times n$
 $= 44 \times 5 \times 10^{-3}$
 $= 220 \times 10^{-3} \text{ g} = 0.220 \text{ g}$

$$\begin{array}{r} 44 \\ 2 \times 5 \\ \hline 220 \end{array}$$

- (4) 20 mole of O_3 in kg
 $W = M \times n$
 $= 48 \times 20 = 960 \text{ g}$
 $= \frac{960}{1000} = 0.960 \text{ kg}$

Type-B II If no. of particles is given

$$\begin{array}{ccc} 6.022 \times 10^{23} & \longrightarrow & 1 \text{ mol} \\ | & & | \\ 1 & \longrightarrow & \frac{1}{6.022 \times 10^{23}} \text{ mol} \end{array}$$

$$\begin{array}{ccc} N & \longrightarrow & \frac{1}{6.022 \times 10^{23}} \times N \text{ mol} \\ & & \downarrow \\ & & N_A \end{array}$$

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

$$\text{no. of moles, } n = \frac{\text{no. of particles given (N)}}{6.022 \times 10^{23}}$$

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

Ques Find no. of moles in a sample of

① 6.022×10^{26} atoms of ~~He~~ He

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

$$= \frac{6.022 \times 10^{26}}{6.022 \times 10^{23}} = 10^3 \text{ mol}$$

② 3.011×10^{21} molecules of O_2

$$n = \frac{3.011 \times 10^{21}}{6.022 \times 10^{23}} = \frac{1}{2} \times \frac{1}{10^2}$$

$$= 0.5 \times 10^{-2}$$

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

③ 1.5×10^{25} molecules of NH_3

$$n = \frac{1.5 \times 10^{25}}{6.022 \times 10^{23}} = \frac{1}{4} \times 10^2 = 0.25 \times 10^2$$

$$= 25 \text{ mol}$$

- (4) ~~60.22~~ 6.022×10^{24} atoms of O in oxygen gas cylinder.

Oxygen gas = O_2
 1 molecule of O_2 = 2 atoms
 2 atoms of oxygen = 1 molecule of O_2
 1 atom = $\frac{1}{2}$ molecule of O_2

$$6.022 \times 10^{24} \times \frac{1}{2} = \frac{1}{2} \times 6.022 \times 10^{24}$$

$$n = \frac{\frac{1}{2} \times 6.022 \times 10^{24}}{6.022 \times 10^{23}} = \frac{10}{2} = 5 \text{ mol of } O_2$$

- Ques Find mass of
 (1) 6.022×10^{25} molecules of O_3

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

$$\frac{W}{48} = \frac{6.022 \times 10^{25}}{6.022 \times 10^{23}}$$

$$W = 10^2 \times 48 = 4800 \text{ g}$$

- (2) 3.011×10^{22} atoms of He

$$\frac{W}{4} = \frac{3.011 \times 10^{22}}{6.022 \times 10^{23}}$$

$$W = \frac{1 \times 10 \times 4}{2 \times 10}$$

$$= 2 \times 10^{-1} = 200 \text{ g } 0.2 \text{ g}$$

(3) 1.5×10^{26} molecules of SO_2 (in kg)

$$\frac{W}{64} = \frac{1.5 \times 10^{26}}{6.022 \times 10^{23}}$$

$$\frac{W}{64} = \frac{1}{4} \times 10^3$$

$$W = \frac{64}{4} \times 10^3 = 16 \times 10^3 = 16000 \text{ g}$$

$$= 16 \text{ kg}$$

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Ques 4.8 g ozone sample is given Find

- (i) no. of molecules of ozone
(ii) no. of atoms.

~~Ans~~ $n = \frac{4.8}{48} = \frac{1}{10} = 0.1 \text{ mol of } \text{O}_3$

(i) no. of molecules of $\text{O}_3 = 0.1 \text{ NA}$
 $= 0.1 \times 6.022 \times 10^{23}$
 $= 6.022 \times 10^{22}$

(ii) no. of atoms $= 3 \times 0.1 \text{ NA}$
 $= 0.3 \text{ NA}$

1 molecules of $\text{O}_3 = 3 \text{ atoms of O}$
 $0.1 \text{ NA} = 3 \times 0.1 \text{ NA atoms of O}$
 $= 0.3 \text{ NA atoms of O}$
 $= 0.3 \times 6.022 \times 10^{23} \text{ atoms}$
 $= 1.8 \times 10^{23} \text{ atoms}$

Ques 132 g of CO_2 Find

- (i) no. of moles of CO_2

$n = \frac{132}{44} = \frac{66}{22} = \frac{33}{11} = 3$

(ii) no. of molecules of $\text{CO}_2 = 3 N_A$

~~no. of~~
(iii) no. of atoms = $3 \times 3 N_A = 9 N_A$

(iv) no. of O - atoms = $2 \times 3 N_A = 6 N_A$

(v) no. of molecules of $\text{O}_2 = 3 N_A$

(vi) no. of C - atom = $3 N_A$

Ques 12.8 g SO_2 is given Find

(i) no. of moles SO_2
$$n = \frac{12.8}{640} = \frac{2}{10} = \frac{1}{5}$$

(ii) no. of molecules of $\text{SO}_2 = \frac{1}{5} N_A$

(iii) no. of atoms = $3 \times \frac{1}{5} N_A = \frac{3}{5} N_A$

(iv) no. of S atoms = $1 \times \frac{1}{5} N_A = \frac{1}{5} N_A$

(v) no. of O - atoms = $2 \times \frac{1}{5} N_A = \frac{2}{5} N_A$

(vi) no. of ~~the~~ oxygen molecule = $1 \times \frac{1}{5} N_A = \frac{1}{5} N_A$

AIPMT

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Ques find no. of atoms in 4.25 g of NH_3 ?

$$\frac{4.25}{17} = \frac{\text{no. of atoms}}{N_A} \times \frac{1}{4}$$

$$\frac{4.25}{17} \times N_A = \text{no. of atoms} \times \frac{1}{4}$$

$$4 \times \frac{4.25}{17} \times N_A = \text{no. of atoms}$$

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

$$\text{no. of atoms} = N_A$$

$$\text{no. of H-atoms} = 3 \times 0.25 N_A = 0.75 N_A$$

$$\text{no. of } e^- = 10 \times \frac{1}{4} N_A = \frac{5}{2} N_A$$

$$\text{no. of proton} = 10 \times 0.25 N_A$$

$$\text{no. of neutrons} = 7 \times 0.25 N_A$$

Ques 3.6 g of NH_4^+ is given ^{then} Find

(i) total atoms $5 \times \frac{1}{5} N_A = N_A$

(ii) total atoms of H $4 \times \frac{1}{5} N_A$

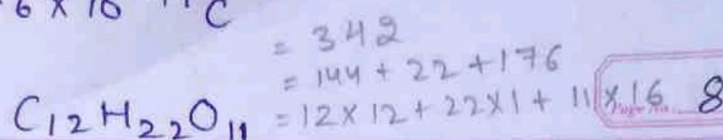
(iii) no. of e^- $= 10 \times 0.2 N_A$

(iv) no. of protons $= 11 \times 0.2 N_A$

(v) no. of neutrons $= 7 \times 0.2 N_A$

$$n = \frac{3.6}{180} = \frac{2}{10} = \frac{1}{5} = 0.2$$

$$1e^- = 1.6 \times 10^{-19} C$$



Ques 3.42 g sucrose is given Find
(i) no. of molecules of ~~sucrose~~ sucrose $0.01 N_A$

(ii) no. of C-atoms $12 \times 0.01 N_A$
 $= 0.12 N_A$

(iii) no. of O-atoms $11 \times 0.01 N_A$
 $= 0.11 N_A$

(iv) no. of H atoms $22 \times 0.01 N_A$
 $= 0.22 N_A$

$$n = \frac{3.42}{34200} = \frac{1}{100} = 0.01$$

Ques 4.2 g of N^{-3} sample is given then find

(i) no. of ions.

$$n = \frac{\text{mass}}{\text{molar mass}} = \frac{4.2}{14 + 3 \times 9.1 \times 10^{-28}} \approx \frac{4.2}{14}$$

$$N \xrightarrow{e^-} N^- \xrightarrow{e^-} N^{2-} \xrightarrow{e^-} N^{3-}$$

$$n = \frac{4.2}{14} = 0.3 \text{ mol of } N^{3-}$$

$$\text{no. of ions} = 0.3 N_A$$

IIT & AIPMT

(ii) no. of electron $= 10 \times 0.3 N_A = 3 N_A$

(iii) no. of proton $= 7 \times 0.3 N_A$

(iv) Find total charge in Coulomb

$$Q = \text{no. of ions} \times \text{charge on one } e^- (3e^-)$$

$$= 0.3 N_A \times 1.6 \times 10^{-19} C \times 3$$

$$= 0.3 \times 6.022 \times 10^{23} \times 1.6 \times 10^{-19} C \times 3 = 2.89 \times 10^4 C$$

$$Q = ne$$

Ques Find no. of atoms, e^- , protons & neutrons in

(i) 0.6 g of $^{12}_6\text{C}$

(ii) 2 g of He

(iii) 4 g of ^1_1H

(i) 0.6 g of $^{12}_6\text{C}$

(ii) 2 g of He

(iii) 4 g of ^1_1H

$$n = \frac{0.6}{12} = \frac{1}{20} = 0.05$$

$$n = \frac{2}{4} = \frac{1}{2} = 0.5$$

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

$$\text{no. of atoms} = 0.05 N_A$$

$$0.5 N_A$$

$$4 N_A$$

$$\text{no. of } e^- = 6 \times 0.05 N_A$$

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

$$4 N_A$$

$$\text{no. of protons} = 6 \times 0.05 N_A$$

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

$$4 N_A$$

$$\text{no. of neutrons} = 6 \times 0.05 N_A$$

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

$$0$$

AIEEE

Ques Find no. of e^- in 1.8 g of water?

$$n = \frac{1.8}{18} = \frac{1}{10} = 0.1 \text{ mol}$$

$$\text{no. of } e^- = 10 \times 0.1 N_A = 1 N_A$$

IIT

Ques Find no. of moles electrons present in 1 kg sample?

$$\text{total mass} = 1 \text{ kg}$$

$$\text{mass of } 1 e^- = 9.1 \times 10^{-31} \text{ kg}$$

$$\text{no. of } e^- = \frac{1 \text{ kg}}{9.1 \times 10^{-31} \text{ kg}}$$

$$\text{no. of mole } e^- = \frac{1}{9.1 \times 10^{-31}} \times \frac{1}{N_A}$$

$$= \frac{1}{9.1 \times 10^{-31} \times 6.022 \times 10^{23}}$$

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Type-3 If volume of gas is given at STP/NTP:-

STP

$$T = 0^{\circ}\text{C}$$

$$P = 1 \text{ bar}$$

$$T = 273.15 \text{ K}$$

at STP/NTP, one mole of any gas have
= 22.4 L volume

$$1 \text{ mol of } \text{H}_2 = 22.4 \text{ L}$$

$$1 \text{ mol of } \text{O}_2 = 22.4 \text{ L}$$

$$1 \text{ mol of } \text{CO}_2 = 22.4 \text{ L}$$

22.4 L $\rightarrow$ It is also known as Gram Molar
Volume (GMV)

$$\text{no. of moles, } n = \frac{\text{Volume (in L)}}{22.4 \text{ L}}$$

$$n = \frac{V(\text{L})}{22.4}$$

$$1 \text{ L} = 1000 \text{ ml}$$

$$1 \text{ m}^3 = 1000 \text{ L}$$

$$(100 \text{ cm})^3 = 1000 \text{ L}$$

$$10^6 \text{ cm}^3 = 1000 \text{ L}$$

$$1 \text{ L} = 1000 \text{ cm}^3 = 1000 \text{ cc}$$

$$1000 \text{ ml} = 1000 \text{ cc}$$

$$1 \text{ ml} = 1 \text{ cc}$$

$$1 \text{ L} = 1000 \text{ ml} = 1000 \text{ cc} = 1 \text{ dm}^3 = 10^{-3} \text{ m}^3$$

Ques Find no. of moles in
(i) 89.6 L of H_2 gas

$$n = \frac{89.6}{22.4} = 4 \text{ mol}$$

$$\frac{22.4}{89.6}$$

(ii) 2.24 L of O_3 gas

$$n = \frac{2.24}{22.4} \times \frac{10}{100} = \frac{1}{10} = 0.1$$

(iii) 112 ml of CO_2 gas

~~$$n = \frac{112}{22.4} \times \frac{10}{100} = \frac{1}{2} = 0.5$$~~

$$n = \frac{112}{22400} = \frac{1}{200} = 0.5 \times 10^{-2} = 5 \times 10^{-3} \text{ mol}$$

(iv) 56 ^{ml} (cc) of SO_2 gas

$$n = \frac{56}{22400} = \frac{1}{4} \times 10^{-2} = 0.25 \times 10^{-2} = 2.5 \times 10^{-3}$$

(v) 2.8 m^3 of H_2S

$$1 m^3 = 1000 L$$

$$n = \frac{2.8 \times 1000}{22.4} = 125 \text{ mol}$$

Ques A container has 5.6 L of SO_2 gas then find

(i) no. of moles

(ii) no. of molecules of $SO_2 = 0.25 N_A$

(iii) no. of atoms = $3 \times 0.25 N_A$

(iv) no. of Oxygen atom = $2 \times 0.25 N_A$

$$n = \frac{5.6}{22.4} = \frac{1}{4} = 0.25$$

(iv) no. of e^- $32 \times 0.25 N_A$

(vi) mass of SO_2 64×0.25

Ques 280 cc NH_3 gas is given Find

(i) Total atoms $= \frac{4}{80} N_A = \frac{1}{20} N_A = 0.05 N_A$

(ii) mass of NH_3 $= \frac{1}{80} \times 17$

(iii) no. of e^- $= 10 \times \frac{1}{80} N_A$

(iv) no. of H atoms

28

$$n = \frac{280}{22400} = \frac{28}{2240} = \frac{1}{80}$$

Ques 1 cc NO_2 is given at STP, then

(i) $\frac{1.8}{224} \times 10^{22}$ atoms

(ii) $\frac{1.38}{224} \times 10^{23}$ electrons

(iii) $\frac{6.022}{22400} \times 10^{23}$ molecules

(iv) all

$$n = \frac{1}{22400} = \frac{10^{-3}}{22.4}$$

$$\text{no. of molecules} = \frac{1}{22400} \times 6.022 \times 10^{23}$$

$$\text{no. of atoms} = 3 \times \frac{1}{22400} \times 6.022 \times 10^{23}$$

$$= \frac{18}{2240} \times 10^{22}$$

$$= \frac{1.8}{224} \times 10^{22}$$

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$$\begin{aligned} \text{no. of } e^- &= 23 \times \frac{1}{22.4} \times 6 \times 10^{23} \\ &= \frac{138 \times 10^{-3} \times 10^{23}}{22.4} \\ &= \frac{1.38 \times 10^{23}}{22.4} \end{aligned}$$

Ques A gas has a density of 1.6 g L^{-1} then find out (i) volume of ~~1.6 g~~ 1 mol gas?

(ii) mass of 1 mol gas

1L $\rightarrow$ 1.6 g
22.4L $\rightarrow$ 1.6×22.4 g

1 mol = 22.4 L

$d = 1.6 \text{ g/L}$

$d = \frac{m}{V}$

$m = d \times V$
 $= 1.6 \times 22.4 = 35.84 \text{ g}$

$$\begin{array}{r} 22.4 \\ \times 1.6 \\ \hline 1344 \\ 224 \times \\ \hline 3584 \end{array}$$

Ques An unknown gas has 1.96 g L^{-1} density then gas is

(i) CO_2 (ii) CO (iii) NO_2 (iv) SO_2

$d = 1.96 \text{ g L}^{-1}$

$d = \frac{m}{V}$

$m = d \times V$
 $= 1.96 \times 22.4$
 $= 44 \text{ g}$

AIEEE

Ques Find no. of moles in 1.8 ml of H_2O ?

$n = \frac{1.8}{22.4} \times 10^{-3} \text{ moles}$ only for gas

$d_{\text{H}_2\text{O}} = 1 \text{ g/ml}$ $V = 1.8 \text{ ml}$ $m = d \times V = 1 \times 1.8 = 1.8 \text{ g}$

SHORT
NOTES

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$$n = \frac{W}{M} = \frac{N}{N_A} = \frac{V(L)}{22.4}$$

$$1 L = 1000 mL = 1000 cc = 1 dm^3 = 10^{-3} m^3$$

(ii) Find no. of e^-

(i) $n = \frac{W}{M} = \frac{1.8}{18} = 0.1 \text{ mol}$

(ii) no. of $e^- = 10 \times 0.1 N_A = N_A$

Ques An unknown gas having mass 8 g is present in a container of 44.8 L. Find

(i) unknown gas

(ii) no. of atoms in gas.

(i) $\frac{8}{M_w} = \frac{44.8}{22.4}$

$$\frac{8}{2} = M_w = 4$$

$$He = 4$$

(ii) $n = \frac{44.8}{22.4} = 2$

$$\text{no. of atoms} = 2 N_A$$

AIMS

Ques 2.2 g of an unknown gas is present in a container of $\frac{2.24 L}{11.2 L}$ $\frac{1.12 L}{11.2 L}$. Then unknown gas is

(i) CO_2 (ii) CO (iii) N_2O (iv) both 1 & 3

$$\frac{2.2}{22.4} \times \frac{1}{10} = \frac{1}{10} =$$

$$\frac{1.12}{22.4} \times \frac{1}{10} = \frac{1}{2} \times \frac{1}{10} = 0.05$$

$$0.05 = \frac{2.2}{M}$$

$$M = \frac{2.2}{0.05} \times 20 = 44$$

$$\frac{28+16}{44}$$

Ques 1 mol each of He, N₂ & CO₂ is present in a container? then find

- (i) Ratio of molecules N_A : N_A : N_A
1 : 1 : 1
- (ii) Ratio of atoms N_A : 2 N_A : 3 N_A
1 : 2 : 3
- (iii) Ratio of vol. 22.4 : 22.4 : 22.4
1 : 1 : 1
- (iv) Ratio of no. of e⁻
2 N_A : 14 N_A : 22 N_A
1 : 7 : 11
x : y : z

Ques The no. of molecules of O₂ present in a container is same as that no. of molecules present in 9.6 g SO₂ then Find -

- (i) no. of moles of O₂ = 0.15
- (ii) no. of atoms of O → 2 × 0.15 N_A
- (iii) Volume of O₂ → 0.15 × 22.4 L

$$\text{no. of molecules of SO}_2 = x = \frac{396}{20640} \times N_A$$

$$x = \frac{3}{20} \times N_A = 0.15 N_A$$

Ques No. of O-atoms present in CO is same as that of O-atoms present in 8.8 g of CO₂ then find

- (i) no. of moles of CO = 0.4 mol
(ii) Total atoms = $2 \times 0.4 N_A$
(iii) Volume of CO = 22.4×0.4

$$n_{CO_2} = \frac{8.8}{44} = 0.2 \text{ mol}$$

$$\text{no. of molecules } CO_2 = 0.2 N_A$$

$$\text{no. of atom of O in } CO_2 = 2 \times 0.2 N_A$$

$$\text{no. of O-atom in CO} = 2 \times 0.2 N_A$$

$$\text{no. of molecules of CO} = 2 \times 0.2 N_A$$

$$n = \frac{N}{N_A} = \frac{0.4 N_A}{N_A} = 0.4$$

Ques The no. of molecules of O₂ present in a container is same as that no. of atoms present in 9.6 g O₃ then Find -

- (i) no. of moles of O₂ $\rightarrow \frac{3}{5}$
(ii) no. of atoms of O $\rightarrow 2 \times \frac{3}{5} N_A$
(iii) Vol. of O₂ $\rightarrow \frac{3}{5} \times 22.4 = 13.44$
 $n = \frac{3 \times 96}{480} N_A = \frac{6}{10} N_A$

Ques In a mixture of gas, a gas 'x' is present 0.56%. then Find no. of moles 'x' gas present in 1 L mixture.

100 L mixture contain = 0.56

1 L mixture contain = $\frac{5.6 \times 10^{-1}}{100}$ L

$$= 5.6 \times 10^{-3} \text{ l}$$

$$n = \frac{5.6 \times 10^{-3}}{22.4} = \frac{1}{4} \times 10^{-3}$$
$$= 2.5 \times 10^{-4} \text{ L}$$
$$= 0.25 \text{ mL}$$

Ques Find which of the following has maximum no. of atoms?

- (i) 27g Al (27) (ii) ~~8g~~ 24g C (12) (iii) 56g Fe (56)
(iv) 108g Ag (108)
(i) $\frac{27}{27} \times 1 \times N_A = N_A$ (ii) $\frac{24}{12} \times 1 \times N_A = 2 N_A$ (iii) $\frac{56}{56} \times 1 \times N_A = N_A$

Ques which of the following has maximum no. of atoms?

- (i) 16 g of H_2 $n = 8$ (ii) 132 g of CO_2 $n = 3$ (iii) 96 g of O_3 $n = 2$ (iv) 1.6 g of O_2 $n = \frac{1.6}{32}$

no. of molecules	$8 N_A$	$3 N_A$	$2 N_A$	$= 0.05$
no. of atoms	$16 N_A$	$9 N_A$	$6 N_A$	$0.05 N_A$

Ques ~~the~~ which has max atoms

- (i) 6.022×10^{24} atoms of C $\rightarrow 10 \text{ mol}$
(ii) 44.8 L of CO_2 $n = 2$
(iii) 12 g of H_2 $n = 6$
(iv) 4 moles of O_2 $\rightarrow 8 \text{ NA}$

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Ques 2.4 g of oxygen is present in how many mass of CaCO_3 ?

1 mole of CaCO_3 (= 100 g CaCO_3) has = 48 g oxygen
 48 g oxygen is present in = 100 g CaCO_3
 1 g " " " " = $\frac{100}{48}$ g CaCO_3
 2.4 g " " " " = $\frac{100}{48} \times 2.4 \text{ g CaCO}_3$
 = 5 g CaCO_3

Ques Find mass of

- (i) 1 atom of C
 - (ii) 4 atom of C
 - (iii) 1 molecule of H_2
 - (iv) 5 molecule of CO_2
- 1 mole C = 12 g

6.022×10^{23} atoms of C = 12 g

(i) 1 atom = $\frac{12}{6.022 \times 10^{23}}$ g

(ii) 4 atom of C = $\frac{12 \times 4}{6.022 \times 10^{23}}$

(iii) 1 mole molecule of H_2

N_A molecules of $\text{H}_2 \rightarrow 2 \text{ g}$

1 molecule of $\text{H}_2 \rightarrow \frac{2}{N_A}$

(iv)

N_A molecule of $\text{CO}_2 \rightarrow 44 \text{ g}$

1 molecule of $\text{CO}_2 \rightarrow \frac{44}{N_A} \text{ g}$

Concepts of atoms & molecules

Atom :- Atom is the smallest particle of matter an element which takes part in chemical reaction.

eg H, C, N, O, F, Fe, Ne
Formed by

Molecule :- It is formed by combination of two or more than two atoms.

eg $H_2, N_2, O_2, CO, CO_2, H_2O, H_2O_2, H_2SO_4$

Standard :- C-12 atom

- easily available
- not very reactive
- not inert
- easily separable from isotopes
- $\frac{1}{12}$ of wt of C-12 atom is comparable to wt. of H-atom (lightest atom)

Atomic Mass unit (amu) : or unified mass (u)



$$1 \text{ amu} = \frac{1}{12} (\text{wt. of C-12 atom})$$

wt. of 1 atom of C-12 atom = $1.992648 \times 10^{-23} \text{ g}$
(spectrometer)

$$1 \text{ amu} = \frac{1}{12} \times 1.992648 \times 10^{-23} \text{ g}$$

$$1 \text{ amu} = 1.66056 \times 10^{-24} \text{ g}$$

or
 $1.67 \times 10^{-24} \text{ g}$

$$\text{Wt. of H atom} = \frac{1.6736 \times 10^{-24} \text{ g}}{1.66056 \times 10^{-24}} \approx 1.008 \text{ amu} \\ \approx 1 \text{ amu} \\ \approx 1 \text{ u}$$

$$\text{wt. of O-atom} = 15.99895 \approx 16 \text{ u}$$

$$\text{wt of C atom} \approx 12 \text{ u}$$

$$\text{wt. of N-atom} = 14 \text{ u}$$

~~Gram Atomic mass (GAM)~~ or :-

It is defined as the no. which represent how many times mass of 1 atom of an element is heavier than mass of $1/12$ of mass of C-12 atom.

Gram Atomic Mass (GAM) or Mass of 1g atom :-

When atomic Mass is defined in gram grams then it is GAM.

$$\text{GAM of H} = 1 \text{ g} = \text{mass of 1 g atom of H}$$

$$1 \text{ g H} = \text{mass of 1 mol of H} = \text{mass of 1 g atom of H}$$

$$\text{GAM of N} = 14 \text{ g} = \text{mass of 1 g atom of N}$$

$$14 \text{ g N} = \text{mass of 1 mol of N} = \text{mass of 1 g atom of N}$$

$$1 \text{ mol} = 1 \text{ g atom}$$

Ques Find no. of g atom in
(ii) 10 Kg of Ca

$$n = \frac{10 \times 1000}{40} = 250 \text{ g atom}$$

(ii) 1000 atoms of C

$$\frac{1000}{N_A} \text{ g atom}$$

Ques **Molecular Mass :-** It is the no. which represent how many times mass of 1 molecule is heavier than $1/12$ mass of C-12 atom.

$$\begin{aligned} \text{MM of 1 molecule of } H_2 &= 2 \text{ amu} = 2u \\ O_2 &= 32u \\ CO_2 &= 44u \end{aligned}$$

Gram Molecular Mass (GMM) or Mass of 1g molecule :-
when molecular mass is defined in grams is c/a GMM.

$$\begin{aligned} \text{GMM of 1 molecule of } H_2 &= 2g = \text{mass of 1g molecule of } H_2 \\ 2g \text{ of } H_2 &= \text{mass of 1 mole } H_2 = \text{mass of 1g molecule of } H_2 \end{aligned}$$

$$\text{GMM of 1 molecule of } N_2 = 28g = \text{mass of 1g molecule of } N_2 = \text{mass of 1 mol of } N_2$$

$$\boxed{1 \text{ mol} = 1 \text{ g molecule.}}$$

04/07/17

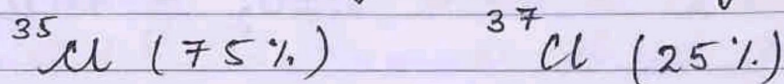
Actual Mass :- It is mass of 1 atom or 1 molecule in grams.

$$\text{Actual mass of } H_2 = \frac{2g}{N_A} g$$

$$\text{of } O_2 = \frac{32}{N_A} g$$

Average Mass :- Calculated for isotope.

Type-1 If isotopes are given in % age



$$\text{Average mass} = \frac{35 \times 75 + 37 \times 25}{100}$$

$$= \frac{25(35 \times 3 + 37)}{100}$$

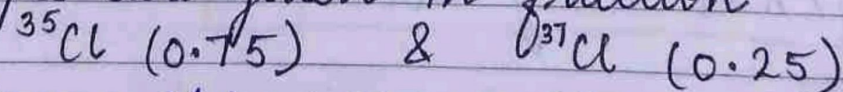
$$= \frac{105 + 37}{4}$$

$$= \frac{142}{4} = 35.5$$

$$\frac{35 \times 3}{105}$$

$$\text{avg. Mass} = \frac{M_1 X_1 + M_2 X_2 + \dots}{X_1 + X_2}$$

Type-2 If isotopes are given in fraction



$$\text{Avg Mass} = M_1 f_1 + M_2 f_2 + M_3 f_3$$

$$\text{Avg Mass} = 35 \times 0.75 + 37 \times 0.25 = 35.5$$

Ques

^{200}X (90%), ^{201}X (8%), ^{202}X (2%)
Find average Mass of X

$$= \frac{200 \times 90 + 201 \times 8 + 202 \times 2}{100}$$

$$= \frac{2(200 \times 45 + 201 \times 4 + 202)}{100}$$

$$= \frac{2(9000 + 802 + 202)}{100}$$

$$= \frac{2(10004)}{100} = 200.08$$

$$\begin{array}{r} 9000 \\ 802 \\ 202 \\ \hline 10004 \end{array}$$

Ques

^{199}X (90%), ^{200}X (8%), ^{202}X (2%)
find avg mass of X?

$$\frac{199 \times 90 + 200 \times 8 + 202 \times 2}{100}$$

$$= \frac{17910 + 1600 + 404}{100} = \frac{19914}{100} = 199.14$$

- (i) 200 u (ii) 199 u (iii) 202 u (iv) 196 u
- 199.05 199.14

Law of Chemical Combination :-

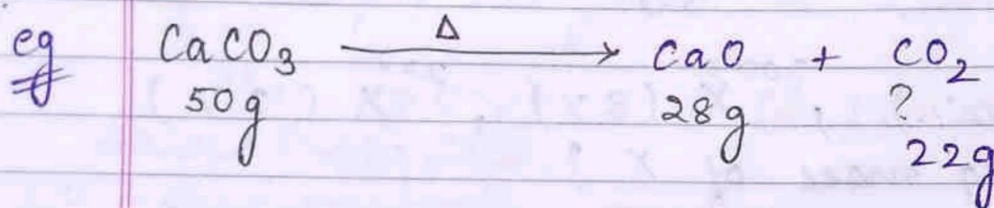
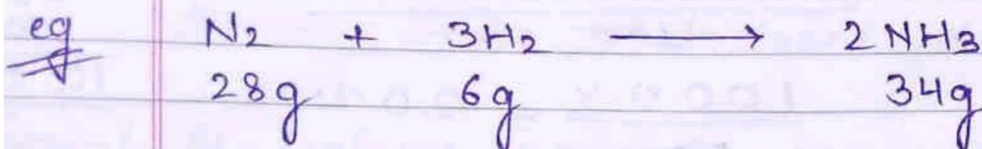
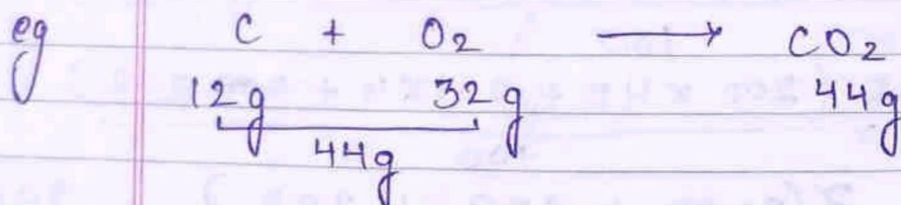
1. Law of Mass Conservation
2. Law of definite Proportion
3. Law of Multiple Proportion
4. Law of Gaseous Volume
5. Avagadro's Law

Law of mass conservation :- Lavoisier Accⁿ to this law, mass can be neither created nor destroyed in a chemical or physical reacⁿ but in chemi physics can be converted into one form to another.

* This law is not follow in nuclear reactions

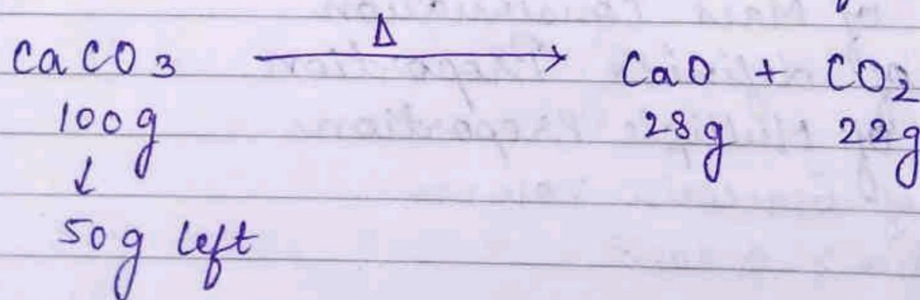
→ If reactant is converted into product completely.

Mass of reactant = Mass of Product



→ If reactant is not completely converted into product then

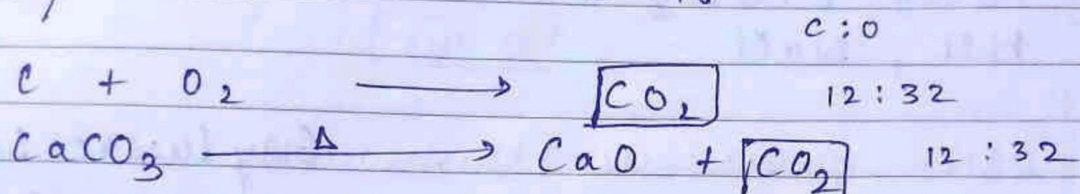
Mass of reactant = mass of product formed + mass of reactant left



Law of definite proportion :- Proust Accⁿ to this law, ratio of components by weight remains same, no matter what is the source of component or method of preparation.

eg

H_2O	H : O
rainy water	2 : 16
Sea water	2 : 16
Mineral water	2 : 16
tap water	2 : 16



Law of Multiple Proportion :-

* Not valid in isotopes.

	H	:	O	
H_2O	2	:	16	$\left(\begin{smallmatrix} 1 \\ \cdot \\ 2 \end{smallmatrix} \right)$
H_2O_2	2	:	32	

	CO	CO ₂	
C	12	12	C $\rightarrow$ fix
O	16	32	
	1	2	

	N_2O	NO	N_2O_3	N_2O_4	N_2O_5
N	28	$14 \times 2 = 28$	28	28	28
O	16	$16 \times 2 = 32$	48	64	80
	1	2	3	4	5

Ques Which of the following prove law of multiple proportion?

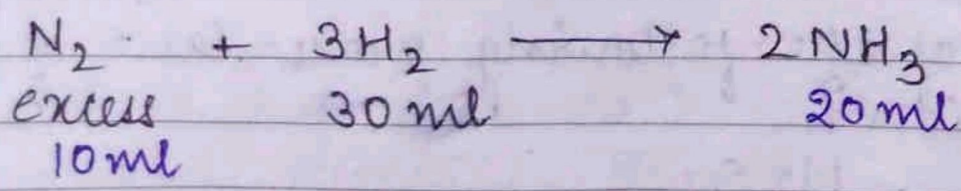
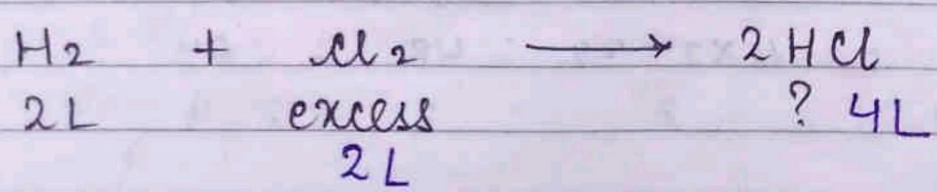
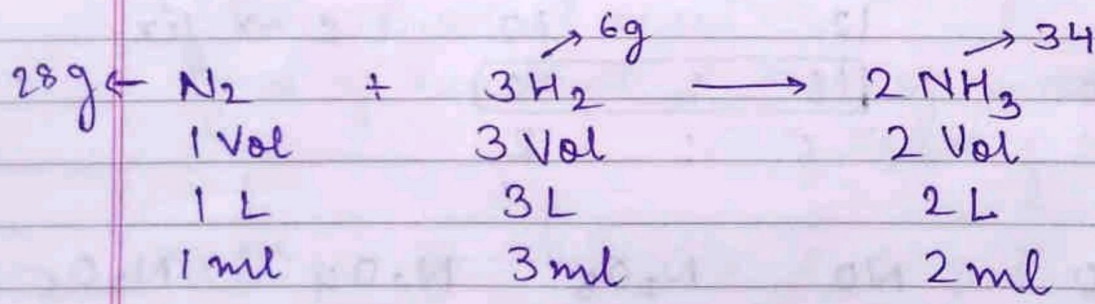
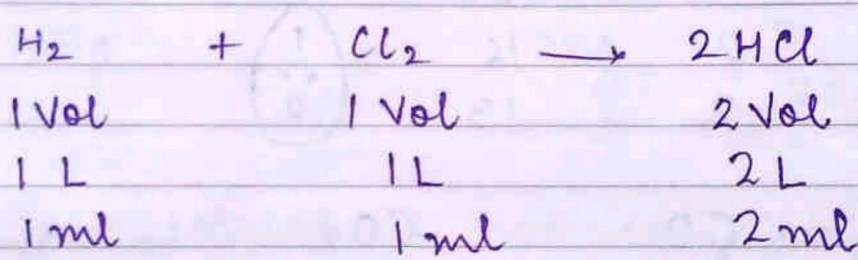
- (i) H_2SO_4 , H_2S
- (ii) CH_4 , CH_4
- (iii) H_2O & H_2O
- (iv) N_2O , NO

Ques Which of the following doesn't follow Law of Multiple Proportion?

- (i) SnCl_2 , SnCl_4
- (ii) PbO , PbO_2
- (iii) FeCl_2 , FeCl_3
- (iv) HCl , NaCl

5/7/18

Law of Gaseous Volumes Gay Lussac Law
In gaseous reactions, at same temp. & Pressure reactants combine with simple ratio of products.



Avagadro's Law :-

At same T & P, equal volume of all gases contain equal no. of molecules.

$$PV = nRT$$

$$V \propto n$$

H_2	+	Cl_2	$\longrightarrow$	$2HCl$
1 L		1 L		2 L
1 molecule		1 molecule		2 molecule
2 molecule		2 molecule		4 molecule
22.4 L		22.4 L		44.8 L
NA molecule		NA molecule		2NA molecule
1 mol		1 mol		2 mol
2 atom		2 atom		4 atom

Atomicity :- no. of atoms present in 1 molecules.

O_2	$\rightarrow$	2
He	$\rightarrow$	1
CO_2	$\rightarrow$	3
O_3	$\rightarrow$	3
H_2SO_4	$\rightarrow$	7

Vapour density :-

$$V.D. = \frac{\text{density of gas}}{\text{density of } H_2 \text{ gas at same T \& P}}$$

$$= \frac{d_{\text{gas}}}{d_{H_2} \text{ at same T \& P}}$$

$\rightarrow$ unit less

$$\rightarrow d_{H_2} = 0.000089 \text{ g/ml}$$

$$d_{H_2} = 9 \times 10^{-5} \text{ g/ml}$$

$$V.D. = \frac{\text{mass of gas at Vol. } V}{\text{mass of } H_2 \text{ at same } V \text{ \& same } T \& P}$$

$$V.D. = \frac{\text{mass of } N \text{ molecules of gas}}{\text{mass of } N \text{ molecules of } H_2 \text{ gas}}$$

$$V.D. = \frac{N \times \text{mass of 1 molecule of gas}}{N \times \text{mass of 1 molecule of } H_2}$$

$$V.D. = \frac{M.W.}{2}$$

$$M.W. = 2 \times V.D.$$

$$\text{Relative density} = \frac{(d_{\text{gas}})_A}{(d_{\text{gas}})_B}$$

Ques $d_{\text{gas}} = 3.6 \times 10^{-3} \text{ g/ml}$ Then gas is
(i) SO_2 (ii) CO_2 (iii) N_2 (iv) SO_3

[Given $d_{H_2} = 9 \times 10^{-5} \text{ g/ml}$]

$$M.W. = V.D. \times 2$$

$$V.D. = \frac{d_{\text{gas}}}{d_{H_2}} = \frac{3.6 \times 10^{-3}}{9 \times 10^{-5}} = \frac{360}{9} = 40$$

$$M.W. = 40 \times 2 = 80$$

Ques If $V.D.$ of a gas is 14. then gas is
(i) CO (ii) NO_2 (iii) N_2 (iv) both 1 & 3
 $M.W. = 2 \times 14 = 28$

Ques $V.D.$ of a gas w.r.t. methane is 4. Then gas is
(i) O_3 (ii) CO_2 (iii) SO_2 (iv) SO_3

$$V.D. = \frac{d_{\text{gas}}}{d_{\text{CH}_4}} = 4$$

$$\frac{M_w}{M_w \text{ of CH}_4} = 4$$

$$\frac{M.w}{16} = 4$$

$$M_w = 64$$

Ques Mass of 1 L of a gas is 1.96 g then Find V.D. & M_w of gas?

$$1 \text{ L} \rightarrow 1.96 \text{ g}$$

$$1 \text{ mol} = 22.4 \rightarrow 1.96 \times 22.4 \approx 44 \text{ g}$$

$$M_w = 44$$

$$V.D. = \frac{44}{2} = 22$$

Percentage composition :-

$$\text{mass \%} = \frac{\text{mass of element}}{\text{molar mass of comp.}} \times 100$$

$$\text{CaCO}_3 = 40 + 12 + 3 \times 16 = 52 + 48 = 100$$

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

$$\text{C} \rightarrow \frac{12}{100} \times 100 = 12$$

$$\text{O} \rightarrow \frac{48}{100} \times 100 = 48$$

H.W

$C_6H_{12}O_6 \rightarrow$ Find %C, %H & %O?

$$\%C = \frac{6 \times 12}{180} \times 100 = \frac{72 \times 100}{180} = 40\%$$

$$\%H = \frac{12}{180} \times 100 = \frac{2}{3} \times 100 = 0.66 \times 100 = 6.6\%$$

$$\%O = \frac{96}{180} \times 100 = \frac{16}{3} \times 10 = 5.33 \times 10 = 53.3\%$$

ques If 3.4% Sulphur is present in insulin then find ^{minimum} Molecular Mass of insulin

$$3.4 = \frac{32}{Mw} \times 100$$

$$Mw = \frac{32}{3.4} \times 100$$

$$\frac{3200}{3.4} =$$

$$\begin{array}{l} 3.4 \text{ g} \longrightarrow 100 \text{ insulin} \\ 1 \text{ g} \longrightarrow \frac{100}{3.4} \end{array}$$

$$32 \text{ g} \longrightarrow \frac{100}{3.4} \times 32 = 941 \text{ g}$$

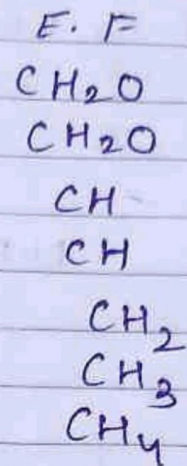
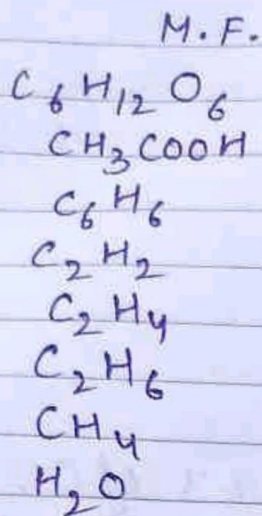
S $\rightarrow$ 32g
1
For min mol. mass at least one atom of S should be present

$$\begin{array}{r} 3 \ 34 \\ \times 9 \\ \hline 306 \end{array}$$

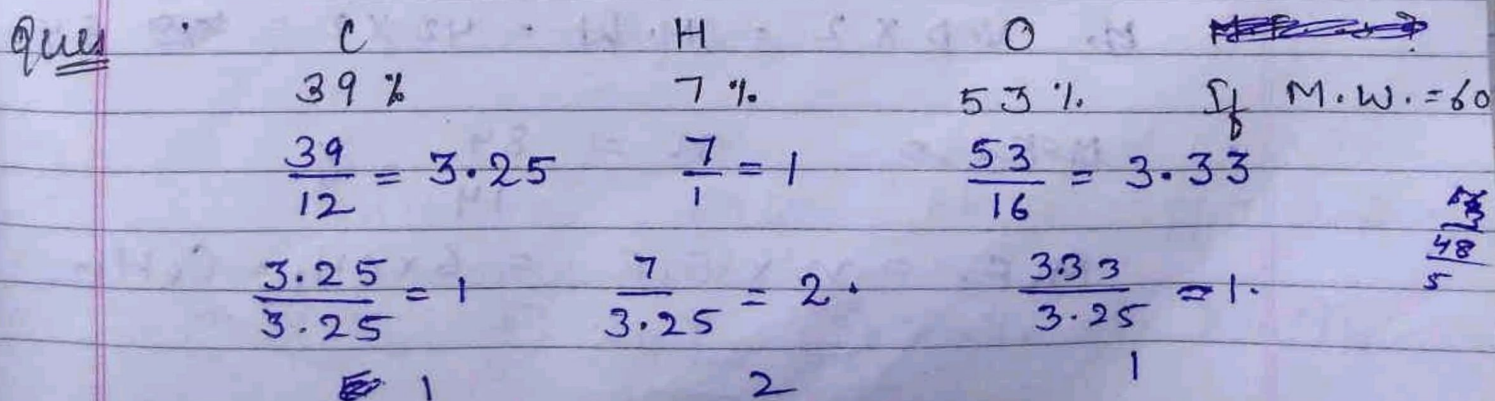
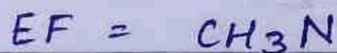
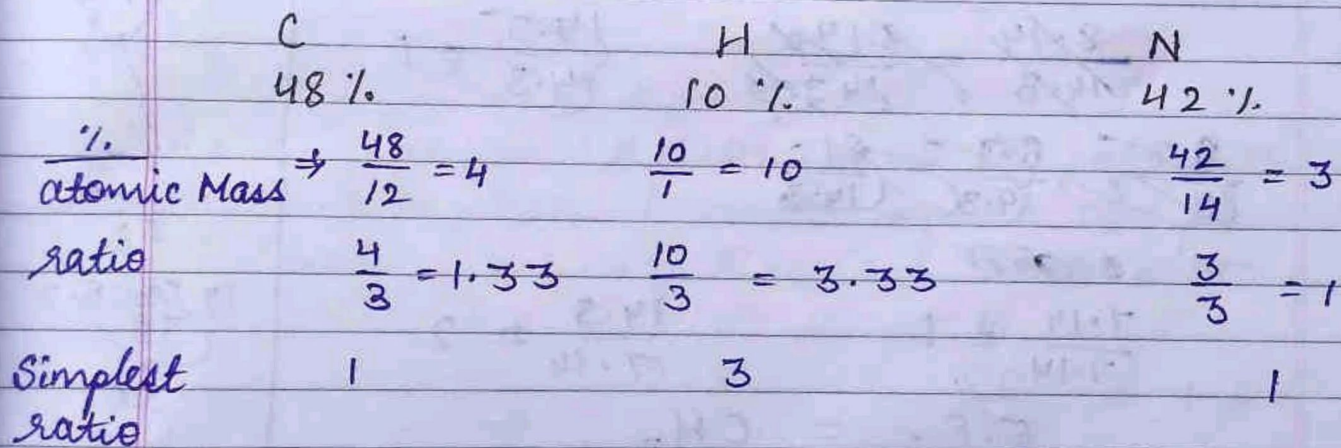
Not Empirical Formula and Molecular Formula :-

Molecular Formula :- It represent exact no. of atoms present in a molecule of compound. eg $C_6H_{12}O_6$, CH_3COOH , H_2O

Empirical Formula :- It represent simplest ratio of atoms present in a molecule of compound.



* $M.F. = n \times E.F.$
 $n = \text{natural no.} = 1, 2, 3 \dots$
 $n = \frac{\text{Molecular Formula Mass}}{\text{Empirical Formula Mass}}$





↓
30

$$n = \frac{60}{30} = 2$$

$$\begin{aligned} M.F. &= n \times E.F. \\ &= 2 \times [CH_2O] \\ &= C_2H_4O_2 \end{aligned}$$

Ques

A hydrocarbon contain 85.7% of C. Find
Find M.F. of hydrocarbon if its V.D. is 42

$$\begin{array}{l} C \\ 85.7\% \\ \frac{85.7}{120} = 7.14 \end{array}$$

$$\begin{array}{l} H \\ 14.3\% \\ \frac{14.3}{1} = 14.3 \end{array}$$

$$\frac{7.14}{14.3} = \frac{714}{1430}$$

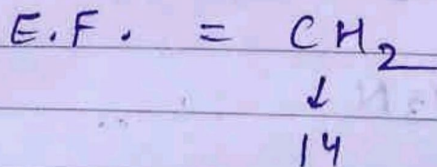
$$\frac{14.3}{14.3} = 1$$

$$\frac{7.1}{14.3} = \frac{71}{143}$$

~~8.57~~

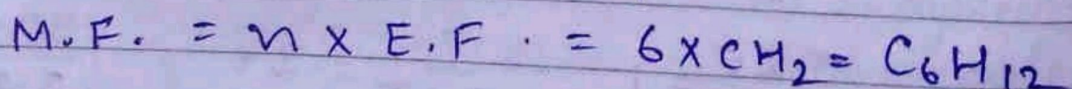
$$\frac{7.14}{7.14} = 1$$

$$\frac{14.3}{7.14} \approx 2$$



$$V.D. \times 2 = M.W. = 42 \times 2 = 84$$

$$M.F.C.E \quad n = \frac{84}{14} = 6$$



$$\begin{array}{r} 14 \\ 2 \times 14 = 28 \\ 28 \\ \hline 56 \\ 56 \\ \hline 112 \\ 112 \\ \hline 224 \\ 224 \\ \hline 448 \\ 448 \\ \hline 896 \\ 896 \\ \hline 1792 \\ 1792 \\ \hline 3584 \\ 3584 \\ \hline 7168 \\ 7168 \\ \hline 14336 \\ 14336 \\ \hline 28672 \\ 28672 \\ \hline 57344 \\ 57344 \\ \hline 114688 \\ 114688 \\ \hline 229376 \\ 229376 \\ \hline 458752 \\ 458752 \\ \hline 917504 \\ 917504 \\ \hline 1835008 \\ 1835008 \\ \hline 3670016 \\ 3670016 \\ \hline 7340032 \\ 7340032 \\ \hline 14680064 \\ 14680064 \\ \hline 29360128 \\ 29360128 \\ \hline 58720256 \\ 58720256 \\ \hline 117440512 \\ 117440512 \\ \hline 234881024 \\ 234881024 \\ \hline 469762048 \\ 469762048 \\ \hline 939524096 \\ 939524096 \\ \hline 1879048192 \\ 1879048192 \\ \hline 3758096384 \\ 3758096384 \\ \hline 7516192768 \\ 7516192768 \\ \hline 15032385536 \\ 15032385536 \\ \hline 30064771072 \\ 30064771072 \\ \hline 60129542144 \\ 60129542144 \\ \hline 120259084288 \\ 120259084288 \\ \hline 240518168576 \\ 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Ques A hydrocarbon contain 80 % of C Find M.F. of hydrocarbon if its V.D. is 15
(i) CH_3 (ii) C_2H_4 (iii) C_2H_6 (iv) C_3H_4

$$\frac{\text{C}}{12} = \frac{80}{100} = 6.66$$

$$\frac{\text{H}}{1} = \frac{20}{100} = 20$$

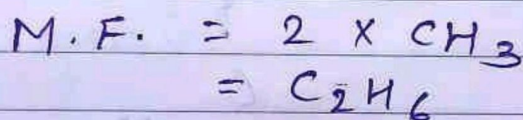
$$\frac{6.66}{6.66} = 1$$

$$\frac{20}{6.66} \approx 3$$



$$\text{M.W.} = 30$$

$$n = \frac{30}{15} = 2$$



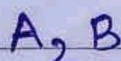
Ques A & B form a compound % of A & B is 50 each Find simplest formula of the compound :
If Atomic wt. of A is 20 & B is 40.

$$\frac{\text{A}}{20} = \frac{50}{100} = 2.5$$

$$\frac{\text{B}}{40} = \frac{50}{100} = 1.25$$

$$\frac{2.5}{1.25} = 2$$

$$\frac{1.25}{1.25} = 1$$



Ques X & Y At. wt of X $\rightarrow$ 30
40% 60% At. wt. of Y $\rightarrow$ 20
then compound is -
(1) X_3Y_4 (2) X_4Y_3 (3) X_9Y_4 (4) X_4Y_9

$$\begin{array}{r} X \\ 40 \\ \hline 30 \\ 1.33 \\ \hline 1.33 \end{array}$$

$$\begin{array}{r} Y \\ 60 \\ \hline 20 \\ 3 \\ \hline 1.33 \end{array}$$

$$\frac{40}{30}$$

$$\frac{60}{20}$$

$$\frac{4}{3}$$

$$\frac{3}{1}$$

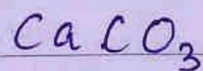
$$4 : 9$$

Ques Find Empirical formula of 4g Ca
6.022 x 10²² atom of C or 4.8g Oxygen

$$\begin{array}{r} Ca \\ 4 \\ \hline 40 \\ \hline 1 \\ 10 \\ \hline 1 \end{array}$$

$$\begin{array}{r} C \\ 6.022 \times 10^{22} \\ \hline 6.022 \times 10^{23} \\ \hline 1 \\ 10 \\ \hline 1 \end{array}$$

$$\begin{array}{r} O \\ 4.8 \\ \hline 160 \\ \hline 3 \\ 10 \\ \hline 3 \end{array}$$



Mole Concept - II

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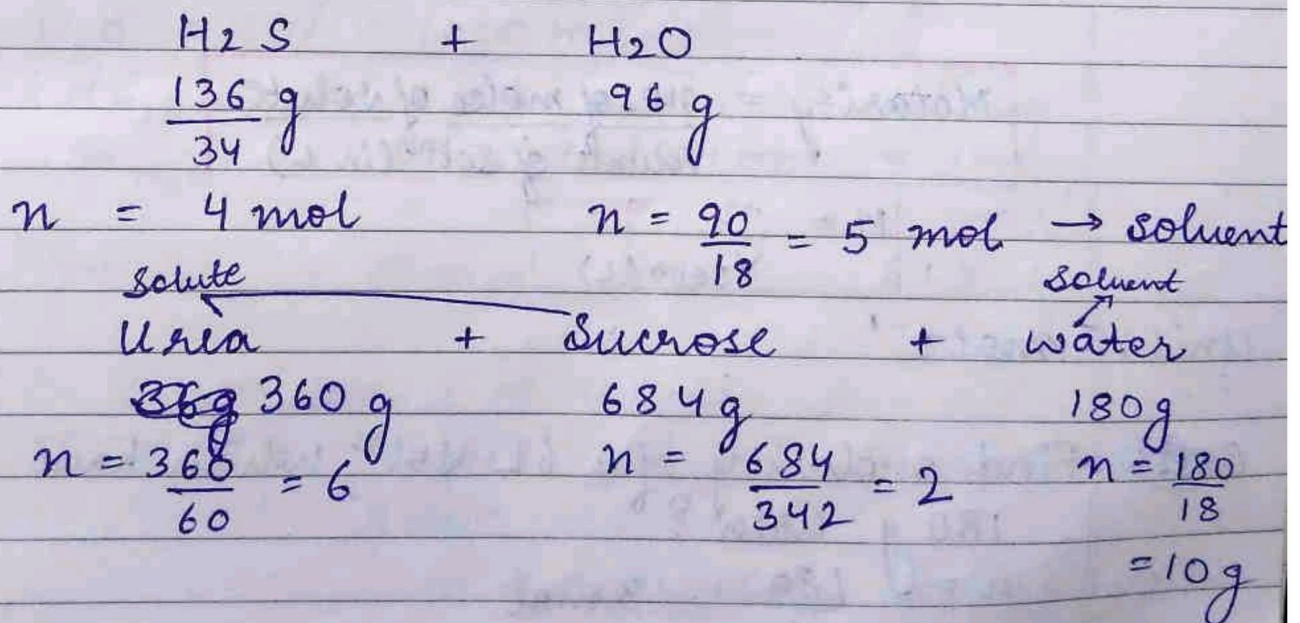
Solution : Homogeneous mixture of 2 or more than component.

Solution component	Solute 1 or more than 1.	Solvent (always 1)
2	1	1
3	2	1
5	4	1

Solution

Solute
which has less amount
(in no. of mole)

Solvent
(largest amount)
(in no. of moles)



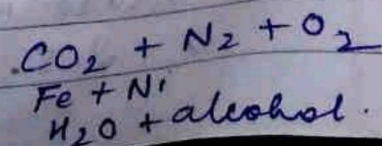
*** Nature of solution depends upon nature of solvent**

Solvent

Gas
Solid
Liq.

Soln

Gas
Solid
Liq.



Concentration Terms :



composition of solⁿ

1. Molarity
2. Molality
3. Mole fraction
4. % composition
 - % w/w
 - % v/v
 - % w/v
5. Parts per million (ppm)
6. Normality

1. **Molarity** : It is the no. of ^{moles of} solute present in 1 L solⁿ

$$\text{Molarity} = \frac{\text{no. of moles of solute}}{\text{Volume of sol}^n (\text{in L})}$$

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

Unit: mol L^{-1}

Ques Find molarity of a 6 L solⁿ which have 180 g urea ?
 $n = \frac{180}{60} = 3 \text{ mol}$

$$M = \frac{3}{6} = 0.5$$

Ques Find mass of 200 ml 2.5 M H_2SO_4
 $2.5 = \frac{n}{200} \times 1000$

$$\frac{500}{1000} = n$$

$$0.5 = \frac{1}{2} = n$$

$$0.5 = \frac{W}{98}$$

$$W = 49 \text{ g}$$

111

Ques 120 g urea is present in 1 L water then find Molarity of the solⁿ?

$$n = \frac{120}{60} = 2$$

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

$$\left[\begin{array}{l} d_{\text{sol}^n} = 1.12 \text{ g/ml} \\ d_{\text{water}} = 1 \text{ g/ml} \end{array} \right.$$

$$\text{urea} = 120 \text{ g}$$

$$\text{H}_2\text{O} = 1 \text{ L} = 1000 \text{ ml}$$

$$d_{\text{H}_2\text{O}} = 1 \text{ g/ml}$$

$$m_{\text{H}_2\text{O}} = d \times V = 1 \times 1000 = 1000 \text{ g}$$

$$m_{\text{sol}^n} = m_{\text{urea}} + m_{\text{H}_2\text{O}} = 1120 \text{ g}$$

$$d_{\text{sol}^n} = 1.12 \text{ g/ml}$$

$$V_{\text{sol}^n} = \frac{m_{\text{sol}^n}}{d_{\text{sol}^n}} = \frac{1120}{1.12} = 1000 \text{ ml} = 1 \text{ L}$$

$$M = \frac{n_{\text{solute}}}{V_{\text{sol}^n} (\text{L})} = \frac{2}{1} = 2 \text{ M}$$

Ques 196 g of H_2SO_4 is present in 1 kg water Find molarity of solⁿ if $d_{\text{sol}^n} = 1.2 \text{ g/ml}$

$$\text{H}_2\text{SO}_4 \rightarrow 196 \text{ g}$$

$$\text{H}_2\text{O} = 1 \text{ kg} = 1000 \text{ g}$$

$$m_{\text{sol}} = 196 + 1000 = 1196 \text{ g}$$

$$V_{\text{sol}} = \frac{\text{mass sol}}{d_{\text{sol}}} \\ = \frac{1196}{1.2} =$$

Ques If 6.022×10^{20} molecules of urea is present in 100 ml solⁿ then find molarity of solⁿ?

(a) 0.1 M (b) 0.02 M (c) 0.01 M (d) 0.001 M

$$M = \frac{6.022 \times 10^{20} / 6.022 \times 10^{23} \times 1000}{100}$$

$$= \frac{1}{10^3 \times 100} \times 1000$$

$$= \frac{1}{100}$$

$$= 0.01 \text{ M}$$

7/7/17

Dilution Law :-
→ no. of moles const.
 $n = MV = \text{const.}$

$$M_1 V_1 = M_2 V_2$$

Ques 68.4 g urea is present in 1L solⁿ find the molarity of solⁿ if it is diluted 10 times?

$n \rightarrow \text{const}$

$$M_1 V_1 = M_2 V_2$$

$$1.14 \times 1 = M_2 \times 10$$

$$M_2 = \frac{1.14}{10} = 0.114 \text{ M}$$

$$\begin{array}{r} 114 \\ 68.4 \\ \hline 600 \end{array}$$

$$\frac{1.14}{10}$$

Ques 180 g urea is present in 4L solⁿ. Find the molarity of solⁿ if it diluted upto to 12 L.

$$\frac{180/60}{4} \times 4 = M_2 \times 12$$

$$\frac{3}{4} \times 4 = M_2 \times 12$$

$$\frac{1}{4} = \frac{3}{12} = M_2$$

$$M_2 = 0.25 M$$

Mixing of solutions :-

$$\boxed{\frac{M_1}{V_1}} + \boxed{\frac{M_2}{V_2}} = \boxed{\frac{n_1+n_2}{M_3(V_1+V_2)}}$$

$$M_3 = \frac{M_1 V_1 + M_2 V_2}{V_1 + V_2}$$

Ques

JEE
Main
2013

$$\boxed{\begin{array}{l} 750 \text{ ml of } 0.5 M \text{ HCl} \\ + \\ 250 \text{ ml of } 2 M \text{ HCl} \end{array}}$$

Find Molarity

$$M_3 = \frac{0.5 \times 750 + 2 \times 250}{1000}$$

$$= \frac{375 + 500}{1000} = \frac{875}{1000} = \frac{875}{1000} = 0.875$$

Ques Find the ~~new~~ Molarity of solⁿ obtained by mixing of same volume of 2 M & 3 M HCl ?

$$M_3 = \frac{2 \times V + 3 \times V}{2V} = \frac{V(2+3)}{2V} = \frac{5}{2} = 2.5M$$

Ques Find Volume of 4M & 2M KOH soln to be added 3L of 2.5M KOH soln

$$V_1 = V \quad V_2 = 3 - V$$

$$2.5 \times 3 = \frac{4 \times V + 2 \times (3 - V)}{3}$$

$$7.5 = 4V + 6 - 2V$$

$$1.5 = 2V$$

$$V_1 = V = \frac{1.5}{2} = \frac{3}{4} = 0.75L$$

$$V_2 = 3 - V = 3 - 0.75 = 2.25L$$

2. **Molality** : It is defined as no. of moles of solute present in 1kg of solvent

$$m = \frac{n_{\text{solute}}}{w(\text{kg})}$$

Unit:- mol kg⁻¹

Ques Find molality of-

(i) 120g urea present in 500g water

$$m = \frac{120/60}{500} \times 1000$$

$$= \frac{2}{5} \times 1000 = 4 \text{ mol kg}^{-1}$$

(ii) 49 g H_2SO_4 present in 2.5 kg water

$$m = \frac{49/98}{2.5}$$

$$= \frac{1/2}{2.5}$$

$$\begin{array}{r} 2+64+32 \\ 96+2 \\ \hline 98 \end{array}$$

$$= \frac{1}{2 \times 2.5} = \frac{1}{5} = 0.2 \text{ mol kg}^{-1}$$

$$= 0.2 \text{ m}$$

Ques 180 g urea is present in 1L aq. solⁿ
then find molality & molarity of solⁿ
[Given $d_{\text{soln}} = 1.18 \text{ g/ml}$]

$$M = \frac{180/60}{1} = \frac{3}{1} = 3 \text{ M}$$

$$m_{\text{soln}} = m_{\text{solute}} + m_{\text{solvent}}$$

$$m_{\text{soln}} = d \times V$$

$$= 1.18 \times 1 = 1.18 \text{ g/ml} \times 1000$$

$$= 1180 \text{ g}$$

$$m_{\text{solvent}} = 1180 - 180$$

$$= 1000 \text{ g} = 1 \text{ kg}$$

$$m = \frac{3}{1} = 3 \text{ mol kg}^{-1}$$

Ques 3m NaOH solⁿ has a volume of 1L
then find Molarity of solⁿ.
 $d_{\text{soln}} = 2 \text{ g/ml}$ given
[$V_{\text{soln}} \approx V_{\text{solvent}}$]

$$3m \rightarrow 3 \text{ mol} \rightarrow 1 \text{ kg solvent}$$

$$M = \frac{n}{V_{\text{soln}}}$$

$$m = \frac{n}{V_{\text{soln}} - V_{\text{solvent}}}$$

$$V = 1 \text{ L}$$

$$m_{\text{soln}} = 2 \times 1000$$

$$= 2000 \text{ g}$$

$$= 2 \text{ kg}$$

$$m = \frac{n}{W_{\text{solvent}}}$$

$$3 = \frac{n}{2}$$

$$\boxed{n = 6 \text{ mol}}$$

$$M = \frac{n}{V} = \frac{6}{1} = 6 \text{ M}$$

Ques

Find the molarity of 3m urea solⁿ of
If density of solvent is 0.8 kg/L
(Assume $V_{\text{soln}} \approx V_{\text{solvent}}$ as solⁿ is very dilute)

$$m = 3m = 3 \text{ mole in } 1 \text{ kg solvent}$$

$$m_{\text{solvent}} = 1 \text{ kg}$$

$$d_{\text{solvent}} = 0.8 \text{ kg/L}$$

$$V_{\text{solvent}} = \frac{m_{\text{solvent}}}{d_{\text{solvent}}} = \frac{1 \text{ kg}}{0.8 \text{ kg/L}} = \frac{1}{0.8}$$

$$= \frac{10}{8} = \frac{5}{4} \text{ L}$$

$$V_{\text{soln}} \approx V_{\text{solvent}} = \frac{5}{4} \text{ L}$$

$$M = \frac{n}{V} = \frac{3}{5/4} = \frac{12}{5}$$

(X)

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3 ~~(Ques)~~ Mole fraction :- It is the ratio of no. of moles of a compound component to the total moles.

Solute
+
Solvent

$$X_{\text{solute}} = \frac{n_{\text{solute}}}{n_{\text{solute}} + n_{\text{solvent}}}$$

$$X_{\text{solvent}} = \frac{n_{\text{solvent}}}{n_{\text{solute}} + n_{\text{solvent}}}$$

$$\begin{aligned} X_{\text{solute}} + X_{\text{solvent}} &= \frac{n_{\text{solute}}}{n_{\text{solute}} + n_{\text{solvent}}} + \frac{n_{\text{solvent}}}{n_{\text{solute}} + n_{\text{solvent}}} \\ &= \frac{n_{\text{solute}} + n_{\text{solvent}}}{n_{\text{solute}} + n_{\text{solvent}}} \end{aligned}$$

$$X_{\text{solute}} + X_{\text{solvent}} = 1$$

Ques 44 g CO_2 + 48 g O_2 find X_{CO_2} & X_{O_2}

$$n_{\text{CO}_2} = \frac{44}{44} = 1$$

$$n_{\text{O}_2} = \frac{48}{32} = \frac{3}{2}$$

$$X_{\text{CO}_2} = \frac{1}{2.5} = \frac{2}{5}$$

$$X_{\text{O}_2} = \frac{1.5}{2.5} = \frac{3}{5}$$

Ques 42 g N_2 + 3.011×10^{24} molecules of O_3
+ 120 g SO_2
 X_{N_2} , X_{O_3} , $X_{\text{SO}_2} = ?$

$$n_{N_2} = \frac{42 \times 10^{-21}}{28} = \frac{21}{14} = \frac{3}{2}$$

$$n_{O_3} = \frac{3.011 \times 10^{24}}{6.022 \times 10^{23}} = \frac{1}{2} \times 10 = 5$$

$$n_{SO_3} = \frac{120}{80} = \frac{3}{2}$$

$$X_{N_2} = \frac{3/2}{8}$$

$$X_{O_3} = 5/8$$

$$X_{SO_3} = \frac{3/2}{8}$$

Ques 6.022×10^{22} atoms of He + 13.2 g of CO_2 + 11.2 L of O_2

$$n_{He} = \frac{6.022 \times 10^{22}}{6.022 \times 10^{23}} = \frac{1}{10} = 0.1$$

$$n_{CO_2} = \frac{13.2}{44} = \frac{3}{10} = 0.3$$

$$n_{O_2} = \frac{11.2}{22.4} = \frac{1}{2} = 0.5$$

$$X_{He} = \frac{0.1}{0.9} = \frac{1}{9}$$

$$X_{CO_2} = \frac{0.3}{0.9} = \frac{3}{9}$$

$$X_{O_2} = \frac{0.5}{0.9} = \frac{5}{9}$$

AIEEE

Ques Mole fraction of urea in aq. solⁿ is 0.25
then find molality of solⁿ.

$$X_{\text{urea}} = \frac{n_{\text{urea}}}{n_{\text{urea}} + n_{\text{H}_2\text{O}}} = 0.25$$

$$X_{\text{H}_2\text{O}} = \frac{n_{\text{H}_2\text{O}}}{n_{\text{urea}} + n_{\text{H}_2\text{O}}} = 0.75$$

$$\frac{n_{\text{urea}}}{n_{\text{H}_2\text{O}}} = \frac{0.25}{0.75} = \frac{1}{3}$$

$$m = \frac{n_{\text{urea}} \times 1000}{18 \times \left(\frac{n_{\text{H}_2\text{O}}}{18} \right) \times 1000}$$

$$m = \frac{n_{\text{urea}} \times 1000}{18 \times n_{\text{H}_2\text{O}}}$$

AIPMT - II

Ques Find mole fraction of solute in 1 m^{aq.} solⁿ?

- ① 0.0177 ② 0.107 ③ 0.177 ④ 0.288

1 m → 1 mol of solute present in 1 kg of solvent (H₂O)

$$X_{\text{solute}} = \frac{n_{\text{solute}}}{n_{\text{solute}} + n_{\text{H}_2\text{O}}} = \frac{1}{1 + n_{\text{H}_2\text{O}}} = \frac{1}{1 + 55.5}$$

$$n_{\text{H}_2\text{O}} = \frac{1000}{18} = 55.5$$

$$= \frac{1}{56.5} = \frac{10}{565} = \frac{2}{113} = 0.01$$

Concentration in terms of % :-

$$\% \frac{W}{W} \text{ of solute} = \frac{\text{wt. of solute}}{\text{wt. of sol}^n} \times 100$$

20% w/w NaOH solⁿ

20 g NaOH present in 100 g solⁿ

$$\% \frac{V}{V} \text{ of solute} = \frac{\text{Vol. of solute}}{\text{Vol. of sol}^n} \times 100$$

20% v/v HCl solⁿ

20 ml HCl in 100 ml solⁿ.

$$\% \frac{W}{V} \text{ of solute} = \frac{\text{wt. of solute (g)}}{\text{Vol. of sol}^n (\text{ml})} \times 100$$

20% w/v NaOH solⁿ

20 g NaOH present in 100 ml solⁿ

Ques 120 g NaOH is present in 2 kg solⁿ.
d solⁿ = 2 g/ml then find

(i) M

$$M = \frac{120/40}{1} = 3M$$

$$d = \frac{M}{V}$$

$$V = \frac{M}{d} = \frac{3 \times 1000}{2}$$

(ii) m

$$m = \frac{3}{1.880} = 1.6$$

$$= 1000 \text{ ml} = 1 \text{ L}$$

(iii)

$$\frac{W}{W} \% = \frac{120}{2000} \times 100 = 6 \% \text{ w/w}$$

$$2000 - 120 = 1880 \text{ g} = 1.880 \text{ kg}$$

(iv) $W/V \% = \frac{120}{1000} \times 100 = 12 \%$

Ques Find molality & molarity of 6% W/V urea solⁿ = 2g/ml ^{IM}

6% W/V = 6g of urea present in 100ml of solⁿ
m_{urea} = 6g

$$d = \frac{M}{V}$$

$$M = d \times V = 2 \times 100 = 200 \text{ g}$$

$$= \frac{200}{1000} \text{ kg} = 0.2 \text{ kg}$$

$$200 - 6 = 194 \text{ g}$$

$$m = \frac{6/60}{100/1000} = \frac{1/10 \times 1000}{100} = \frac{100}{100} = 1$$

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

Ques Find molality of 20% W/W NaOH solⁿ?

NaOH
23+17
40

20% W/W = 20g of solute present in 100g of solⁿ

$$\text{molality} = \frac{20/40}{0.08}$$

$$= \frac{1/2}{0.08}$$

$$= \frac{1}{2} \times \frac{100}{8} = 6.25 \text{ m}$$

$$W_{\text{solvent}} = 100 - 20 = 80 \text{ g}$$

$$= \frac{80}{1000} \text{ kg} = 0.08$$

Ques Find W/W% of 3m urea solⁿ?

3m $\rightarrow$ 3 mol of solute present in 1kg of solvent

$$3 = \frac{m}{60} \quad \left| \quad m_{\text{solution}} = 1000 + 180 \right| \quad \left| \quad W/W\% = \frac{180}{1180} \times 100 \right|$$

$$m = 180g \quad \left| \quad \right| \quad \left| \quad = \frac{1800}{118} = 15.2 \right|$$

AIPMT-2013

Ques How many grams of 70% HNO_3 required to prepare 250 ml of 2.0 M HNO_3 ?

$$V_{\text{soln}} = 250 \text{ ml} \quad M = 2 \text{ M}$$

$$M = \frac{n}{V(L)}$$

$$2 = \frac{n}{0.250}$$

$$n = 2 \times 0.25 = 0.5$$

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

$$0.5 = \frac{w}{63}$$

$$w = 31.5g$$

$$\frac{70g}{100g} \text{ present} \rightarrow \frac{100g}{70}$$

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

Parts per million :- no. of parts of component (solute) present in 10^6 parts of solⁿ.

$$\text{ppm by mass} = \frac{\text{mass of solute}}{\text{mass of soln}} \times 10^6$$

$$\text{ppm by volume} = \frac{\text{volume of solute}}{\text{volume of soln}} \times 10^6$$

70 ppm NaOH ~~soln~~ by mass
70 g NaOH present in 10^6 g soln

5 ppm HCl by vol.
5 ml HCl in 10^6 ml soln
5 L HCl in 10^6 L soln

Ques 10 g CaCO_3 is present in 1000 g soln then
concⁿ of soln is -
(i) 100 ppm (ii) 10 ppm (iii) 10000 ppm
(iv) 1000 ppm

$$\text{ppm} = \frac{10}{1000} \times 10^6$$

$$= 10000 \text{ ppm}$$

Ques 0.15 W/W % urea is given Find concⁿ
is terms of ppm
0.15 g urea present 100 g soln
 $\text{ppm} = \frac{0.15}{100} \times 10^6 \text{ ppm}$

10/07/17

Normality (N) :- It is no. of equivalent or
g equivalent present in 1 L soln.

$$\text{Normality (N)} = \frac{\text{no. of equivalents}}{\text{Volume of soln (L)}}$$

$$\text{no. of equivalents} = \frac{\text{wt}}{\text{eq. wt}} = \frac{W}{E}$$

$$\text{Equivalent wt.} = \frac{\text{Molar mass}}{\text{Valency factor}}$$

$$E = \frac{M}{n\text{-factor}}$$

$$\text{no. of equivalents} = \frac{W}{\frac{M}{n\text{-factor}}} = \frac{W}{M} \times n\text{-factor}$$

$$= n \times n\text{-factor}$$

$$N = \frac{n \times n\text{-factor}}{V}$$

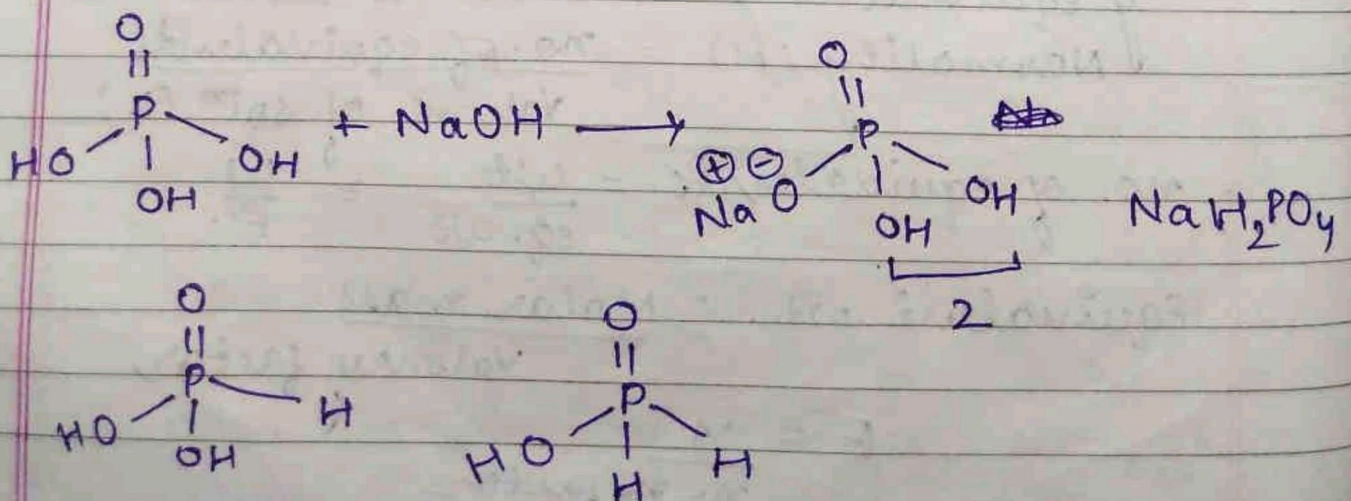
$$N = M \times n\text{-factor}$$

Note We never calculate Normality direct
first calculate Molarity & then Normality

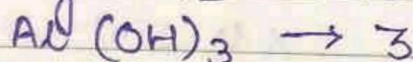
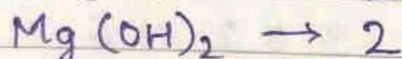
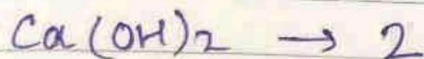
n-factor :-

(i) n-factor for acids = no. of replaceable H^+
= basicity

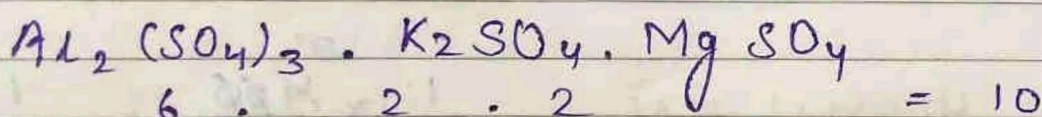
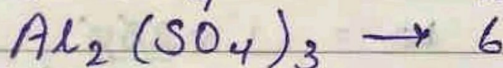
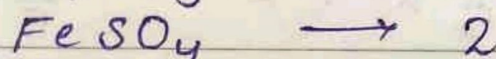
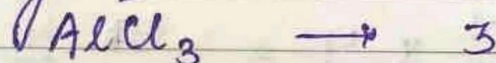
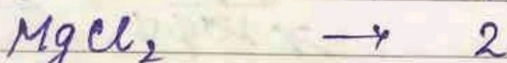
	n-factor
HCl	1
HNO ₃	1
H ₂ SO ₄	2
H ₃ PO ₄	3
H ₃ PO ₃	2
H ₃ PO ₂	1



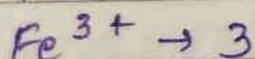
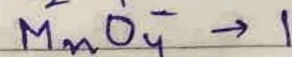
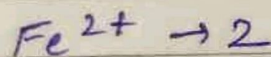
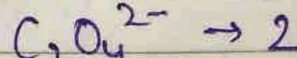
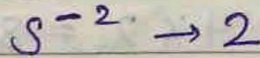
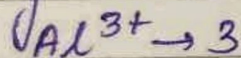
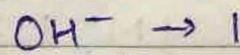
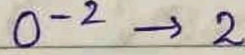
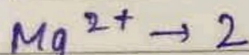
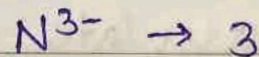
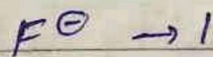
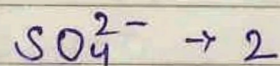
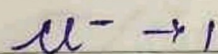
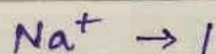
(ii) n-factor for base :-
no. of replaceable OH^- or no. of H^+ accepted



(iii) n-factor for salts :- Total charge on cations
or
Total charge on anion



(iv) n-factor for ion = |charge on ion|



Ques calculate no. of equivalents in

- ① 4 mol HNO_3 $4 \times 1 = 4$
- ② 3 mol Ca(OH)_2 $3 \times 2 = 6$
- ③ 0.5 mol Al(OH)_3 $3 \times 0.5 = 1.5$
- ④ 0.25 mol H_2SO_4 $0.25 \times 2 = 0.5$
- ⑤ 5 m mol FeSO_4 $5 \times 10^{-3} \times 2 = 10 \times 10^{-3} = 10^{-2}$
- ⑥ 3 m mol FeCl_3 $3 \times 10^{-3} \times 3 = 9 \times 10^{-3}$
- ⑦ 4 N 500 ml H_2SO_4 $= \frac{2 \times 800}{2 \times 1000} = 2$
- ⑧ $\frac{N}{5}$ 4 L NaOH $= \frac{N}{5} \times 4 = \frac{4}{5}$
- ⑨ $\frac{N}{10}$ 200 ml H_3PO_4 $= \frac{1 \times 200}{10 \times 500} = \frac{1}{50}$
- ⑩ $\frac{N}{20}$ 400 ml HCl $= \frac{1 \times 400}{10 \times 20 \times 500} = \frac{1}{50}$
- ⑪ 0.5 N 4 L HNO_3 $0.5 \times 4 = 2$

Ques calculate Normality of

- ① 4 M H_2SO_4 solⁿ $4 \times 2 = 8$
- ② 0.5 M H_3PO_4 solⁿ $0.5 \times 3 = 1.5$
- ③ 0.2 M NaOH solⁿ $0.2 \times 1 = 0.2$

- (4) 2M $Mg(OH)_2$ solⁿ
 $2 \times 2 = 4$
- (5) 1M HCl
 $1 \times 1 = 1$

Ques Calculate Molarity of

(1) 2N NaOH

$$M = \frac{N}{V.F} = \frac{2}{1} = 2$$

(2) $\frac{N}{10} H_2SO_4$ $M = \frac{1}{10 \times 2} = \frac{1}{20}$

(3) $\frac{N}{20} H_3PO_3$ $M = \frac{1}{20 \times 2} = \frac{1}{40}$

(4) $\frac{N}{10} H_3PO_2$ $\frac{1}{10 \times 1} = \frac{1}{10}$

(5) $\frac{N}{20} H_3PO_4$ $\frac{1}{20 \times 3} = \frac{1}{60}$

(6) 0.4N $Mg(OH)_2$ $\frac{0.4}{2} = 0.2$

(7) 0.6N $Al(OH)_3$ $\frac{0.6}{3} = 0.2$

Ques Find Normality of 50g $CaCO_3$ present in 500 ml solⁿ?

$$N = \frac{50/100 \times 2 \times 1000}{500}$$

$$= \frac{1 \times 2 \times 1000}{500} = 2N$$

Ques Find Normality of 4.1g H_3PO_3 present in 100 ml solⁿ

$$N = \frac{4.1/82 \times 2 \times 1000}{100} = \frac{44 \times 2 \times 10}{820} = 1N$$

$$\begin{array}{r} 3 + 48 + 30 \\ 34 + 48 \\ \hline 82 \end{array}$$

Ques

0.5 g of a base was completely neutralised by 100 ml of 0.2 N acid. Find eq. wt. of the base

$$\text{no. of eq. of acid} = \text{no. of eq. of base}$$

$$0.2 \times 0.1 = \frac{\text{no. of eq. of base}}{E}$$

$$0.02 = \frac{0.5}{E}$$

$$E = \frac{0.5}{0.02} = 25$$

Ques

0.45 g of acid [Mol. wt. = 90] was exactly neutralised by 20 ml of 0.5 N NaOH. Find basicity of acid.

$$\text{no. of eq. of acid} = \text{no. of eq. of base}$$

$$\frac{0.45}{90} \times \text{V.F.} = 0.5 \times \frac{20}{1000}$$

$$2 \frac{45}{90 \times 100} \times \text{V.F.} = \frac{10}{1000}$$

$$\frac{1}{200} \times \text{V.F.} = \frac{1}{100}$$

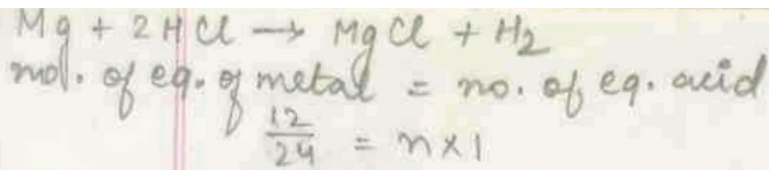
$$\frac{1}{2} \times \text{V.F.} = 1$$

$$\text{V.F.} = 2$$

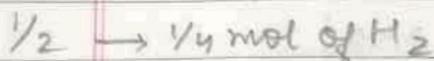
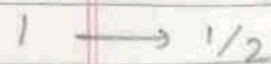
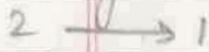
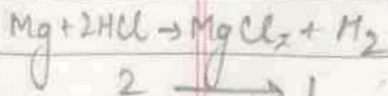
Ques

The eq. wt. of a divalent metal is 24. The vol. of hydrogen liberated at STP by 12 g of same metal when added to excess of an acid soln is

- ① 2.8 L ② 5.6 L ③ 11.2 L ④ 22.4 L



$$n = 1/2 \quad \text{Eq. wt} = \frac{\text{Molar mass}}{\text{V.F.}}$$



$$= 1/4 \times 22.4$$

$$= 5.6 \text{ L}$$

$$\text{Volume} = \frac{12}{48} \times 22.4 = \frac{22.4}{4} = 5.6$$

Ques When an element forms an oxide in which oxygen is 20% of the oxide by mass, the eq. mass of element will be

$$\text{eq. of metal} = \text{eq. of O}$$

$$\frac{80}{E} = \frac{20}{16/2}$$

$$E = 32$$

or

$$\frac{\text{wt. of metal}}{\text{Eq. wt. of metal}} = \frac{\text{wt. of oxygen}}{\text{eq. of oxygen}}$$

$$\begin{array}{l} 100\text{g} \nearrow 20\text{g O} \\ \searrow 80\text{g M} \end{array}$$

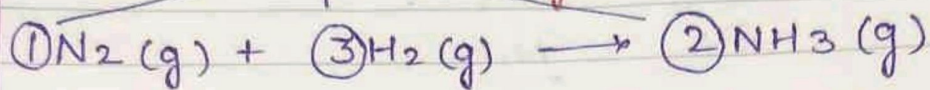
Mole concept in Reactions :-

- In Balanced reacⁿ
- In unbalanced reacⁿ

For balanced reacⁿ

- by charge conservations
- by atom conservations.

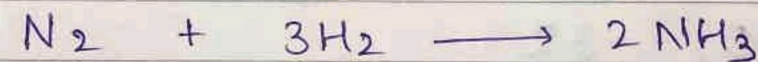
Stoichiometry



	1 mol	3 mol	2 mol
	1 molecule	3 molecule	2 molecule
	1 L	3 L	2 L
	1 ml	3 ml	2 ml
	22.4 L	22.4 × 3 L	22.4 × 2 L
	28 g	6 g	34 g
but	1 g	3 g	2 g
			X

Notes: Solve numericals by calculating no. of moles.

Ques When 56 g N_2 reacts with 12 g H_2 then find
(i) mass of NH_3



$$\frac{56}{28} = 2$$

$$\frac{12}{2} = 6$$

$$4 \text{ mol}$$

$$17 \times 4 = m$$

$$68 \text{ g} = m$$

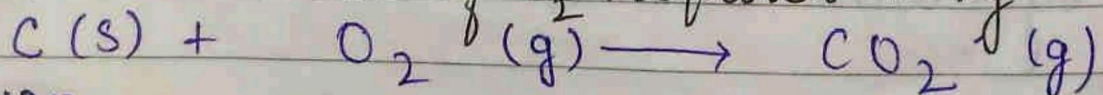
(ii) Vol. of NH_3 at STP

$$22.4 \times 4 = V = 89.6 \text{ L}$$

(iii) total atoms in final product

$$4 \times 4 \times N_A = 16 N_A$$

Ques When 120 g of C is completely burnt in presence of oxygen at 0°C & 1 atm then find (i) amount of O_2 required in kg.



$$\frac{120}{12} = 10 \text{ mol} \quad 10 \text{ mol}$$

$$32 \times 10 = m$$

$$m = 320 \text{ g}$$

$$= 0.320 \text{ kg}$$

(ii) Vol. of O_2 required

$$V = 10 \times 22.4 = 224 \text{ L}$$

Ques During the complete decomposition of $KClO_3$ 12.8 g O_2 is formed Find initial mass of $KClO_3$?



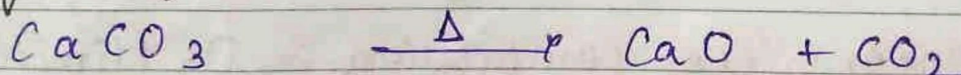
$$0.32 \text{ mol}$$

$$\frac{12.8}{320} = \frac{4}{10}$$

$$0.32 \times 122.5 \text{ g}$$

$$= 0.4$$

Ques Calculate mass of quicklime obtained by heating 400 g $CaCO_3$ which is 80% pure?



$$\frac{400}{100} = 4 \times$$

$$3.2 \text{ mol}$$

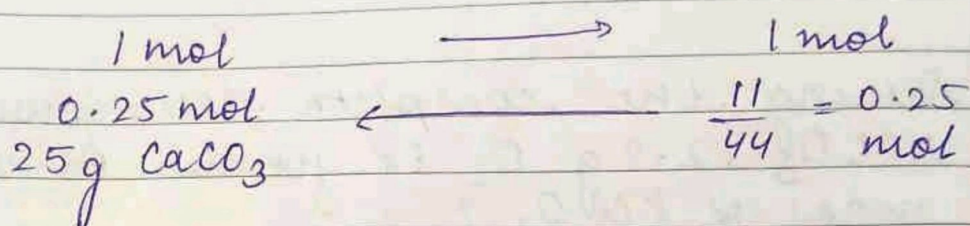
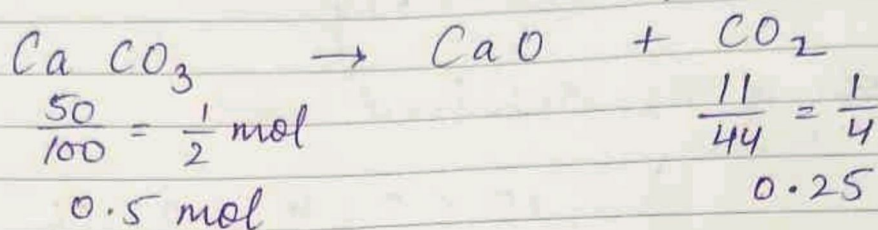
$$\text{mass} = 3.2 \times 56 \text{ g}$$

$$\begin{array}{l} 100 \text{ g} \rightarrow 80 \text{ g} \\ 1 \text{ g} \rightarrow \frac{80}{100} \\ 400 = \frac{80}{100} \times 400 \\ = 320 \end{array}$$

$$4 \text{ mol} \times \frac{80}{100}$$

$$= 3.2 \text{ mol}$$

Ques By decomposition of 50g CaCO_3 11g of CO_2 is obtained then find % purity of CaCO_3

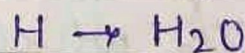


Given : 50 g
impurity = 50 - 25 = 25g
% impurity = $\frac{25}{50} \times 100 = 50\%$

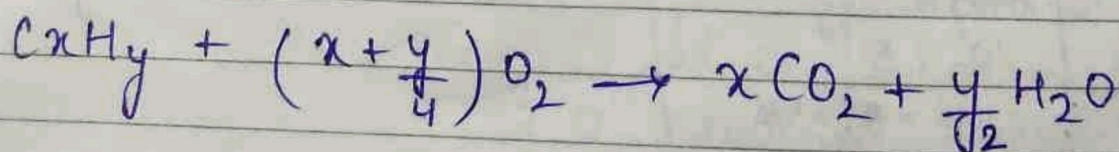
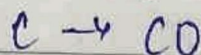
% purity = 100 - 50 = 50%

Combustion Reaction :-

Complete Combustion :- O_2 (excess)



Incomplete Combustion :- O_2 (limited)

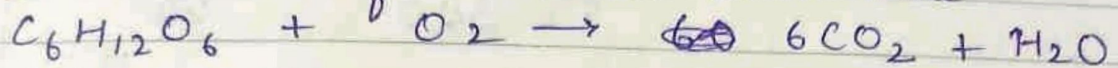


Balancing a Combustion Reaction :-

I Write a combustion reaction



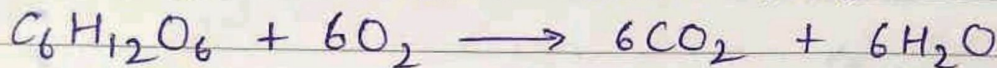
II Balance no. of C-atoms both side



III Balance no. of H-atom both side



IV Balance O-atom both side



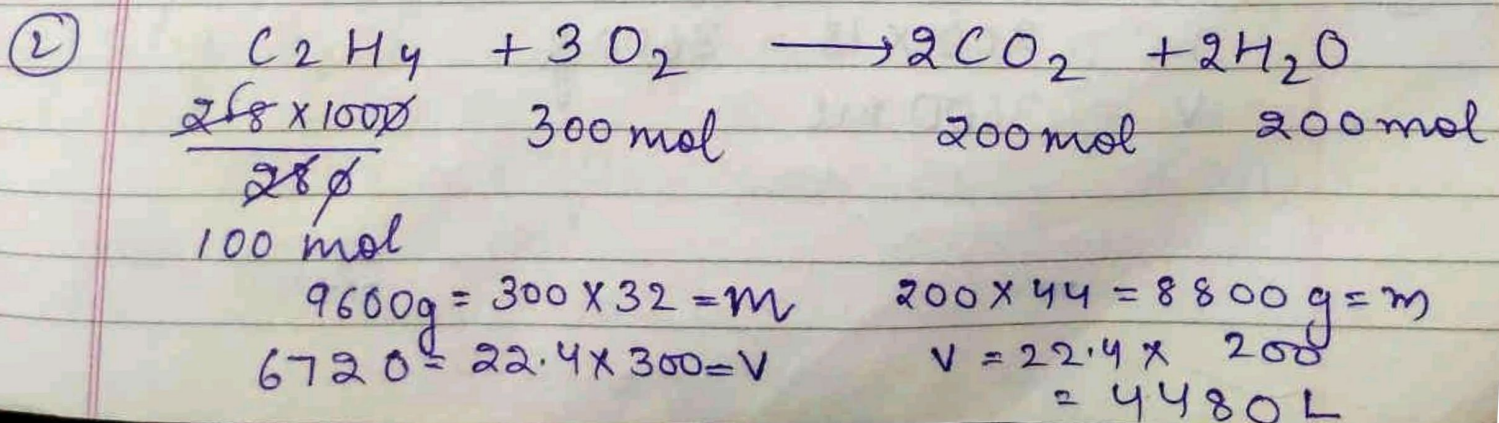
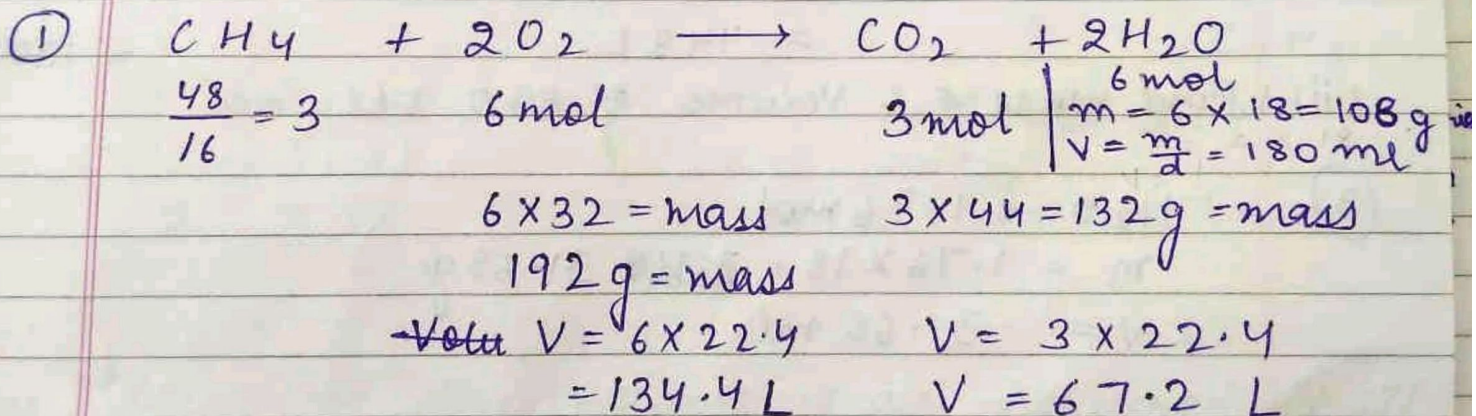
Ques For the following combustion reaction at STP

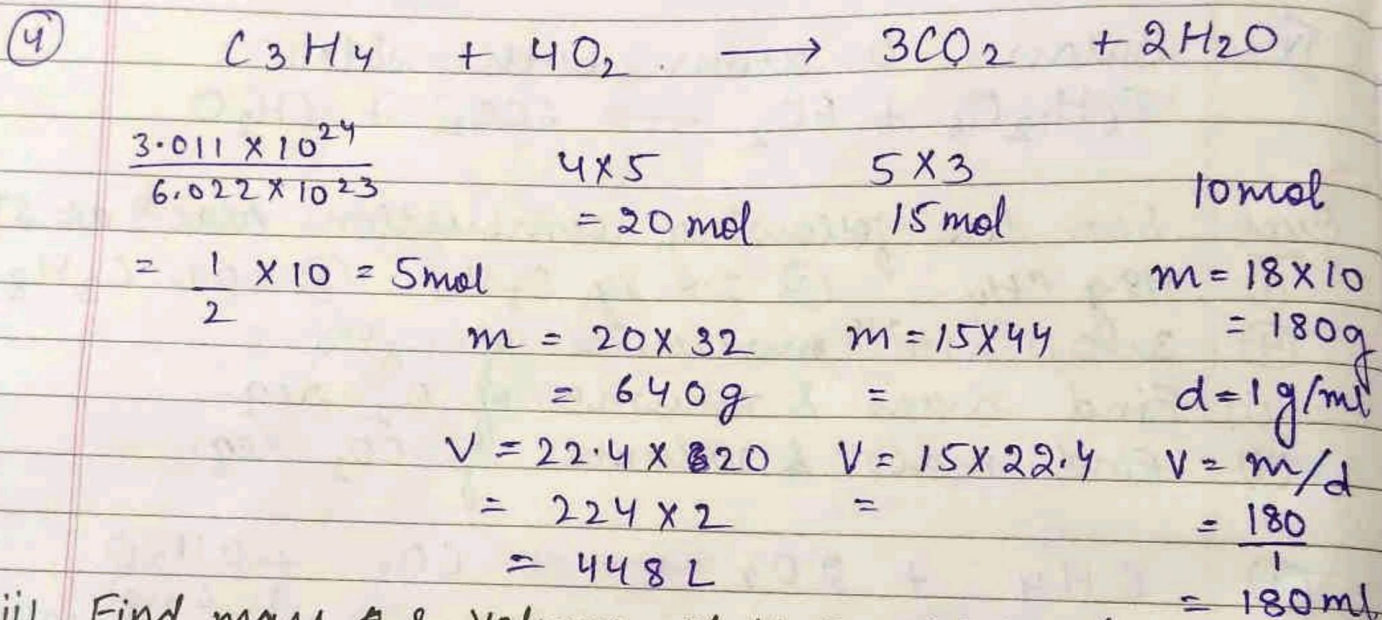
① 48 g CH_4 ② 2.8 kg C_2H_4 ③ 10 L C_3H_8

④ 3.011×10^{24} molecules of C_3H_4

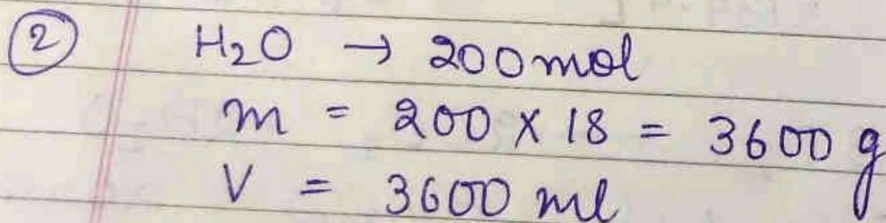
(i) Find mass & volume of O_2 req.

(ii) Find mass & volume of CO_2 req.

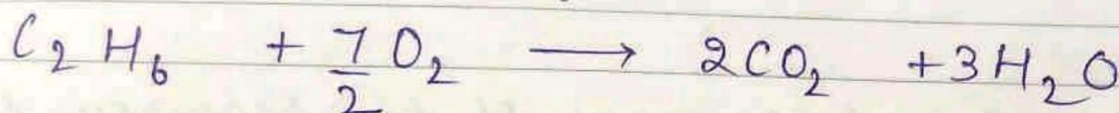




(iii) Find mass & volume of H_2O obtained



Ques = Calculate the vol. of O_2 required at STP during the combustion of C_2H_6 if vol. of H_2O formed is H_2O ~~108~~ ¹⁰⁸ ml
[$d_{H_2O} = 1g/ml$]



108 ml

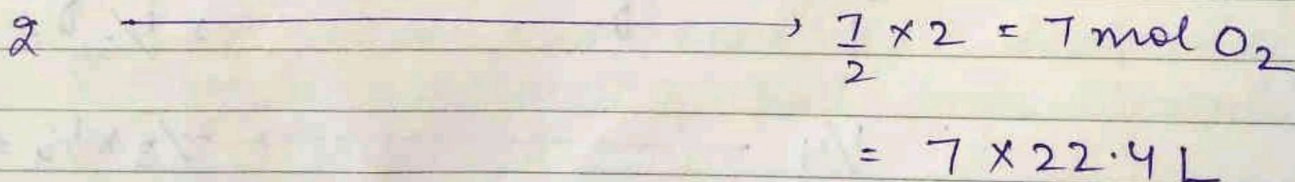
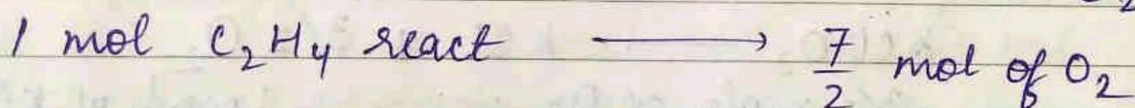
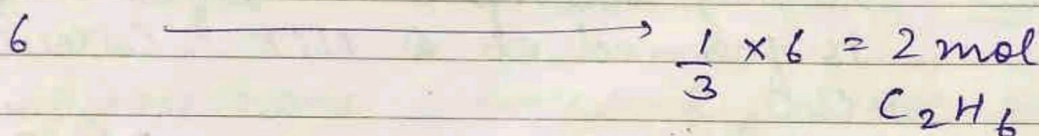
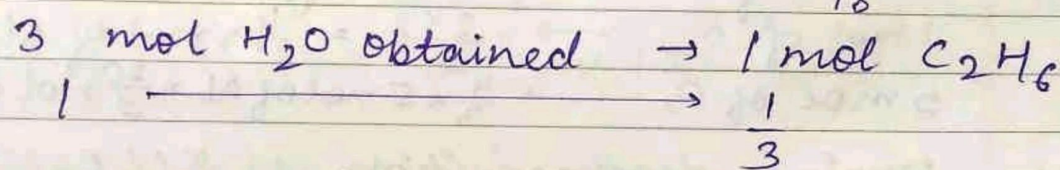
$$m = d \times V$$

$$= 1g/ml \times 108ml$$

$$= 108g$$

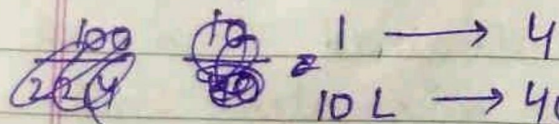
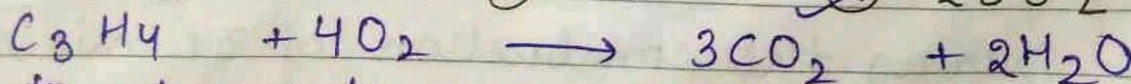
$$\frac{108}{18} = 6 \text{ mol}$$

3 mol $H_2O \rightarrow \frac{7}{2}$ mol of O_2
1 mol $\rightarrow \frac{7}{6}$
6 $\rightarrow \frac{7}{6} \times 6 = 7$ mol of O_2



Ques Calculate the volume of air required at STP for complete combustion of 10L C_3H_4 ?
Note: atmospheric air contain 20% O_2 ?

- ① 40L ② 80L ③ 120L ④ 200L



20% O_2 in air

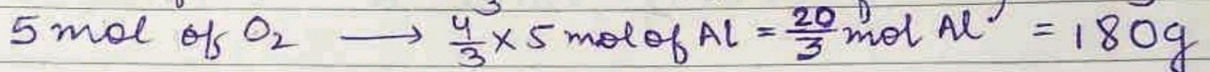
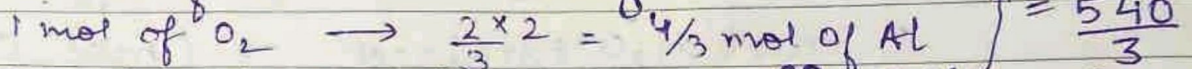
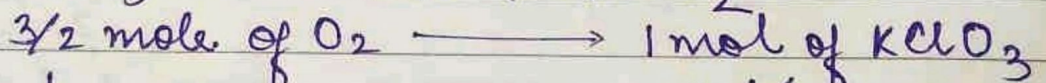
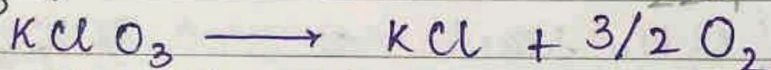
40 L

$$\frac{100}{20} \times 40$$

$$= 200 \text{ L}$$

$$\frac{112 \text{ g}}{22.4} = \frac{10 - 5 \text{ mol}}{2}$$

$$m = \frac{20}{3} \times 27$$


$$\frac{5.6}{22.4} = \frac{1}{4}$$


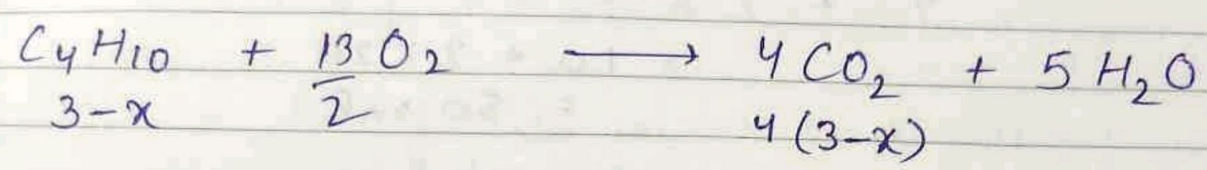
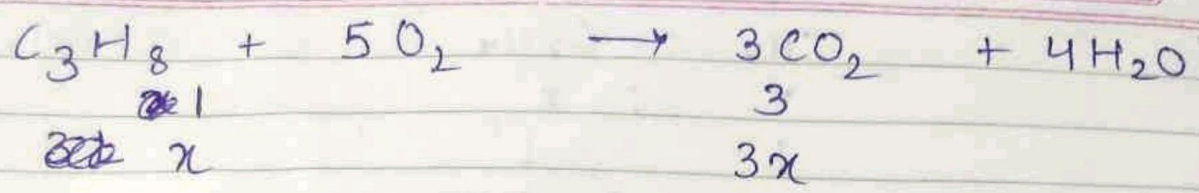
$$1 \text{ mol} \rightarrow \frac{1}{3/2} = \frac{2}{3} \text{ mol}$$

$$\frac{1}{4} \longrightarrow \frac{2}{3} \times \frac{1}{4} = \frac{1}{6} \times 122.5g$$

$$= \frac{12265}{60}$$

$$= 2.4 \text{ g}$$

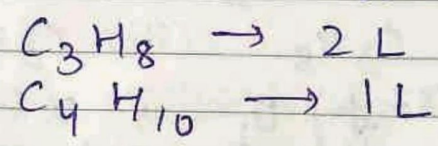
Ques During the combustion of 3 L mix of propane & butane 10 L of CO_2 is obtained. Find Vol. of propane & butane in mix also find % composition of mixture.



$$3x + 4(3-x) = 10$$

$$x = 2\text{L}$$

$\text{C}_3\text{H}_8 \rightarrow 2\text{L}$
 $\text{C}_4\text{H}_{10} \rightarrow 1\text{L}$

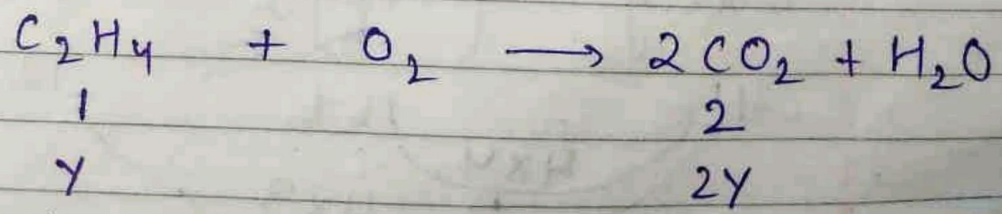
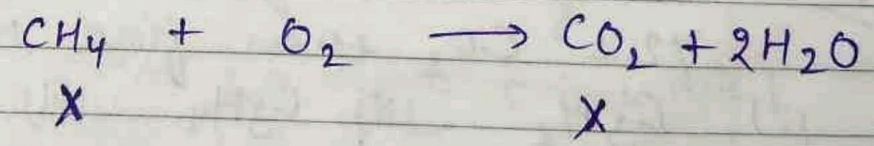


$$\% \text{ comp. } \text{C}_3\text{H}_8 = \frac{2}{3} \times 100 = 66.6$$

$$\% \text{ comp. } \text{C}_4\text{H}_{10} = \frac{1}{3} \times 100 = 33.3$$

Ques A mix of methane & ethylene in vol. ratio of $x:y$ has a total vol. of 30 ml. On complete combustion it gives 40 ml CO_2 . If ratio had been $y:x$ instead of $x:y$. What vol. of CO_2 had been obtained.

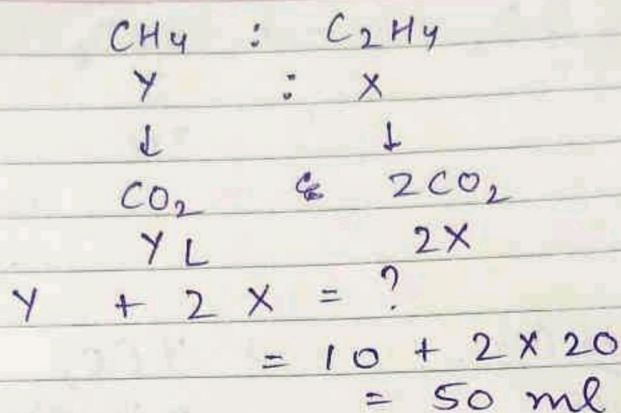
$\text{CH}_4 \quad x$
 $\text{C}_2\text{H}_4 \quad y$



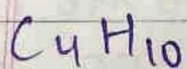
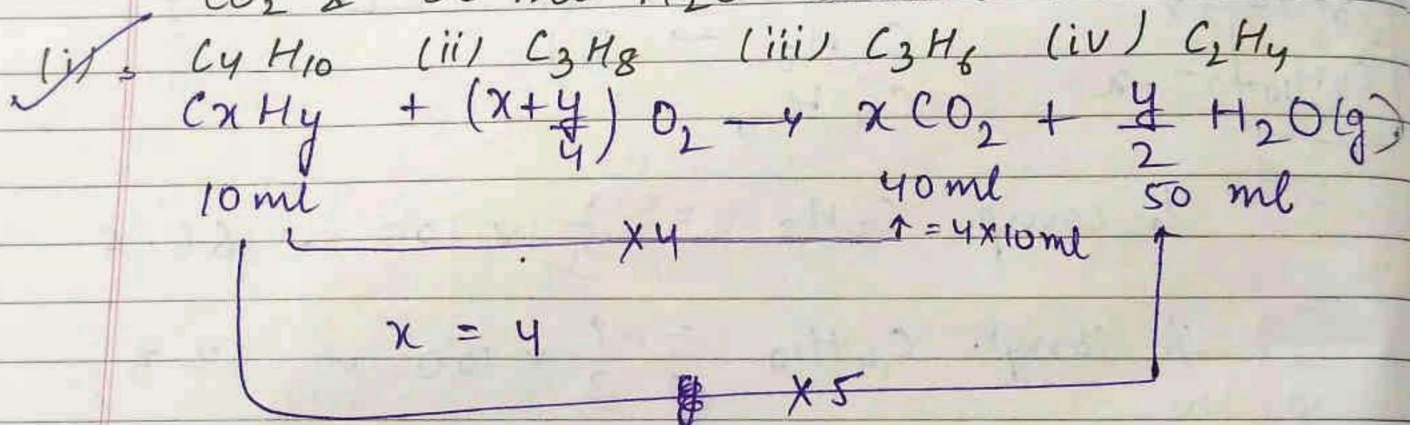
$$x + y = 30\text{ml} \quad \text{--- (1)}$$

$$x + 2y = 40\text{ml} \quad \text{--- (2)}$$

$$\begin{array}{l} y = 10\text{ml} \\ x = 20\text{ml} \end{array}$$

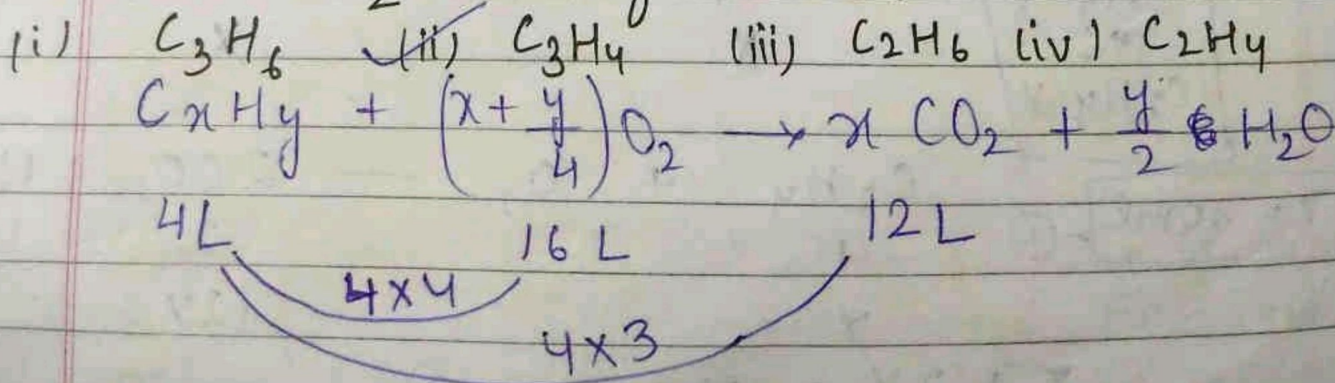


Ques 10 ml of Hydrocarbon on combustion give 40 ml CO_2 & 50 ml H_2O steam then HC is



$$\begin{aligned}
 \frac{y}{2} &= 5 \\
 y &= 10
 \end{aligned}$$

Q. 4 L of HC required 16 L of O_2 to produce 12 L CO_2 then find HC?



$$x = 3$$

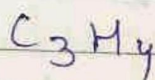
$$x + \frac{y}{4} = 4$$

$$3 + \frac{y}{4} = 4$$

$$\frac{12 + y}{4} = 4$$

$$12 + y = 16$$

$$y = 16 - 12 = 4$$



Limiting Reagent :-

The reactant which is consumed completely in reacⁿ is c/a L.R.

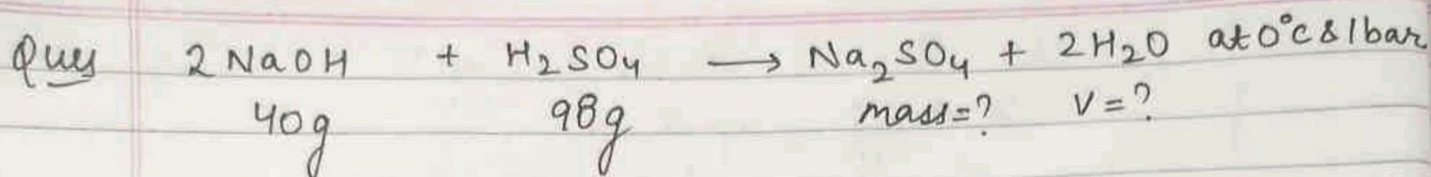
Excess Reagent :- The reactant which is not consumed completely in reacⁿ.

Note :- Extent of reacⁿ is decided by L.R.

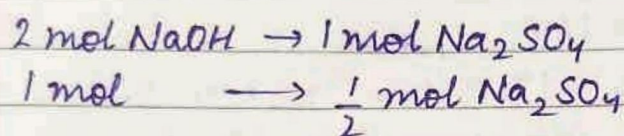
$$L = \frac{\text{no. of moles of reactants}}{\text{Stoichiometry coefficient}}$$

The reactants which have least value L is c/o L.R.

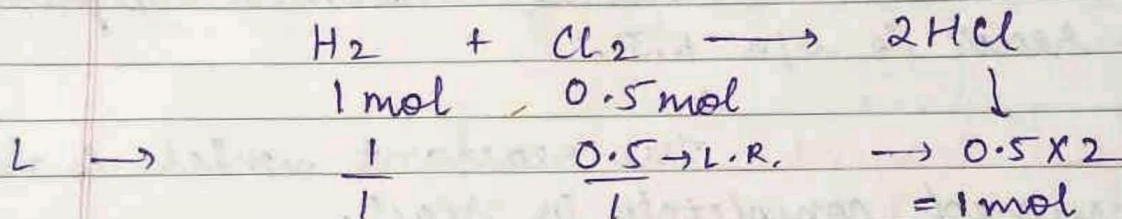
Note :- Ques. solve करते समय LR जरूर check करें।



$n = \frac{40}{40} = 1$ $\frac{98}{98} = 1$ $\frac{1}{2} \times 142$ $2\text{ mol NaOH} \rightarrow 2\text{ mol H}_2\text{O}$
 $1\text{ mol} \rightarrow 1\text{ mol H}_2\text{O}$
 $L \Rightarrow \boxed{\frac{1}{2} = 0.5}$ $\frac{1}{1} = 1$ $= 719$ $= 18\text{g}$
 $= 18\text{ml}$

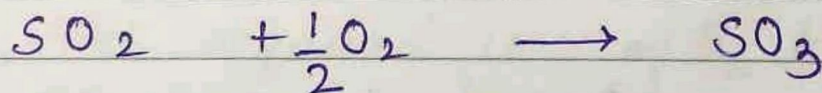


Ques 1 mol of H_2 gas react with 0.5 mol of Cl_2 gas then find no. of moles of HCl formed?



Ques 24×10^{23} molecules of SO_2 react with 128g of O_2 find ① mass & volume of SO_3 obtained at STP which is L.R.

② amount of E.R. reagent left.



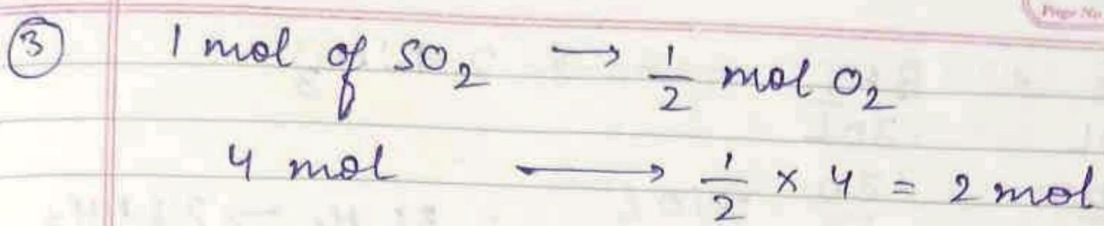
$\frac{24 \times 10^{23}}{6 \times 10^{23}} = 4\text{ mol}$ $\frac{128}{32} = 4\text{ mol}$

4 mol
 $m = 4 \times 80 = 320$

$L \rightarrow \frac{4}{1} = 4$ $\frac{4 \times 2}{1} = 8$
L.R.

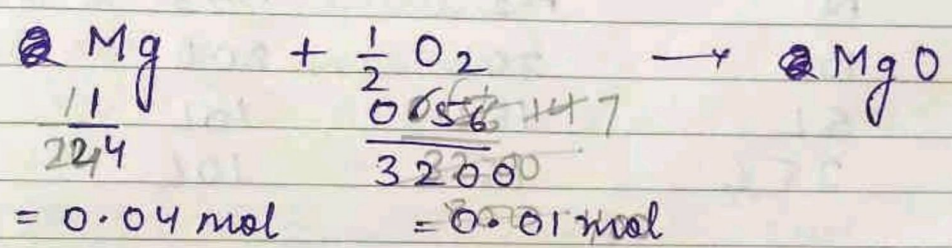
$V = 4 \times 22.4 = 89.6\text{L}$





moles of O_2 left = $4 - 2 = 2 \text{ mol}$
~~32~~ = $2 \times 32 \text{ g}$
 $= 64 \text{ g}$

Ques 1g Mg is burnt in 0.56g oxygen then find which reagent is left in reaction mixture & How much?



L $\rightarrow 0.0404$ $= 0.01 \times 2$
 $\frac{0.04}{1} \quad \frac{0.61 \times 2}{0.62 \text{ R.}}$

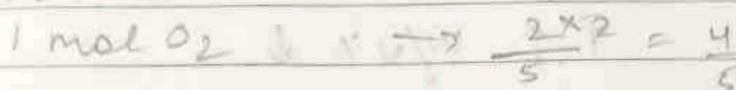
$\frac{1}{2} \text{ mol of O}_2 \text{ react with } \rightarrow 1 \text{ mol Mg}$
 $\frac{1}{1/2} = 2 \text{ mol Mg}$
 $\frac{0.56}{32} \rightarrow 2 \times \frac{0.56}{32} \text{ mol Mg}$
 $= 2 \times \frac{0.56}{32} \times 24$
 $= 0.84 \text{ g}$

Ques 30L of dinitrogen react with 30L of hydrogen to give 50% of expected yield? Then composition of reaction mixture is -



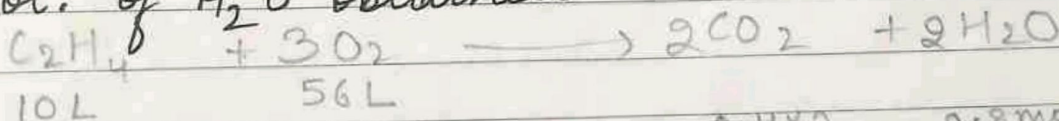
L → $\frac{8}{1} \quad \frac{5}{5/2} = \frac{10}{5} = 2$ $V = 4 \times 22.4$
 $V = 89.6 L$

L.R.



Ques 10 L of ethylene react with 56 L O_2 then find
① mass of CO_2 obtained.

② Vol. of H_2O obtained



10 L

56 L

n

$\frac{100}{22.4} = 0.4$

$\frac{56}{22.4} = \frac{10}{4} = \frac{5}{2} = 2.5$

0.4×2

0.8 mol

$= 0.8 \text{ mol}$

$m = 0.8 \times 44$

$m = 0.8 \times 18$

$= 14.4 g$

$= 35.2 g$

$V = 14.4 ml$

L

$\frac{0.4}{1} = 0.4$
L.R.

$\frac{2.5}{30} = \frac{5}{6} = 0.6$

Ques Which of the following concentration term is does not depend upon T ?

- (i) Molarity (ii) Molality (iii) Normality
(iv) All of above.

T depends on →

① Molarity = $\frac{n}{V}$ $T \uparrow M \downarrow$

② Molality = $\frac{n}{W}$

- (3) Normality = $\frac{\text{no. of eq.}}{V}$
- (4) w/w % no effect
- (5) v/v % no effect
- (6) w/v % + ↑ w/v % ↓
- (7) mole fraction no effect

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