☆ Mole Concept ☆

mole – Mole is the S.I unit for any substance.

→ 1 Mole is that quantity which contains as many as entities as there are atoms in exactly 12 gram of C_{12}-isotope

→ Result

There are 6.022×10^{23} atoms in exactly 12 gram of C-12 isotope.

$6.022 \times 10^{23} = N_A =$ ~~Avogadro's~~ Avogadro's Number

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

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

1 mole neutrons $= 6.022 \times 10^{23}$ neutrons $= N_A$ Neutrons.

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

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

12 → number ⇒ 1 dozen → Counting unit

100 → century → counting unit

6 ball → 1 over → counting unit

6.022×10^{23} Entities → 1 mole entities → counting unit

12.044×10^{23} O-atoms

⇓

2 mol O-atoms

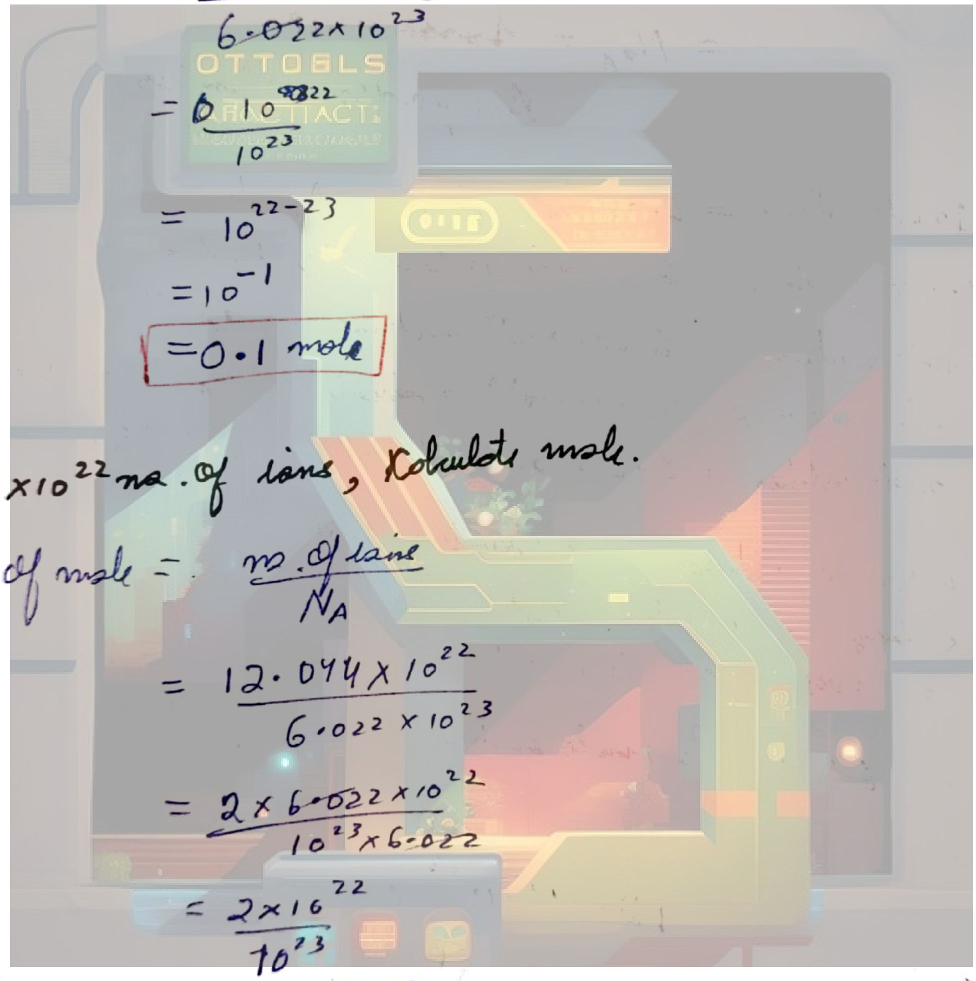
6.022×10^{24} Protons ⇒ 10 mol Proton

$$\text{no. of moles of any entity} = \boxed{\frac{\text{Total no of entity}}{6.022 \times 10^{23} (N_A)}}$$

Q1. 6.022×10^{22} no. of proton, calculate mole of proton.

$$\text{no. of mole} = \frac{\text{no. of proton}}{N_A}$$

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



$$= \frac{10^{22}}{10^{23}}$$

$$= 10^{22-23}$$

$$= 10^{-1}$$

$$\boxed{= 0.1 \text{ mole}}$$

Q2. 12.044×10^{22} no. of ions, calculate mole.

$$\text{no. of mole} = \frac{\text{no. of ions}}{N_A}$$

$$= \frac{12.044 \times 10^{22}}{6.022 \times 10^{23}}$$

$$= \frac{2 \times 6.022 \times 10^{22}}{10^{23} \times 6.022}$$

$$= \frac{2 \times 10^{22}}{10^{23}}$$

$$= 2 \times 10^{22-23}$$

$$= 2 \times 10^{-1}$$

$$= 2 \times 0.1$$

$$\boxed{= 0.2 \text{ mole}}$$

Q Q3. A vessel contains 6.022×10^{22} "Helium" atoms.

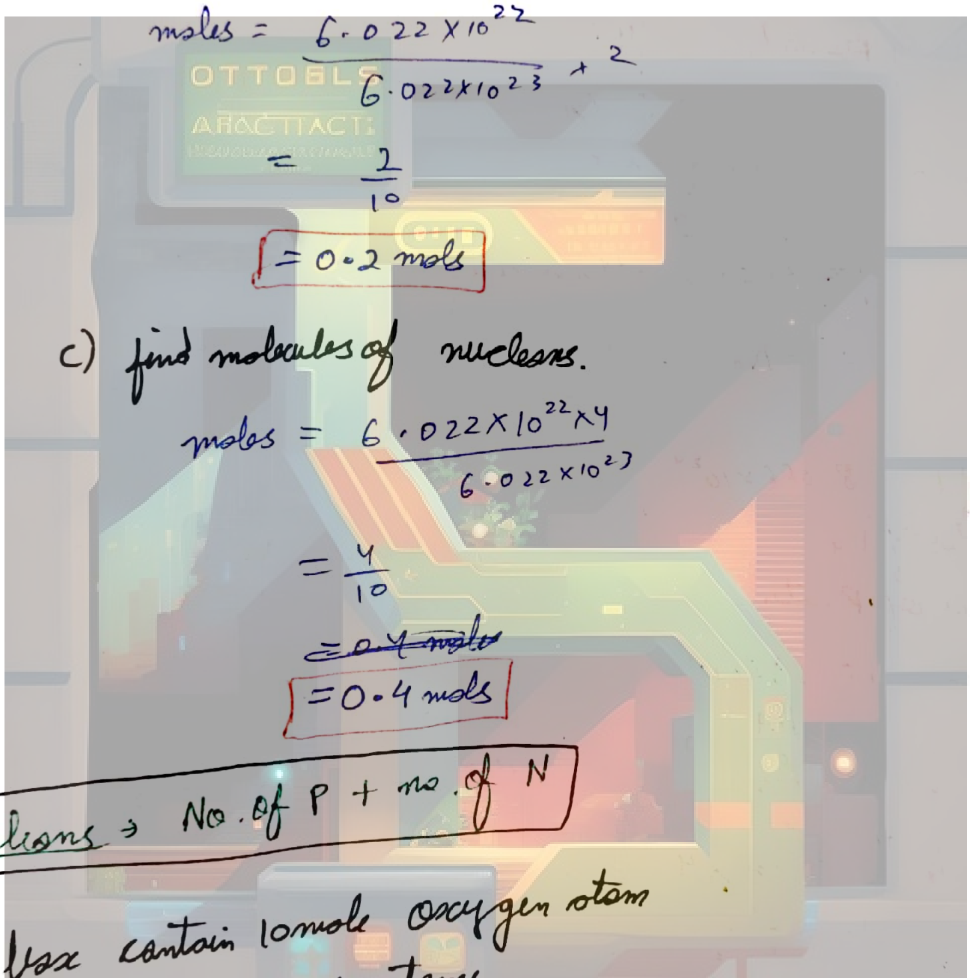
a) find moles of 'He'

$$\text{moles} = \frac{6.022 \times 10^{23}}{6.022 \times 10^{23}}$$

$$\boxed{= 0.1 \text{ mole}}$$

b) find moles of e^-

no. of e^- in one Helium = 2



$$\text{moles} = \frac{6.022 \times 10^{22}}{6.022 \times 10^{23}} \times 2$$

$$= \frac{2}{10}$$

$$\boxed{= 0.2 \text{ mols}}$$

c) find molecules of nucleons.

$$\text{moles} = \frac{6.022 \times 10^{22} \times 4}{6.022 \times 10^{23}}$$

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

~~= 0.4 mols~~

$$\boxed{= 0.4 \text{ mols}}$$

$\boxed{\text{Nucleons} \Rightarrow \text{No. of P} + \text{no. of N}}$

Q4. A box contain 10 mole oxygen atom

a) find no. of oxygen atoms

b) find no. of proton, e^-, n in the box

c) find max no. of O_2 can be produced

a) no. of atoms $= N_A \times 10$

$\boxed{= 6.022 \times 10^{24} \text{ atoms}}$

b) no. of $e^- =$ no. of atoms $\times 8$

$= 6.022 \times 8 \times 10^{24} e^-$

$\boxed{= 48.176 \times 10^{24} e^-}$

no of proton $\boxed{= 48.176 \times 10^{24} e^-}$

no. of ~~Pro~~ neutron $= \boxed{48.176 \times 10^{24} e^-}$

$= 80 N_A$

c) no. of $O_2 = \dfrac{\text{no. of atoms}}{2}$

$\boxed{= 3.011 \times 10^{24} \text{ molecules}}$

$= 5 N_A$

Q5. no. of $P_4 = 18.066 \times 10^{24}$

a) moles of P_4

b) moles of P-atom

a) moles $= \dfrac{18.066 \times 10^{24}}{NA}$

$\boxed{= 30 \text{ moles}}$

b) moles of P-atom $= 30 \text{ moles} \times 4$

$\boxed{= 120 \text{ moles}}$

~~Q5. H_2SO_4~~

~~Note~~

Q6. 2 mole of H_2SO_4 is presen.

a) Calculate no. of Hydrogen atoms

no. of H atom in 1 H_2SO_4 → 2

~~2 mole~~

1 mole → 2 ~~mole~~ N_A

no. of H atom in 2 mole H_2SO_4 → ~~4 moles~~ $\boxed{4N_A}$

b) no. of neutron

in 1 H_2SO_4 → 0 + 16 + 8(4)

→ 32 + 16

→ 48

in 2 mole $\boxed{\rightarrow 96\ N_A}$

c) no. of moles of O-atoms.

in 1 H_2SO_4 → 4 O-atom

2 mol → $\boxed{8 \text{ mole}}$

d) Total no. of atoms.

1 H_2SO_4 → 7 atom

2 mole → $\boxed{14\ N_A}$

e) no. of proton in S-atom.

no. of Proton in 1 H_2SO_4 → 16

2 moles → $\boxed{32\ N_A}$

f) moles of neutrons present in H-atom

$\boxed{0 \text{ mole}}$

g) no. of e^- in O-atom

no. of e^- in 1 H_2SO_4 of O → 32

no of e^- in 2 mole H_2SO_4 → $\boxed{64\ N_A}$

Q7. Calculate charge on 1 mole e^-

~~charge on 1 e^- → 104.8 $\times 10^{-18}$~~

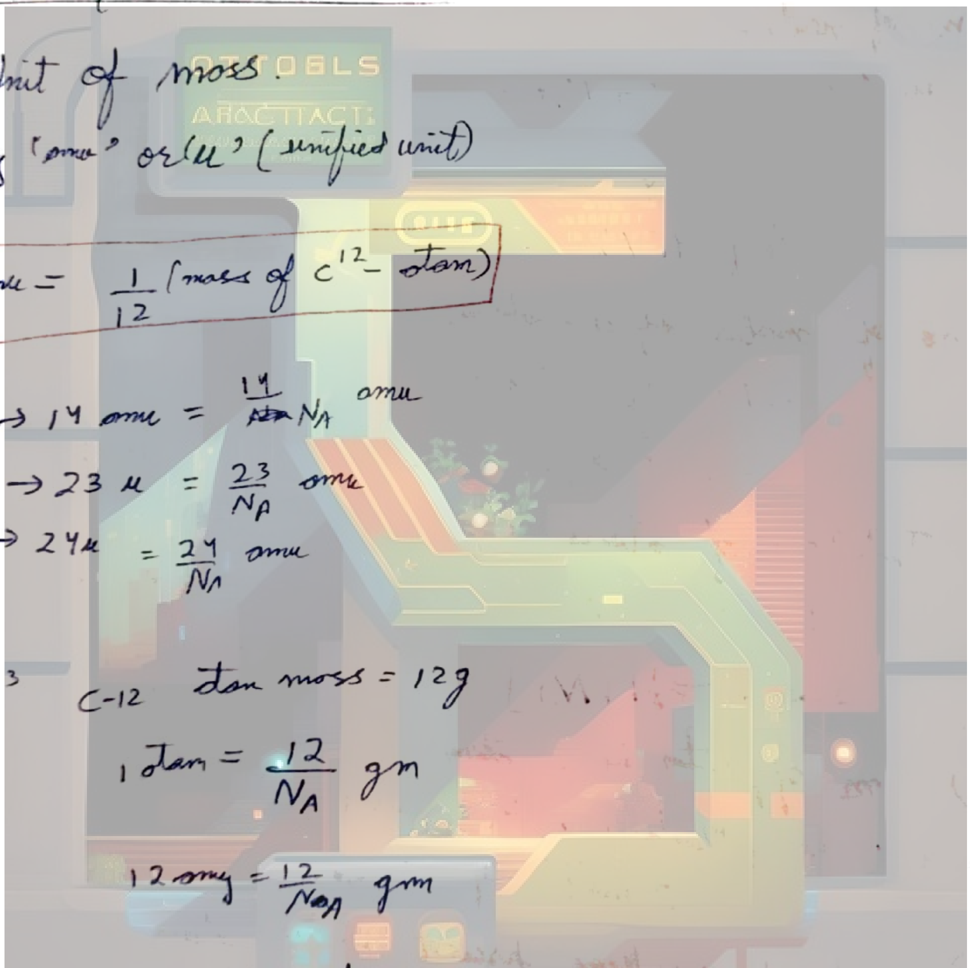
charge on 1 e^- → 1.6×10^{-19} Cb

in 1 mole $= 1.6 \times 10^{-19} \times 6.022 \times 10^{23}$

$= 9.6352 \times 10^{6}$

$\boxed{\text{Exact} = 96500 \text{ Cb}}$

Concept of AMU (Atomic Mass Unit)



→ Smallest Unit of mass.

→ Denoted by 'amu' or 'u' (unified unit)

$\boxed{1 \text{ amu} = \frac{1}{12} (\text{mass of } C^{12} - \text{atom})}$

Eg. $N \rightarrow 14 \text{ amu} = \frac{14}{N_A}$ amu

$Na \rightarrow 23\,u = \frac{23}{N_A}$ amu

$Mg \rightarrow 24\,u = \frac{24}{N_A}$ amu

→ 6.022×10^{23} C-12 atom mass = 12g

$1 \text{ atom} = \frac{12}{N_A}$ gm

$12 \text{ amu} = \frac{12}{N_A}$ gm

$1 \text{ amu} = \frac{1}{N_A}$ gram

$\boxed{1 \text{ amu} = 1.67 \times 10^{-24} \text{ gram}}$

Types of atomic Mass

(1) Relative atomic mass (RAM):-

$$RAM = \frac{\text{mass of single atom}}{\frac{1}{12} \times (\text{mass of single C-12 atom})}$$

eg. N →

$$RAM = \frac{14 \text{ amu}}{\frac{1}{12}(12 \text{ amu})} = 14$$

→ It has no unit.

atom	Atomic mass	RAM
N	14 amu	14
O	16 amu	16
Na	23 amu	13

Note:- If atomic mass is given but unit is not written then we assume it to be RAM.

Q 8. find mass of 1 N-atom in kg ?

$1 \text{ N-atom} = 1 \text{ u} \times 14$

$1 \text{ N-atom} = \frac{1}{N_A} \text{ gram} \times 14$

$= \cancel{\frac{1000}{N_A} \text{ kg}}$

$= \frac{1}{1000 N_A} \times 14$

$$\boxed{= \frac{14}{1000 N_A} \text{ kg}}$$

Q9. Relative atomic mass on conventional scale is 14 for Nitrogen atom. Suppose a new system is designed in which 1 amu = $\frac{1}{6}$ mass of single C-12 atom. Then find new relative mass.

$$RAM = \frac{14}{\frac{1}{6} \times 12}$$

$$= \frac{14}{2}$$

$$\boxed{= 7}$$

② Gram-Atomic-Mass (GAM)

→ mass of 1 mole atoms in "gm"

or

mass of N_A atoms in "gm"

Eg. N-atom

1 N-atom mass = 14 amu = $\frac{14}{N_A}$ gram

1 mole N-atom mass = $\frac{14}{N_A} \times N_A = 14g$

→ GAM = 1 mole atoms mass = N_A atoms mass ⇒ gram

atom	RAM	GAM	A.M
N	14	14 g	14 u
O	16	16 g	16 u
Mg	24	24 g	24 u

Q10. N-atom has 28 grams? mole?

$14g = 1 \text{ mole}$

$\frac{28}{14} = \boxed{2 \text{ mole}}$

$$\boxed{\text{no. of mole} = \frac{\text{given weight in gram}}{GAM}}$$

Q11. A closed vessel contain 64g of oxygen-atom.

① find mole of O-atom

$\frac{64}{16} = \boxed{4 \text{ mole}}$

② no. of O-atom.

$\boxed{4 N_A}$

③ find moles of proton in atom.

$8 \times 4 = \boxed{32 \text{ mole}}$

Q12. A container contains 32 mg S^{2-} ions.

① find moles of S^{2-} ions.

$\boxed{1 \text{ mole}}/1000$

② find Total no. of S^{2-} ions.

$\boxed{N_A}/1000$

③ no. of e^- in container

$16N_A + 2N_A = \boxed{18N_A}/1000$

③ Average Atomic Mass

→ Many atoms exist in different isotopic form. In such cases we can calculate average atomic mass. To calculate average atomic mass, we need to know relative abundance of these isotopes in nature

$$\overset{m_1}{X}, \overset{m_2}{X}, \overset{m_3}{X} \ldots$$

$n_1 \quad n_2 \quad n_3$ (relative abundance in mole)

$$\text{Total Moles} = \frac{\text{Total mass in gram}}{\text{Average atomic mass}}$$

$$n_1 + n_2 + n_3 = \frac{n_1 m_1 + n_2 m_2 + n_3 m_3}{\text{Avg mass}}$$

when mole is given

$$\text{Average atomic mass} \boxed{= \frac{n_1 m_1 + n_2 m_2 + n_3 m_3}{n_1 + n_2 + n_3}} = \boxed{\frac{\Sigma n_i m_i}{\Sigma n_i}}$$

$$\text{Average atomic mass} = \boxed{m_1 x_1 + m_2 x_2 + m_3 x_3}$$ when % is given.

$x_1, x_2, x_3 \rightarrow$ fraction of x^n isotope

Q13. ^{35}Cl 75 mole, ^{37}Cl 25 mol.

find Avg atomic mass of Cl atom

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

$\boxed{= 35.5}$ g/mol

Q.14 Chlorine has two isotopes Cl^{35} & Cl^{37} with having 75% by mole abundance of Cl^{35} in nature. find the avg atomic mass of Cl-atom?

$$Avg = 35 \times 0.75 + 37 \times 0.25$$

$$\boxed{= 35.5} \text{ g/mol}$$

Q15. If an element exist in two isotopic form in ^{30}X & X^{32}. ~~stop~~ Avg mass is 30.2. find % abundance by mole of lighter element.

$$30.2 = \frac{30x + 32(100-x)}{100}$$

$$3020 = 30x + 3200 - 32x$$

$$2x = 3200 - 3020$$

$$\boxed{x = 90\%}$$

Q16. Boron has 2 isotopes B^{10} & B^{11}, if avg atomic mass is 10.8. find abundance % of both.

$$10.8 = \frac{10x + 11(100-x)}{100}$$

$$1080 = 10x + 1100 - 11x$$

$$x = 1100 - 1080$$

$$x = 20$$

$$\boxed{\begin{aligned} B^{10} &= 20\% \\ B^{11} &= 80\% \end{aligned}}$$

Q17. 'A' has 3 isotopes A^{18}, A^{20}, A^{22}. % abundance of A^{18} is 20%. & avg atomic mass = 20.4 g/mol. find abundance of remaining isotope.

$$20.4 = \frac{18\times 20 + 20\times x + 22(80-x)}{100}$$

$$2040 = 360 + 20x + 1760 - 22x$$

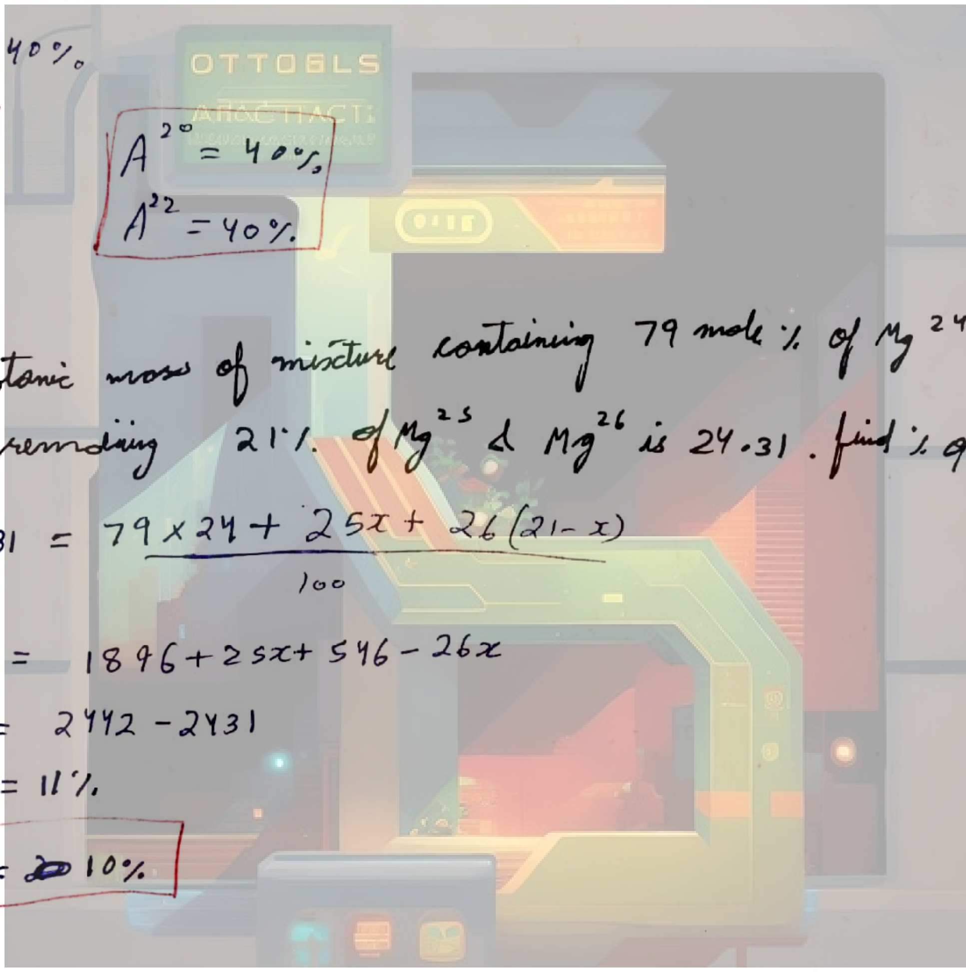
$$2x = 2120 - 2040$$

$$x = 40\%$$

$\cancel{A^{20} = 80\%}$

$\cancel{A^{22} = 2\%}$

$$\boxed{\begin{aligned} A^{20} &= 40\% \\ A^{22} &= 40\% \end{aligned}}$$



Q18. Avg atomic mass of mixture containing 79 mole % of Mg^{24} and remaining 21% of Mg^{25} & Mg^{26} is 24.31. find % of Mg^{26}.

$$24.31 = \frac{79\times 24 + 25x + 26(21-x)}{100}$$

$$2431 = 1896 + 25x + 546 - 26x$$

$$x = 2442 - 2431$$

$$x = 11\%$$

$$\boxed{Mg^{26} = \cancel{20}\ 10\%}$$

Types of Molecular mass

① Mass of a single molecule

1. $O_2 \rightarrow m(O) \times 2 \rightarrow 16 \times 2 \rightarrow 32$ amu $\rightarrow \frac{32}{N_A}$ gram

2. $H_2O \rightarrow m(O) \times 1 + m(H) \times 2 \rightarrow 2 + 16 \rightarrow 18$ amu $\rightarrow \frac{18}{N_A}$ g

② Relative Molecular Mass (R.M.M)

$$RMM = \frac{\text{mass of single molecule}}{\frac{1}{12}(\text{mass of single C-12 isotope})}$$

Molecular

molecule	molecular mass	RMM	GMM
O_3	48 amu	48	48 g
O_2	32 amu	32	32 g
D_2O	20 amu	20	20 g
N_2	28 amu	28	28 g
CO_2	44 amu	44	44 g
H_2SO_4	98 amu	98	98 g

③ Gram - Molecular Mass (GMM)

→ mass of 1 mole molecules in gram
or
mass of N_A molecules in gram

$O_2 \rightarrow 32g$

no. of mols of molecules = $\frac{\text{given weight in g}}{\text{GMM}}$

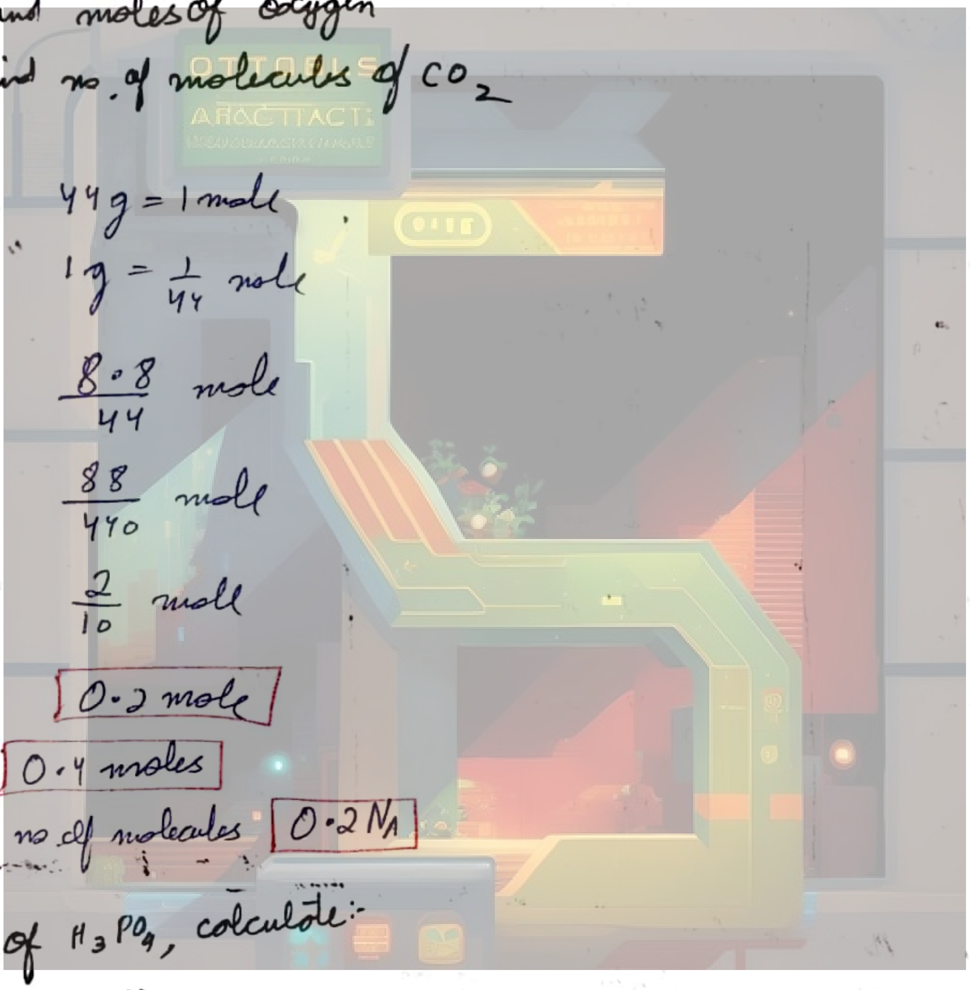
<u>Note</u>:- If molecular mass is given & unit is not given, we assume R.M.M.

Q19. A Closed Vessel contains $8.8\,g\ CO_2$ ~~fo~~

a) find mole of CO_2

b) find moles of oxygen

c) find no. of molecules of CO_2



a) $44\,g = 1$ mole

$1\,g = \frac{1}{44}$ mole

$\frac{8.8}{44}$ mole

$\frac{88}{440}$ mole

$\frac{2}{10}$ mole

$\boxed{0.2 \text{ mole}}$

b) $\boxed{0.4 \text{ moles}}$

c) no. of molecules $\boxed{0.2 N_A}$

Q20. 196 g of H_3PO_4, calculate:-

a) moles of H_3PO_4

b) no. of O- atoms

c) no. of H-atoms

d) no. of atoms

e) moles of proton in P- atoms

a) moles = $\frac{196}{3+64+31}$

$= \frac{196}{98}$

$\boxed{= 2 \text{ mole}}$

b) no. of O-atom in 1 H_3PO_4 = 4

in 2 N_A = $\boxed{8N_A}$

c) 1 H-atom = 3

in 2 N_A = $\boxed{6N_A}$

d) 1 molecule = 8

$2N_A$ = $\boxed{16\ N_A}$

e) in 1 P → 15

~~$1N_A$ → $15N_A$~~

~~$2N_A$ → $\boxed{30N_A}$~~

1 mole → 15 mol

2 Mole → $\boxed{30 \text{ mol}}$

$$\boxed{\text{no. of entities}} \underset{\times N_A}{\overset{\times \frac{1}{N_A}}{\rightleftarrows}} \boxed{\text{no. of moles}} \underset{\times GAM/GMM}{\overset{\times \frac{1}{GAM/GMM}}{\rightleftarrows}} \boxed{\text{given weight in grams}}$$

Important Terms

① GAM is also called atomic weight

② GMM is also called ~~atomic mass~~ molecular weight

③ no. of gram-atoms = moles of atom

④ no. of gram-molecules = moles of molecules.

Q21. A Beaker contains 180 ml of liquid H_2O. If density of water is 1g per ml. Calculate.

① no. of gram-molecules of H_2O.

② no. of gram-atoms of O-atom in Beaker.

③ Total no. of neutrons in water in terms of N_A.

$$\text{density} = \frac{\text{mass}}{\text{Volume}}$$

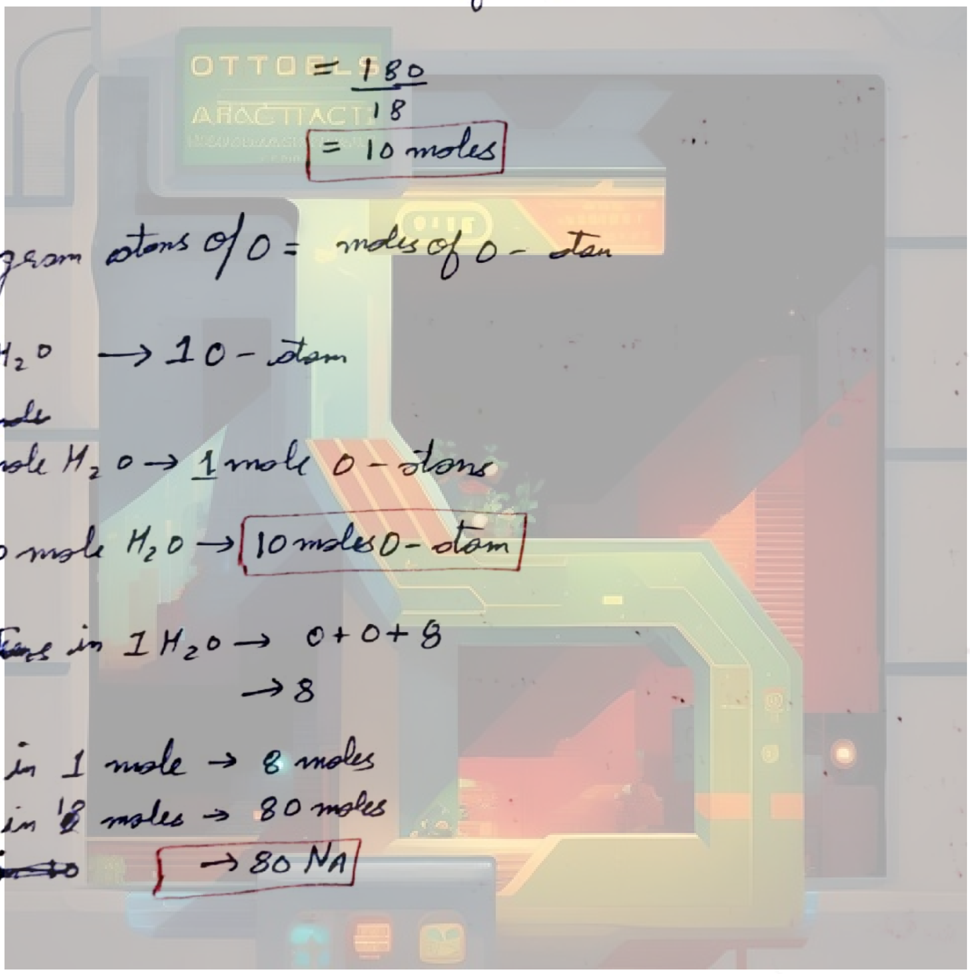
$$1\,g/ml = \frac{\text{mass}}{180\,ml}$$

$$\text{mass} = 180\,ml \times 1\,\frac{gm}{ml}$$

$$\boxed{\text{mass} = 180\ \text{gram}}$$

① no. of gram-molecules = moles of H_2O

$$= \frac{\text{mass of } H_2O \text{ in vessel}}{\text{mass of } 1\,H_2O}$$



$$= \frac{180}{18}$$

$$\boxed{= 10\ \text{moles}}$$

② no. of gram atoms of O = moles of O - atom

$1\,H_2O \rightarrow 1\,O$ - atom

~~10 mole~~

1 mole $H_2O \rightarrow 1$ mole O - atoms

10 mole $H_2O \rightarrow \boxed{10\ \text{moles O - atom}}$

③ no. of neutrons in $1\,H_2O \rightarrow 0 + 0 + 8$

$\rightarrow 8$

in 1 mole $\rightarrow$ 8 moles

in 10 moles $\rightarrow$ 80 moles

~~in 10~~ $\boxed{\rightarrow 80\,N_A}$

IDeal Gas Equation

$$\boxed{PV = nRT}$$

$P \Rightarrow$ Pressure exerted by gas
$V \Rightarrow$ Volume of gas / Container ~~gas~~ Volume
$n \Rightarrow$ no. of moles of gas
$R \Rightarrow$ Gas Constant
$T \Rightarrow$ absolute Temperature (in Kelvin scale)

Units

(1) Temperature (T):-

SI unit $\Rightarrow$ ~~Kelvin~~ Kelvin

$T(\text{Kelvin}) = T(^\circ C) + 273.15$

$T(\text{Kelvin}) = T(^\circ C) + 273$ (For easy of numericals)

Eg: $27^\circ + 273$
$= 300\,K$

(2) Volume (V):-

S.I. unit $\Rightarrow m^3$

$1\,m^3 = 1000\,l$

$1\,cm^3 = 1\,ml$

$1\,dm = 10^{-1}\,m$
$1\,cm = 10^{-2}\,m$
$1\,mm = 10^{-3}\,m$
$1\,\mu m = 10^{-6}\,m$

(3) Pressure (P)

$P = \frac{\text{Force}}{\text{Area}}$ $\quad \frac{N}{m^2}$ or Pa

$1\,atm = 1.01325 \times 10^5\,Pa$
$1\,atm = 1.01325\,bar$
$1\,atm = 760\,mm / 76\,cm$ of Hg
$1\,atm = 760\,torr$

$1\,mm$ of $Hg = 1\,torr$

eg. 38 cm of Hg = ____ atm

$78 \text{ cm Hg} = 1 \text{ atm}$

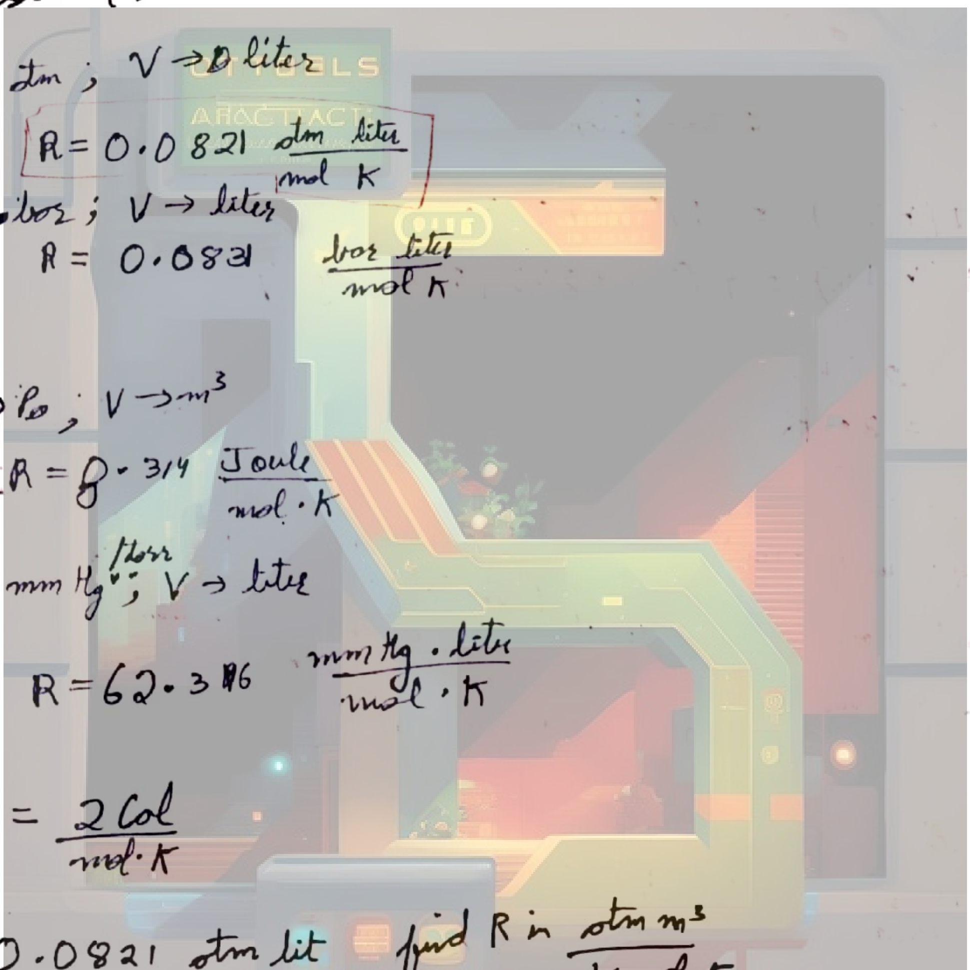
$1 \text{ cm Hg} = \frac{7}{78} \text{ atm}$

$38 \text{ cm Hg} = \frac{1}{2} \text{ atm} = 0.5 \text{ atm}$

eg. $1 \text{ atm} = 760 \text{ torr}$

$\frac{1}{2} \text{ atm} = 380 \text{ torr}$

(4) Gas Constant (R):-



(1) $P \to$ atm ; $V \to$ liter

$$\boxed{R = 0.0821 \frac{\text{atm liter}}{\text{mol K}}}$$

(2) $P \to$ bar ; $V \to$ liter

$$R = 0.0831 \frac{\text{bar liter}}{\text{mol K}}$$

(3) $P \to Pa$, $V \to m^3$

$$R = 8.314 \frac{\text{Joule}}{\text{mol} \cdot K}$$

(4) $P \to$ mm Hg / torr ; $V \to$ liter

$$R = 62.386 \frac{\text{mm Hg} \cdot \text{liter}}{\text{mol} \cdot K}$$

(5) $R = \frac{2 \text{ Cal}}{\text{mol} \cdot K}$

Q22. $R = 0.0821 \frac{\text{atm lit}}{\text{mol K}}$ find R in $\frac{\text{atm } m^3}{\text{Kmol} \cdot K}$

$$R = \frac{0.0821 \times \frac{1}{1000} \text{ atm } m^3}{\frac{1}{1000} \text{ Kmol} \cdot K}$$

$$R = 0.0821 \frac{\text{atm } m^3}{\text{Kmol} \cdot K}$$

Q23. A closed container of volume $V = 8.21\,l$ contains Helium gas at $27^\circ C$. If the pressure of the gas is 152 cm of Hg then find moles of gas.

$P = 152$ cm Hg $= 1520$ mm Hg $= 2$ atm

$V = 8.21\,l$

$T\,K = 300\,K$

$R = 62.36$

$PV = nRT$

$n = \frac{PV}{RT}$

$n = \cancel{\frac{1520 \times 8.21}{300 \times 62.36}}$

$= \cancel{\frac{152 \times 82.1}{6236}}$

$=$

$n = \frac{2 \times 8.21}{300 \times 0.0821}$

$= \frac{16.42}{24.63}$

$\boxed{= \frac{2}{3}\ mol}$

Q24. A closed container of volume $V = 44.8\,l$ contains $CD_4(g)$ at $P = 1$ atm at $0^\circ C$

i) find gram-molecules of CD_4.

ii) find weight in gram of CD_4 in container.

iii) find gram-atoms of D in container.

iv) Find total no. of neutrons.

$\frac{PV}{RT} = n$

$n = \frac{1 \times 44.8}{273 \times 0.0821}$

$n = \frac{448000}{273 \times 821}$

$n = \frac{448000}{224133}$

$n = \frac{44.8}{22.4}$

$\boxed{n = 2\ mol}$

$$\boxed{\begin{aligned} 0.0821 \times 273 &\Rightarrow 22.4 \\ 0.0821 \times 300 &\Rightarrow 24.63 \end{aligned}}$$

i) $\boxed{2\ mol}$

ii) $20 \times 2 = \boxed{40\ g}$

iii) $\boxed{8\ mol}$

iv) $\boxed{20\ N_A}$

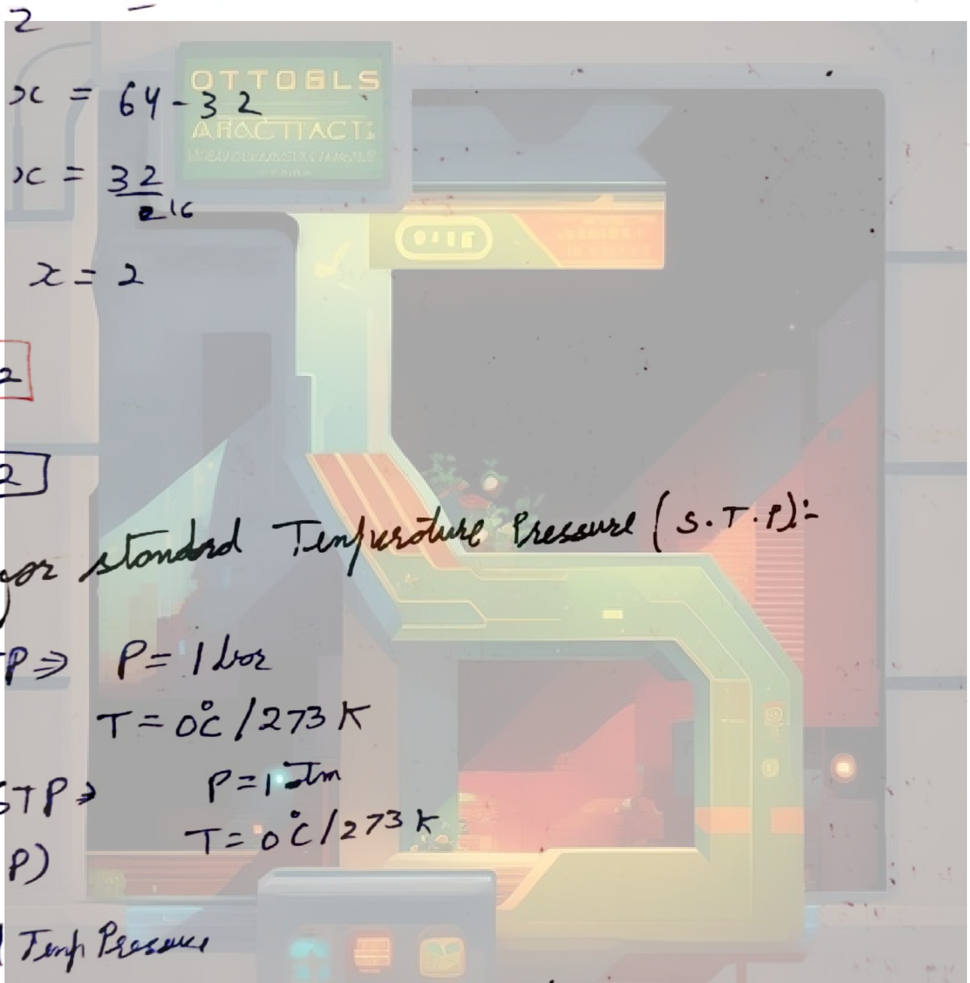
Q25. 32 g of SO_x gas is present in a container having volume 8.21 l. at 127°C and 2 atm pressure. find value of x.

$$n = \frac{PV}{RT}$$

$$n = \frac{2 \times 8.21}{400 \times 0.0821}$$

$$n = \frac{1}{2} \text{ mol}$$

$$\frac{(16x + 32)}{2} = 32$$



$$16x = 64 - 32$$

$$x = \frac{32}{16}$$

$$x = 2$$

$\boxed{SO_2}$

$\boxed{x = 2}$

Condition for standard Temperature Pressure (S.T.P):-

New STP ⇒ P = 1 bar
T = 0°C / 273 K

Old STP ⇒ P = 1 atm
(N.T.P) T = 0°C / 273 K
↓
normal Temp Pressure

Q26. find volume (in lit) of one mole gas
i) at STP
ii) at old STP

i) $V = \frac{nRT}{P}$

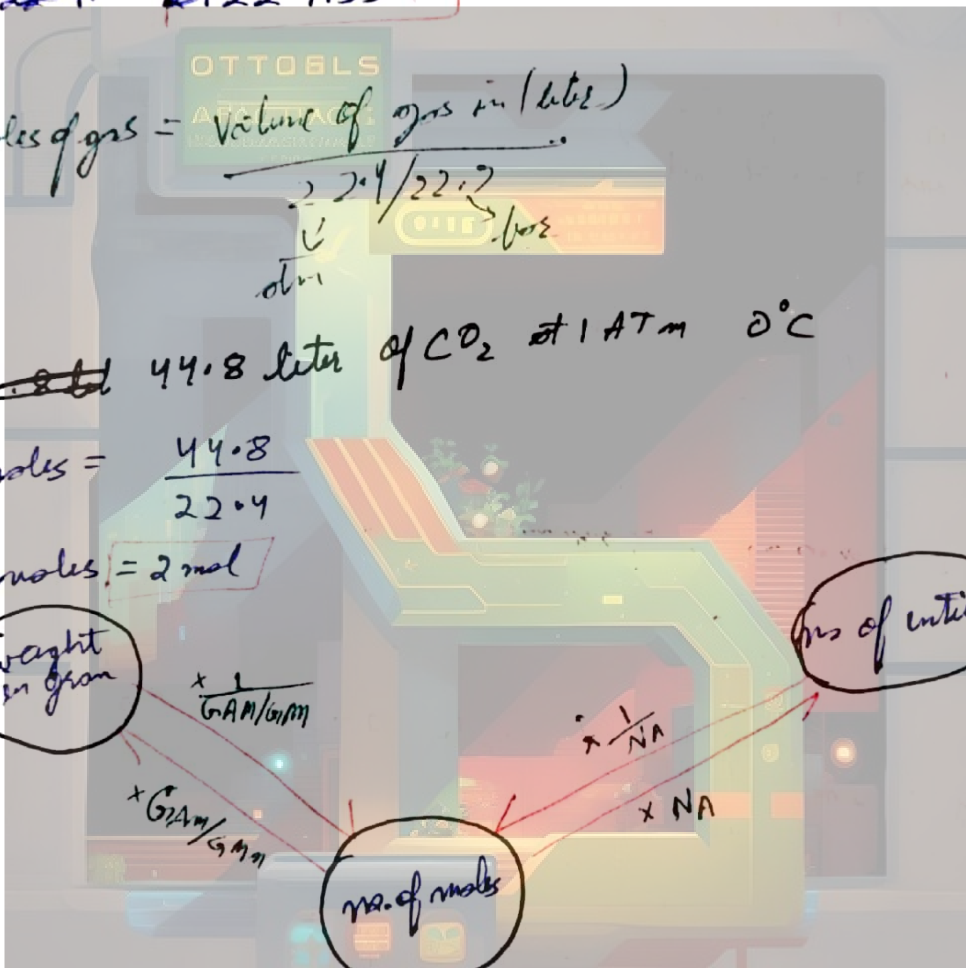
$V = \frac{1 \times 0.0831 \times 273}{1}$

$\boxed{V = 22.6863\,l} = 22.7\,l$

ii) $V = \frac{nRT}{P}$

$= \frac{1 \times 0.0821 \times 273}{1}$

$= \cancel{22.4133}\ \boxed{\cancel{21}\,22.4133\ l} = 22.4\,l$



no. of moles of gas $= \frac{\text{Volume of gas in (litre)}}{22.4/22.7}$

22.4 → atm; 22.7 → bar

Q27. ~~11.2 l~~ 44.8 liter of CO_2 at 1 ATM 0°C

moles $= \frac{44.8}{22.4}$

moles $\boxed{= 2\text{ mol}}$

weight in gram $\xrightarrow{\times \frac{1}{GAM/GMM}}$ no. of moles

no. of moles $\xrightarrow{\times GAM/GMM}$ weight in gram

no. of moles $\xrightarrow{\times NA}$ no. of entities

no. of entities $\xrightarrow{\times \frac{1}{NA}}$ no. of moles

no. of moles $\xrightarrow{\times 22.4/22.7}$ Volume of gas in liters

Volume of gas in liters $\xrightarrow{\times \frac{1}{22.4/22.7}}$ no. of moles

Q28. Calculate volume of 20 g $H_{2(g)}$ at 0°c & 1 atm

mass of 1 ~~molecule~~ H_2 → 2g

~~1 mol~~ –

10 mol → 20g

$$V = \frac{nRT}{P}$$

$$V = \frac{10 \times 273 \times 0.0821}{1}$$

$$V = 10 \times 22.4$$

$$\boxed{V = 224 l}$$ ✓

Q29. 14 g $N_{2(g)}$ & 22g $CO_{2(g)}$ are mixed together. find the volume of gaseous mixture at 0°c & 1 atm.

~~1 mol N_2, 22~~

1 mol N_2 = 28 g

0.5 mol = 14 g

1 mol CO_2 = 44

0.5 mol = 22 g

$$V = \frac{nRT}{P}$$

$$= \frac{1 \times 273 \times 0.0821}{1}$$

$$\boxed{V = 22.4 l}$$ ✓

Q30. mass of 11.2 m^3 of CH_4 at 1 atm 273 K in Kg

$$n = \frac{PV}{RT}$$

$$= \frac{1 \times 11200}{273 \times 0.0821}$$

$$= \frac{11200}{22.4}$$

$$= \frac{112000}{224}$$

$$= 500 \text{ mol}$$

1 mol CH_4 = 16 g

500 mol = 16 × 500 g

= 8000 g

$$\boxed{= 8 kg}$$ ✓

Q.31. no. of molecules of SO_2 in 45.4 liters of $SO_{2(g)}$ at STP?

$n = \frac{PV}{RT}$

$= \frac{1 \times 45.4}{273 \times 0.0831}$

$= \frac{45.4}{24.63}$

$=$

moles $= \frac{\text{Vol (in ltrs) (in STP)}}{22.7}$

$= \frac{45.4}{22.7}$

$\boxed{= 2 \text{ mol}}$ ✓

$= 2 N_A$

☆☆ Q.32. Total no. of atoms in 2.463 liters of $H_2O_{(l)}$ at 27°C & 1 atm.

$n = \frac{PV}{RT}$

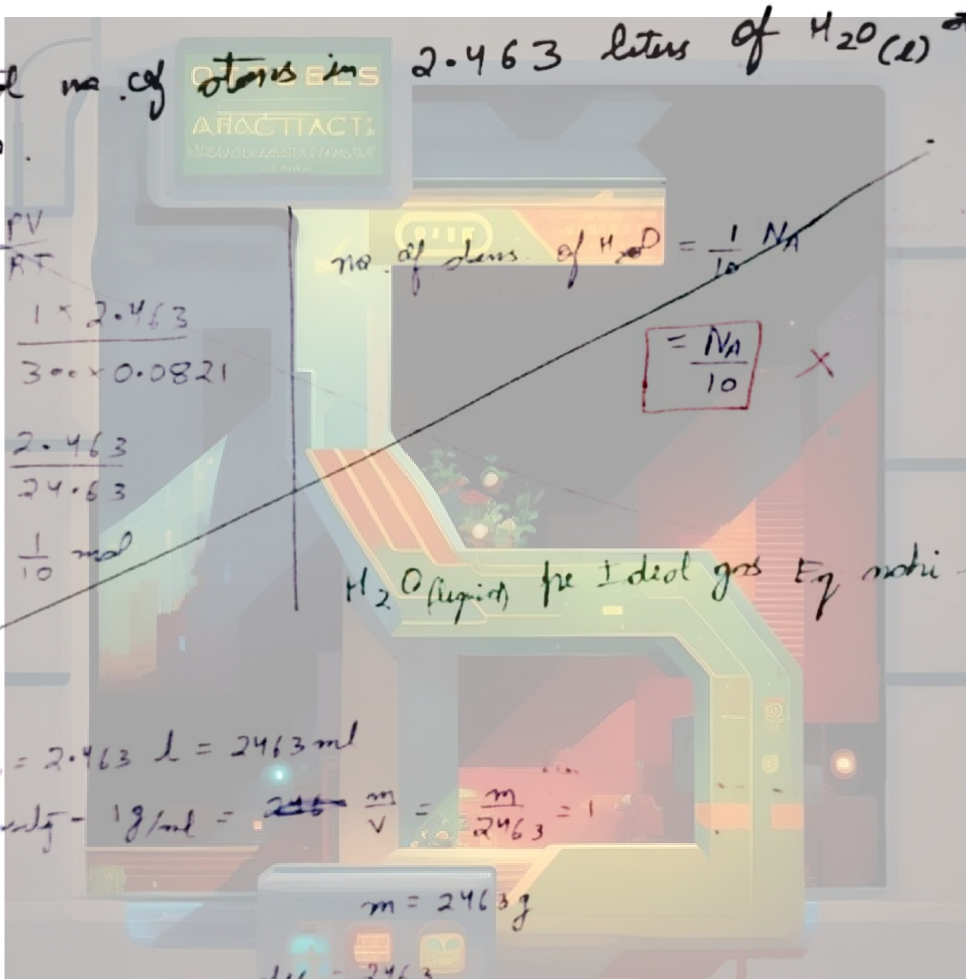
$= \frac{1 \times 2.463}{300 \times 0.0821}$

$= \frac{2.463}{24.63}$

$n = \frac{1}{10}$ mol

no. of atoms of $H_2O = \frac{1}{10} N_A$

$\boxed{= \frac{N_A}{10}}$ ✗



H_2O (liquid) pe Ideal gas Eq nahi lagti [illegible].

$V_{H_2O} = 2.463\ l = 2463$ ml

Density $= 1$ g/ml $= \frac{m}{V} = \frac{m}{2463} = 1$

$m = 2463$ g

moles $= \frac{2463}{18}$

$\boxed{\text{moles} = 137 \text{ moles}}$

no. of atoms $= 137 \times 3$

$\boxed{= 411 N_A}$ ✓

Q33. from 160g of $SO_{2}(g)$ Sample, 1.2046×10^{24} molecules of $SO_{2}(g)$ are removed. then find out volume of left over SO_2 gas at 0°C & 1 atm.

moles in 160 g SO_2 = $\frac{160}{64}$

moles removed = ~~20~~ 2

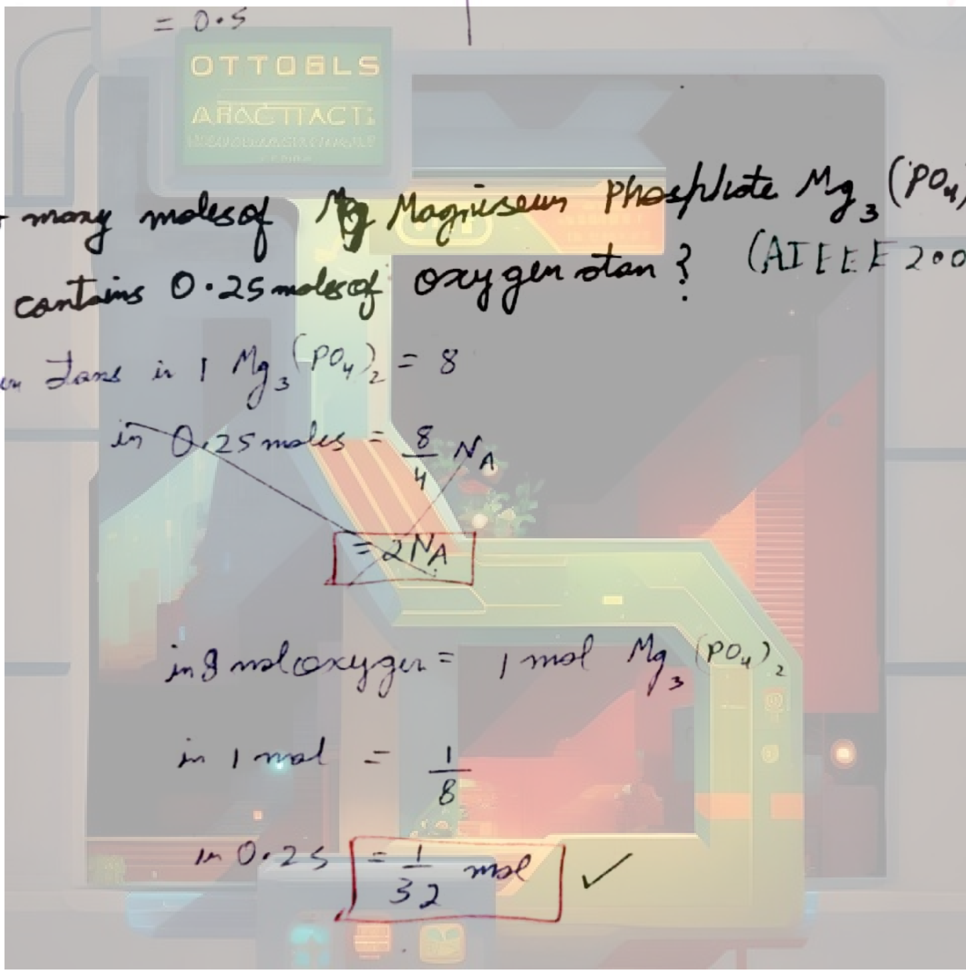
moles left = $\frac{160 - 128}{64}$

$= \frac{32}{64}$

$= 0.5$

Volume = 22.4×0.5

$\boxed{= 11.2\ l}$ ✓



Q.34. How many moles of ~~Mg~~ Magnisium Phosphate $Mg_3(PO_4)_2$ will contains 0.25 moles of oxygen atom? (AIEEE 2006)

Oxygen atoms in 1 $Mg_3(PO_4)_2$ = 8

~~in 0.25 moles = $\frac{8}{4} N_A$~~

~~$\boxed{= 2N_A}$~~

in 8 mol oxygen = 1 mol $Mg_3(PO_4)_2$

in 1 mol = $\frac{1}{8}$

in 0.25 $\boxed{= \frac{1}{32}\ \text{mol}}$ ✓

Average Molecular Mass.

Q35. 3 mol O_2 calculate average mass
5 mol N_2

mass of $O_2 \rightarrow$ 32 g/mol
mass of $N_2 \rightarrow$ 28 g/mol

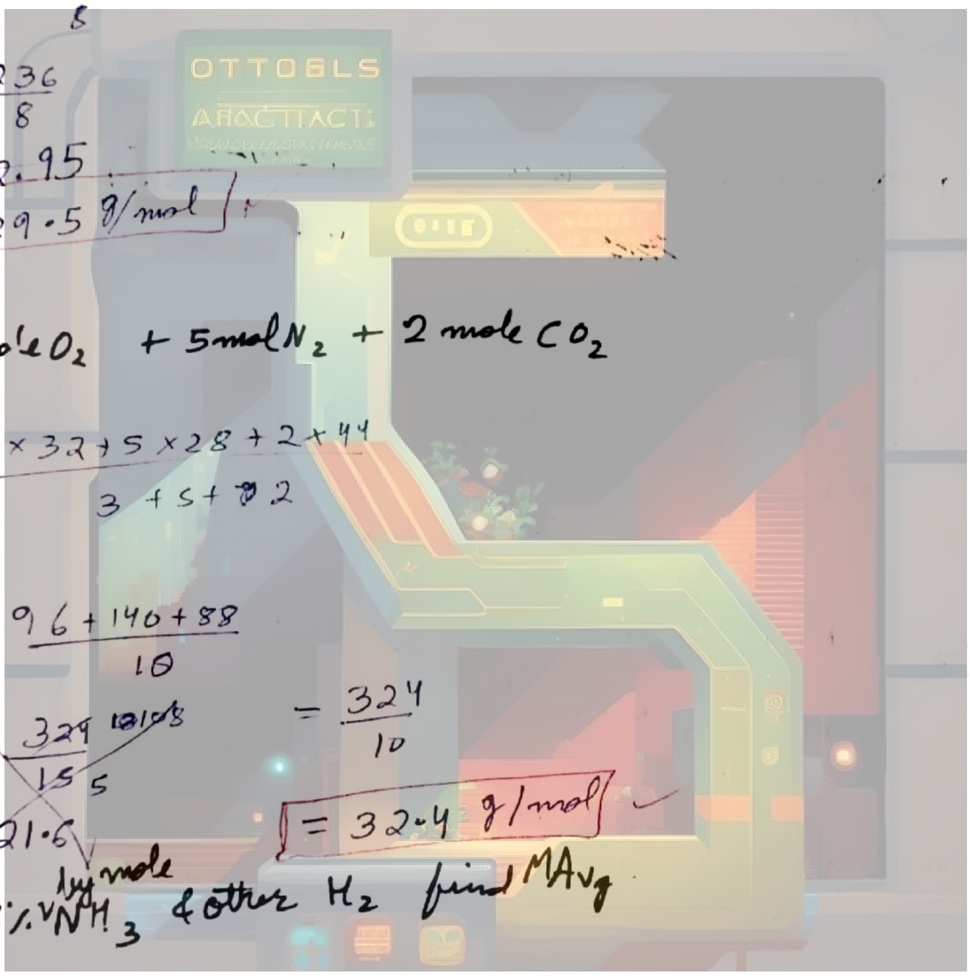
$$M_{Avg} = \frac{3 \times 32 + 5 \times 28}{8}$$

$$M_{Avg} = \frac{96 + 140}{8}$$

$$= \frac{236}{8}$$

$$= 2.95$$

$$\boxed{= 29.5 \text{ g/mol}}$$



Q36. 3 mole O_2 + 5 mol N_2 + 2 mole CO_2

$$= \frac{3 \times 32 + 5 \times 28 + 2 \times 44}{3 + 5 + 2}$$

$$= \frac{96 + 140 + 88}{10}$$

$$= \cancel{\frac{324}{15}} \qquad = \frac{324}{10}$$

$$\cancel{= 21.6} \qquad \boxed{= 32.4 \text{ g/mol}}$$

Q36. 68% NH_3 by mole & other H_2 find M_{Avg}

$$= \frac{68 \times 17 + 32 \times 2}{100}$$

$$= \frac{64 + 1156}{100}$$

$$= \frac{1220}{100}$$

$$\boxed{= 12.2}$$

Q 37. If 68% by mass NH_3 gas. other H_2

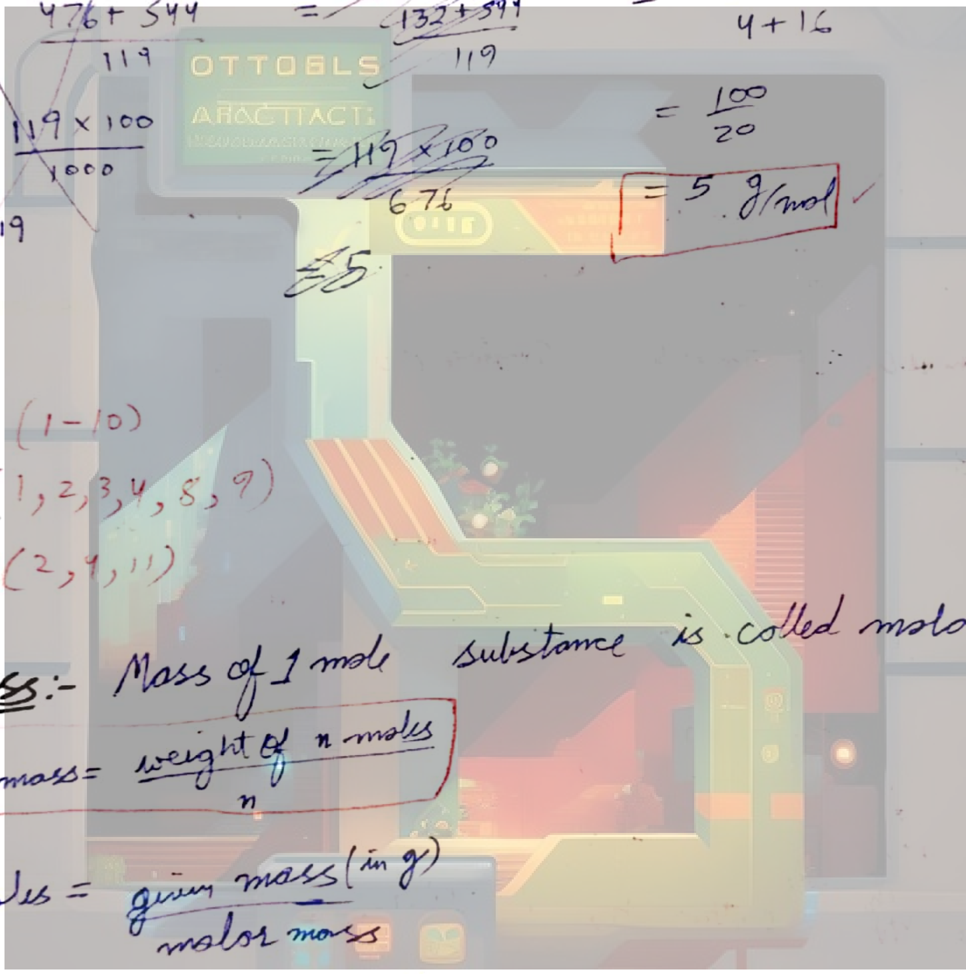
let $\frac{68}{17}$ mole NH_3 , $\frac{32}{2}$ mole H_2

$$= \frac{\frac{68}{17} \times 17 + \frac{32}{2} \times 2}{\frac{68}{17} + \frac{32}{2}}$$

$$\cancel{= \frac{100}{\frac{476+544}{119}}} \qquad \cancel{= \frac{100}{\frac{132+544}{119}}} \qquad = \frac{100}{4+16}$$

$$\cancel{= \frac{119 \times 100}{1000}} \qquad \cancel{= \frac{119 \times 100}{676}} \qquad = \frac{100}{20}$$

$$\cancel{= 119} \qquad \cancel{\approx 5} \qquad \boxed{= 5 \text{ g/mol}}$$



H.W.

S-1 (1–10)

O-1 (1, 2, 3, 4, 8, 9)

JM – (2, 4, 11)

Molar Mass:- Mass of 1 mole substance is called molar mass.

$$\boxed{1 \text{ mole mass} = \frac{\text{weight of } n \text{ moles}}{n}}$$

$$\text{moles} = \frac{\text{given mass (in g)}}{\text{molar mass}}$$

Molar Volume:- Volume of 1 mole substance

$$\boxed{\text{molar volume} = \frac{\text{total volume}}{\text{moles}}}$$

Q.38. Calculate molar volume of an ideal gas at
i) STP
ii) 0°C & 1 atm

i) $= \frac{V}{n} = \frac{nRT}{Pn}$

$= \frac{RT}{P}$

$= \frac{273 \times 0.0831}{1}$

$\boxed{= 22.7 \text{ L/mol}}$

ii) $= 0.0821 \times 273$

$\boxed{= 22.4 \text{ L/mol}}$

Q.39. Which of the following options have same molar volume at similar condition of temperature & pressure.

A) 44 gm CO_2 C) 16 gm O_2

B) 4 gm He D) 20 gm N_2

~~Q.40. Arrange the following options have same molar volume~~

Q.40. Arrange in increasing order of masses.

i) 0.5 mole O_3 24 g
ii) 0.5 gram-atom of oxygen 8 g
iii) 3.011×10^{23} molecule of O_2 16 g
iv) 5.6 liter of CO_2 at 1 atm & 273 K. ~~17.6 g~~ 11 g

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

$\boxed{\cancel{ii) < iii) < i) < iv)}}$

$\boxed{ii) < iv) < iii) < i)}$ ✓

Density :- (d or δ)

$$\left[d = \frac{\text{Mass}}{\text{Volume}} \right]$$

S.I :- kg/m^3
other - g/ml, g/cm^3, g/lit

$$1 \frac{gm}{ml} = 1 \frac{gm}{cm^3} = 1000 \frac{kg}{m^3}$$

water - $1\ g/ml$ or $1000\ kg/m^3$

Hg - $13.6\ g/ml$ or $13600\ kg/m^3$

Specific Volume

$$\left[\text{Specific Volume} = \frac{\text{Volume}}{\text{mass}} \right]$$

S.I = m^3/kg
other :- ml/g, cm^3/g, $liter/g$

Energy :-

$$\left[E = \text{Force} \times \text{Displacement} \right]$$

S.I. = N.m / Joule (J)
other :- Calorie (cal), e.V, erg, atm-liter, bar-liter

$1\ Cal = 4.18\ J / 4.2\ J$

$1\ eV = 1.6 \times 10^{-19}$ Joule

$1\ atm\text{-}l = 101.325\ J$

$1\ bar\text{-}l = 100\ J$

Density of Ideal Gas :-

$PV = nRT$

$PV = \frac{m}{M} RT$

$m \rightarrow$ weight in mass
$M \rightarrow$ molar mass.

$PM = \left(\frac{m}{V}\right) RT$

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

$$\boxed{d = \frac{PM}{RT}} \qquad \boxed{d_{mixture} = \frac{P M_{Avg}}{RT}}$$

H.W 23/7/24
Race - 1 (Physical)

Concept of Relative Density

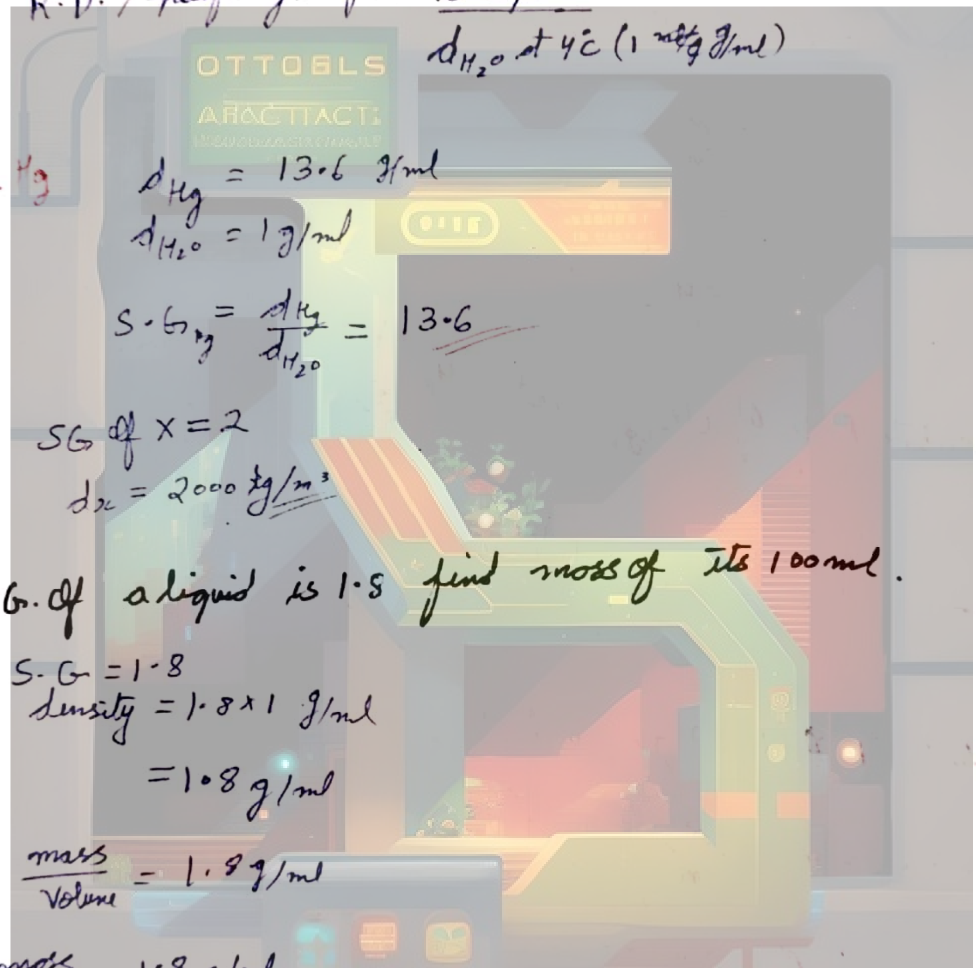
→ Relative density is equals to ~~dens~~ density of any substance with respect to another substance.

$$R.D. = \frac{d_{substance}}{d_{ref.\ substance}}$$

→ ~~For Solid/L Gas/liquid:~~

→ For Solid/liquid

$$R.D./\text{specific gravity} = \frac{d_{liquid}}{d_{H_2O} \text{ at } 4^\circ C\ (1\ \cancel{mg}\ g/ml)}$$



eg. Hg

$$d_{Hg} = 13.6\ g/ml$$
$$d_{H_2O} = 1\ g/ml$$
$$S.G_{Hg} = \frac{d_{Hg}}{d_{H_2O}} = 13.6$$

eg. SG of $x = 2$

$$d_x = 2000\ kg/m^3$$

Q41. S.G. of a liquid is 1.8 find mass of its 100ml.

$$S.G = 1.8$$
$$\text{density} = 1.8 \times 1\ g/ml$$
$$= 1.8\ g/ml$$
$$\frac{\text{mass}}{\text{Volume}} = 1.8\ g/ml$$
$$\frac{\text{mass}}{100ml} = 1.8\ g/ml$$
$$\text{mass} = 180\ g/ml \times ml$$
$$\boxed{\text{mass} = 180g}$$

→ For Gases:-

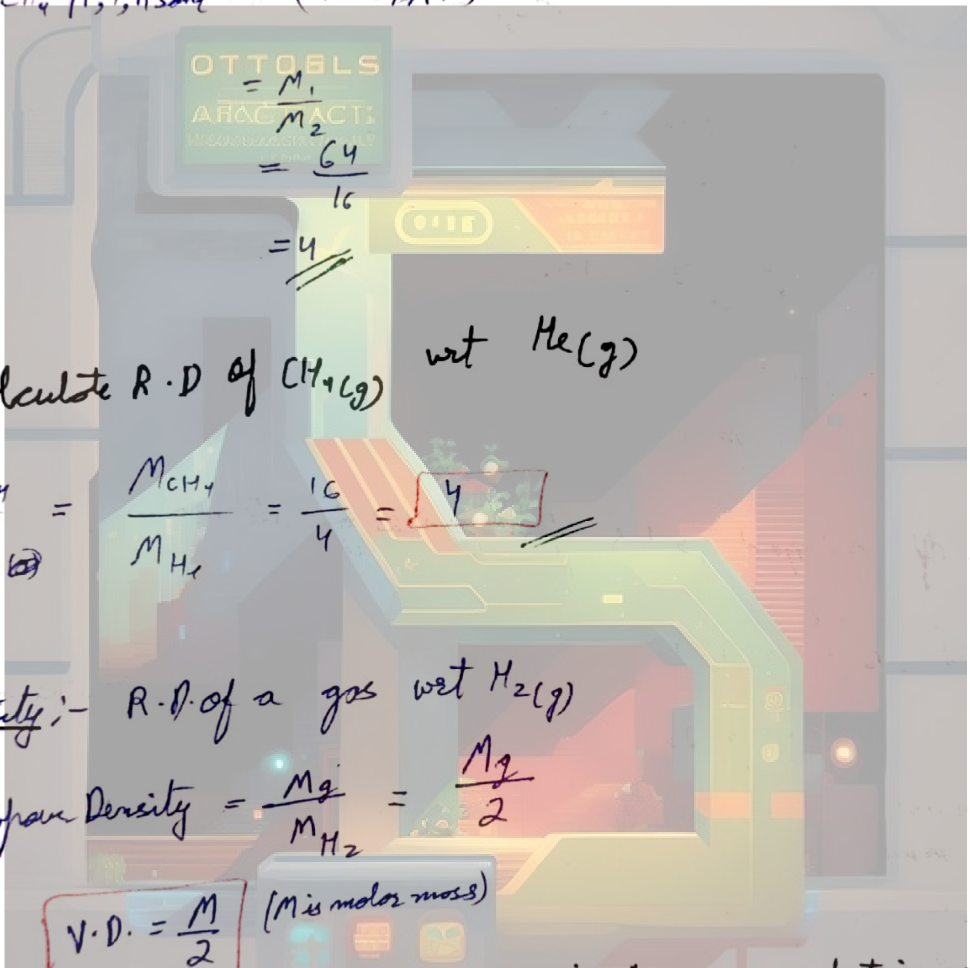
R.D.= Density of gas wrt another gas at same Temp & Pressure.

$d = \frac{PM}{RT}$, P & T are constant so R is also constant

$\cancel{R.D.} = \boxed{d \propto M}$

eg. R.D of $SO_{2(g)}$ wrt $CH_{4(g)}$

$$\left.\frac{d_{SO_2}}{d_{CH_4}}\right|_{P,T,R\ same} = \frac{(PM_1/RT)}{(PM_2/RT)}$$



$$= \frac{M_1}{M_2} = \frac{64}{16} = 4$$

Q42. Calculate R.D of $CH_{4(g)}$ wrt $He_{(g)}$

$$\frac{d_{CH_4}}{d_{He(g)}} = \frac{M_{CH_4}}{M_{He}} = \frac{16}{4} = \boxed{4}$$

→ Vapour Density:- R.D. of a gas wrt $H_{2(g)}$

$$\text{Vapour Density} = \frac{M_g}{M_{H_2}} = \frac{M_g}{2}$$

$\boxed{V.D. = \frac{M}{2}}$ (M is molar mass)

Q43. 8 l of a gas at 0°C, 1 atm weighs 16 g what is vapour density.

moles $= \frac{8}{22.4}$

molar mass $= \frac{16}{8} \times 22.4$

$= 44.8$

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

$= \frac{44.8}{2}$

$\boxed{= 22.4}$

Q44. A gaseous sample of 2 mole $N_2O_4(g)$ & 3 mole $NO_2(g)$ find V.D.

$$Mass_{avg} = \frac{2 \times m_{N_2O_4} + 3 \times m_{NO_2}}{5}$$

$$= \frac{2 \times \cancel{88}\,92 + 3 \times 46}{5}$$

$$= \frac{\cancel{172}\,184 + 138}{5}$$

$$= \cancel{\frac{310}{5}} = \frac{\cancel{318}\,322}{5}$$

$$= \cancel{62} \quad \cancel{63.6} \quad 64.4$$

$$V.D = \frac{64.4}{2}$$

$$\boxed{= 32.2}$$

Q45. V.D. of mix of NO_2 & N_2O_4 is 27.6

i) calculate mol % of NO_2

ii) mass % of NO_2

$$V.D = \frac{M_{Avg}}{2}$$

$$27.6 \times 2 = M_{Avg}$$

$$M_{Avg} = 55.2$$

$$\frac{46x + (100-x)\,92}{100} = 55.2$$

$$46x + 9200 - 92x = 5520$$

$$46x = 3680$$

$$x = \frac{3680}{46}$$

$$x = 80$$

$$\boxed{\%\,NO_2\ (mole) = 80\%}$$ i)

let 80 mol NO_2, 20 mol N_2O_4

$\downarrow$ 3680 g, $\downarrow$ 1840 g

Total mass = 5520

$$\%\,NO_2\,(mass) = \frac{3680}{5520} \times 100$$

$$= \frac{200}{3}$$

$$= 66.66$$

$$\boxed{\%\,NO_2\,(mass) = 66.66\%}$$ ii)

Q46. calculate % mass & % mol of $CH_4(g)$ of C & H.

moles = 1
moles of C = 1
of H = 4

mole % C = $\frac{1}{5}$ = 20%

mole % H = 80%

mass % = $\frac{12}{16} = \frac{3}{4} \times 100 = 75\%$

mass % of H = $\frac{4}{16} = \frac{1}{4} = 25\%$

Chemical Reactions

$H_2O_{(l)}$ → liquid form
$H_2O_{(g)}$ → Steam / Water Vapour.

1 atm & T < 100°C	T = 100°C & 1 atm	1 atm & T > 100°C
H_2O → Liquid (stable)	Both states are present in equilibrium (no. of moles remain constant)	H_2O → Gaseous form (stable)
(PV = nRT) ✗		PV = nRT ✓

Q47. Calculate moles of 90 ml of H_2O at 1 atm & 27°C.

H_2O → liquid

PV = nRT ✗

90 ml = 90 g

$\frac{90}{18}$ = moles

$\boxed{\text{moles} = 5}$

Q48. Calculate ~~mass~~ moles of H-atom of 90 ml H_2O at 1 atm & 127°C

$H_2O \rightarrow$ gas

$$PV = nRT$$

$$n = \frac{PV}{RT}$$

$$n = \frac{1 \times 9 \times 10^{-2}}{400 \times 0.0821}$$

$$n = \frac{9 \times 10^{-2}}{32.84}$$

$$n = \frac{9}{3284} \quad (\text{of } H_2O)$$

$$\boxed{n(\text{of } H) = \frac{18}{3284}}$$

Chemical Reactions

→ The symbolic representation of reactant & product in balanced condition represents balanced chemical reaction which must follow:-

1. law of conservation of atoms
2. law of conservation of mass
3. law of conservation of charge.

Stoichiometry — By stoichiometry, we can determine amount of reactant reacted & amount of product produce in a chemical reaction.

→ For ~~these~~ this a balanced chemical is required.

$$aA + bB \longrightarrow cC + dD$$

$A, B \rightarrow$ Reactant
$C, D \rightarrow$ Products

a: stiochiometry coff. of Reactant A
b: stiochiometry coff. of Reactant B
c: stiochiometry coff. of Product C
d: stiochiometry coff. of Product D

Law of stiochiometry -
→ 'a' moles of A react with 'b' moles of B to produce 'c' moles of C & 'd' moles of D.

Or

$$\frac{\text{moles of 'A' reacted}}{a} = \frac{\text{moles of 'B' reacted}}{b} = \frac{\text{moles of 'C' reacted}}{c} = \frac{\text{moles of 'D' reacted}}{d}$$

what ~~doe~~ info does a unbalance chemical reaction give:- Qualitative

$$N_2 + H_2 \longrightarrow NH_3 \text{ (Qualitative)}$$

$$N_2 + 3H_2 \longrightarrow 2NH_3 \text{ (Qualitative \& Quantitative)}$$

Balancing Reactions :-
1. Trial - error method
2. ~~Ot~~ arbitary - coff. method.

Q49. Balance $N_2 + H_2 \rightarrow NH_3$

$$aN_2 + bH_2 \longrightarrow cNH_3$$

N: atom

$2a = c$
$\boxed{a = 1}$
$\boxed{c = 2}$

H: atom
$2b = 3c$
$2b = 6$
$\boxed{b = 3}$

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

Q.50. Balance $Cl_2 + KOH \rightarrow KCl + KClO_3 + H_2O$

$$aCl_2 + b\,KOH \rightarrow c\,KCl + d\,KClO_3 + e\,H_2O$$

Cl	K	O	H
$2a = c+d$	$b = c+d$	$b = 3d+e$	$b = 2e$

$3d = e$

$2a = b$

$\cancel{a=2,\ b=4,\ c=3,\ d=1,\ e=2}$

$c = 5$
$a = 3$
$b = 6$
$e = 3$
$d = 1$

$$3Cl_2 + 6KOH \rightarrow 5KCl + KClO_3 + 3H_2O$$

$$1\,N_{2(g)} + 3\,H_{2(g)} \rightarrow 2\,NH_{3(g)}$$

1 mol N_2 | 3 mol H_2 | 2 mol NH_3

N_A molecul N_2 | $3N_A$ molecul H_2 | $2N_A$ molecul NH_3

at constant (P, T)

V liter N_2 | 3V liter H_2 | 2V liter NH_3

ratio remains constant.

~~1g (N_2) 3g (H_2) 2g (NH_3)~~ ✗

28g (N_2) 6g (H_2) 34 (NH_3) ✓

Q51. Find mass of H_2O produced & O_2 reacted with ~~12~~ 4 gm of H_2

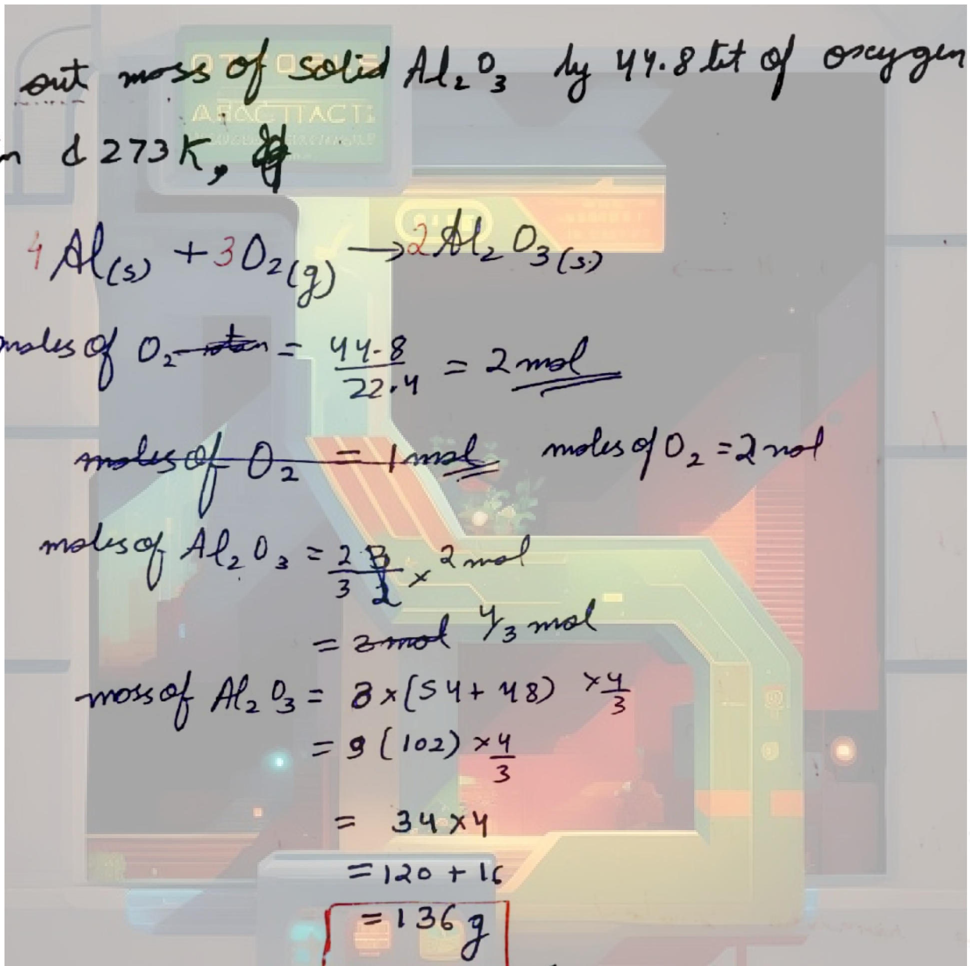
$$H_2 + O \rightarrow H_2O$$

1 : 8 (mass)

$$4g(H_2) = 8 \times 4$$

$$\boxed{= 32g(O_2)}$$

$$\boxed{36g(H_2O)}$$



Q52. find out mass of solid Al_2O_3 by 44.8 lit of oxygen at 1 atm & 273 K, ~~g~~

$$4Al_{(s)} + 3O_{2(g)} \rightarrow 2Al_2O_{3(s)}$$

moles of O_2 ~~atm~~ $= \frac{44.8}{22.4} = 2$ mol

~~moles of O_2 = 1 mol~~ moles of O_2 = 2 mol

moles of $Al_2O_3 = \frac{2}{3} \times 2$ mol

$= \cancel{2 mol}$ $\frac{4}{3}$ mol

mass of $Al_2O_3 = 3 \times (54 + 48) \times \frac{4}{3}$

$= 9(102) \times \frac{4}{3}$

$= 34 \times 4$

$= 120 + 16$

$$\boxed{= 136 g}$$

~~Q53.~~

Note:- Complete combustion of hydrocarbon.

$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$$

$$C_xH_y + \frac{4x+y}{4}O_2 \rightarrow xCO_2 + \frac{y}{2}H_2O$$

Q 53. find volume of CO_2 produced by complete combustion of 10 mole Sugar at 1 atm, 273 K.

$10\ C_{12}H_{22}O_{11} + O_2 \longrightarrow 120\ CO_2\ \ H_2O$

120 moles of CO_2

$120 \times 22.4 = $ Volume

$\boxed{\text{Volume} = 2688\ l}$

Q 54. What is total volume produced at 1 atm 600 °C temp by complete ~~combustion of~~ decomposition of 16 g Ammonium Nitrate ($NH_4NO_{3(s)}$) into nitrogen, oxygen & H_2O

~~moles = $\frac{35}{16}$~~

~~$\frac{35}{16}\ N$~~

~~$\frac{35}{16} NH_4NH_3 + O_2 \longrightarrow \frac{35}{16} N_2 + O_2 + \frac{7}{32} H_2O$~~

moles = $\frac{80}{16}$

$= \frac{1}{5}$ moles

$\frac{1}{5} NH_4NO_3 \longrightarrow \frac{1}{5} N_{2(g)} + \frac{1}{10} O_{2(g)} + \frac{2}{5} H_2O_{(g)}$

Vol (N_2) $\rightarrow 5 \times 0.0821 \times 873$; Vol (N_2) $= \frac{873 \times 0.0821}{5}$

Vol (O_2) $\rightarrow 5 \times 0.0821 \times 873$; Vol (O_2) $= \frac{873 \times 0.0821}{5} \times 0.5$

Vol (H_2O) $\rightarrow 10 \times 0.0821 \times 873$; Vol (H_2O) $= \frac{0.0821 \times 873}{5} \times 2$

Vol Total $= 20 \times 0.0821 \times 873$; Vol Total $= \frac{3.5}{5} \times 0.0821 \times 873$

$= 0.821 \times 873 \times 2$

$\boxed{= 1.642 \times 873\ l}$

Vol Total =

moles = $\frac{16}{80} = \frac{1}{5}$ moles (NH_4NO_3)

$$\frac{1}{5} NH_4NO_3 \xrightarrow{600^\circ C} \frac{1}{5} N_{2(g)} + \frac{0.5}{5} O_{2(g)} + \frac{2}{5} H_2O_{(g)}$$

Vol (N_2) → $\frac{1}{5} \times 0.0821 \times 873$

Vol (O_2) → $\frac{0.5}{5} \times 0.0821 \times 873$

Vol (H_2O) = $\frac{2}{5} \times 0.0821 \times 873$

Total Vol = $0.7 \times 0.0821 \times 873$

$\boxed{\text{Vol} = 50.17131\ l}$

Problems Related to more than one reactant

1 : 3 : 2

$N_2 + 3H_2 \rightarrow 3NH_3$

Initial 1 mole + 3 mole → 0

Final 0 + 0 → 2 mole

stoichiometric amount (Reactants are present in the required proportion to react)

Initial 3 mole + 6 mole → 0

Final 1 mole + 0 → 4 mole

non-stoichiometric amount.

$N_2 + 3H_2 \rightarrow 2NH_3$

(Excess Reagent) (in excess amount)

L.R. (Limiting Reagent) (in Limiting amount)

Present in less amount than required

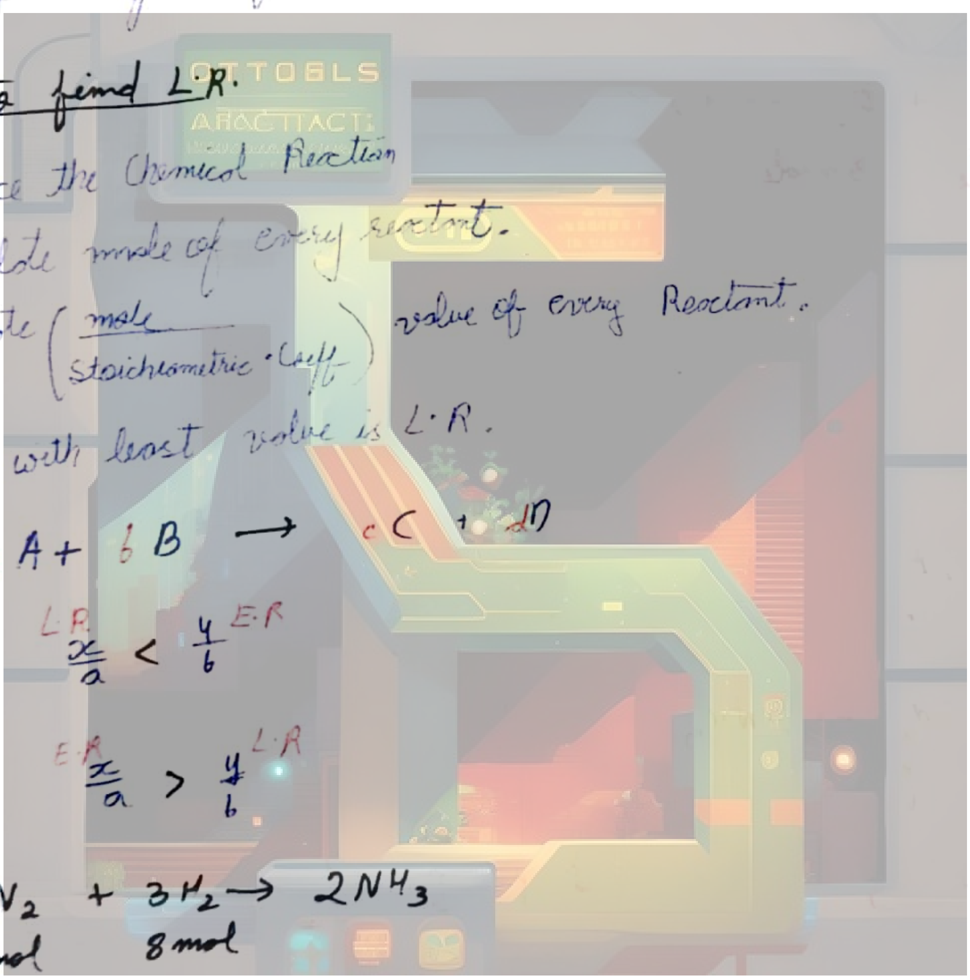
$$\frac{\text{mole of } N_2 \text{ reacted}}{1} = \frac{\text{mole of } H_2 \text{ reacted}}{3}$$

mole of N_2 reacted $= \frac{6}{3}$
$= 2$

Limiting Reagent - The reagent or reactant which is present in limiting amount or which ~~is~~ is consumed first during the reaction completely is known as limiting reagent.

Excess Reagent - The reagent which is left ~~as~~ after the end of the reaction is known as excess reagent.

Note :- The amount of product formed & amount of excess reagent left at the end of reaction will be decided by the amount of limiting reagent.



Rules to find L.R.

- Balance the Chemical Reaction
- Calculate mole of every reactant.
- Calculate $\left(\frac{\text{mole}}{\text{Stoichiometric Coeff}}\right)$ value of every Reactant.
- One with least value is L.R.

$$aA + bB \rightarrow cC + dD$$

$$\underset{L.R}{\frac{x}{a}} < \underset{E.R}{\frac{y}{b}}$$

$$\underset{E.R}{\frac{x}{a}} > \underset{L.R}{\frac{y}{b}}$$

Q 55. $N_2 + 3H_2 \rightarrow 2NH_3$

$\quad$ 2 mol $\quad$ 8 mol

$1 : 3$

$\frac{2}{1} \quad \frac{8}{3}$

$2 < 2....$

$N_2 \rightarrow$ LR

$H_2 \rightarrow$ ER

Q 56. $A + 2B + 3C \longrightarrow$ Praudt

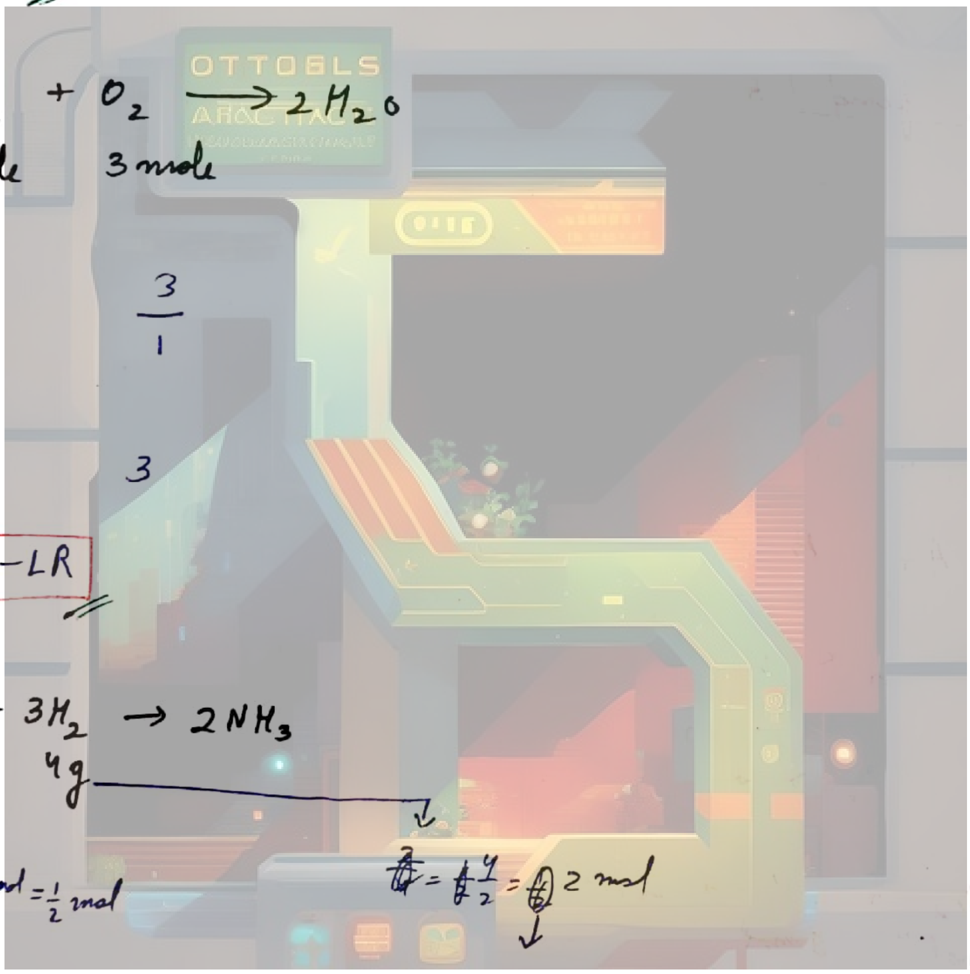
5 mole   9 mole   12 mole

$\frac{5}{1}$ $\frac{9}{2}$ $\frac{12}{3}$

5   4.5   4

~~LR~~

$\boxed{C - LR}$



Q 57. $2H_2 + O_2 \longrightarrow 2H_2O$

4 mole   3 mole

$\frac{4}{2}$ $\frac{3}{1}$

2   3

$\boxed{H_2 - LR}$

Q 58. $N_2 + 3H_2 \rightarrow 2NH_3$

14 g   4 g

$\frac{14}{28} = 0.5$ mol $= \frac{1}{2}$ mol $\frac{4}{2} = 2$ mol

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

0.66

0.5

$\boxed{N_2 - LR}$

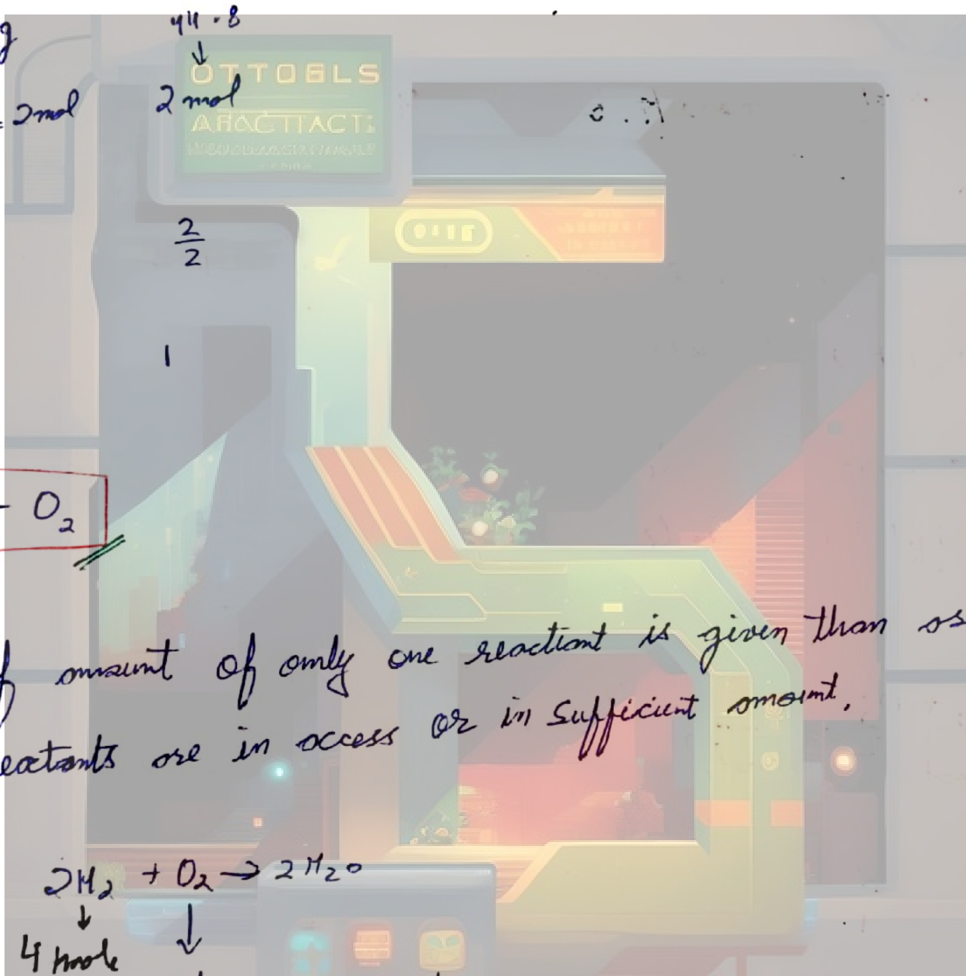
Q 59. $H_2 + I_2 \rightarrow 2HI$

4 mol   4 mol

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

$\boxed{L.R - \text{None}}$

Q60. $CH_{4(g)} + 2\,O_{2(g)} \xrightarrow{1\text{ atm } 0^\circ C} CO_2 + 2H_2O$



32 g ↓ $\frac{32}{16} = 2$ mol   44.8 ↓ 2 mol

$\frac{2}{1}$ $\frac{2}{2}$

2   1

$\boxed{LR - O_2}$

Note:- If amount of only one reactant is given than assume that other reactants are in access or in sufficient amount.

$2H_2 + O_2 \rightarrow 2H_2O$

4 mole ↓   ↓

2 mole (not given) (required) → 4 mole

→ If we have 4 mole of H_2 then we will get 4 mole of H_2O.

Q 61. $A + 2B \rightarrow C$

for a given reactions 5 ~~mass~~ mole of A react with 8 ~~mass~~ moles of B, then calculate amount of the moles of C produced and also the amount of ER. left.

$\frac{5}{1}$, $\frac{8}{2}$

5 , 4

$B \rightarrow LR$

$\frac{\text{no. of A react}}{1} = \frac{\cancel{\text{no. of B react}}}{} \frac{8}{2}$

⇒ 4 mole A react with 8 moles B for 4 moles of C

left ER(A) = 1 mole

$\boxed{\begin{array}{l} \text{C- moles} \rightarrow 4 \text{ mole} \\ \text{Lefft ER} \rightarrow 1 \text{ mole} \end{array}}$ //

Q 62. $2SO_2 + O_2 \longrightarrow 2SO_3$

5 mol $\quad O_2 \rightarrow$ 2 mole

$\frac{5}{2}$, $\frac{2}{1}$

2.5 , 2

$O_2 - LR$

2 mol O_2 react with 4 mol SO_2 for 4 mol SO_3

ER left = 5 - 4
= 1 mol

$\boxed{\begin{array}{l} \text{i) } O_2 \\ \text{ii) } 4 \text{ mole} \\ \text{iii) } 1 \text{ mole} \end{array}}$ //

Q63 find out the volume of liquid water from 300K temp which have a density of H_2O 1.5 g/cm³ when 4 g of Hydrogen react with 4 g O_2. Also calculate the mass of reactant left at the end of reaction.

$$2H_2 + O_2 \rightarrow 2H_2O$$

4 mol, 4 mol.

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

2, 4

L.R → H_2

2 mol O_2 react

4 mol H_2O formed

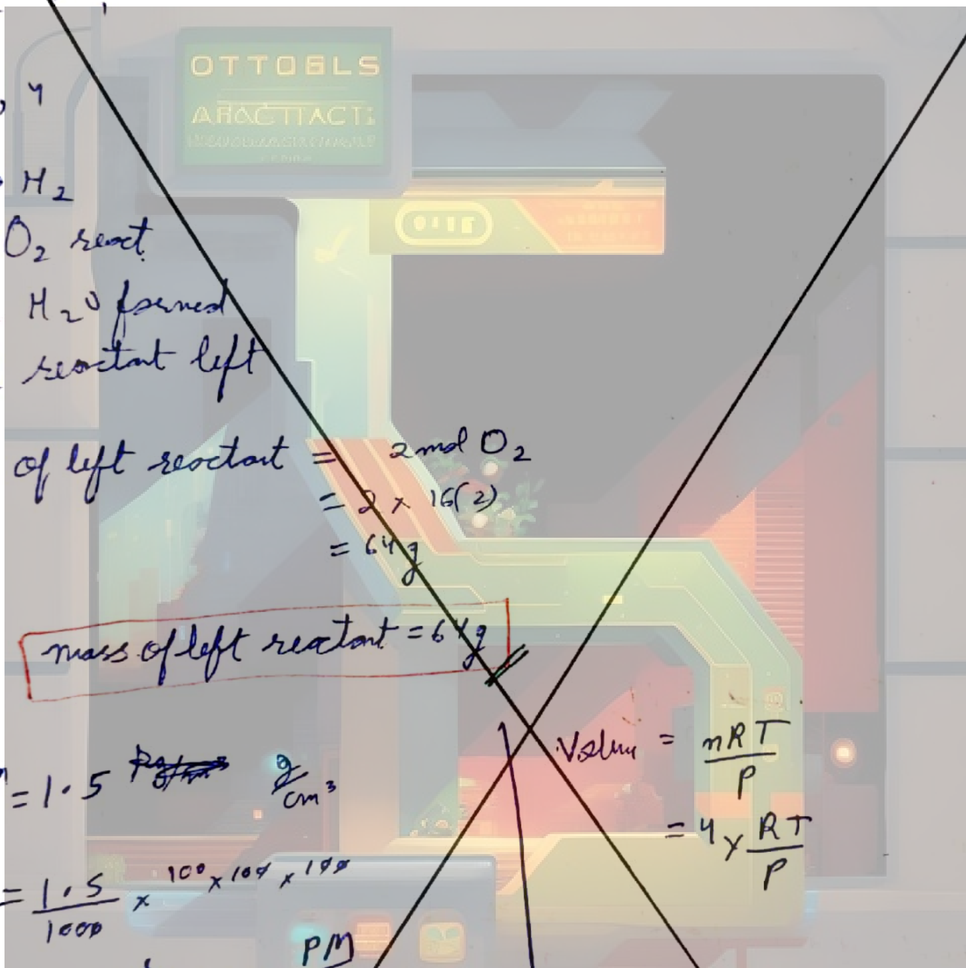
2 mol reactant left

mass of left reactant = 2 mol O_2

$= 2 \times 16(2)$

$= 64g$

$\boxed{\text{mass of left reactant} = 64g}$



Volume $= \frac{nRT}{P}$

$= 4 \times \frac{RT}{P}$

$\frac{PM}{RT} = 1.5$ ~~kg/m³~~ $\frac{g}{cm^3}$

$= \frac{1.5}{1000} \times 100 \times 100 \times 100$

$= 1500\ kg/m^3 = \frac{PM}{RT}$

~~= 1500 × 0.~~

$= \frac{1500}{18} = \frac{P}{RT}$

$$2H_2 + O_2 \rightarrow 2H_2O$$

$4g \quad 4g$

$2\,mol \quad \frac{1}{8}\,mol$

$\frac{2}{2} \quad , \quad \frac{1}{8}$

$1 \quad , \quad \frac{1}{8}$

L.R − O_2

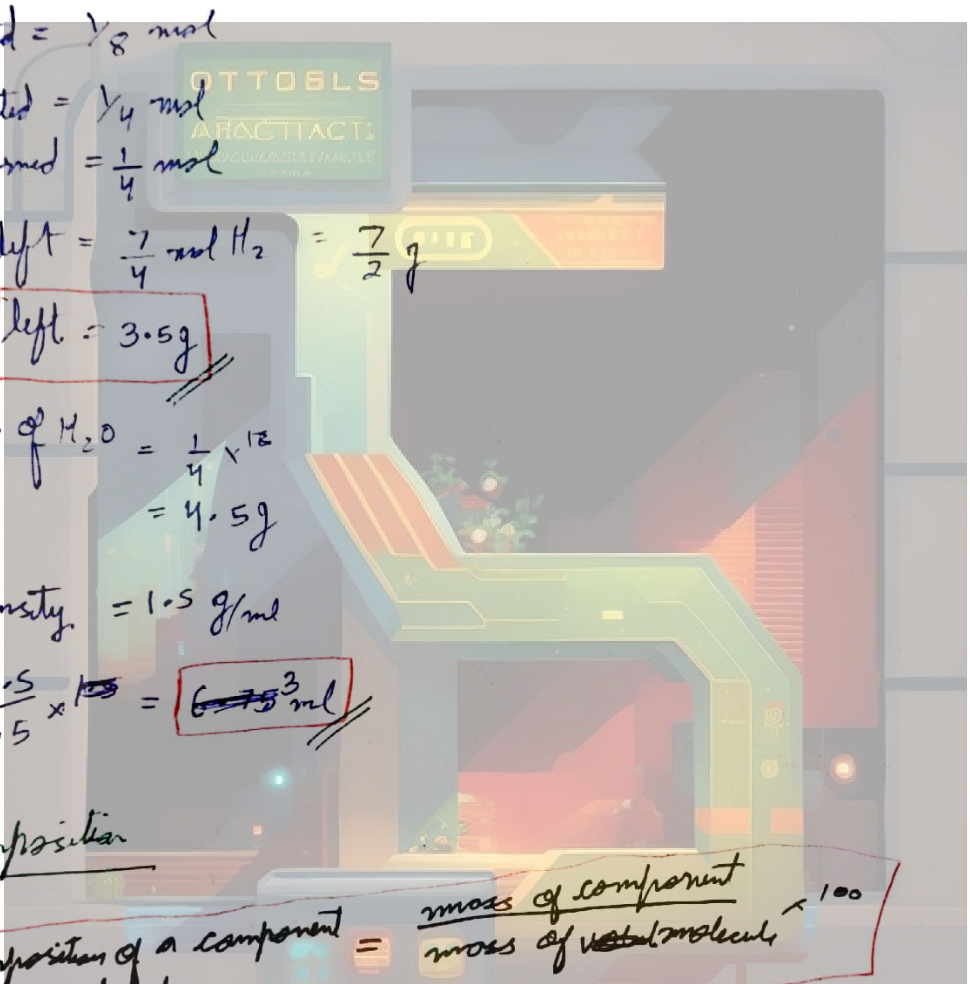
O_2 reacted = $\frac{1}{8}$ mol

H_2 reacted = $\frac{1}{4}$ mol

H_2O formed = $\frac{1}{4}$ mol

reactant left = $\frac{7}{4}$ mol H_2 = $\frac{7}{2}$ g

$\boxed{\text{left} = 3.5g}$



mass of H_2O = $\frac{1}{4} \times 18$

$= 4.5g$

density = 1.5 g/ml

$\frac{4.5}{1.5} \times \cancel{1.5} = \boxed{\cancel{6.75}\,3\,ml}$

% Composition

$$\boxed{\text{\% Composition of a component in a molecule} = \frac{\text{mass of component}}{\text{mass of } \cancel{\text{total}} \text{ molecule}} \times 100}$$

Eg. H_2O (1 mole)

2H — 2g

O — 16g

$\% H = \frac{2}{18} \times 100 = 11.1\%$

$\% O = \frac{16}{18} \times 100 = 89.99\%$

eg 2. $CuSO_4 \cdot 5H_2O$ (Blue Vitriol) $(Cu = 63.5,\ S = 32)$

$$\text{Total mass} = 63.5 + 32 + 64 + 10 + 80 = 249.5\ g$$

$$\%\,Cu = \frac{63.5}{249.5} \times 100$$

$$\boxed{= 25.8}$$

$$\%\,S = \frac{32}{249.5} \times 100$$

$$\boxed{= 12.82}$$

$$\%\,O = \frac{(64+80)}{249.5} \times 100$$

$$= \frac{144}{249.5} \times 100$$

~~% H =~~

$$\boxed{= 57.7}$$

$$\%\,H = \frac{10}{249.5} \times 100$$

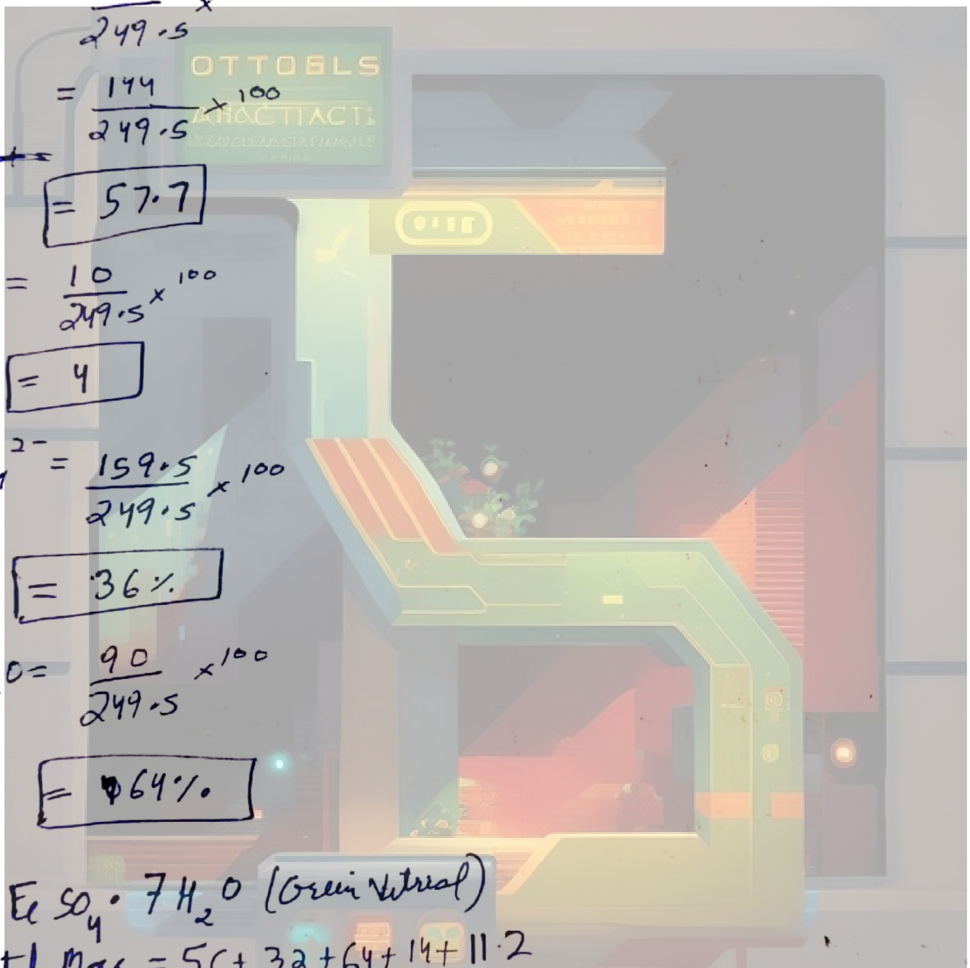
$$\boxed{= 4}$$

$$\%\,SO_4^{2-} = \frac{159.5}{249.5} \times 100$$

$$\boxed{= 36\%}$$

$$\%\,H_2O = \frac{90}{249.5} \times 100$$

$$\boxed{= 64\%}$$



eg 3. $FeSO_4 \cdot 7H_2O$ (Green Vitriol)

$$\text{Total Mass} = 56 + 32 + 64 + 14 + 11 \cdot 2$$
$$= 278$$

$$\%\,Fe = \frac{56}{278} \times 100 = 20.14$$

$$\%\,S = \frac{32}{278} \times 100 = 11.51$$

$$\%\,O = \frac{178}{278} \times 100 = 64.02$$

$$\%\,H = \frac{14}{278} \times 100 = 5.03$$

Important Decomposition reactions

(1) Alkali Metal Carbonates $\xrightarrow{\Delta}$ No reaction

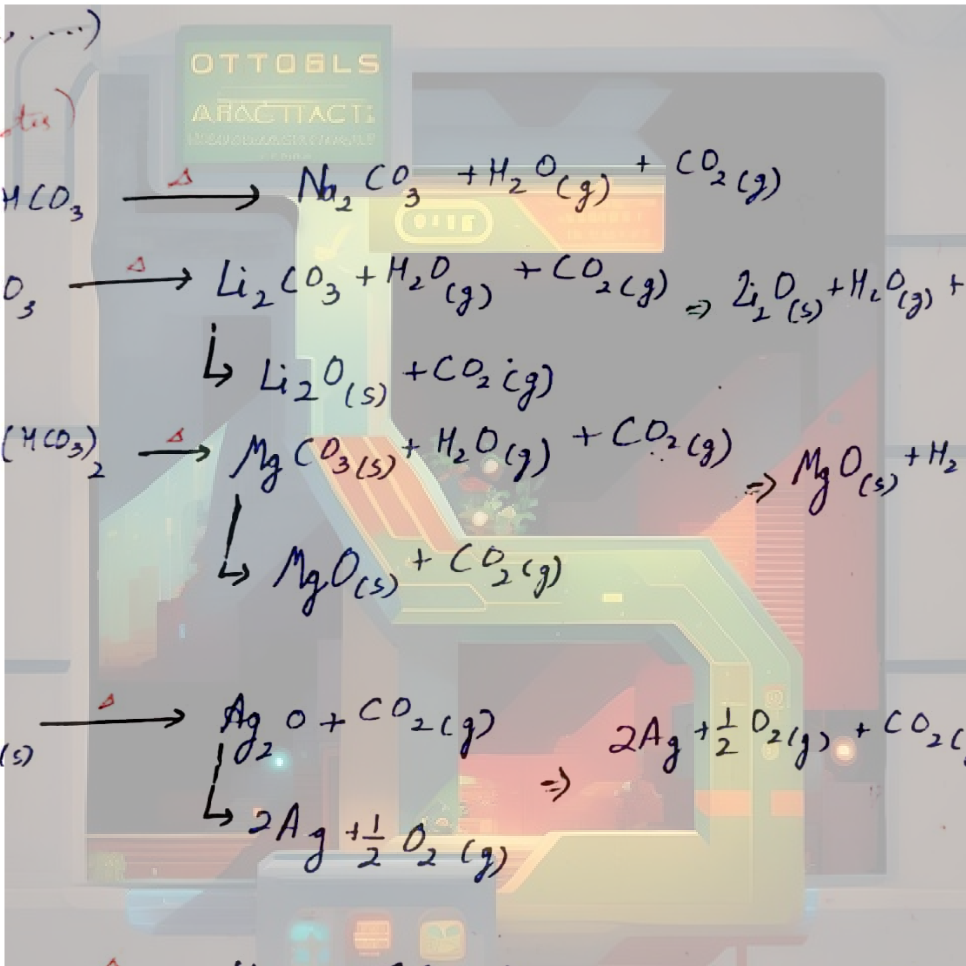
Except - $Li_2CO_3 \xrightarrow{\Delta} Li_2O_{(s)} + CO_2\uparrow_{(g)}$

(2) Alkali Earth Metals $\xrightarrow{\Delta}$ Metal Oxide $+ CO_2\uparrow_{(g)}$

$MCO_3 \xrightarrow{\Delta} MO_{(s)} + CO_2\uparrow_{(g)}$

$\downarrow$

(Mg, Ca, ...)



Bicarbonates)

i) $2NaHCO_3 \xrightarrow{\Delta} Na_2CO_3 + H_2O_{(g)} + CO_2(g)$

ii) $LiHCO_3 \xrightarrow{\Delta} Li_2CO_3 + H_2O_{(g)} + CO_2(g) \Rightarrow Li_2O_{(s)} + H_2O_{(g)} + 2CO_2(g)$

$\hookrightarrow Li_2O_{(s)} + CO_2(g)$

iii) $Mg(HCO_3)_2 \xrightarrow{\Delta} MgCO_{3(s)} + H_2O(g) + CO_2(g) \Rightarrow MgO_{(s)} + H_2O_{(g)} + 2CO_{2}(g)$

$\hookrightarrow MgO_{(s)} + CO_2(g)$

(3) $Ag_2CO_{3(s)} \xrightarrow{\Delta} Ag_2O + CO_2(g) \Rightarrow 2Ag + \frac{1}{2}O_2(g) + CO_2(g)$

$\hookrightarrow 2Ag + \frac{1}{2}O_2(g)$

(4) $Hg_2CO_3(s) \xrightarrow{\Delta} HgO + CO_2(g) \Rightarrow Hg + \frac{1}{2}O_2(g) + CO_2(g)$

$\hookrightarrow Hg + \frac{1}{2}O_2(g)$

(5) Nitrates of Alkali Metal dissociates on heating

$$KNO_{3(s)} \xrightarrow{\Delta} KNO_{2(s)} + \frac{1}{2} O_2(g)$$

$$NaNO_{3(s)} \xrightarrow{\Delta} NaNO_{2(s)} + \frac{1}{2} O_2(g)$$

Except → ~~Li do~~ Nitrate of Li disassociate like alkal earth metals

(6) Nitrates of Alkali Earth Metal.

$$2LiNO_{3(s)} \xrightarrow{\Delta} Li_2O_{(s)} + 2NO_{2(g)} + \frac{1}{2} O_2(g)$$

$$Mg(NO_3)_{2(s)} \xrightarrow{\Delta} MgO_{(s)} + 2NO_{2(g)} + \frac{1}{2} O_2(g)$$

Hydroxides

→ Hydroxides of Alkali ~~Earth~~ metals are stable except 'Li'.

$$NaOH \xrightarrow{\Delta} \text{no reaction}$$

$$2LiOH \xrightarrow{\Delta} Li_2O_{(s)} + H_2O_{(g)}$$

→ Hydroxides of Alkali Earth metals are unstable

$$Mg(OH)_2 \xrightarrow{\Delta} MgO_{(s)} + H_2O_{(g)}$$

formation of nitride

→ Alkali Metals except N_2 do not react with 'N_2'.

$$Na + N_2 \xrightarrow{\Delta} \text{no reaction}$$

$$6Li + N_2 \xrightarrow{\Delta} 2Li_3N$$

→ Alkali earth metal elements burn in N_2 to form ionic nitrides with formula M_3N_2

$$3Mg + N_2 \xrightarrow{\Delta} Mg_3N_2$$

$$3Ca + N_2 \xrightarrow{\Delta} Ca_3N_2$$

$$CaCO_3 \xrightarrow{\Delta} CaO_{(s)} + CO_{2\,(g)}$$

200 g → 2 mole (112 g) → 2 mole (88 g)

$\frac{200}{100} = 2$ mole

closed container

$$\boxed{CaCO_3} \xrightarrow{\Delta} \boxed{\begin{matrix} CaO_{(s)} + CO_2 \\ 112g \quad 88g \end{matrix}}$$

200 g → 200 g

open container

$$\boxed{\begin{matrix} 200\ g \\ CaCO_{3(s)} \end{matrix}} \xrightarrow{\Delta} \begin{matrix} CaO_{(s)} & CO_2 \\ 112\ g & 88\ g \end{matrix}$$

CO_2 ↗ release in Atmosphere

$$\boxed{\%\ \text{loss (mass)} = \frac{\text{mass of gases in product}}{\text{Total mass}} \times 100}$$

Q64. find % loss in weight due to heating $KHCO_{3(s)}$ (K = 39u)

$$2KHCO_3 \xrightarrow{\Delta} K_2CO_3 + H_2O + CO_{2(g)}$$

2 mole → 1 mole, 1 mole, 1 mole

~~250~~ 200 g → 122 g, 18 g, 44 g

$$\%\ \text{loss} = \frac{62}{200} \times 100$$

$$\boxed{= 31\%}$$

Q65. Mixture of Li_2CO_3 + Na_2CO_3 is heated in an open container due to heating ~~loss~~ % loss of weight is $\frac{220}{9}$%. find the ratio of moles of Li_2CO_3 to Na_2CO_3 in original mixture.

$$Li_2CO_3 \xrightarrow{\Delta} Li_2O_{(s)} + CO_{2(g)}$$

n mole

$74n$ g $30n$ g $44n$ g

$$Na_2CO_3 \xrightarrow{\Delta} X$$

m mole

$106m$ g

$\cancel{\% \text{ loss} = \frac{44}{180} \times 100 = \frac{2200}{9}\% = \frac{220}{9}}$

$\cancel{n = 1}$

$$\% \text{ loss} = \frac{44n}{74n + 106m} \times 100 = \frac{220}{9}$$

$$= 396n = 2.2(74n + 106m)$$

$$= 396n = 162.8n + 233.2m$$

$$= 233.2n = 233.2m$$

$$\frac{n}{m} = \frac{233.2}{233.2}$$

$n : m$

$\boxed{1:1}$

H.W 30-07-24

S-1 [11-24]

O-1 [5, 6, 7, 10, 11, 12, 13-21]

J-M [7, 8, 10, 12-17, 25, 26, 27, 28]

Note :- Maximum product formation will occur when reactants are taken in stiochimetric ratio.

Mixtures - It is suggested to write balanced chemical reaction for all components of mixture which prosticipate in the reaction.

Q66. 4 g of Mixture of $CaCO_3$ & Sand (SiO_2) is reacted with excess of HCl which forms 0.224 litre of CO_2 at $0^\circ C$, 1 atm. find % Sand in the mixture {Sand is inert to HCl}

moles of $CO_2 = \frac{0.224}{22.4}$

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

$SiO_2 + HCl \longrightarrow \times$

$CaCO_3 + 2HCl \longrightarrow CO_2 + H_2O + CaCl_2$

$CO_2 \downarrow \frac{1}{100}$ mol

moles of $CaCO_3 = \frac{1}{100}$

mass $= \frac{1}{100} \times (40+12+48)$

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

$= 1$ g

% mass of $CaCO_3 = \frac{1}{4} \times 100$

$= 25\%$

$\boxed{\%\ \text{Sand} = 75\%}$

Q67 5g of CH_4 & C_2H_4 was burnt in excess O_2, giving $\frac{44}{3}$ g CO_2 & some H_2O.

i) % C_2H_4

ii) mole % C_2H_4

$(CH_4 + C_2H_4) = 5g$
x mol   y mol

mass of mixture = 5

$16x + 28y = 5$ — (1)

$CH_4 + O_2 \rightarrow CO_2 + 2H_2O$
↓
x mole

$C_2H_4 + O_2 \longrightarrow 2CO_2 + 2H_2O$
↓
2y mole

mole of $CO_2 = (x + 2y)$

mass of $CO_2 = (x+2y)44 = \frac{44}{3}$

$x + 2y = \frac{1}{3}$

$3x + 6y = 1$ — (2)

$y = \frac{1}{12}$ $x = \frac{1}{6}$

i) mass of $C_2H_4 = 28y$
$= \frac{28}{12}$

% $C_2H_4 = \frac{28}{12} \times \frac{1}{5} \times 100$

$= \frac{140}{3}$

$\boxed{= 46.66\%}$ i)

ii) mol % $C_2H_4 = \frac{\frac{1}{12}}{\frac{1}{12} + \frac{2}{12}} \times 100$

$= \frac{100}{3}$

$\boxed{= 33.33\%}$ ii)

Note :-

$A \rightarrow M_A$ gram

$B \rightarrow M_B$ gram

mass fraction of $A = \left[\dfrac{M_A}{M_A + M_B}\right]$

Q68. When 2.86 g of Butene (C_4H_8) & Butane (C_4H_{10}) was burned in excess of oxygen, 8.8 g CO_2 & 4.14 g H_2O. Calculate mass%. of Butane. (60.83%)

Q69. A 2 g mixture of Na_2CO_3 & $NaHCO_3$ losses 0.248 g when heated at 300°C at which $NaHCO_3$ decomposes to Na_2CO_3, CO_2, H_2O.
What is %. of Na_2CO_3 in the given mixture. (66.4%)

Q70. A mixture of $CaCO_3$ & $MgCO_3$ weighs 1.84 g. On heating leaves a residue 0.96 g. Calculate %. of each in mixture (54.34%)

Ans-68.

$C_4H_8 + 6O_2 \longrightarrow 4H_2O + 4CO_2$

$\downarrow$ x g

$\downarrow$ $\dfrac{x}{44}$ mol

$C_4H_{10} + \frac{13}{2}O_2 \rightarrow 5H_2O + 4CO_2$

$\downarrow$ $8.8 - x$ g

$\downarrow$ $\dfrac{8.8-x}{44}$ mol

moles of $C_4H_8 = \dfrac{x}{44} \times \dfrac{1}{4}$

mass $= \dfrac{7x}{22}$

mass of $C_4H_{10} = \dfrac{(8.8-x)}{44_{22}} \times 58^{29} \times \dfrac{1}{4}$

$= \dfrac{58}{20} - \dfrac{29x}{88}$

total moles $= \dfrac{58}{20} - \dfrac{22x}{88} = 2.86$

$= \dfrac{x}{4} = \dfrac{58}{20} - 2.86$

$\dfrac{x}{4} = \cancel{\dfrac{58-14.3}{10}}\ 2\ 0.04$

$\dfrac{x}{4} = \cancel{6.7}\ 4\ 0.04$

mass% $= \dfrac{29 \times (2.86)}{22} \times \dfrac{1}{2.86} \times 100$

$=$

$x = 0.16$

mass% $C_4H_{10} = \dfrac{8.64}{22} \times \dfrac{29}{4} \times \dfrac{1}{2.86} \times 100$

$= \dfrac{216}{286 \times 22} \times 100$

$= \dfrac{56}{143 \times 11} \times 100$

$= \dfrac{5600}{1573}$

$=$

Ans 68.

$$C_4H_8 + 6O_2 \longrightarrow 4H_2O + 4CO_2$$

C_4H_8: x mol; H_2O: $4x$; CO_2: $4x$

$$C_4H_{10} + \tfrac{13}{2}O_2 \longrightarrow 5H_2O + 4CO_2$$

C_4H_{10}: y mol; H_2O: $5y$; CO_2: $4y$

$$56x + 58y = 2.86 \quad \text{— (1)}$$

$$44(4x) + 44(4y) = 8.8g$$

$$176(x+y) = 8.8g \quad \text{— (2)}$$

$$\cancel{4x+4y} = x+y = 0.05$$

$$4x(18) + 5y(18) = 4.14$$

$$72x + 90y = 4.14 \quad \text{— (3)}$$

$$72(0.05-y) + 90(y) = 4.14$$

$$y = 0.03$$

$$\%\ \text{Butane} = \frac{0.03(58)}{2.86}$$

$$\boxed{= 60.83}$$

Ans 69.

$$2NaHCO_3 \xrightarrow{\Delta} Na_2CO_3 + CO_2 + H_2O$$

CO_2: x → $44x$; H_2O: x mole → $18x$

$$44x + 18x = 0.248$$

$$62x = 0.248$$

$$x = \frac{0.248}{62 \times 1000}$$

$$x = \frac{4}{1000}$$

$$\text{mass of } NaHCO_3 = \frac{4}{1000} \times 2 \times 84$$

~~% NaHCO₃~~

~~mass of Na₂~~

$$\%\ Na_2CO_3 = 100 - \frac{4}{1000} \times \frac{2 \times 84}{2} \times 100$$

$$= 100 - 33.6$$

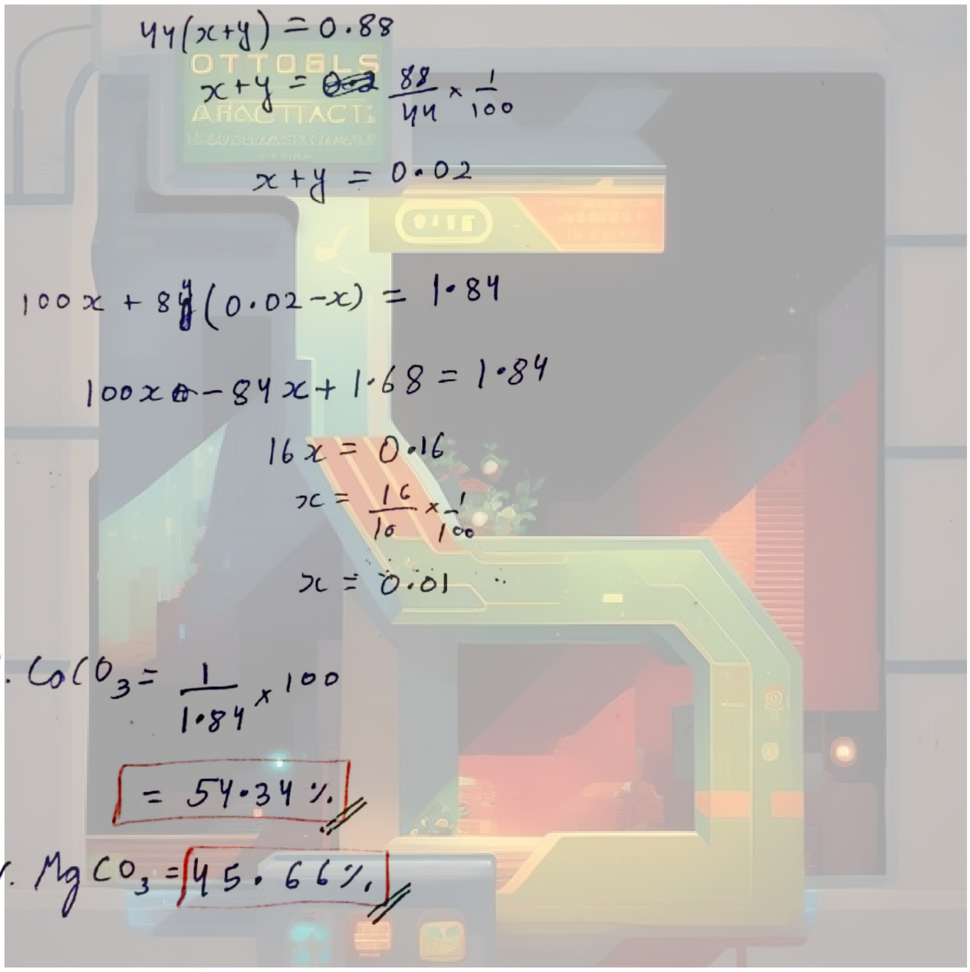
$$\boxed{= 66.4\%}$$

Ans 70. loss of heating $= 1.84 - 0.96$

$= 0.88\,g$

$$\underset{\substack{\downarrow \\ 100x\,g}}{CaCO_{3(s)}} \xrightarrow{\Delta} CaO_{(s)} + \underset{\substack{\downarrow \\ x \text{ mol} \\ \downarrow \\ 44x\,g}}{CO_2\uparrow_{(g)}}$$

$$\underset{\substack{\downarrow \\ 84y\,g}}{MgCO_{3(s)}} \xrightarrow{\Delta} MgO_{(s)} + \underset{\substack{\downarrow \\ y \text{ mol} \\ \downarrow \\ 44y\,g}}{CO_2\uparrow_{(g)}}$$



$$44(x+y) = 0.88$$

$$x+y = \cancel{0.2}\ \frac{88}{44} \times \frac{1}{100}$$

$$x+y = 0.02$$

$$100x + 84(0.02 - x) = 1.84$$

$$100x - 84x + 1.68 = 1.84$$

$$16x = 0.16$$

$$x = \frac{16}{16} \times \frac{1}{100}$$

$$x = 0.01$$

$$\% \, CaCO_3 = \frac{1}{1.84} \times 100$$

$$\boxed{= 54.34\,\%}$$

$$\% \, MgCO_3 = \boxed{45.66\,\%}$$

Percentage Purity

→ Defined only for Reactant.

→ Pure amount of Reactant will participate in the reaction.

$$\boxed{\%\ \text{Purity} = \frac{\text{Pure amount of Reactant}}{\text{Total amount of Reactant}} \times 100}$$

eg. 100 g of 80% pure $CaCO_{3(s)}$

Total weight = 100g

Pure $CaCO_3 = \frac{100}{100} \times 80 = 80g$

$CaCO_{3(s)} \rightarrow CaO_{(s)} + CO_{2(g)} \rightarrow$ 0.8 mole

↓

80g

mole $= \frac{80}{100} = 0.8$ mole

Q 71. Find the amount of CaO that can be produced by heating of 200 Kg 95% Pure Limestone ($CaCO_3$).

$CaCO_3 \rightarrow 200000g$

Pure $\rightarrow \frac{200000}{100} \times 95$

$\rightarrow 190000g$

$CaCO_3$ moles :- 1900 mol

$CaCO_3 \xrightarrow{\Delta} CaO + CO_2$

moles of CaO :- = 1900 mol

mass :- 1900×56

$= 106400\ g$

$\boxed{= 106.4\ kg}$

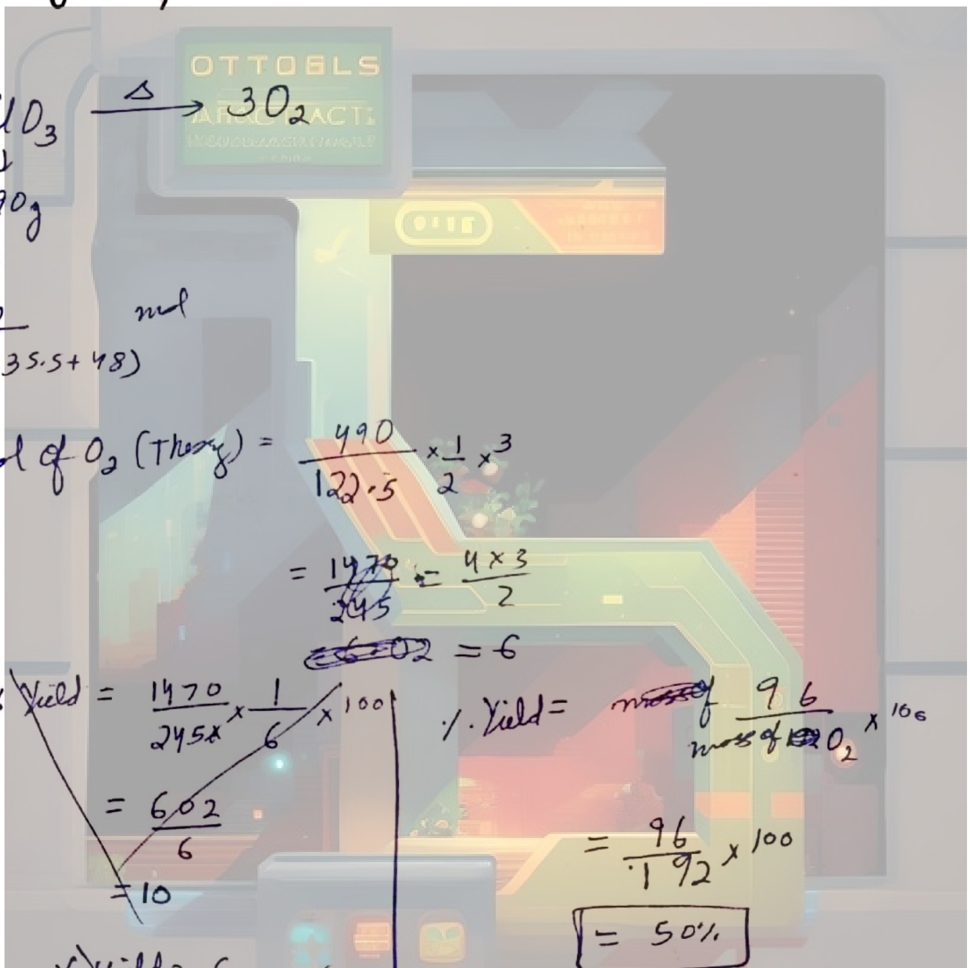
Q ~~72~~

% Yield:-

→ It is defined for product.

$$\boxed{\% \text{ Yield} = \frac{\text{experimental amount of product}}{\text{Theoritical amount of product}} \times 100}$$

Q 72: 490 g $KClO_3$ was heated in a container to yield 96 g O_2 gas. find % yield of the reaction [K = 39, Cl = 35.5]



$$2KClO_3 \xrightarrow{\Delta} 3O_2$$

↓

490 g

↓

$\frac{490}{(39+35.5+48)}$ mol

mol of O_2 (Theory) $= \frac{490}{122.5} \times \frac{1}{2} \times 3$

$= \frac{1470}{245} = \frac{4 \times 3}{2}$

~~6.02~~ $= 6$

~~% Yield $= \frac{1470}{245} \times \frac{1}{6} \times 100$~~

~~$= \frac{6.02}{6}$~~

~~$= 10$~~

~~% yield $= \frac{6}{6.02} \times 100$~~

~~$= \frac{600}{6.02}$~~

~~$=$~~

% Yield $= \frac{\text{~~mass of~~ } 96}{\text{mass of } ~~120~~ O_2} \times 100$

$= \frac{96}{192} \times 100$

$\boxed{= 50\%}$

$\boxed{= 50\%}$

Q73. Calculate mass of Coal (in kg) containing 0.05% by mass of FeS_2 that produces 44.8 lit SO_2 at 1 atm, 0°C with 40% yield

[Fe = 56, S = 32]

$$FeS_2 + \frac{5}{2}O_2 \longrightarrow FeO + 2SO_{2(g)}$$

2 mol

64 g

moles of $SO_2 = \frac{44.8}{22.4}$

= 2 mol

moles of FeS_2 = 1 mol

mass = 1 × (56 + 64)

= 120 g

~~mass of Coal~~ $\frac{\text{mass of } FeS_2}{\text{Total mass}} \times 100 = 0.05$

$\frac{120\,0000}{0.05}$ = Total mass

Total mass = 240000 g

Coal mass = 240000 − 120 g

~~% 40 = mass of SO_2 / 64 × 100~~

$\%\,40 = \frac{64}{\text{mass of } SO_2} \times 100$

160 ~~256~~ = mass of SO_2

moles of SO_2 = $\frac{\cancel{256}\,160}{32}$

$= \frac{256}{32}$ ~~$\frac{4}{10}$~~

~~8 mol~~

= 5 mol

mole of FeS_2 = ~~$\frac{4}{10}$ mol~~ $\frac{5}{2}$ mol

mass = $120 \times \frac{5}{2}$

~~48 g~~

= 300

$\frac{\cancel{48}\,300}{\text{Total mass}} = \frac{0.05}{100}$

Total mass = $\frac{\cancel{4.80000}}{5}$ = $\frac{3000000}{5}$

~~= 96000 g~~ = 600000 g

~~Coal = 96000 g~~

~~= 96 kg~~

$\boxed{= 600\text{kg}}$

H.W 2-8-24

Race (2, 3)

S 74. Calculate mass of $KClO_3$ required to produce 1.49 g of KCl upon heating if % Yield is –

i) 100% ii) 20% iii) 50%

i) $2KClO_3 \xrightarrow{\Delta} 2KCl + 3O_2$

1.49 g

$\frac{1.49}{74.5} = \frac{149}{74.5} \times \frac{1}{100}$

$= \frac{2}{100}$

$= \frac{1}{50}$

moles of $KClO_3$ = $\frac{1}{50}$

mass = $\frac{1}{50} \times 122.5$

$\boxed{= 2.45 g}$ i)

ii) ~~$\frac{20}{100} \times \frac{1}{50}$ = moles of $KClO_3$~~

~~$\frac{1}{250}$ mole $KClO_3$~~

~~mass = $\frac{2.45}{5}$~~

~~= 0.49~~

iii) $\frac{x}{100} \times 50 = \frac{1}{50}$

$x = \frac{1}{50} \times \frac{100}{50}$

$x = \frac{1}{25}$

mass = $\frac{122.5}{50} \times 2$

$\boxed{= 4.9 g}$ iii)

ii) $\frac{x}{100} \times 20 = \frac{1}{50}$

$x = \frac{1}{50} \times \frac{100}{20}$

$x = \frac{1}{10}$

mass = $\frac{122.5}{10}$

$\boxed{= 12.25 g}$ ii)

Q75.

Degree of Dissociation (DOD) (α) :-

$$\boxed{\alpha = \frac{\text{no. of moles of reactant dissociated}}{\text{Total moles of reactant}}}$$

% Dissociation $= \alpha \times 100$

$0\% \le \alpha \le 100\%$

$0 \le \alpha \le 1$

no. of moles $= a$ moles
no. of dissociated $= a\alpha$ moles.

eg. $2NH_{3(g)} \longrightarrow N_{2(g)} + 3H_{2(g)}$

	$2NH_{3(g)}$	$N_{2(g)}$	$3H_{2(g)}$
$t=0$	a mol	0	0
$t=t$	$a-x$ mol ↳ reacted	$\frac{x}{2}$	$\frac{3x}{2}$

in terms of α

$t=0$	a mol	0	0
$t=t$	$a-a\alpha$	$\frac{a\alpha}{2}$	$\frac{3a\alpha}{2}$

Q75. For a reaction $2A \longrightarrow B + 3C$ If 5 mol A is initially taken & A dissociate 60%. then calculate.
i) moles of B
ii) moles of C
iii) mols of A remaining

$$2A \longrightarrow B + 3C$$

$\downarrow$ 3 mol, $\downarrow$ 1.5 mol, $\downarrow$ 4.5 mol

moles of A react $= 5 \times 0.6$

$= 3$ mol

moles of B $=$ of A reacted $\times \frac{1}{2}$

$= \frac{3}{2}$

$\boxed{= 1.5 \text{ mol}}$ i)

moles of C $= \frac{3}{2} \times 3$

$\boxed{= 4.5 \text{ mol}}$ ii)

of A left $=$ total $-$ reacted

$= 5 - 3$

$\boxed{= 2 \text{ mol}}$ iii)

Q76. If 5 mol of A were taken initially & moles of B formed after dissociation is 6 then calculate. i) α ii) moles of C formed.

$$2A \longrightarrow 3B + 4C$$

$\downarrow$ (B) 6 mol

no. of moles of C reacted $= \frac{6}{3} \times 4$

$= 2 \times 4$

$\boxed{= 8 \text{ mol}}$ ii)

no of moles of A reacted $= \frac{6}{3} \times 2$

$= 2 \times 2$

$= 4$ mol

$\alpha =$ DOD $= \frac{\text{moles reacted}}{\text{moles present}}$

$\alpha = \frac{4}{5}$ $\boxed{\alpha = 0.8}$ i)

Q77. If initially 12 moles of A & α is 0.6 find total moles in the container after dissociation.

$$A \longrightarrow 2B + C$$

moles of A reacted $= 12 \times 0.6$

$$= \frac{12 \times 6}{10}$$

$$= \frac{72}{10}$$

moles of A $= 7.2$ mol

moles of B $= 2 \times 7.2$
$= 14.4$ mol

moles of C $= 7.2$ mol

left after reaction $= (14.4 + 7.2)$ mol $+ (12 - 7.2)$ mol
$= 21.6 + 4.8$
$\boxed{= 26.4 \text{ mol}}$

Q78. If initial moles of A → 10 mol, DOD = 0.4 find the moles of C formed if Reaction Yield is 80%.

$$A \longrightarrow 2B + C$$

moles of A react $= 10 \times 0.4$
$= 4$ mol

moles of A reacted according to Yield $= 4 \times 0.8$
$= 3.2$ mol

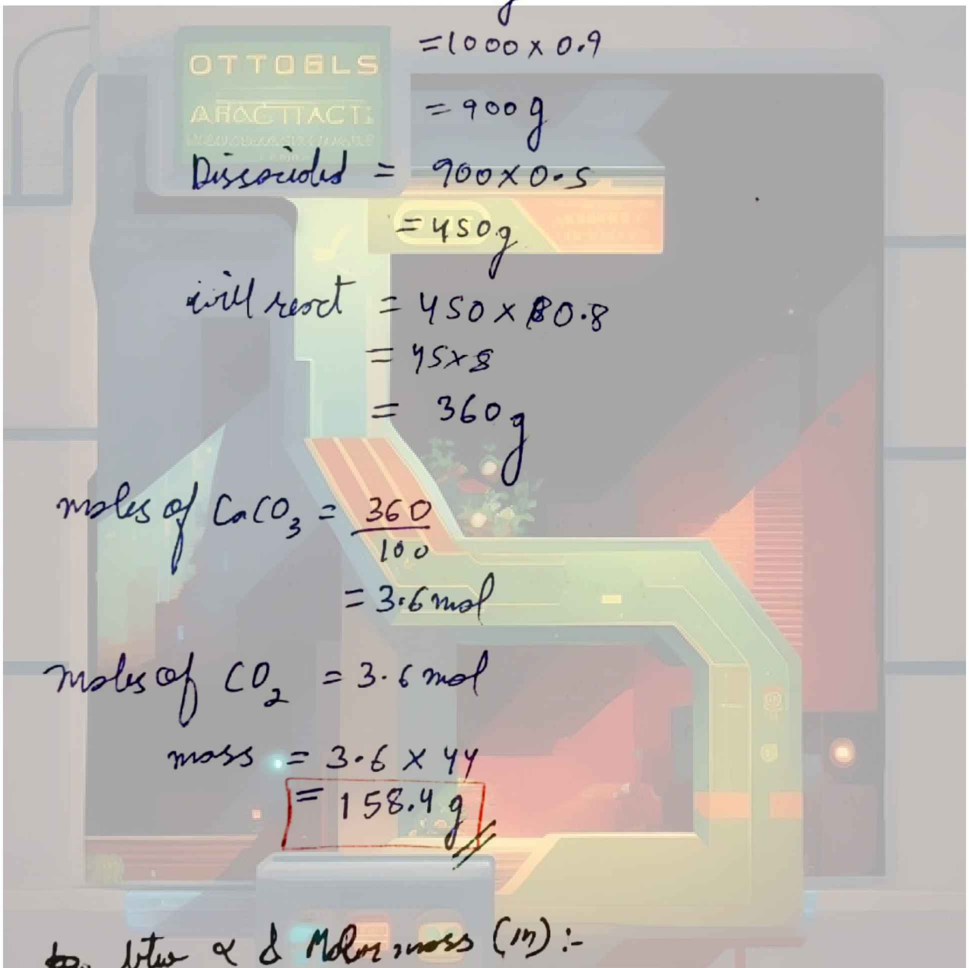
moles of C formed $= \boxed{3.2 \text{ mol}}$

Q79. $CaCO_{3(s)} \longrightarrow CaO_{(s)} + CO_{2(g)}$

If 1 kg $CaCO_3$ taken with 90% Purity, 50% DOD then find mass of CO_2 gas in g produced if % Yield of reaction is 80%.

~~Pure $CaCO_3$ =~~

Pure $CaCO_3$ = 1 kg
= 1000 g



= 1000 × 0.9

= 900 g

Dissociated = 900 × 0.5

= 450 g

will react = 450 × 0.8

= 45 × 8

= 360 g

moles of $CaCO_3$ = $\frac{360}{100}$

= 3.6 mol

moles of CO_2 = 3.6 mol

mass = 3.6 × 44

$\boxed{= 158.4\,g}$

Relation ~~bw~~ btw α & Molar mass (M):-

$$A \longrightarrow nB$$

	A	nB
t = 0	a	0
t = t	a − aα	n(aα)

$$M_i = M_f$$

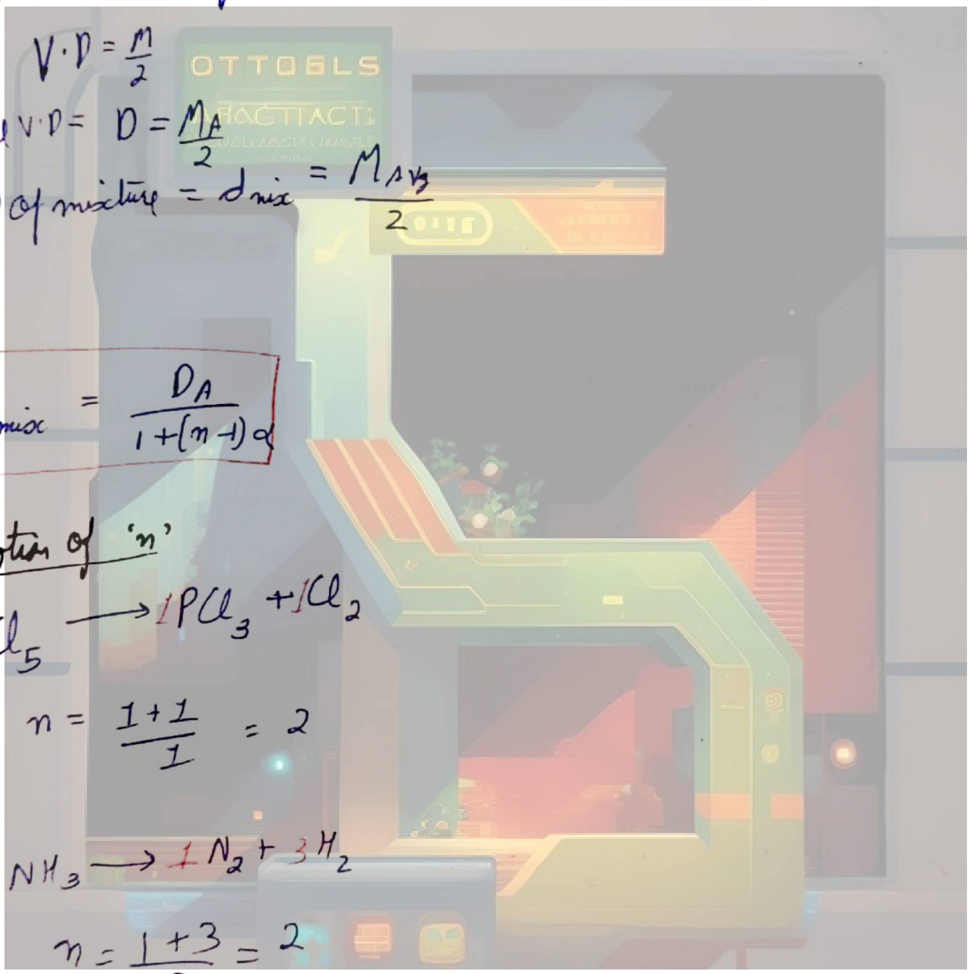
~~for M_A~~

$$aM_A = [a - a\alpha + na\alpha]\, M_{Avg}$$

$$M_A = (1+(n-1)\alpha)\, M_{Avg}$$

$$\boxed{M_{Avg} = \frac{M_A}{1+(n-1)\alpha}}$$

M_A - Molar mass of Reactant



$$V\cdot D = \frac{M}{2}$$

Initial V·D = $D = \frac{M_A}{2}$

V·D of mixture = $d_{mix} = \frac{M_{Avg}}{2}$

$$\boxed{d_{mix} = \frac{D_A}{1+(n-1)\alpha}}$$

Calculation of 'n'

(1) $1PCl_5 \longrightarrow 1PCl_3 + 1Cl_2$

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

(2) $2NH_3 \longrightarrow 1N_2 + 3H_2$

$$n = \frac{1+3}{2} = 2$$

Q.80. Calculate α if molar mass of mixtures is 13.6.

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

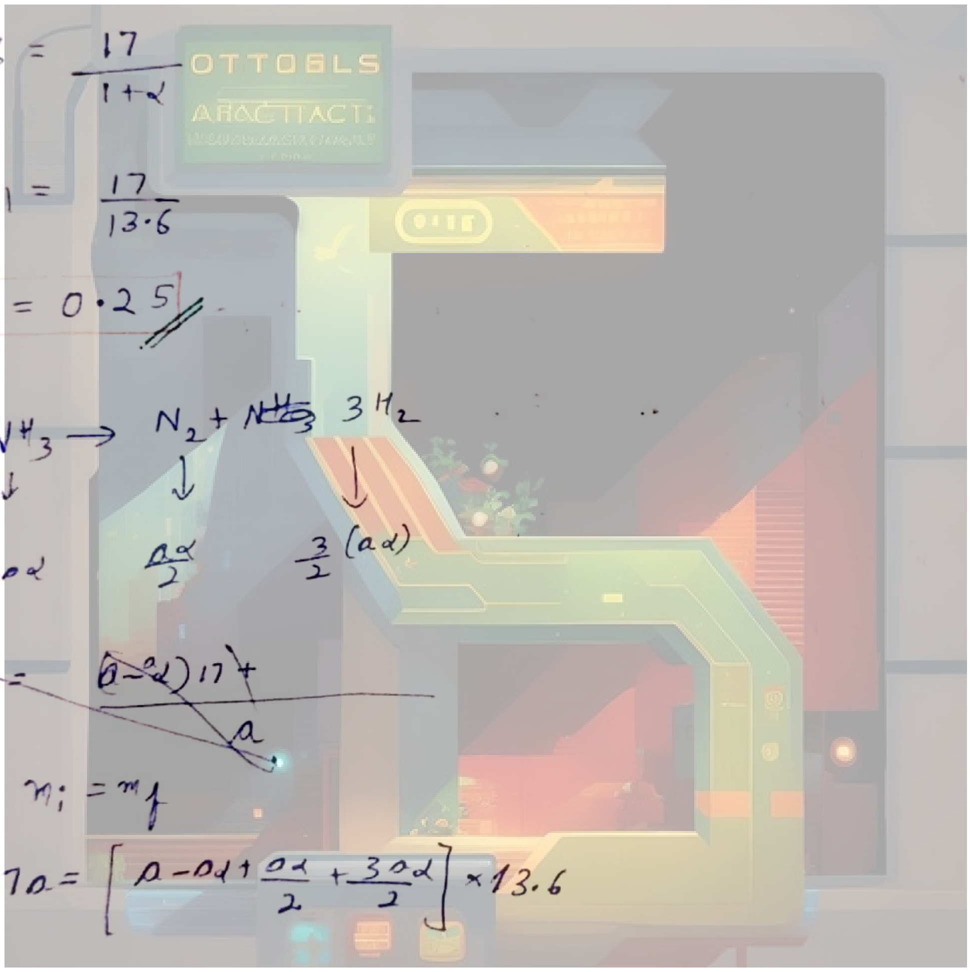
[M I]

$$M_{mix} = \frac{M_{NH_3}}{1+(n-1)\alpha}$$

$$n = \frac{3+1}{2} = 2$$

$$M_{mix} = 13.6$$

$$M_{NH_3} = 17$$



$$13.6 = \frac{17}{1+\alpha}$$

$$\alpha + 1 = \frac{17}{13.6}$$

$$\boxed{\alpha = 0.25}$$

[M II]

$$2NH_3 \longrightarrow N_2 + \cancel{NH_3}\ 3H_2$$

$$a - a\alpha \qquad \frac{a\alpha}{2} \qquad \frac{3}{2}(a\alpha)$$

$$\cancel{13.6 = \frac{(a-\alpha)17+}{a}}$$

$$m_i = m_f$$

$$17a = \left[a - a\alpha + \frac{a\alpha}{2} + \frac{3a\alpha}{2}\right] \times 13.6$$

$$\boxed{\alpha = 0.25}$$

Q81. $N_2O_4 \longrightarrow 2NO_2$. $\alpha = 0.5$ calculate V.D of mixture.

$n = 2$

$$M_{mix} = \frac{M_{N_2O_4}}{1+(n-1)\alpha}$$

$$M_{mix} = \frac{92}{1.5}$$

$$M_{mix} = \frac{184}{3}$$

$$V.D = \frac{184}{3} \times \frac{1}{2}$$

$$= \frac{92}{3}$$

$$\boxed{= 30.66}$$

Q82. If Density of Reaction mixture is 1.5 g/ml at 4 atm 400 K calculate DOD. [R → 0.08]

$$2NH_{3(g)} \rightarrow N_{2(g)} + 3H_{2(g)}$$

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

$$1.5 = \frac{4 \times M_{Avg}}{0.08 \times \cancel{400}\ 100}$$

$$12.0 = M_{Avg}$$

$$12.0 = \frac{17}{1+\alpha}$$

$$\alpha = \frac{17}{120} - 1$$

$$\alpha = \frac{5}{12}$$

$$\boxed{\alpha = 0.416}$$

Q83. Density of partially dissociated sample of SO_3 is 2.5 g/L at 0°C 1 atm. find degree of dissociation of SO_3.

$$SO_3 \rightarrow SO_2 + \frac{1}{2} O_2$$

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

$$\frac{2.5}{\cancel{1000}} = \frac{1 \times M}{273 \times 0.0821}$$

$$\frac{22.4 \times 2.5}{\cancel{1000}} = M$$

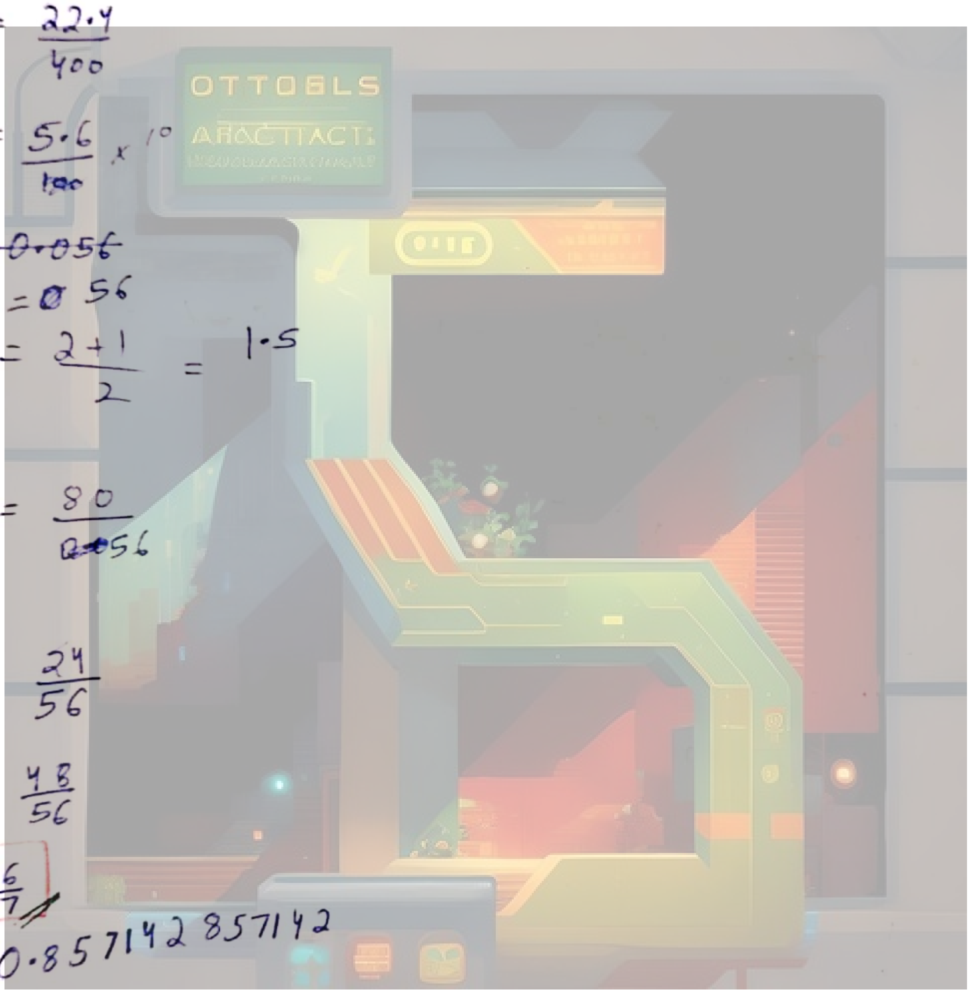
$$M = \frac{22.4}{400}$$

$$M = \frac{5.6}{\cancel{100}} \times 10$$

$$\cancel{M = 0.056}$$

$$M = \cancel{0}56$$

$$n = \frac{2+1}{2} = 1.5$$



$$\frac{\alpha}{2} + 1 = \frac{80}{\cancel{0.0}56}$$

$$\frac{\alpha}{2} = \frac{24}{56}$$

$$\alpha = \frac{48}{56}$$

$$\boxed{\alpha = \frac{6}{7}}$$

$$\alpha = 0.857142857142$$

Sequential Reaction

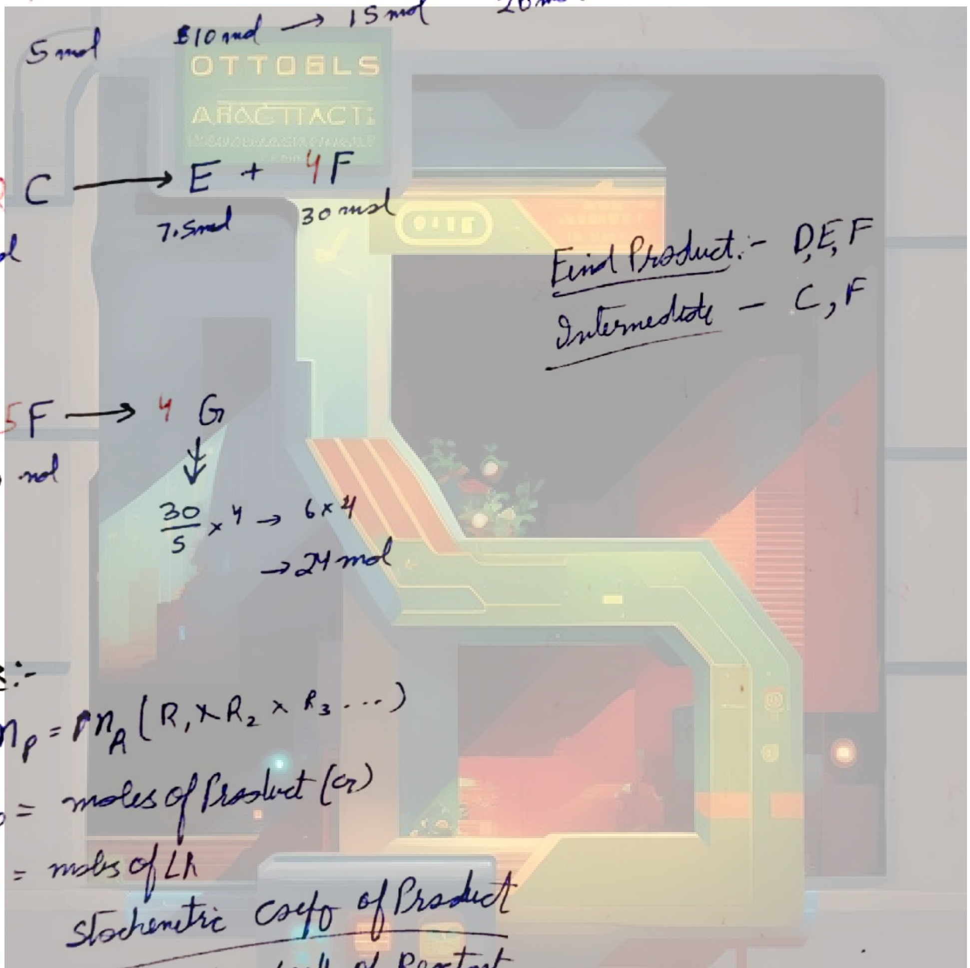
→ Such reactions occurs in multiple steps, such that at least one of the product of a particular step acts as reactant in next step.

eg. $A + 2B \longrightarrow 3C + 4D$

given 5 mole, 15 mole

$\frac{5}{1}$ $\quad \frac{15}{2} = 7.5$

will react 5 mol, 10 mol → 15 mol, 20 mol



$2C \longrightarrow E + 4F$

15 mol, 7.5 mol, 30 mol

Final Product :- D, E, F

Intermediate – C, F

$5F \longrightarrow 4G$

30 mol

$\frac{30}{5} \times 4 \to 6 \times 4$

$\to 24$ mol

Trick :-

$n_P = n_R (R_1 \times R_2 \times R_3 \dots)$

n_P = moles of Product (G)

n_R = moles of LR

$R : \dfrac{\text{Stoichometric coefficient of Product}}{\text{Stoichometric coeff of Reactant}}$

$n_G = 5 \times \left(\frac{3}{1} \times \frac{\cancel{4}^{2}}{\cancel{2}} \times \frac{4}{5} \right)$

$n_G = 24$ mol

Q84. $KClO_4$ can be produced by Cl_2 and KOH by the following reactions: i) find mass of Cl_2 required to produce 10 mol $KClO_4$ ii) Also find total mass of KCl produced.

$$Cl_2 + 2KOH \longrightarrow KCl + KClO + H_2O$$

$$3KClO \longrightarrow 2KCl + KClO_3$$

$$4KClO_3 \longrightarrow 3KClO_4 + KCl$$

$3KClO_4$ → 10 mol

moles of $KClO_3$ $= \frac{10}{3} \times 4$

moles of $KClO$ $= \frac{10}{3} \times 4 \times 3$

$= 10 \times 4$

$= 40$

moles of Cl_2 $= 40$ mol

mass of Cl_2 $= 71 \times 40$

$\boxed{= 2840\ g}$ i)

moles of KCl $= \left(\frac{10}{3}\right) + \left(\frac{10}{3} \times 4 \times 2\right) + (40)$

$= \frac{10}{3} + \frac{80}{3} + \frac{120}{3}$

$= \frac{210}{3}$

$= 70$

mass $= 70(39 + 35.5)$

$= 74.5 \times 70$

$\boxed{= 5215.0\ g}$ ii)

68

Q85. HCN can be produced by following reaction.

i) when 25.5 g NH_3 & 32 g CH_4 are used with excess O_2 find weight of HCN produced.

$$4NH_3 + 5O_2 \longrightarrow 4NO + 6H_2O \quad -(1)$$
$$2NO + 2CH_4 \longrightarrow 2HCN + 2H_2O + H_2 \quad -(2)$$

given:- $NH_3 = 22.5g = \frac{2\overset{5}{\cancel{2}}.5}{17}$ g mol

$CH_4 = 32g = 2$ g mol

moles ~~mass~~ of NO from ~~1st~~ (1) = moles of NH_3

$= \frac{2\overset{5}{\cancel{2}}.5}{17}$

L.R — NO for (2)

moles of HCN $= \frac{25.5}{17}$

mass $= \frac{25.5}{17} \times 27$

mass $= 1.5 \times 27$

$= 27 + 13.5$

$\boxed{= 40.5\ g}$ i)

Note:-

(1) In the problems of sequential Reaction, If % yield of each step is also given then following formula can be used.

$$n_p = n_R (R_1 \times R_2 \times R_3 \ldots) \times \frac{y_1}{100} \times \frac{y_2}{100} \times \frac{y_3}{100}$$

$y_1, y_2, y_3 \Rightarrow$ % Yield

Q86. A Sample of $CuSO_4 \cdot 5H_2O$ undergoes following set of reactions

$$CuSO_4 \cdot 5H_2O \xrightarrow{100\%} CuSO_4 + 5H_2O$$

$$CuSO_4 + 2KCN \xrightarrow{80\%} Cu(CN)_2 + K_2SO_4$$

$$2Cu(CN)_2 \xrightarrow{50\%} Cu_2(CN)_2 + (CN)_2$$

$$Cu_2(CN)_2 + 6KCN \xrightarrow{50\%} 2K_3[Cu(CN)_4]$$

If moles of $K_3[Cu(CN)_4]$ is 0.1. find volume of $(CN)_2$ gas at 0°C, 1 atm

① moles of $K_3[Cu(CN)_4] = 0.1$

moles of $Cu_2(CN)_2 = x$

② $50 = \frac{0.1}{2x} \times 100$

$\frac{2x \times 50}{\cancel{100}_2} = 0.1$

$x = \frac{0.2}{2}$

$x = 0.1$

moles of $Cu_2(CN)_2 = 0.1$ mol

③ moles of $Cu(CN)_2 = y$

$50 = \frac{0.1}{y/2} \times 100$

$\frac{y}{2} \times 50 \times \frac{1}{100} = 0.1$

$y = 0.4$

moles of $Cu(CN)_2 = 0.4$ mol

moles of $CuSO_4 = z$

$80 = \frac{0.4}{z} \times 100$

$z = \frac{0.4}{0.8}$

$z = \frac{1}{\cancel{0.2}}\ \frac{1}{2}$

$\cancel{z = \frac{1}{2}}$

$\cancel{z = 5}$

$z = 1/2$

moles of $CuSO_4 = 1/2$

~~Volume of~~

moles of $(CN)_2 = 0.92$

Volume $= 22.4 \times 0.4$

Volume =

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moles of $(CN)_2$ = moles of $Cu_2(CN)_2 = x$

moles of $K_3[Cu(CN)_4] = 0.1$

moles of $Cu_2(CN)_2 = 0.1$

moles of $(CN)_2 = 0.1$

Volume $= 0.1 \times 22.4$

$\boxed{= 2.24\,l}$

H.W. 6-8-24

S-1 [25-34]

O-1 [22-27]

Race [4, 5]

Parallel Reactions

→ Two or more reactions involving same reactants & forms different products in the same container.

$$A \begin{cases} \to B \\ \to C \end{cases}$$

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

$$N_2 + 2H_2 \longrightarrow N_2H_4$$

Q 87. 6 mole $KClO_3$ dissociates as following & form 22.4 lt O_2 at STP. find mole of $KClO_4$ produced.

$$2KClO_3 \to 2KCl + 3O_2 \quad -(1)$$

$$4KClO_3 \to 3KClO_4 + KCl \quad -(2)$$

moles of $O_2 = 1$ mol

moles of $KClO_3$ in (1) $= \frac{2}{3}$

moles left $= 6 - \frac{2}{3}$

$= \frac{16}{3}$

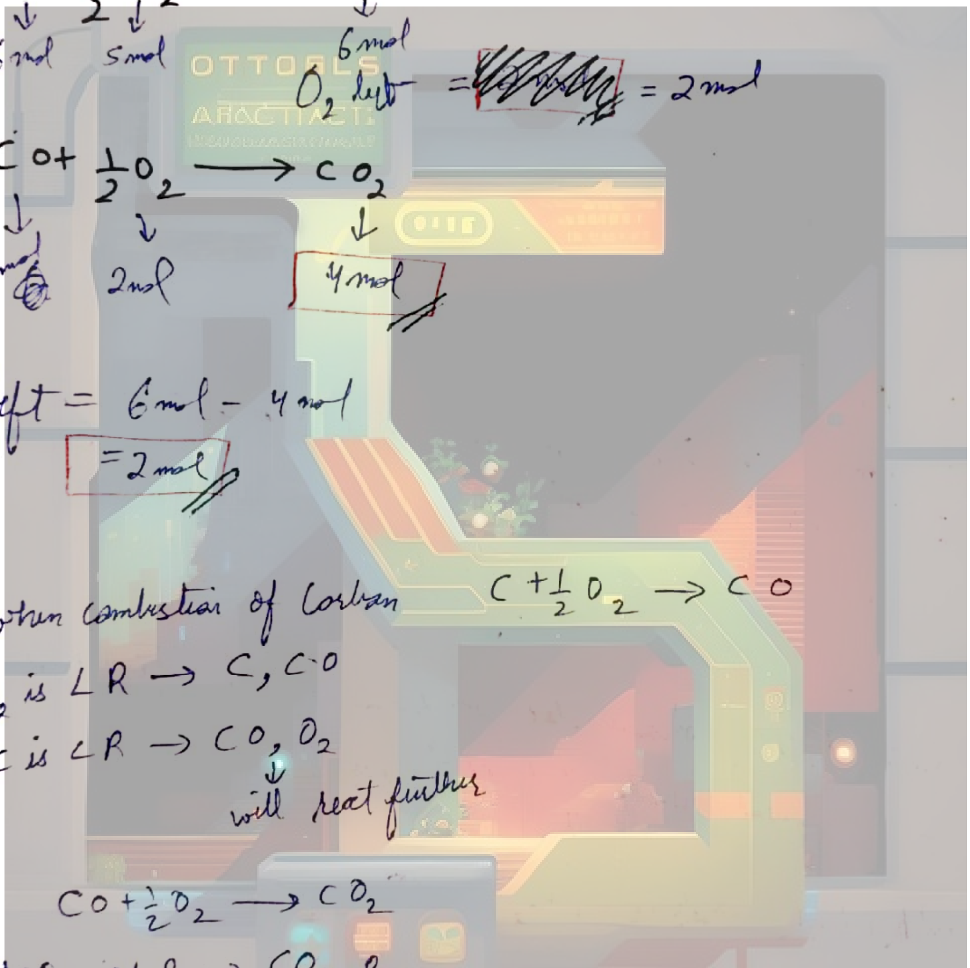
moles of $KClO_3$ for (2) $= \frac{16}{3}$

moles of $KClO_4 = \frac{16}{3} \times \frac{3}{4} = \boxed{4\text{ mol}}$

Q 88. 160 g O_2 & 72 g Carbon reacted to form CO, CO_2 find moles of CO & CO_2 in the final mixture.

$$\cancel{5O_2 + 6C \longrightarrow 4CO_2 + 2CO}$$

$$\underset{\substack{\downarrow \\ 160\,g \\ \downarrow \\ 5\,mol}}{}\qquad \underset{\substack{\downarrow \\ 72\,g \\ \downarrow \\ 6\,mol}}{}$$



$$C + \frac{1}{2}O_2 \longrightarrow CO$$

6 mol   5 mol   6 mol

O_2 left = ~~...~~ = 2 mol

$$CO + \frac{1}{2}O_2 \longrightarrow CO_2$$

6 mol   2 mol $\boxed{4\ mol}$

CO left = 6 mol − 4 mol

$\boxed{= 2\ mol}$

Note:- when combustion of Carbon $C + \frac{1}{2}O_2 \longrightarrow CO$

(1) If O_2 is LR → C, CO

(2) If C is LR → CO, O_2
will react further

$$CO + \frac{1}{2}O_2 \longrightarrow CO_2$$

(3) If CO_2 is LR → CO_2, O_2

(4) If O_2 is LR → CO, CO_2

Q 89. Carbon react with O_2 to form CO or CO_2. find moles of each substance obtained when 160 g O_2 react with

i) 12 g carbon

ii) 120 g carbom

$$C + \tfrac{1}{2}O_2 \rightarrow CO \quad (1)$$

$$CO + \tfrac{1}{2}O_2 \rightarrow CO_2 \quad (2)$$

i) moles of $O_2 = \frac{160}{32} = 5$ mol

moles of Carbon $= \frac{12}{12} = 1$ mol

in (1)

L.R $\rightarrow$ Carbon

moles of produced CO by (1) $=$ 1 mol

moles of O_2 left after ~~(2)~~ (1) $=$ ~~4 mol~~ 4.5 mol

~~moles of CO~~

in (2)

L.R $\rightarrow$ CO

moles of produced CO_2 $= \boxed{1\ mol}$ i)

moles of O_2 left $= \boxed{4\ mol}$ i)

ii) moles of O_2 = 5 mol

moles of Carbon = 10 mol

moles of CO produced $= \boxed{10\ mol}$ ii)

moles of $CO_2 = 0$

H.W. 8-8-24

S-1 → 35-38

O-1 → 28-31

J-M → 5, 9, 18, 20, 21

S-2 → 1, 2, 4, 5, 7, -11

O-2 → 5-11, 16-18, 23-25, 32

POAC (Principle of Atomic Conservation)

→ According to this principle atoms can ~~be~~ neither be created nor be destroyed. If no. of atoms are conserved then its moles of atoms ~~do~~ must also be conserved.

eg

$$KClO_3 \longrightarrow KCl + O_2$$

POAC on K

$$(\text{atoms of } K)_{Left} = (\text{atoms of } K)_{right}$$

$$\frac{1}{N_A} \times (\text{atoms of } K)_{Left} = \frac{1}{N_A} \times (\text{atoms of } K)_{right}$$

$$(\text{moles of } K)_{Left} = (\text{Moles of } K)_{Right}$$

→ When we apply POAC to solve a problem we do not need to balance the chemical reaction & many times, the complete Knowledge of Reactions is also not required.

Note :- POAC should be used with caution that is used only if all atoms has converted to product

eg.

$$\underset{a \text{ mole}}{KClO_3} \rightarrow KCl + \underset{x \text{ mol}}{O_2}$$

POAC on O_2

$$(\text{moles of } O)_{Left} = (\text{moles of } O)_{Right}$$

$$3 \times (\text{moles of } KClO_3) = 2 \times (\text{moles of } O_2)$$

$$3a = 2x$$

$$\boxed{x = \frac{3}{2} a}$$

Application of POAC

① Solving Problems where reaction is not known.

→ In such Questions always try to find that atom for which POAC can be applied.

Q90. All carbon present in 1016 g $KH_3(C_2O_4)_2 \cdot 2H_2O$ is converted to CO_2. find mass of CO_2

$(\text{moles of } C)_{Left} = (\text{moles of } C)_{Right}$

$8 \times (\text{moles of } KH_3(C_2O_4)_2 \cdot 2H_2O) = 2 \times \text{moles of } CO_2$

$\text{moles of } CO_2 = 4 \text{ moles of } KH_3(C_2O_4)_2$

$\cancel{= 4 \times \frac{1016}{218}}$

$\cancel{= \frac{2032}{109}}$

$\cancel{\text{mass of } CO_2 = \frac{2032}{109} \times 44}$

$= 4 \times \frac{1016}{254}$

$= 16$

$\text{mass of } CO_2 = 16 \times 44$

$\boxed{= 704 g}$

Q91. K_2CO_3 weighing 276 g by a series of reactions is converted to $K_2Zn_3[Fe(CN)_6]_2$. find weight of complex compound if carbon is conserved $(Zn - 65, Fe = 56)$ (molecular weight $= 698$)

$(\text{moles of } c)_{Left} = (\text{moles of } c)_{Right}$

$\frac{276}{138} = 2 = 12 \times \text{moles of compound}$

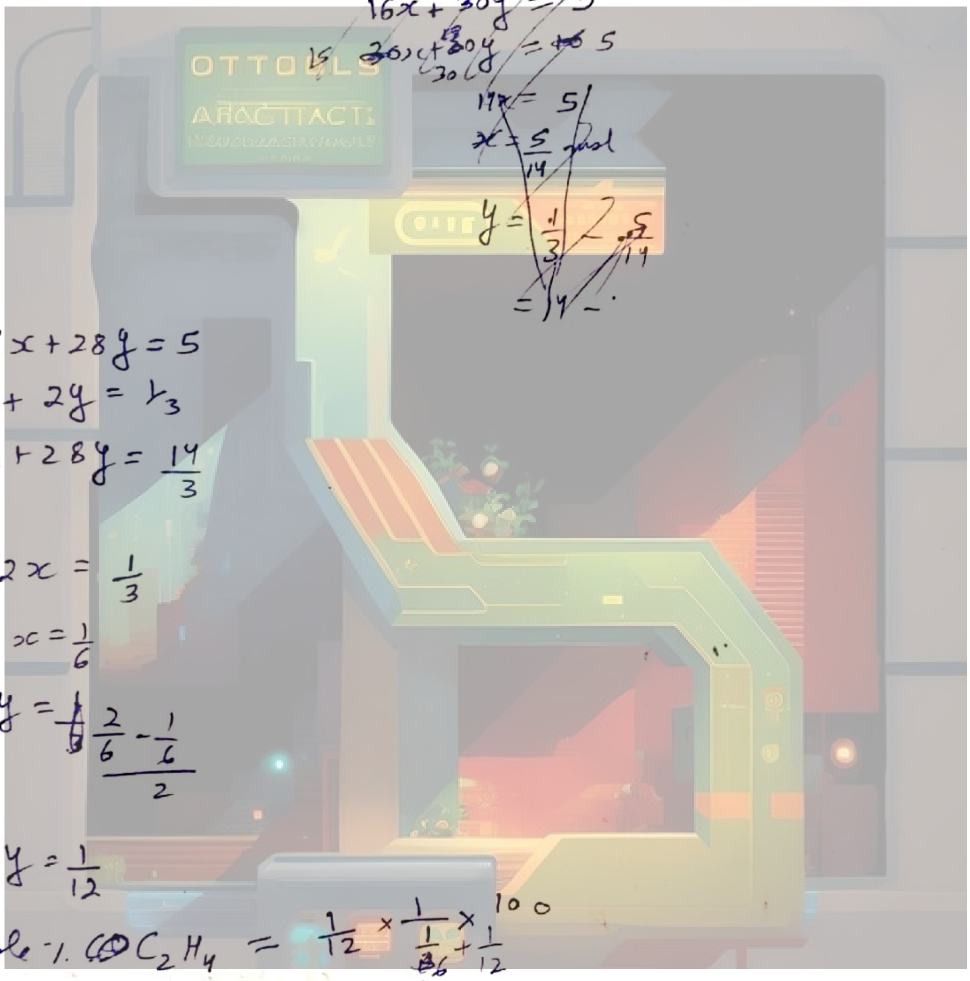
mass ~~moles~~ of compound $= \frac{1}{6} \times 698 = \boxed{116.3 g}$

Q92. 5g mixture of CH_4 & C_2H_4 was completely burned in excess of Oxygen to yield $\frac{44}{3}$ g CO_2 find mole % of C_2H_4.

moles of C in RHS $= \frac{44}{3} \times \frac{1}{44}$

$= \frac{1}{3}$ mol

moles of C in LHS $=$ $\underbrace{\text{moles of } CH_4}_{x \text{ mol}} + 2\,\underbrace{\text{moles of } C_2H_4}_{y \text{ mol}} = \frac{1}{3}$



$\cancel{x + 2y = \frac{1}{3}}$

$\cancel{16x + 30y = 5}$

$\cancel{30x + 30y = 5}$

$\cancel{14x = 5}$

$\cancel{x = \frac{5}{14} \text{ mol}}$

$\cancel{y = \frac{1}{3} - 2\frac{5}{14}}$

$\cancel{= 14 -}$

$16x + 28y = 5$

$x + 2y = \frac{1}{3}$

$14x + 28y = \frac{14}{3}$

$2x = \frac{1}{3}$

$x = \frac{1}{6}$

$y = \dfrac{\frac{2}{6} - \frac{1}{6}}{2}$

$y = \frac{1}{12}$

mole % of C_2H_4 $= \frac{1}{12} \times \dfrac{1}{\frac{1}{6} + \frac{1}{12}} \times 100$

$= \frac{1}{3} \times 100$

$\boxed{= 33.33\ \%}$

② Problems of Parallel reaction. → All reactors ~~are~~ consumed

Q93. 72g Carbon & 160 g O_2 is Put in a container where they react to form CO & CO_2 such that no reactant is left. Find moles of CO & CO_2.

$(\text{moles of Carbon})_{Left} = \frac{72}{12} = 6 \text{ mol}$

$(\text{moles of } O)_{Left} = \frac{160}{16} = 10 \text{ mol}$

$$C + O_2 \longrightarrow CO + CO_2$$

C: 6 mol, O_2: 5 mol, CO: x, CO_2: y

$x + y = 6$ (POAC on C)

$x + 2y = 10$ (POAC of O)

$y = 4$

$x = 2$

$\boxed{\text{moles of } CO = 2}$

$\boxed{\text{moles of } CO_2 = 4}$

Q94. ~~One~~ 1 mole P_4 & 4 mole O_2 are kept in a container where they react to form P_4O_6 & P_4O_{10} or both such that no reactant is left. find moles of P_4O_6 & P_4O_{10}.

M.I

$$P_4 + O_2 \longrightarrow P_4O_6 + P_4O_{10}$$

P_4: 1 mol, O_2: 4 mol, P_4O_6: x mol, P_4O_{10}: y mol

$4x + 4y = 4$

$x + y = 1$

$3x + 5y = 4$

$3(1-y) + 5y = 4$

$3 + 2y = 4$

$2y = 1$

$\boxed{y = 1/2}$

$\boxed{x = 1/2}$

M II

$$P_4 + 3O_2 \longrightarrow P_4O_6$$
1 mol   4 mol   1 mol

L.R = L.R = P_4

moles O_2 left = $\frac{4}{4} - 3 = 1$ mol

$$P_4O_6 + 2O_2 \longrightarrow P_4O_{10}$$
1 mol   1 mol $\boxed{1/2 \text{ mol}}$

left = $\boxed{1/2 \text{ mol}}$

③ % Determination of element in a compound

1. ~~Liebig's~~ Liebig's Method – to determine % C & % H in organic compound.
2. Duma's Method – % N in organic compound.
3. Carius Method – % Halogen (except F) in an organic compound.

$$O.C(X) \xrightarrow[HNO_3]{AgNO_3} AgX \downarrow (PPT)$$

AgF → Soluble
AgCl → white PPT
AgBr → Light Yellow PPT
AgI → dark yellow PPT

Q95. In Carius Method, for estimation of Halogen, 250 mg of organic compound gave 141 mg AgBr. find % of Br.
(Ag → 108, Br → 80)

moles of Ag ~~Cl~~Br = $\frac{141}{1000} \times \frac{1}{188}$

moles of Br = $\frac{141}{188 \times 1000}$ mol

mass of Br = $\frac{141}{188} \times 80$ mg

% ~~Ag~~Br = $\frac{141 \times 80}{188 \times 250} \times 100$

$= \frac{1128}{47}$

$\boxed{= 24 \%}$

Q96. In Sulfur Estimation, 0.22 g of organic compound give 0.46 g $BaSO_4$ (ppt) find % Sulfur ($BaSO_4$ = 233)

moles of $BaSO_4$ = moles of Sulfur $= \frac{0.46}{233} = \frac{46}{233} \times 10^{-2}$

mass of Sulphur $= \frac{46}{233} \times \frac{1}{100} \times 32$

$\% S = \frac{46 \times \cancel{32}}{233 \times \cancel{100}} \times \frac{1}{\cancel{0.32}} \times \cancel{100}$

$= \frac{4600}{233}$

$\boxed{= 19.41}$

Q97. 0.124 g organic compound containing Phosphorous gives 0.222 g $Mg_2P_2O_7$ by a usual analysis. calculate % of P in O.C?

moles of $Mg_2P_2O_7$ = $\frac{\text{moles of P}}{2}$ = $\frac{0.222}{222}$ mol

mass of P $= \frac{1}{1000} \times 2 \times 31$

$= \frac{62}{1000}$ g

$\% P = \frac{62}{1000 \times 0.124} \times 100$

$= \frac{62}{124} \times 100$

$\boxed{= 50\%}$

Q98. 2 g Organic compound is completely burned, 150 ml of N_2 at 27°C 0.0821 atm is obtained. find mass fraction of (N-atom) in Organic compound

moles of $N_2 = \frac{0.0821 \times 150}{1000 \times 0.0821 \times 300} = \frac{1}{2000}$

mass of N $= \frac{1}{2000} \times 2 \times 14$

$= \frac{14}{1000}$ g

$\% N = \frac{14}{2 \times 1000} \times 100$

$\% N = 0.7\%$

fraction $\boxed{N = 0.007}$

4. Kjeldahl's Method [N]

$$\underset{(N)}{\text{Organic Compound}} \xrightarrow[CuSO_4/Hg]{H_2SO_4,\ \Delta} (NH_4)_2SO_4$$

$$(NH_4)_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + H_2O + 2NH_3$$

$$NH_3 + \text{Suitable Acid} \rightarrow \text{Product}$$

Q99. A sample of 0.5 g of an organic compound was treated according to Kjeldahl's method. The Ammonia evolved was absorbed by 2.45 g H_2SO_4. The residual acid requires 1.2 g NaOH for neutralisation. Find % Nitrogen in organic compound.

$$H_2SO_4 + 2NaOH \longrightarrow Na_2SO_4 + 2H_2O$$

H_2SO_4: $\frac{1.2}{80}$ mol

NaOH: 1.2 g → $\frac{1.2}{\cancel{23}\,40}$ mol

H_2SO_4 left $= \frac{2.45}{98} - \frac{1.2}{80} =$ ~~0.0125 mol~~ 0.01 mol

moles of $NH_3 = 0.02$ mol

moles of $N = 0.02$ mol

mass $= 0.02 \times 14$

$= 0.28$ g

$$\% N = \frac{0.28}{0.5} \times 100$$

$$= 2.8 \times 20$$

$$\boxed{= 56\%}$$

Q100. Calculate % Ca in $CaCO_3$ having 80% Purity.

$\rightarrow$ 80g $CaCO_3$

$\rightarrow \frac{80}{100}$ mole

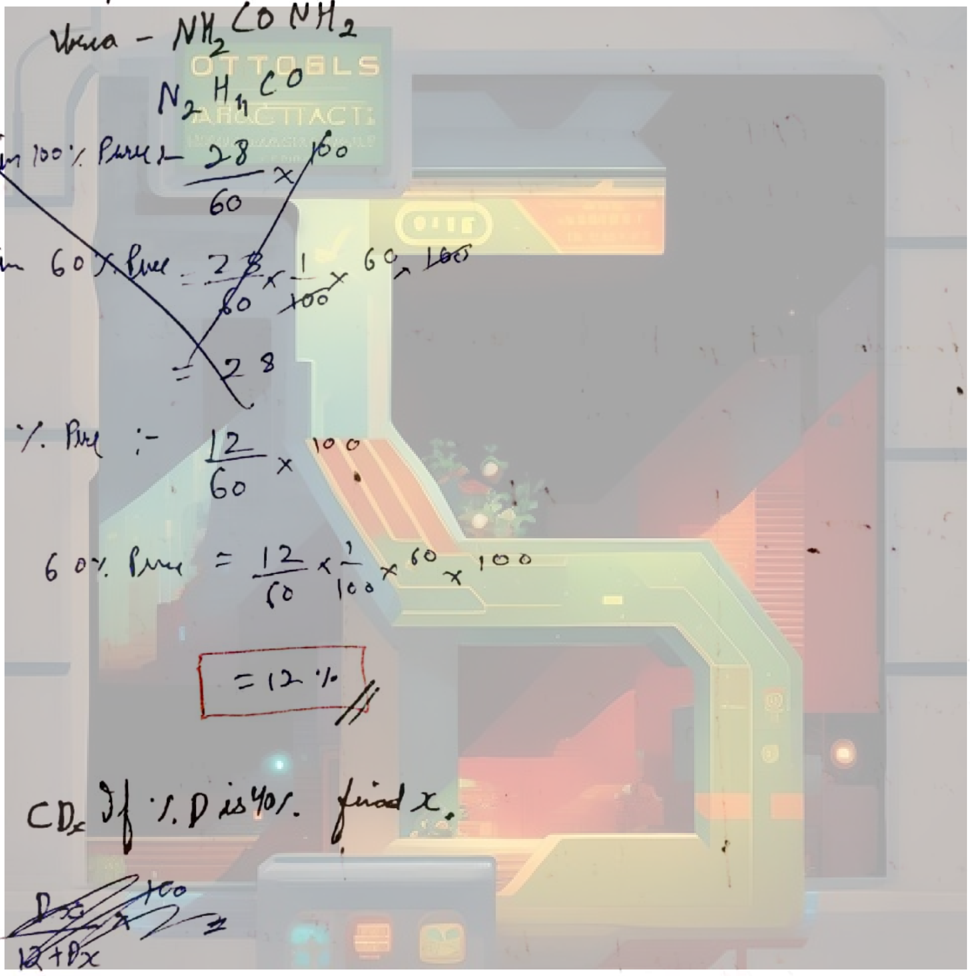
$\rightarrow \frac{80}{100} \times 40$ g Ca

$$\rightarrow \frac{80 \times 40}{100} \times \frac{1}{\cancel{100}} \times \cancel{100} = \frac{3200}{100} = \boxed{32\%}$$

Q101. Find % composition of C in Urea Sample 60% Purity

Urea – NH_2CONH_2

N_2H_4CO



~~in 100% Pure :-~~ $\cancel{\frac{28}{60} \times 100}$

~~in 60% Pure :-~~ $\cancel{\frac{28}{60} \times \frac{1}{100} \times 60 \times 100}$

$\cancel{= 28}$

100% Pure :- $\frac{12}{60} \times 100$

60% Pure $= \frac{12}{60} \times \frac{1}{100} \times 60 \times 100$

$\boxed{= 12\%}$

Q102. In CD_x If % D is 40% find x.

$\cancel{\frac{Dx \times 100}{12 + Dx}}$

$$\frac{2x \times 100}{12 + 2x} = 40$$

$20x = 48 + 8x$

$12x = 48$

$\boxed{x = 4}$

Q103. In a sample of Urea, % C is 10%. find Purity %.

$$\%C \text{ in } 100\% = \frac{12}{60} \times 100$$

$$\% C \text{ in } x\% \text{ Purity} = \frac{12}{60} \times 100 \times \frac{1}{100} \times x$$

$$10 = \frac{12x}{60}$$

$$\frac{600}{12} = x$$

$$\boxed{x = 50\%}$$

~~Q104~~ Empirical/Molecular Formula :-

→ Molecular Formula - (MF) :→ It is a chemical formula of a substance which shows exact no. of atoms present in 1 molecule of a substance.

→ Emperical formula - It is the formula which shows simplest ratio of atoms present in one molecule of a substance.

Sr.	Compound	MF	EF
1.	Glucose	$C_6H_{12}O_6$	CH_2O
2.	Sucrose	$C_{12}H_{22}O_{11}$	$C_{12}H_{22}O_{11}$
3.	Hydrogen Peroxide	H_2O_2	HO
4.	Oxalic Acid	$H_2C_2O_4$	HCO_2
5.	Benzene	C_6H_6	CH

Molecular Formula = n × ~~Molecu~~ Emperical Formula

$$\boxed{MF = n\, EF}$$

~~Molecular weight = n × Molecular we~~

Molecular weight = n × Emperical weight

Note - (1) For any given compound Empirical formula & molecular formula may or may not be same.

(2) Empirical formula is not unique (For 2 diff compound E.F. may be same). eg.

	(MF)	(EF)
Acetic Acid (CH_3COOH)	$C_2H_4O_2$	CH_2O
Glucose	$C_6H_{12}O_6$	CH_2O

~~Q104~~. Steps to find E.F.

Step-1 Assume the % composition of a given atom to be equal to its mass.

Step-2 Divide these masses by molar masses to obtain ratio of moles.

Step-3 If these ratios of moles is not in simplest whole no. ratio, Then multiply or divide by suitable factor to obtain simplest ratio.

Q 104. An organic compound has 60% Carbon, 32% Oxygen & rest Hydrogen. find E.F.

mass ratio 60 : 32 : 8

mole ratio 5 : 2 : 8

$\boxed{E.F. - C_5H_8O_2}$

Q 105. A Compound contains 38.8% C, 16% H, 45.2% N. If vapour density is 31, find i) E.F ii) M.F.

C : H : N

mass ratio = 38.8 : 16 : 45.2

mole ratio = $\frac{38.8}{12} : \frac{16}{1} : \frac{45.2}{14}$

$\frac{97}{3} : \frac{160}{1} : \frac{226}{7}$

32.3 : 160 : 32.2

323 : 1600 : 323

1 : 5 : 1

$\boxed{E.F. - CH_5N}$ i)

$62 = 12 + 5 + 14$

$62 = 31n$

$n = 2$

$\boxed{M.F = C_2H_{10}N_2}$ ii)

Q106. An organic compound contain 49.3% C, 6.84% H & other O by mass find i) EF ii) MF if V.D = 73.

	C	: H :	O
mass	49.3 :	6.84 :	43.86
mole	$\frac{49.3}{12}$:	6.84 :	$\frac{43.86}{16}$

4.10 : 6.84 : 2.74

1.36 : 2.28 : 0.89

136 : 228 : 89

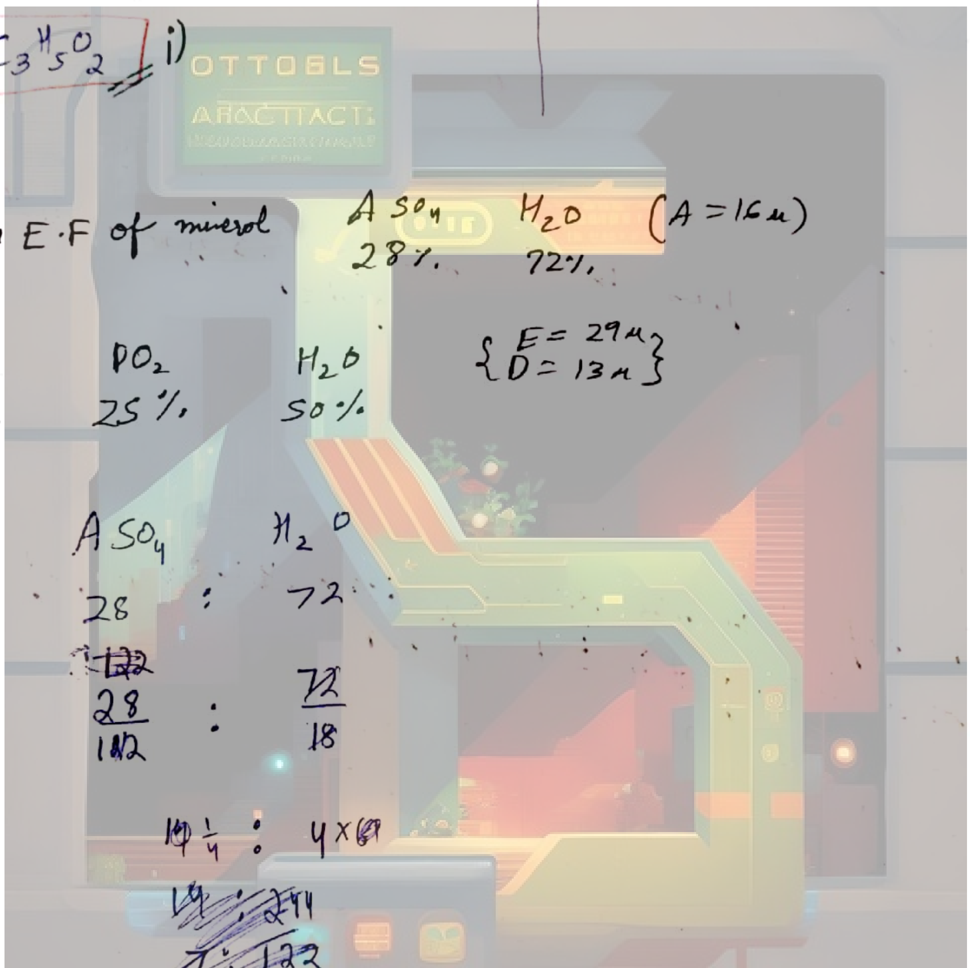
3 : 5 : 2

$\boxed{C_3H_5O_2}$ i)

ii) 146 = n(73)

$\boxed{n=2}$

MF - $\boxed{C_6H_{10}O_4}$ ii)



Q107. Find E.F of mineral ASO_4 28% H_2O 72% (A = 16u)

Q108. EO 25% DO_2 25% H_2O 50% {E = 29u, D = 13u}

Ans 107.

	ASO_4		H_2O
mass	28	:	72
moles	$\frac{28}{112}$	:	$\frac{72}{18}$

$\frac{1}{4}$: 4

1 : 16

$\boxed{ASO_4 \cdot 16H_2O}$

Ans 108.

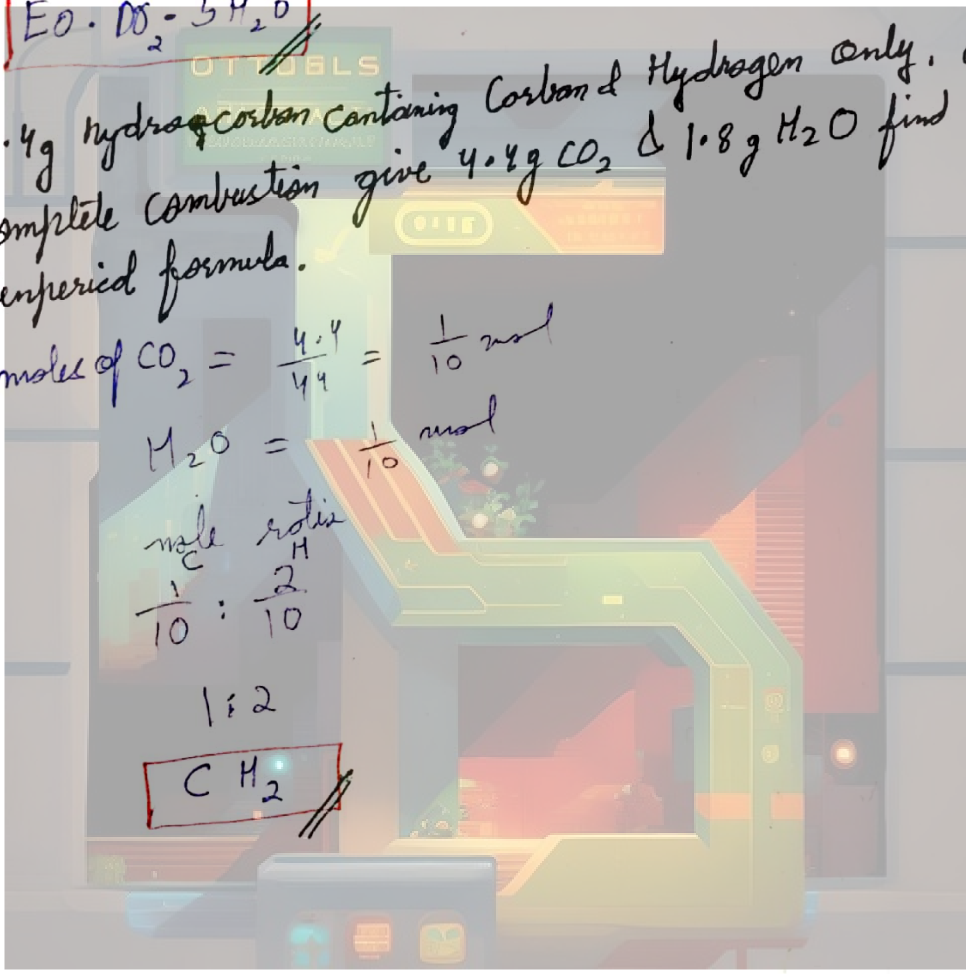
EO	DO_2	H_2O
25	25	50
$\frac{\cancel{25}\ 5}{\cancel{45}\ 9}$	$\frac{\cancel{25}\ 5}{\cancel{45}\ 9}$	$\frac{\cancel{50}\ 25}{\cancel{18}\ 9}$

$5 : 5 : 25$

$1:1:5$

~~$EO \cdot DO_2$~~

$\boxed{EO \cdot DO_2 \cdot 5H_2O}$



Q109. 1.4g hydrocarbon containing Carbon & Hydrogen only. On complete combustion give 4.4g CO_2 & 1.8g H_2O find Emperical formula.

moles of $CO_2 = \frac{4.4}{44} = \frac{1}{10}$ mol

$H_2O = \frac{1}{10}$ mol

mole ratio

$\underset{C}{\frac{1}{10}} : \underset{H}{\frac{2}{10}}$

$1:2$

$\boxed{CH_2}$

Eudiometry (Gas Analysis)

→ The word Ediometry comes from the apparatus called Eudiometry tube in which gas analysis experiments are performed.

→ In these experiments, the volume of gases are measured at constant pressure & Temp.

$$\underset{\substack{\downarrow \\ 1\,mol}}{1\,N_{2(g)}} + \underset{\substack{\downarrow \\ 3\,mol}}{3\,H_{2(g)}} \longrightarrow \underset{\substack{\downarrow \\ 2\,mol}}{2\,NH_{3(g)}}$$

$$V = n\frac{RT}{P} \qquad V = n\frac{RT}{P} \qquad V = n\frac{RT}{P}$$

Same

$$\boxed{V \propto n}$$

$$V = 1L + V = 3L \rightarrow V = 2L$$

Note :- ① In such cases, Problems may be solved directly by using volume in place of moles.

② Volume of solid or liquid is neglected in comparision to the volume of gas

Let initial Volume $= V_i$
final Volume $= V_f$

Case - 1

$$V_i > V_f$$

Volume contraction $= (V_i - V_f)$

Case 2

$$V_f > V_i$$

Volume expansion $(V_f - V_i)$

Eg. $N_{2(g)} + 3H_{2(g)} \longrightarrow 2NH_{3(g)}$

	$N_{2(g)}$	$3H_{2(g)}$	$2NH_{3(g)}$
initial	10 ml	30 ml	—
final	—	—	20 ml

$V_i = 10 + 30 = 40$ ml

$V_f = 20$ ml

$V_{contraction} = V_i - V_f$

$= 40 - 20$

$\boxed{= 20 \text{ ml}}$

Q110. $2HI_{(g)} \longrightarrow H_{2(g)} + I_{2(g)}$

	$2HI_{(g)}$	$H_{2(g)}$	$I_{2(g)}$
initial	20 ml	—	—
final	—	10 ml	10 ml

$V_i = 20$ ml

$V_f = 10 + 10 = 20$

Neither contraction nor expansion.

$\boxed{V_{contraction/Expansion} = 0}$

Q111. $2NH_{3(g)} \longrightarrow N_{2(g)} + 3H_{2(g)}$

	$2NH_{3(g)}$	$N_{2(g)}$	$3H_{2(g)}$
initial	20 ml	—	—
final	—	10 ml	30 ml

$V_i = 20$ ml

$V_f = 10$ ml $+ 30$ ml $= 40$ ml

$V_{Expansion} = V_f - V_i$

$\boxed{V_{Expansion} = 20 \text{ ml}}$

Q112. 10 ml ~~each~~ N_2 & ~~8~~ 40 ml H_2 react in a eudiometry tube to form NH_3. find volume contraction or expansion?

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

initial (LR) 10 ml, 40 ml → 0

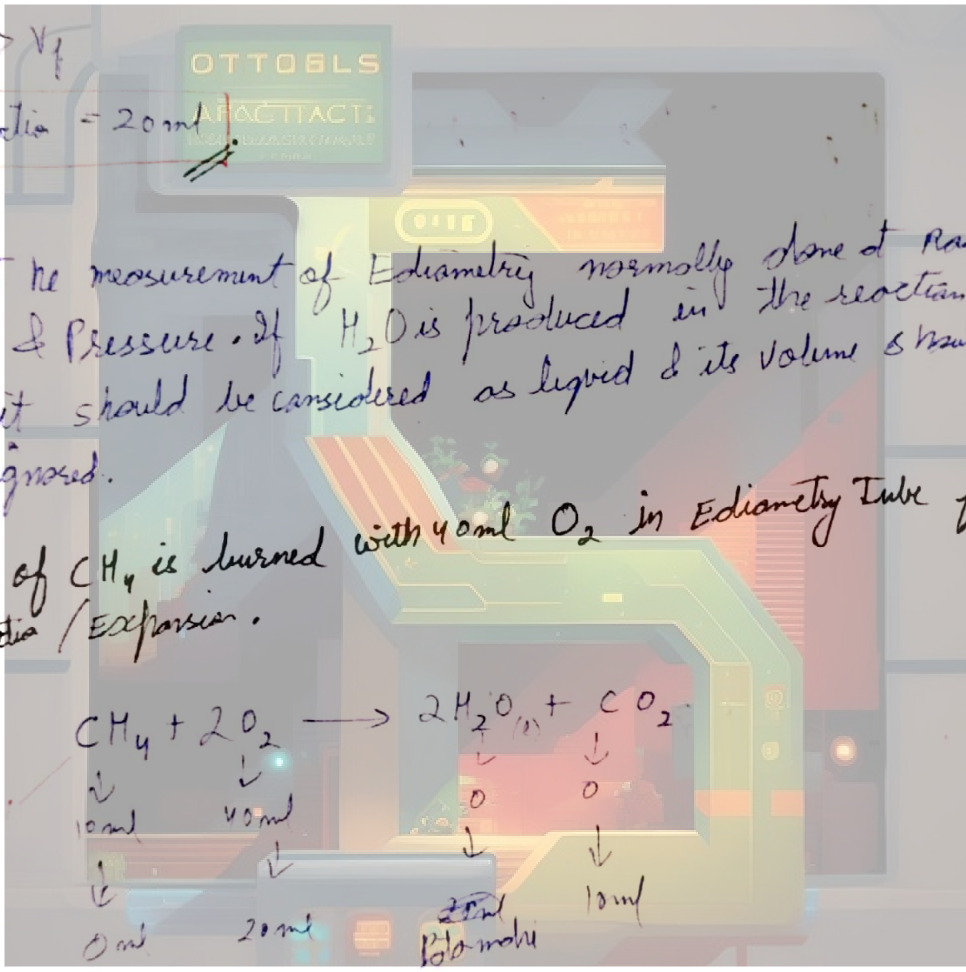
final — , 10 ml → 20 ml

$V_i = 40 + 10 = 50$ ml

$V_f = 10$ ml $+ 20$ ml $= 30$ ml

$V_i > V_f$

$\boxed{V_{contraction} = 20 \text{ ml}}$



Note: The measurement of Eudiometry normally done at Room temp & Pressure. If H_2O is produced in the reaction then it should be considered as liquid & its volume should be ignored.

Q113. 10 ml of CH_4 is burned with 40 ml O_2 in Eudiometry Tube find the volume contraction / Expansion.

$$CH_4 + 2O_2 \longrightarrow 2H_2O_{(l)} + CO_2$$

LR: 10 ml, 40 ml → 0, 0

0 ml, 20 ml → ~~20 ml~~ (l) ignored, 10 ml

$V_i = 50$ ml

$V_f = \cancel{50 \text{ ml}}$ 30 ml

$V_{contraction} = 50 - 30$

$\boxed{= 20 \text{ ml}}$

Common reactions

① Combustion Reaction:-

~~$C_xH_y + O_2$~~

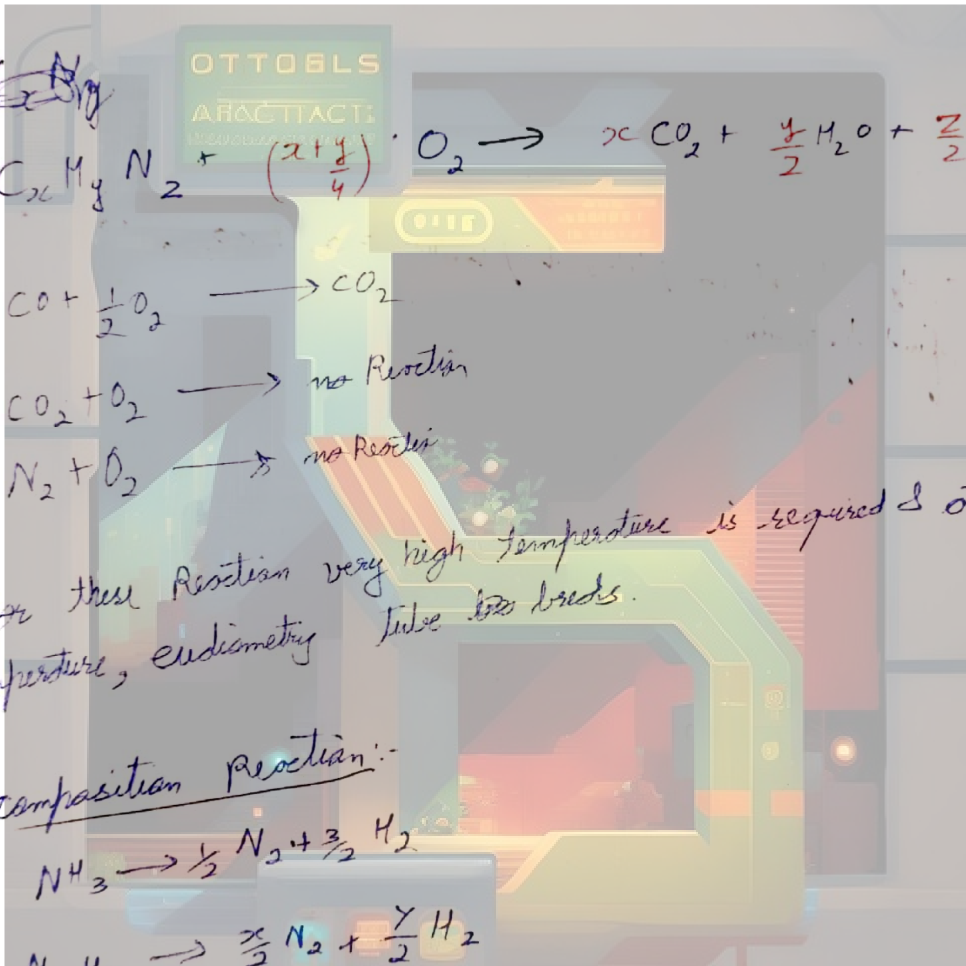
1. $C_xH_y + \left(x+\frac{y}{4}\right)O_2 \longrightarrow xCO_2 + \frac{y}{2}H_2O$

2. $C_xH_yO_z + \left(x+\frac{y}{4}-\frac{z}{2}\right)O_2 \longrightarrow xCO_2 + \frac{y}{2}H_2O$

$\left(x+\frac{y}{4}-\frac{z}{2}\right)$

②

~~C_xH_y~~



3. $C_xH_yN_z + \left(x+\frac{y}{4}\right)O_2 \longrightarrow xCO_2 + \frac{y}{2}H_2O + \frac{z}{2}N_2$

4. $CO + \frac{1}{2}O_2 \longrightarrow CO_2$

5. $CO_2 + O_2 \longrightarrow$ no Reaction

6. $N_2 + O_2 \longrightarrow$ no Reaction

Note:- for these Reaction very high temperature is required & at this temperature, eudiometry tube breaks.

② Decomposition Reaction:-

1. $NH_3 \longrightarrow \frac{1}{2}N_2 + \frac{3}{2}H_2$

2. $N_xH_y \longrightarrow \frac{x}{2}N_2 + \frac{y}{2}H_2$

3. $O_3 \longrightarrow \frac{3}{2}O_2$

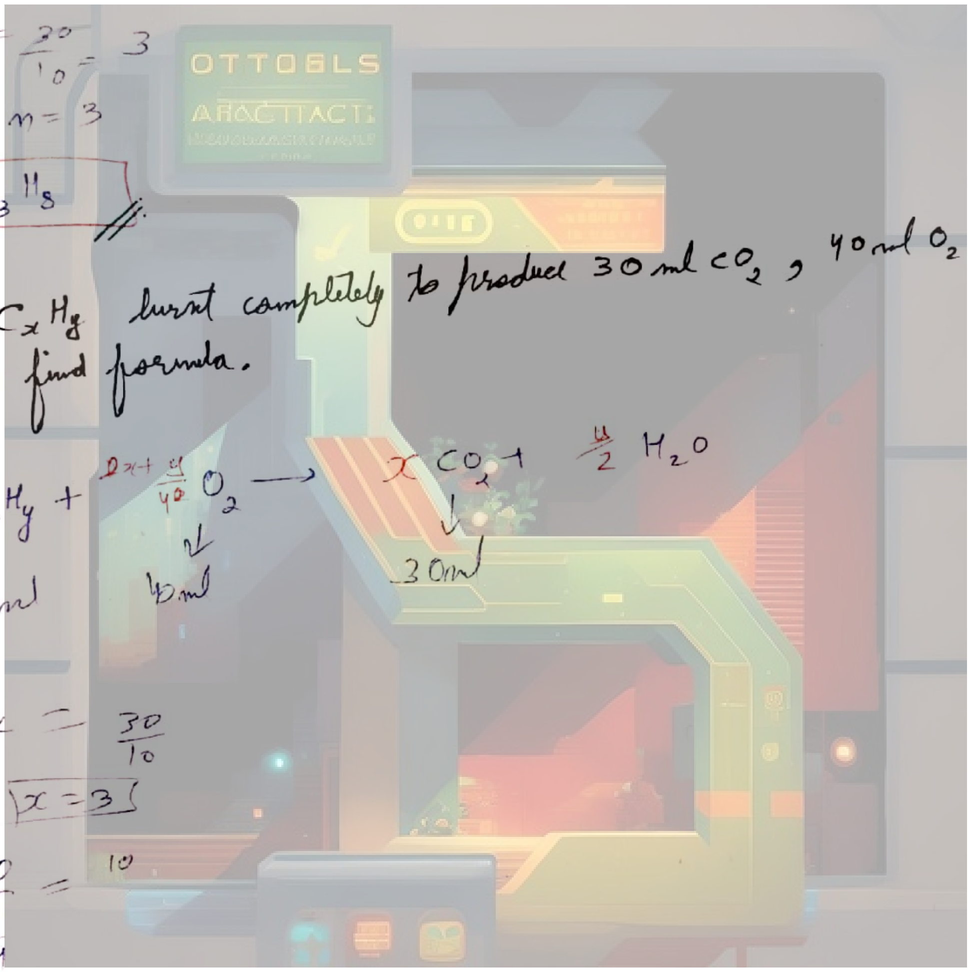
4. $O_x \longrightarrow \frac{x}{2}O_2$

Q114. 10 ml Alkane ~~of~~ on complete combustion give 30 ml CO_2 & some H_2O. find formula of Alkane.

$$C_nH_{2n+2} + \frac{3n+1}{2}O_2 \longrightarrow nCO_2 + (n+1)H_2O$$

10 ml   x ml   30 ml   0

0   ~~x ml~~ 0   30 ml



$n = \frac{30}{10} = 3$

$n = 3$

$\boxed{C_3H_8}$

Q115. 10 ml C_xH_y burnt completely to produce 30 ml CO_2, 40 ml O_2 was required. find formula.

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

10 ml   40 ml   30 ml

$x = \frac{30}{10}$

$\boxed{x = 3}$

$\frac{40}{x + \frac{y}{4}} = 10$

$40 = 30 + \frac{10y}{4}$

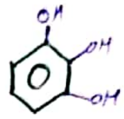
$10 = \frac{10y}{4}$

$40 = 10y$

$\boxed{y = 4}$

$\boxed{C_3H_4}$

Note:- ① When the reaction is performed in Eudiometry tube, then the contraction in Volume is called first volume contraction.
② After the reaction the remaining gases are sometimes passed through certain reagent which absorb specific gas. This result is second volume contraction.

	Gases	Absorbing Reagent
1.	CO_2, Cl_2, NO_2, SO_2	aq. NaOH or aq KOH.
2.	O_2	Alkaline Pyrogallol 
3.	O_3	Turpentile oil
4.	CO	Ammonical Cu_2Cl_2
5.	H_2O	AnHydrous $CuSO_4$, Silica gel
6.	NH_3, HCl	Liquid H_2O.

Q116. 10ml CH_4 burned with 50 ml oxygen find volume contraction after the reaction. If the gas left are passed through Alkaline Pyrogallol find 2nd volume contraction.

$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$$

	CH_4	$2O_2$	CO_2	$2H_2O$
initial	10ml	50ml	—	—
final	0ml	30 ml	10 ml	×

$V_i = 60$

$V_f = 40$

$V_{contraction} = 60 - 40$

$\boxed{= 20 \text{ ml}}$

2nd Volume contraction.
= Volume of O_2

$\boxed{= 30 \text{ ml}}$

Q117. 10 ml gaseous C_xH_y burned completely in 80 ml of O_2 gas the remaining gas after reaction occupies ~~of~~ 70 ml. These volume becomes 50 ml on passing through KOH sol.. find ~~for~~ C_xH_y formula

$$C_xH_y + \frac{x+y}{4} O_2 \longrightarrow x CO_2 + \frac{y}{2} H_2O$$

$\downarrow$ 10 ml $\quad \downarrow$ 80 ml $\quad \downarrow$ ~~20 ml~~ 20 ml

Volume of CO_2 = 70 ml − 50 ml

= ~~20~~ 20 ml

Volume of O_2 = 50 ml (left)

$\frac{20}{x} = 10$

$\boxed{x = 2}$

$\frac{\cancel{80}\ 30}{2+\frac{y}{4}} = 10$

$30 = 20 + \frac{10y}{4}$

$10 \times 4 = 10y$

$y = 4$

$\boxed{y = 4}$

$\boxed{C_2H_4}$

Q118. 20 ml gaseous C_xH_y on combustion with excess O_2 observe a volume contraction of 60 ml when gasses passed through aq KOH. Another contraction of 80 ml was observed.

Volume of CO_2 = 80 ml

$$C_xH_y + \frac{x+y}{4} O_2 \longrightarrow x CO_2 + \frac{y}{2} H_2O$$

$\downarrow$ 20 ml $\quad \downarrow$ 80 ml

$\frac{80}{x} = 20$

$\boxed{x = 4}$

$V_i = 20 + 80 + 5y$

$V_f = 80$ ml

$V_i - V_f = 60$ ml

$20 + 5y = 60$

$5y = 40$

$\boxed{y = 8}$

$\boxed{C_4H_8}$

S-2 (Q12-17) nidhi Prasad

Q119. 10 ml mixture of CH_4, C_2H_4, CO_2 was exploded with excess O_2. After explosion & cooling there was a contraction of 17 ml & on treatment with KOH, further contraction of 14 ml. find vol of CH_4 in original mixture.

$\cancel{CH_4 + C_2H_4 + CO_2 + O_2 \longrightarrow CO_2 + H_2O}$

$\cancel{CH_4 + CO_2} \longrightarrow C_2H_4$

$\cancel{C_2H_4 + O_2 \longrightarrow CO_2}$

$$\underset{x\,ml}{CH_4} + \underset{2x}{2O_2} \longrightarrow \underset{x\,ml}{CO_2} + 2H_2O$$

$$\underset{y\,ml}{C_2H_4} + \underset{3y}{3O_2} \longrightarrow \underset{2y\,ml}{2CO_2} + 2H_2O$$

$x + 2y + z = 14$

$z = 10 - (x+y)$

$x + 2y + 10 - x - y = 14$

$y = 14 - 10$

$\boxed{y = 4\ ml}$

$V_i = x + 2x + y + 3y + 10 - (x+y)$

$V_f = x + 2y + 10(-x-y)$

$V_i - V_f = 17$

$3x + 4y - x - 2y = 17$

$2x + 2y = 17$

$2x = 9$

$\boxed{x = 4.5}$

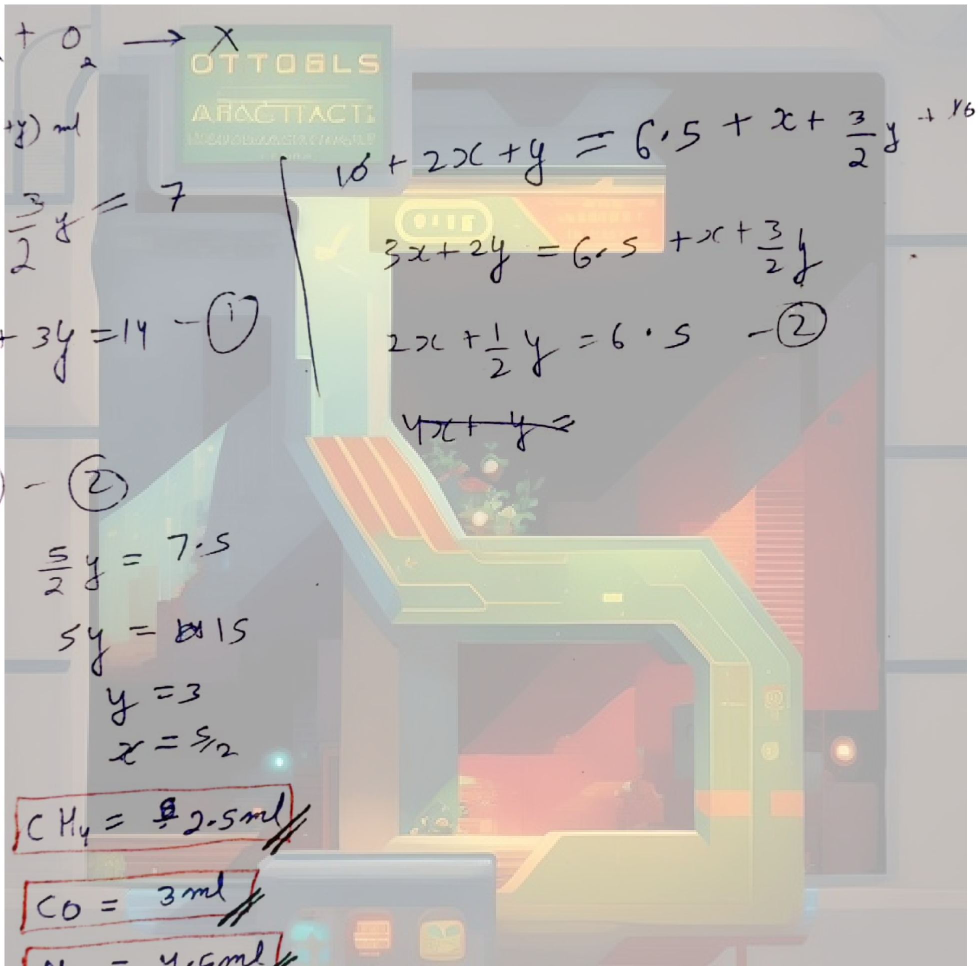
Volume of $CH_4 = x = \boxed{4.5\ ml}$

Q120. 10 ml mixture of CH_4, CO, N_2 exploded with O_2. first vol contraction was observed 6.5 ml & the remaining gases passes through KOH sol. so another 7 ml vol contraction. find the Vol of CH_4, CO & N_2 in the mixture.

$$\underset{x\text{ ml}}{CH_4} + \underset{2x\text{ ml}}{2O_2} \rightarrow \underset{x\text{ ml}}{CO_2} + 2H_2O$$

$$\underset{y\text{ ml}}{CO} + \underset{y\text{ ml}}{O_2} \rightarrow \underset{\frac{3}{2}y\text{ ml}}{\frac{3}{2}CO_2}$$

$$\underset{10-(x+y)\text{ ml}}{N_2} + O_2 \rightarrow \times$$



$x + \frac{3}{2}y = 7$

$2x + 3y = 14$ —(1)

$10 + 2x + y = 6.5 + x + \frac{3}{2}y + 10 - (x+y)$

$3x + 2y = 6.5 + x + \frac{3}{2}y$

$2x + \frac{1}{2}y = 6.5$ —(2)

$\cancel{4x + y =}$

(1) − (2)

$\frac{5}{2}y = 7.5$

$5y = 15$

$y = 3$

$x = 5/2$

$\boxed{CH_4 = 2.5\text{ ml}}$

$\boxed{CO = 3\text{ ml}}$

$\boxed{N_2 = 4.5\text{ ml}}$

Laws of chemical Combination

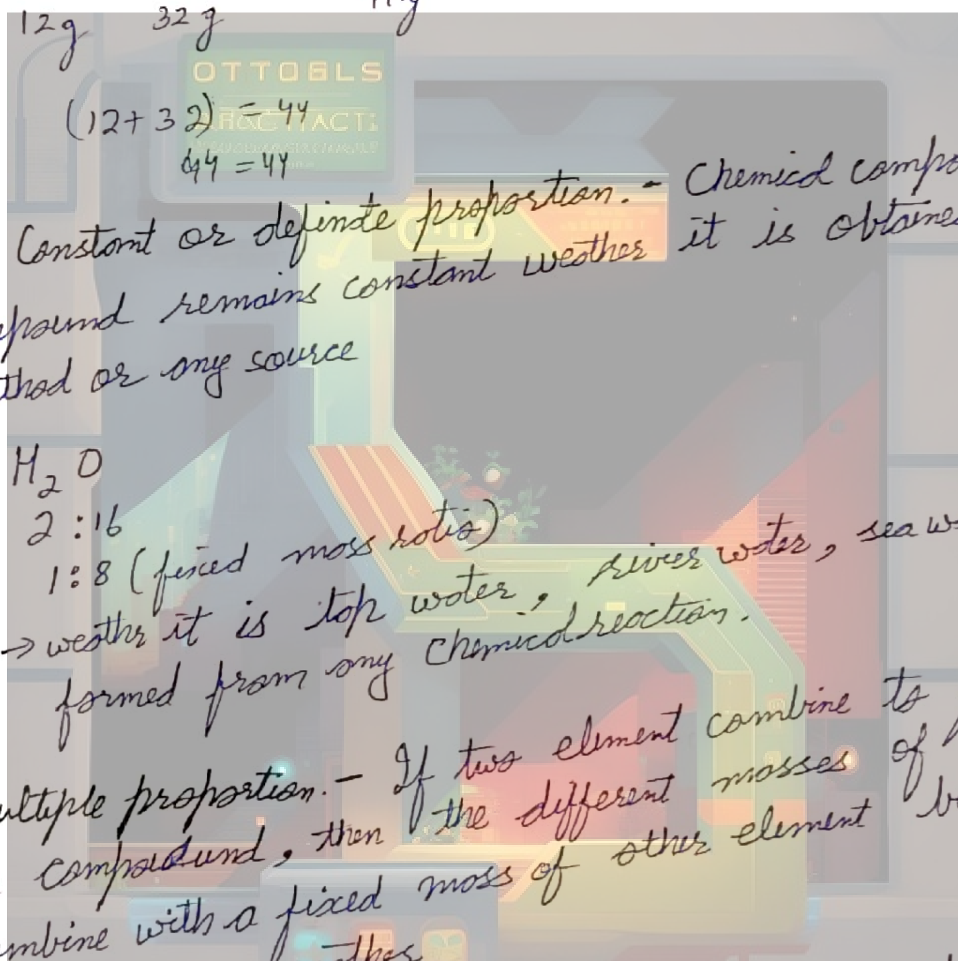
① Law of Conservation of mass – In all Physical or chemical process, the total mass of the system remains constant.

[Total mass of reactant = Total mass of product formed + Total mass of unreacted reactant]

eg. $C + O_2 \longrightarrow CO_2$

1 mol 1 mol 1 mol

12 g 32 g 44 g



(12 + 32) = 44

44 = 44

② Law of Constant or definite proportion. – Chemical composition of a compound remains constant wether it is obtained by any method or any source

Eg. H_2O

2 : 16

1 : 8 (fixed mass ratio)

→ wether it is tap water, river water, sea water or formed from any chemical reaction.

③ Law of Multiple proportion. – If two element combine to form more than one compound, then the different masses of one element which combine with a fixed mass of other element bear a simple ~~ratio~~ ratio to one another.

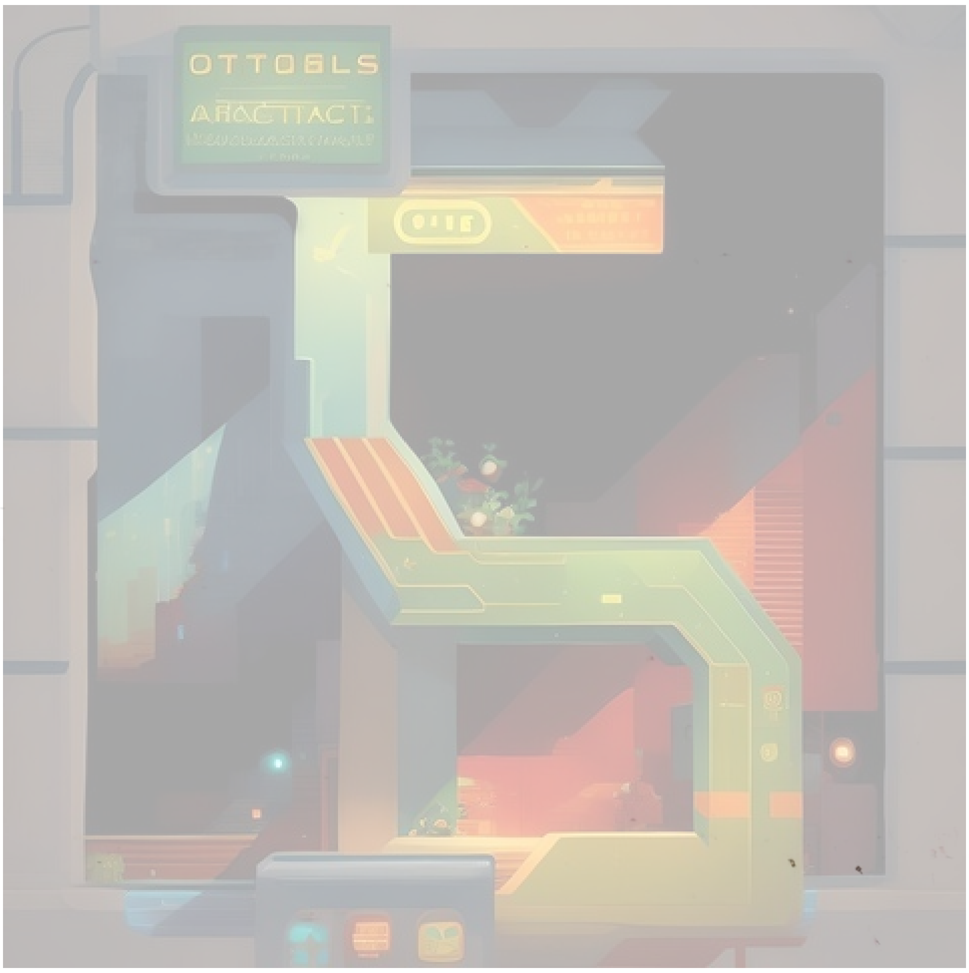
eg. Carbon & oxygen to form following ~~2~~ compound.

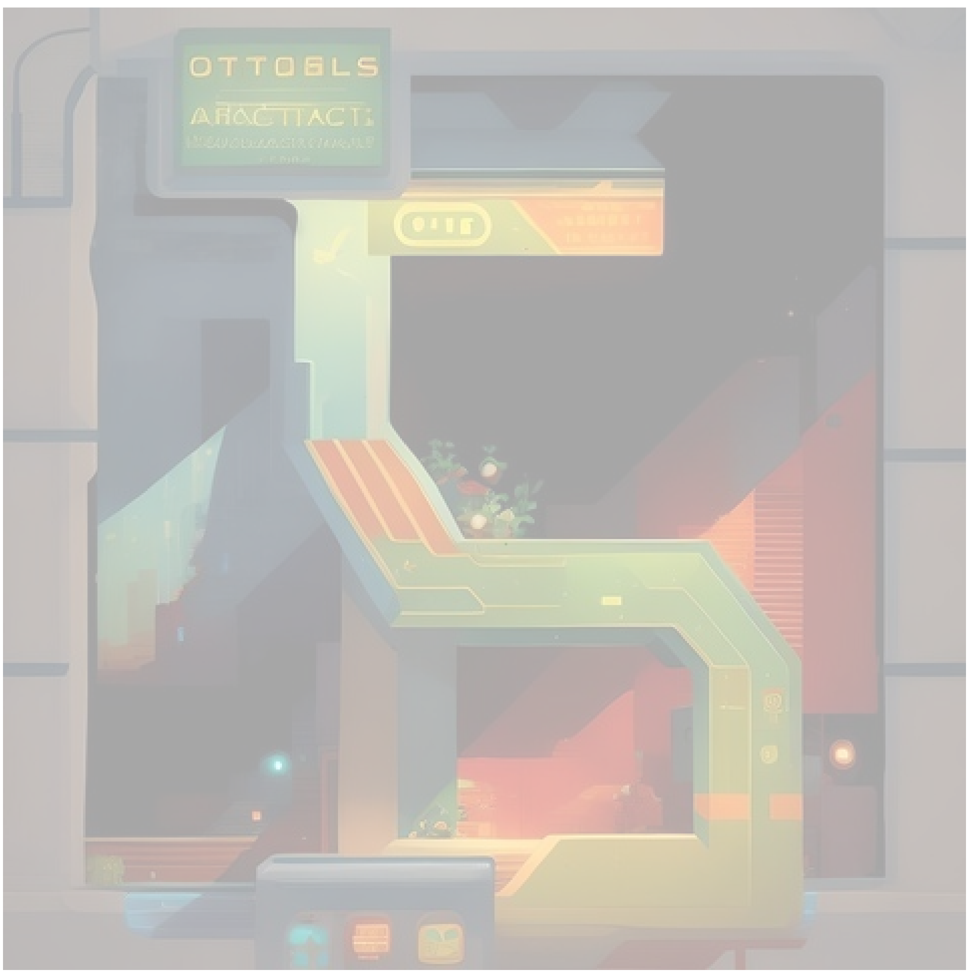
CO	CO_2
12 : 16	12 : 32
3 : 4	3 : 8

(4) Law of gaseous ~~vo~~ volume - According to this law gases react with each other in the simple ~~ratio~~ ratio of their volume & If products are also gases, then they are also formed In simple ratio of volume provided all volumes are measured at same pressure & temp.

Eg $N_{2(g)} + 3H_{2(g)} \longrightarrow 2NH_{3(g)}$ } at same Temp & Pressure

1 vol + 3 vol → 2 vol





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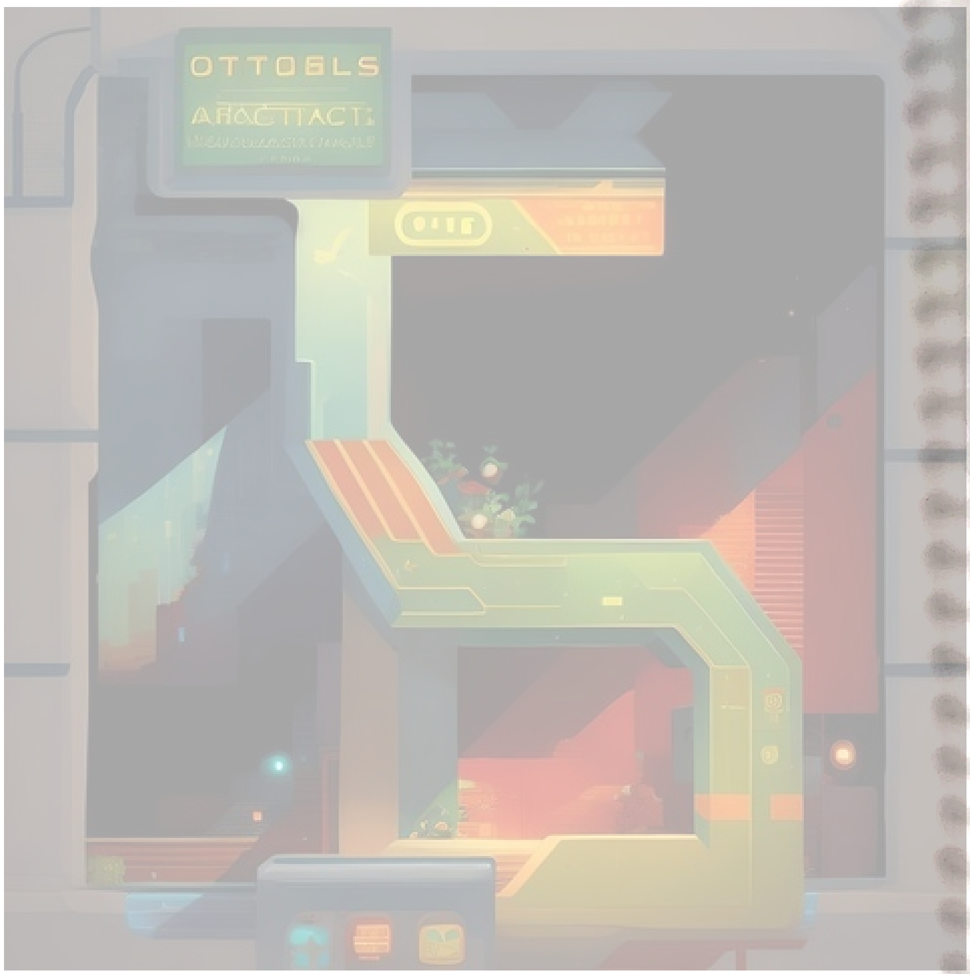

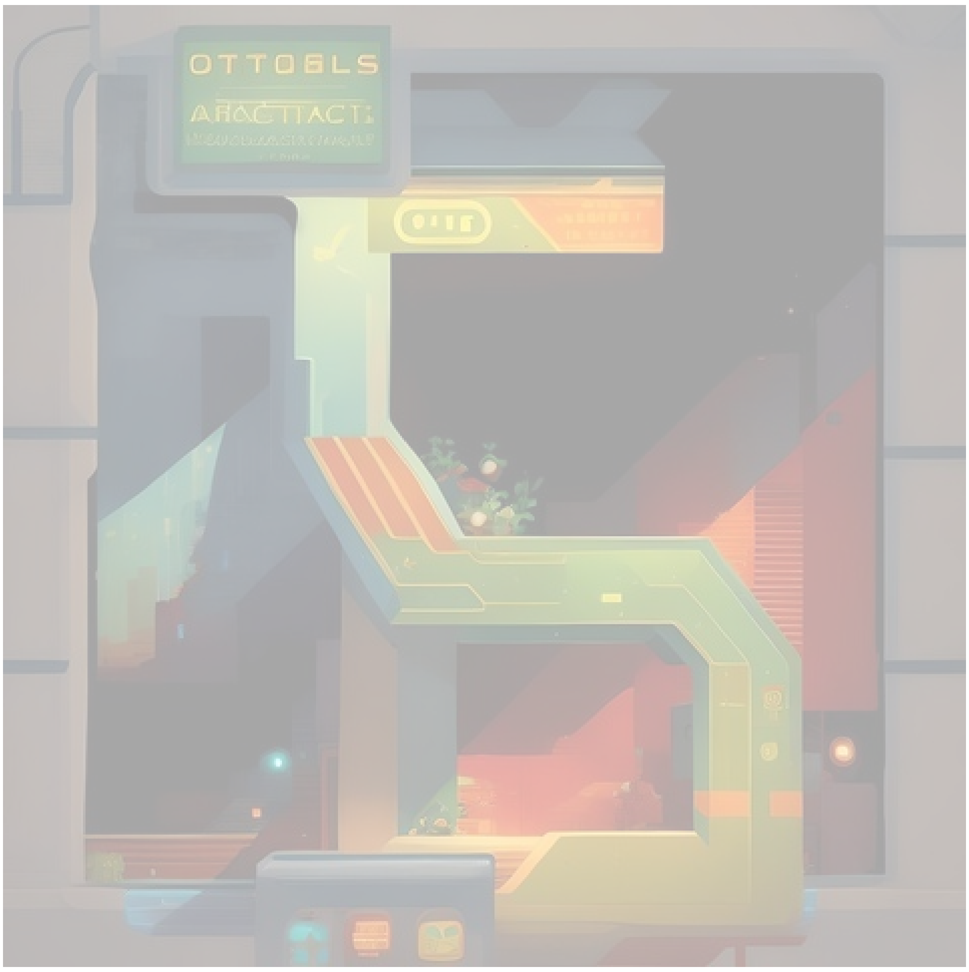

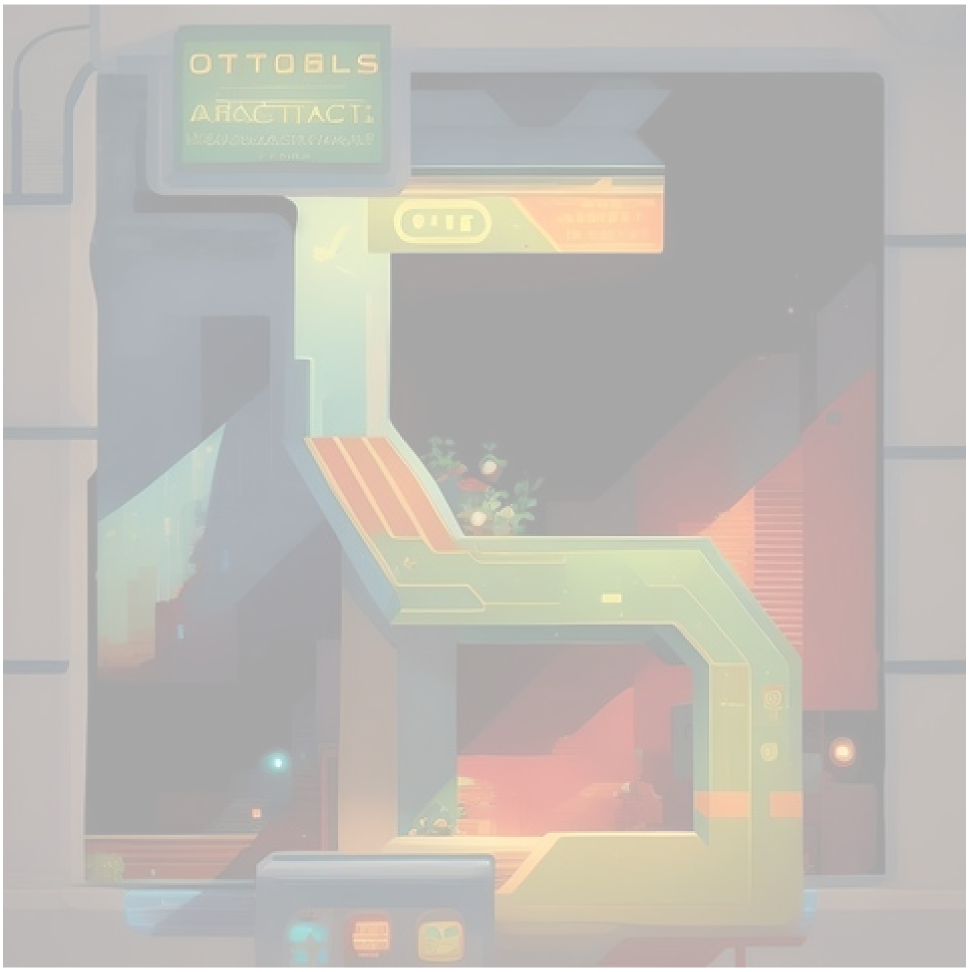
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