Chemistry - 3 (Physical)

# ⋆ Mole Concept ⋆

**mole** – Mole is the SI 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 $6.022 \times 10^{23}$ atoms in exactly 12 gram of C-12 isotope.

$6.022 \times 10^{23} = N_A = $ ~~Avogadoros~~ 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

$6.022 \times 10^{23}$ Entities → 1 mole entities → counting unit

$12.044 \times 10^{23}$ O- atoms

⇓

2 mol O – atoms

$6.022 \times 10^{24}$ 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. $6.022 \times 10^{22}$ 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. $12.044 \times 10^{22}$ no. of ions, calculate mole.

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

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

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

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

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

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

$$= 2 \times 0.1$$

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

Q3. A vessel contains $6.022 \times 10^{22}$ "Helium" atoms.

a) find moles of 'He'

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

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

b) find moles of $e^-$

no. of $e^-$ in one Helium = 2

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

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

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

c) find moles of nucleons.

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

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

~~= 0.4 mole~~

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

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

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 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 $= \dfrac{18.066 \times 10^{24}}{N_A}$

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

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

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

Ex. $H_2SO_4$

~~Abit~~

Q6. 2 mole of $H_2SO_4$ is present.

a) Calculate no. of Hydrogen atoms

no. of H atom in 1 $H_2SO_4$ → 2

2 moles

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 $\boxed{\to 96 N_A}$

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 $e^-$ → 1.6 $104.8 \times 10^{-18}$~~

charge on 1 $e^-$ → $1.6 \times 10^{-19}$ Cb

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

$= 9.60352 \times 10^{6}$

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

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

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

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

→ $6.022 \times 10^{23}$ C-12 atom mass = 12g

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

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

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

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

## Types of Atomic Mass

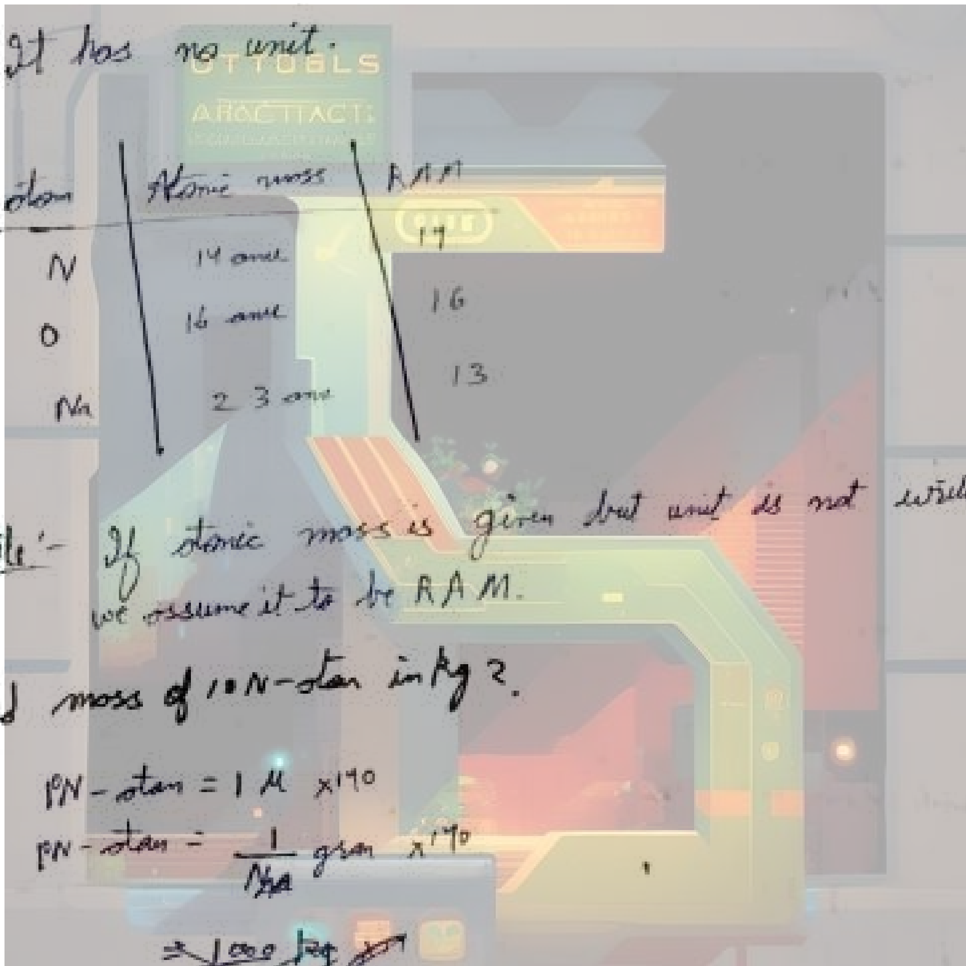
### (1) Relative Atomic mass (RAM):-

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

e.g. N →

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

→ 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.

Q8. find mass of 10 N-atom in kg?

$1N\text{-atom} = 1\ u \times 140$

$1N\text{-atom} = \frac{1}{N_A}\ \text{gram} \times 140$

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

$= \frac{1}{1000\,N_A}\ NA \times 140$

$\boxed{= \frac{140}{1000\,N_A}\ kg}$

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 <u>Gram-Atomic-Mass (GAM)</u>

→ 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 | 14g | 14u |
| O | 16 | 16g | 16u |
| Mg | 24 | 24g | 24u |

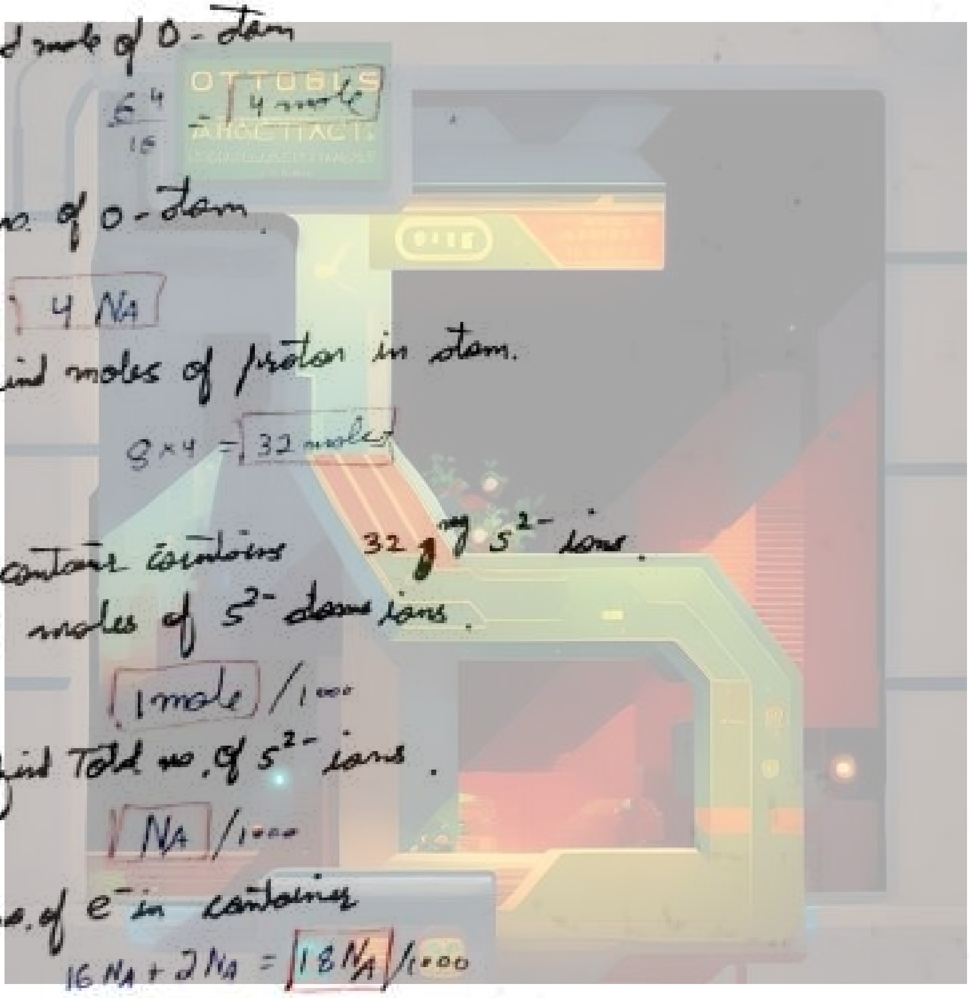
Q10. N-atom in 28 gram? mole?

$14g = 1 \text{ mole}$

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

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

Q11. A closed vessel contain 64 g 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 of $S^{2-}$ ions.

① find moles of $S^{2-}$ atoms ions.

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

② find Total no. of $S^{2-}$ ions.

$\boxed{N_A}/1000$

③ no. of $e^-$ in container

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

## (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.

$$^{m_1}X, \; ^{m_2}X, \; ^{m_3}X \ldots$$
$$n_1 \quad n_2 \quad n_3 \quad \text{(relative abundance in mole)}$$

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

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

when mole is given

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

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

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

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

find Avg atomic mass of Cl atom

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

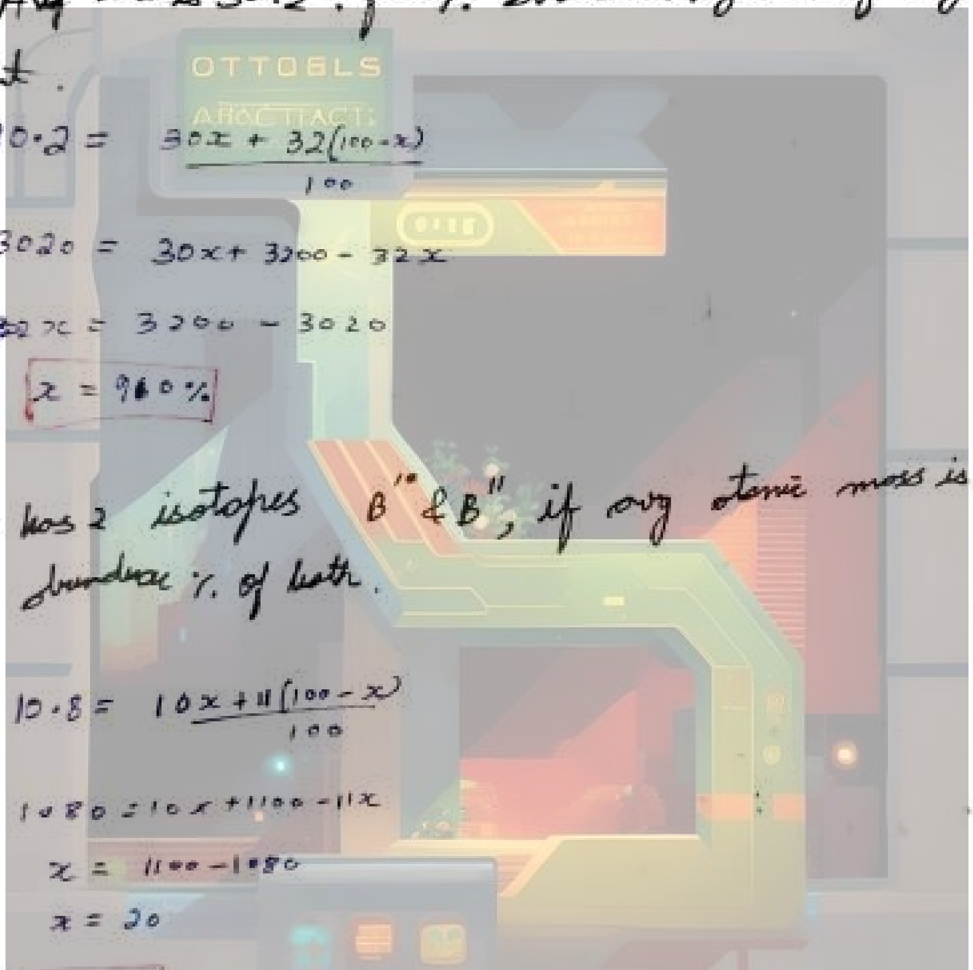
$$\boxed{= 35.5} \text{ g/mol}$$

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 isotope form as $X^{30}$ & $X^{32}$. ~~str~~ 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.

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

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

$$x = 1100 - 1080$$

$$x = 20$$

$$\boxed{\begin{array}{l} B^{10} = 20\% \\ B^{11} = 80\% \end{array}}$$

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.

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

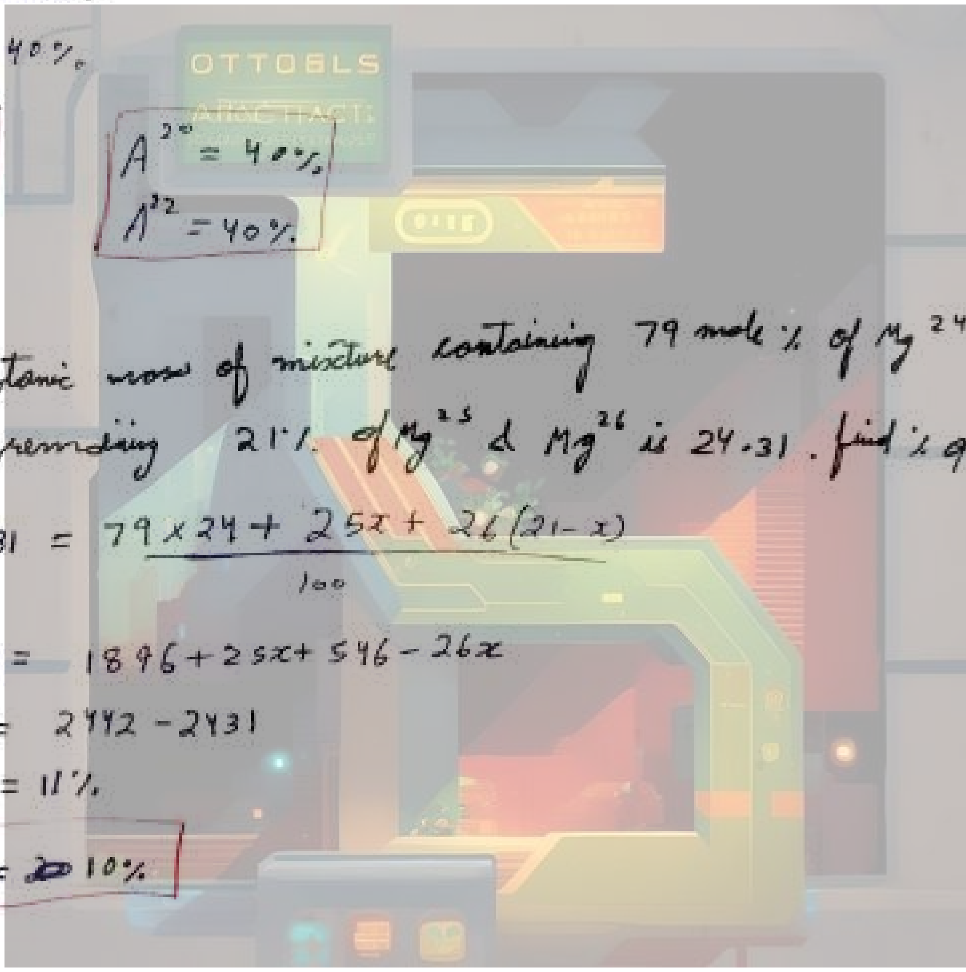
$$2040 = 360 + 20x + 1760 - 22x$$

$$2x = 2120 - 2040$$

$$x = 40\%$$

$$\boxed{\cancel{A^{20} = 80\%} \quad \cancel{A^{22} = 2\%}}$$

$$\boxed{A^{20} = 40\% \quad A^{22} = 40\%}$$



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 $Mg^{26}$.

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

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

$$x = 2442 - 2431$$

$$x = 11\%$$

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

# Types of Molecular mass

## ① Mass of a single molecule

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

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

## ② Relative Molecular Mass (R.M.M)

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

molecules

| 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

$O_2 \to 32$ g

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

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

Q19. A Closed Vessel contains 8.8 g $CO_2$ ~~fat~~

a) find mole of $CO_2$

b) find moles of oxygen

c) find no. of molecules of $CO_2$

a) $44g = 1$ mole

$1g = \frac{1}{44}$ 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 $2N_A = \boxed{8N_A}$

c) in 1 H-atom = 3

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

d) 1 molecule = 8

$2N_A = \boxed{16N_A}$

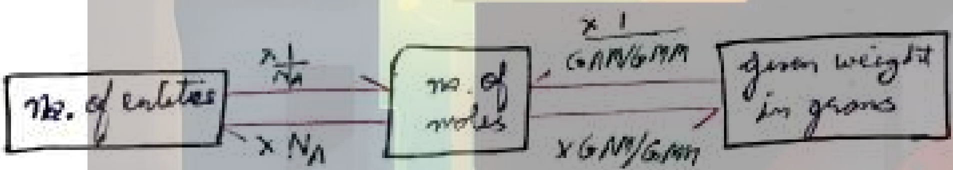
e) in 1 P → 15

~~$1N_A \rightarrow 15N_A$~~

~~$2N_A \rightarrow \boxed{30N_A}$~~

1 mole → 15 mol

2 Mole → $\boxed{30 \text{ mol}}$




## 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 ~~wa~~ water in terms of $N_A$.

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

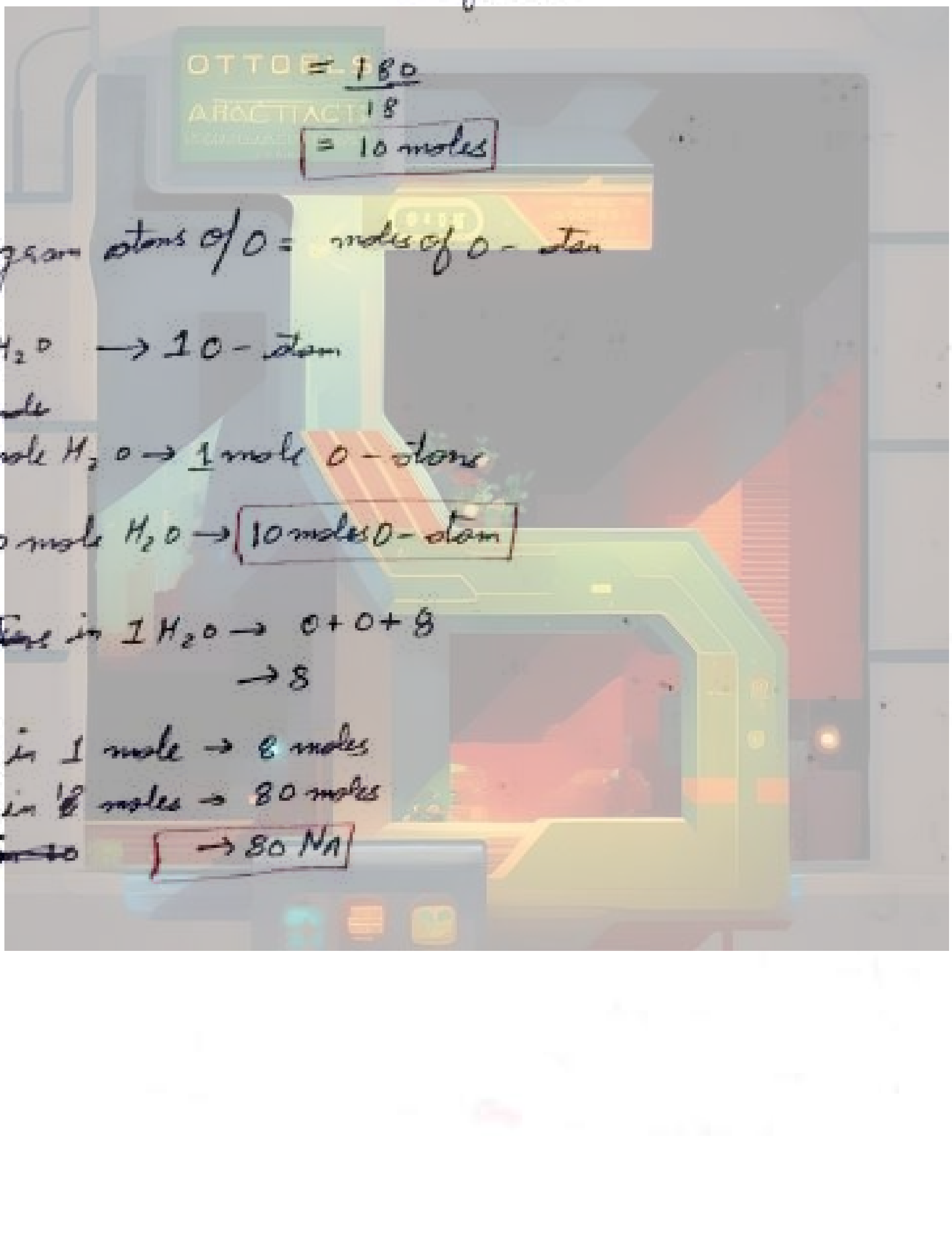
$$1\ g/ml = \frac{\text{mass}}{180\ ml}$$

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

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

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 $H_2O \rightarrow \underline{1}$ mole O-atom

$10$ 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 ⇒ Pressure exerted by gas

V ⇒ Volume of gas / container ~~gas~~ Volume

n ⇒ no. of moles of gas

R ⇒ Gas Constant

T ⇒ absolute temperature (in Kelvin scale)

## Units

① Temperature (T):-

SI unit ⇒ ~~Kelvin~~ Kelvin

$T(\text{Kelvin}) = T(°C) + 273.15$

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

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

② Volume (V):-

S.I. unit ⇒ $m^3$

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

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

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

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 cm Hg = 1 atm

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

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

eg. 1 atm = 760 torr

$\frac{1}{2}$ atm = 350 torr

(4) Gas Constant (R):-

(1) P → atm ; V → liter

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

(2) P → bar ; V → liter

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

(3) P → Pa , V → $m^3$

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

(4) P → mm Hg / torr ; V → liter

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

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

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

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

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

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.

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

$V = 8.21\ l$

$T\,K = 300\ K$

$R = 62.36$

$PV = nRT$

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

$\cancel{n = \frac{1520 \times 8.21}{300 \times 62.36} = \frac{152 \times 82.1}{6236}}$

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

$= \frac{16.42}{24.63}$

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

$0.0821 \times 273 \Rightarrow 22.4$

$0.0821 \times 300 \Rightarrow 24.63$

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.

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

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

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

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

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

$\boxed{n = 2\ mol}$

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

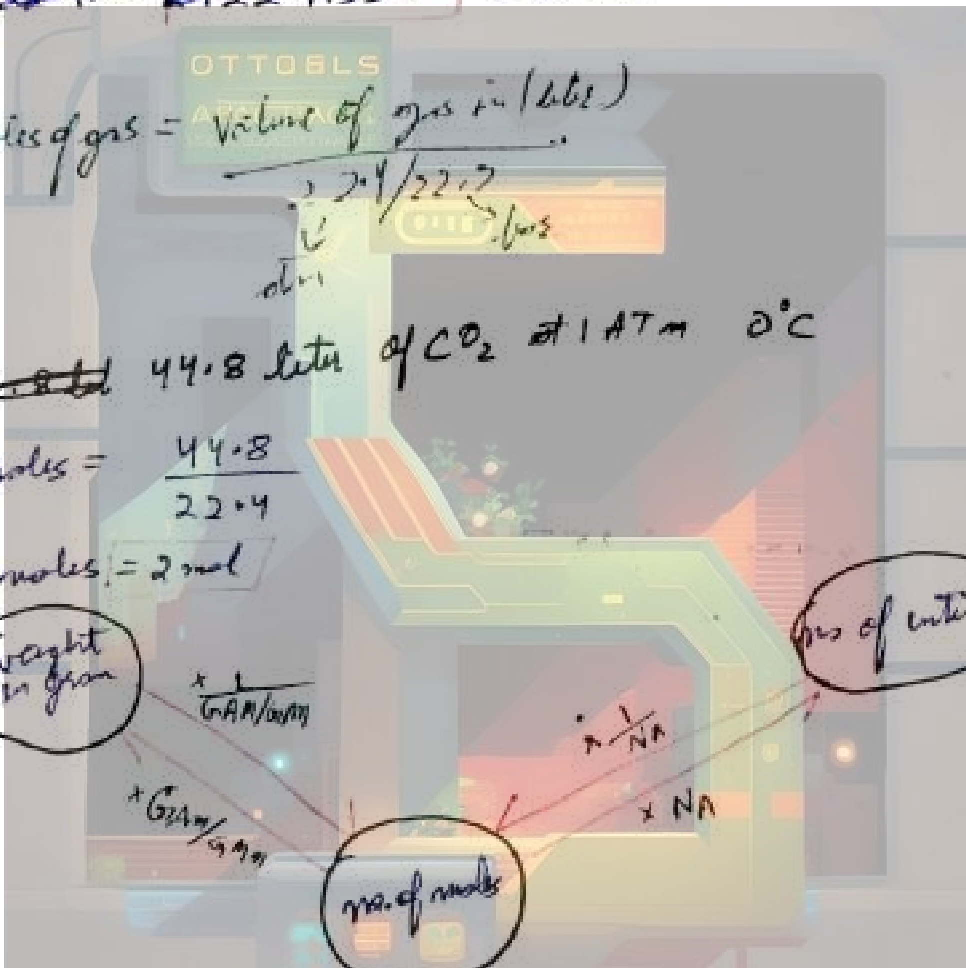
$V = \frac{1 \times 0.0831 \times 273}{1}$

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

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

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

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



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

22.4 → atm, 22.7 → bar

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

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

moles = 2 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~~ $H_2 \rightarrow 2g$

~~1 mol~~

10 mol $\rightarrow$ 20 g

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

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

$$V = 10 \times 22.4$$

$$\boxed{V = 224\,l}$$

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 273K 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 = $16 \times 500$ g

= 8000 g

$\boxed{= 8\,kg}$

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

~~$n = \frac{PV}{RT} = \frac{1 \times 45.4}{273 \times 0.0821} = \frac{45.4}{24.63}$~~

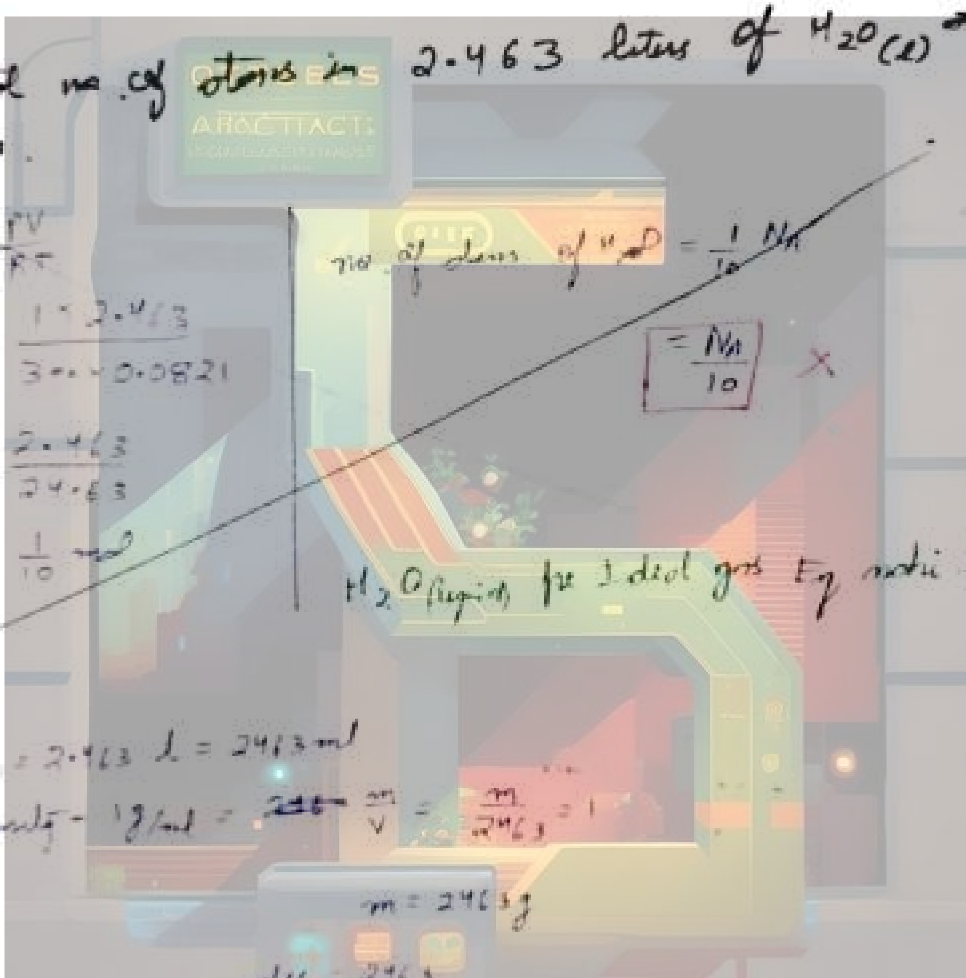
$\text{moles} = \frac{\text{vol (in litres)(at STP)}}{22.7}$

$= \frac{45.4}{22.7}$

$\boxed{= 2 \text{ mol}}$ ✓

$= 2 N_A$

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) for ideal gas Eq not applicable.

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

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

$m = 2463$ g

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

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

no. of atoms $= 137 \times 3$

$\boxed{= 411 N_A}$ ✓

Q33. from 160g of $SO_2(g)$ Sample, $1.2046\times10^{24}$ molecules of $SO_2(g)$ are removed. then find out volume of left over $SO_2$ gas at 0°C & 1atm.

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

moles removed = 2

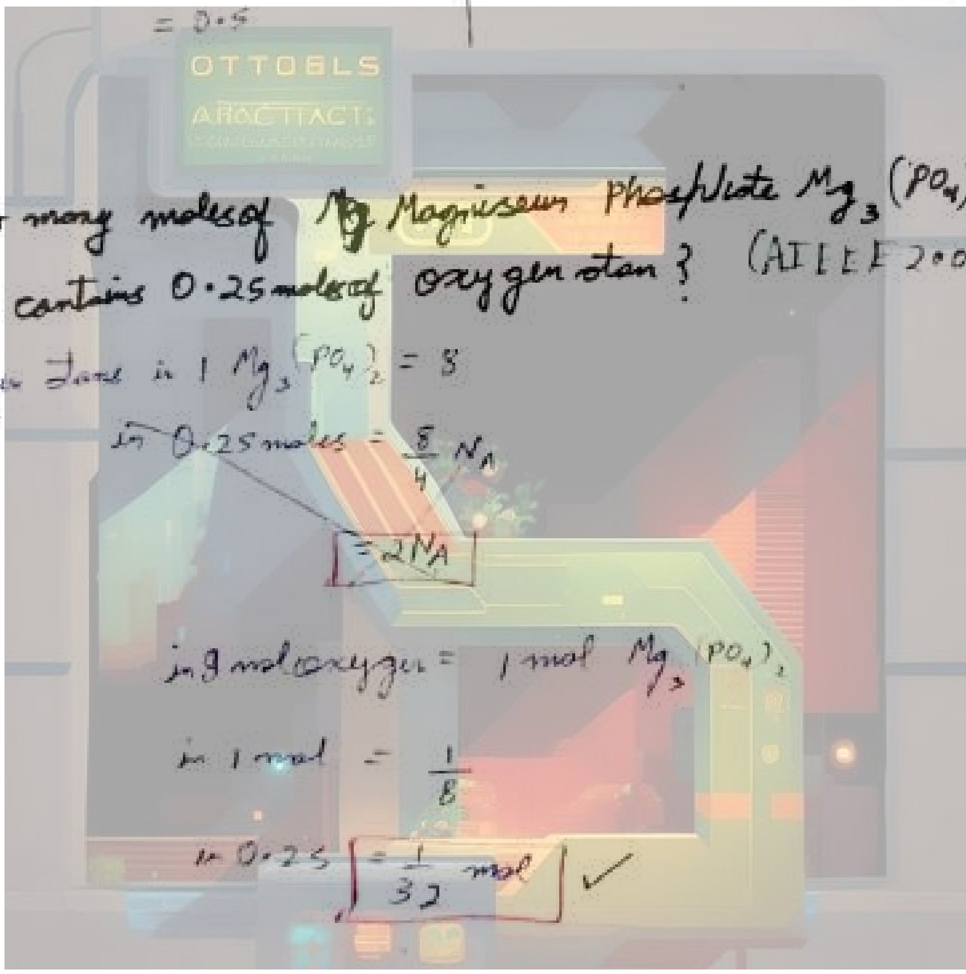
moles left = $\frac{160-128}{64}$

= $\frac{32}{64}$

= 0.5

Volume = 22.4 × 0.5

$\boxed{= 11.2\ L}$ ✓



Q.34. How many moles of ~~Mg~~ Magnesium 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 $\boxed{= \frac{1}{32}\ mol}$ ✓

# Average Molecular Mass.

Q35. 3 mol $O_2$ calculate average mass
5 mol $N_2$

mass of $O_2$ → 32 g/mol
mass of $N_2$ → 28 g/mol

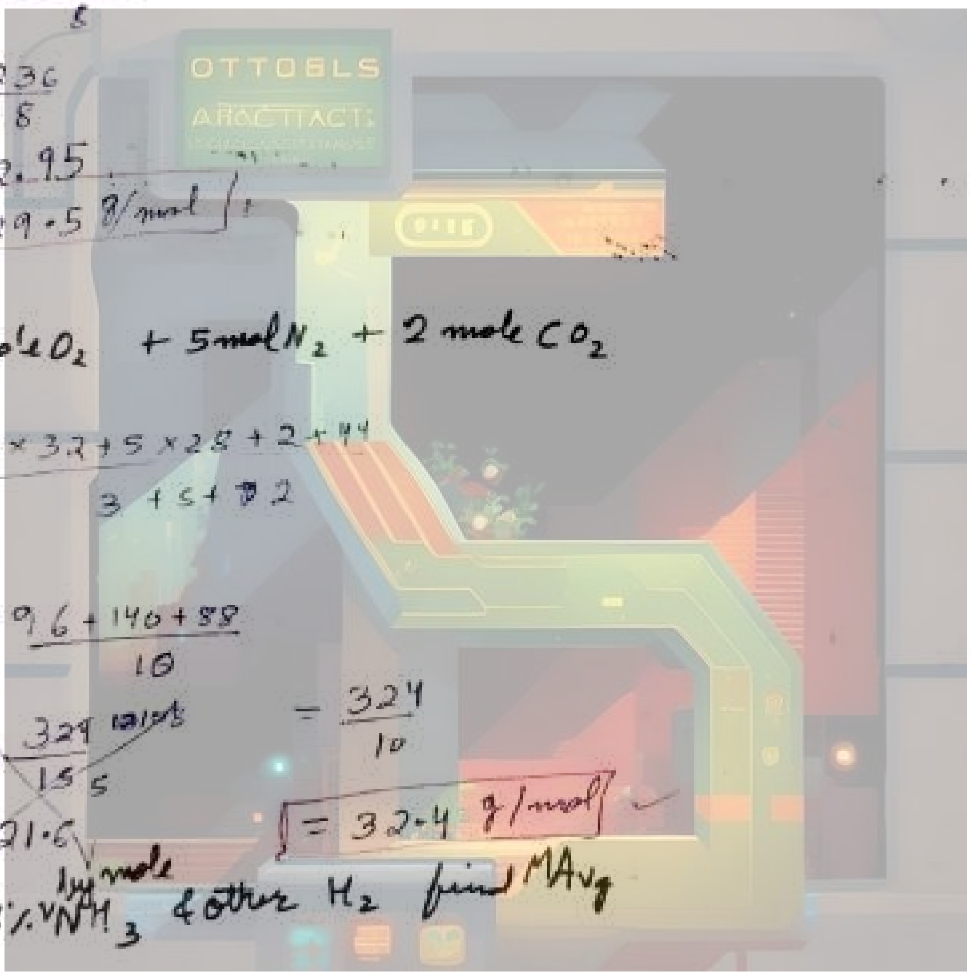
$$M_{Avg} = \frac{3 \times 32 + 5 \times 28}{8}$$

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

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

$$= 2.95$$

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



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

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

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

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

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

Q36. 68% $NH_3$ & 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 $H_2$

$$= \frac{\frac{68}{17} \times 17 + \frac{32}{2} \times 2}{\frac{68}{17} + \frac{32}{02}}$$

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

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

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

H.W.

S-1 (1-10)

O-1 (1, 2, 3, 4, 5, 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

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

Q38. Calculate molar volume of an ideal gas at

i) STP

ii) 0°C & 1 atm

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

$= \frac{RT}{P}$

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

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

ii) $= 0.0821 \times 273$

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

Q39. 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 $N_2$

~~Q40. Arrange the following options have same molar volume~~

Q40. Arrange in increasing order of masses.

i) 0.5 mole $O_3$ 24 g

ii) 0.5 gram-atom of oxygen 8 g

iii) $3.011 \times 10^{23}$ molecule of $O_2$ 16 g

iv) 5.6 litre of $CO_2$ at 1 atm & 273K. ~~17.6 g~~ 11 g

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

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

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

## Density :- ($d$ or $\delta$)

$$\left[ d = \frac{Mass}{Volume} \right]$$ S.I :- $kg/m^3$
other - $g/ml$, $g/cm^3$, $g/cc$

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

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

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

## Specific Volume

$$\left[ \text{Specific Volume} = \frac{Volume}{mass} \right]$$ S.I = $m^3/kg$
other :- $ml/g$, $cm^3/g$, litre/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 mgs
$M \rightarrow$ molar mass

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

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

$\boxed{d = \frac{PM}{RT}}$  $\boxed{d_{mixture} = \frac{PM_{Avg}}{RT}}$

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

# Concept of Relative Density

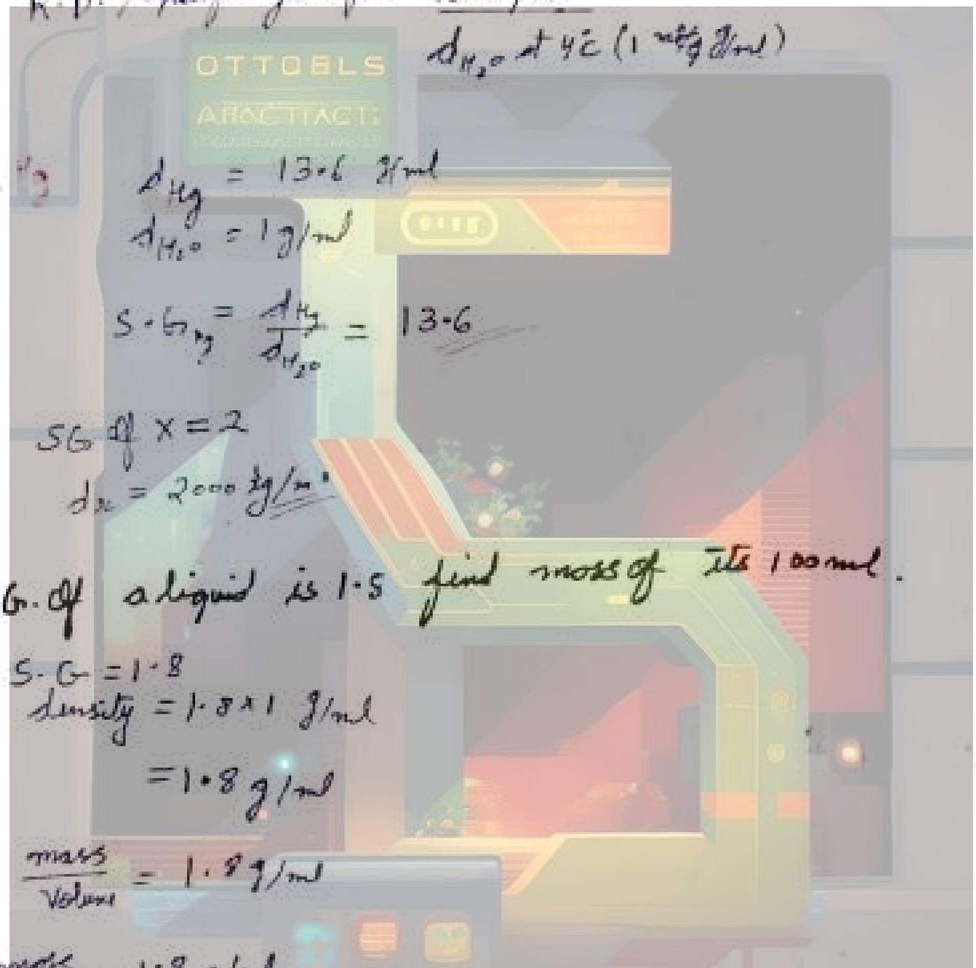
→ Relative density is equal to ~~dest~~ density of any substance with respect to another substance.

$$\left[R.D. = \frac{d_{substance}}{d_{ref.\ substance}}\right]$$

~~→ For Solid/Li Gas/liquid:~~

→ For Solid/liquid

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



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 1.5 find mass of its 100 ml.

S.G = 1.8

density = 1.8 × 1 g/ml

= 1.8 g/ml

$\frac{mass}{Volume} = 1.8$ g/ml

$\frac{mass}{100\ ml} = 1.8$ g/ml

mass = 180 g/ml × ml

$\boxed{mass = 180\ g}$

→ For Gases:-

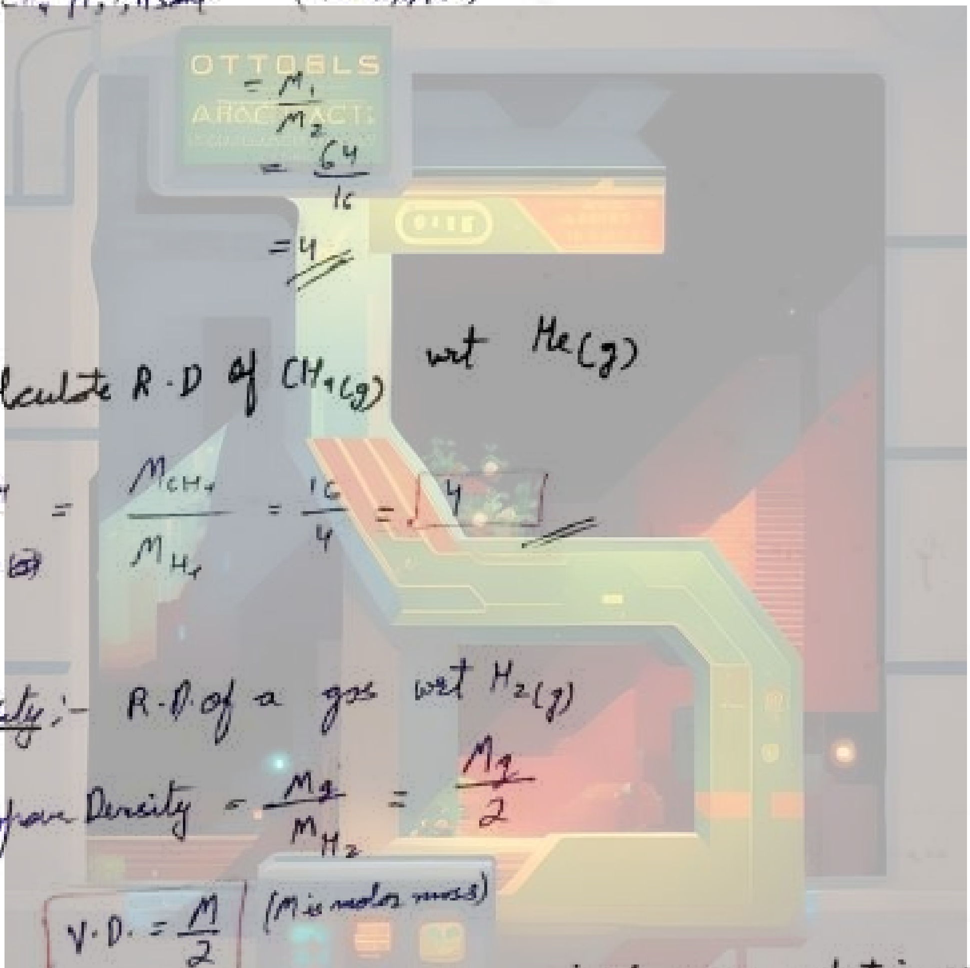
R.D. = Density of gas wrt another gas at same Temp & Pressure.

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

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

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, 1atm weighs 16g what is vapour density.

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

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

$= 44.8$

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

$= \frac{44.8}{2}$

$\boxed{= 22.4}$

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

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

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

$$= \frac{184 + 138}{5}$$

$$= \frac{322}{5}$$

$$= 64.4$$

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

$$\boxed{= 32.2}$$

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

i) calculate mol % of $NO_2$

ii) mass % of $NO_2$

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

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

$$M_{Avg} = 55.2$$

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

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

$$46x = 3680$$

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

$$x = 80$$

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

Let 80 mol $NO_2$, 20 mol $N_2O_4$

3680 g, 1840 g

Total mass = 5520

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

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

$$= 66.66$$

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

Q 46. calculate % mass & % mol of $CH_{4(g)}$ of C & H.

~~mo~~ moles = 1
moles of C = 1
of H = 4

~~case~~

~~mo~~ 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)

(PV = nRT) ✗

Both states are present in equilibrium

(no. of moles remain constant)

$H_2O$ → Gaseous form (stable)

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

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



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

$H_2O \rightarrow$ gas

$PV = nRT$

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

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

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

$n = \frac{9}{3284}$ (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 → Reactant
C,D → Products

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

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

Or

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

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

$N_2 + H_2 \longrightarrow NH_3$ (Qualitative)

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

Balancing Reactions:-

1. Trial - error method
2. ~~a~~ arbitrary - 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 $Cl_2 + KOH \rightarrow KCl + KClO_3 + H_2O$

$a Cl_2 + b KOH \rightarrow c KCl + d KClO_3 + e H_2O$

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

$3d = c$

$2a = 1$

$\cancel{a = ?}$
$\cancel{b = ?}$
$\cancel{c = ?}$
$\cancel{d = }$
$\cancel{e = 2}$

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

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

---

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

| | | |
|---|---|---|
| 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 litre $N_2$ | 3V litre $H_2$ | 2V litre $NH_3$ |

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 & 273K,

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

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

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

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

$= ~~2 mol~~ \ 4/3 mol$

mass of $Al_2O_3 = 2 \times (54 + 48) \times \frac{4}{3}$

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

$= 34 \times 4$

$= 120 + 16$

$\boxed{= 136 g}$

~~Q53.~~

Note:- Complete combustion of hydrocarbon

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

$C_xH_y + \frac{4x+y}{4} O_2 \rightarrow x CO_2 + \frac{y}{2} H_2O$

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

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

120 moles of $CO_2$

$120 \times 22.4 = \text{Volume}$

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

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

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

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($N_2$) $\rightarrow \frac{5 \times 0.0821 \times 873}{1}$ 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 =

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

$$\frac{1}{5} NH_4NO_3 \xrightarrow{\text{heat}} \frac{1}{5} N_{2(g)} + \frac{0.5}{5} O_{2(g)} + \frac{2}{5} H_2O_{(g)}$$

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

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

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

$$\text{Total Vol} = 0.7 \times 0.0821 \times 873$$

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

## Problems Related to more than one reactant

$$\begin{array}{ccccc} 1 & : & 3 & : & 2 \\ N_2 & + & 3H_2 & \rightarrow & 3NH_3 \end{array}$$

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

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

$N_2$: (Excess Reagent) (in excess amount)

$H_2$: L.R. (Limiting Reagent) (in Limiting amount) → Present in less amount than required

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

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

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

**Excess Reagent** - The reagent which is left 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.

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

$$\underset{LR}{\frac{x}{a}} < \underset{ER}{\frac{y}{b}}$$

$$\underset{ER}{\frac{x}{a}} > \underset{LR}{\frac{y}{b}}$$

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

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

$1 : 3$

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

$2 < 2.\cdots$

$N_2 \rightarrow$ LR

$H_2 \rightarrow$ ER

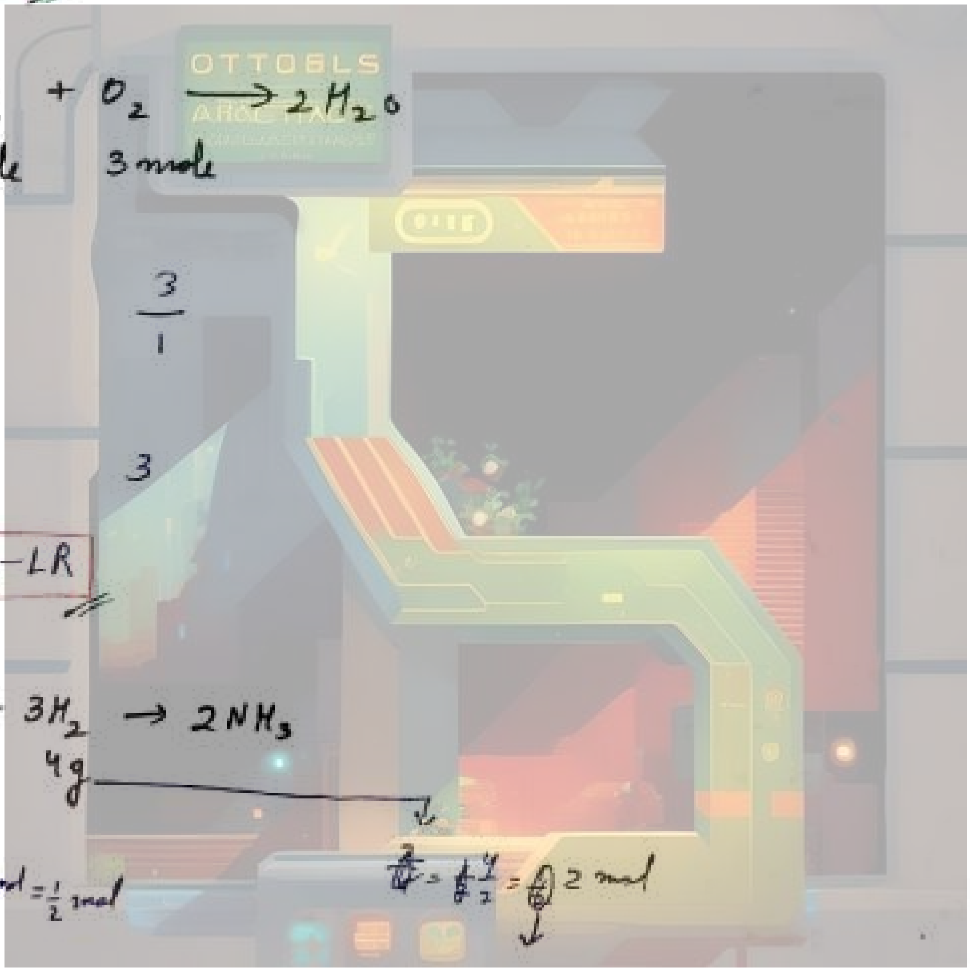
Q56. $A + 2B + 3C \longrightarrow$ product

5 mole  9 mole  12 mole

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

5  4.5  4

$\boxed{C - LR}$



Q57. $2H_2 + O_2 \longrightarrow 2H_2O$

4 mole  3 mole

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

2  3

$\boxed{H_2 - LR}$

Q58. $N_2 + 3H_2 \rightarrow 2NH_3$

14g  4g

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

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

0.66

0.5

$\boxed{N_2 - LR}$

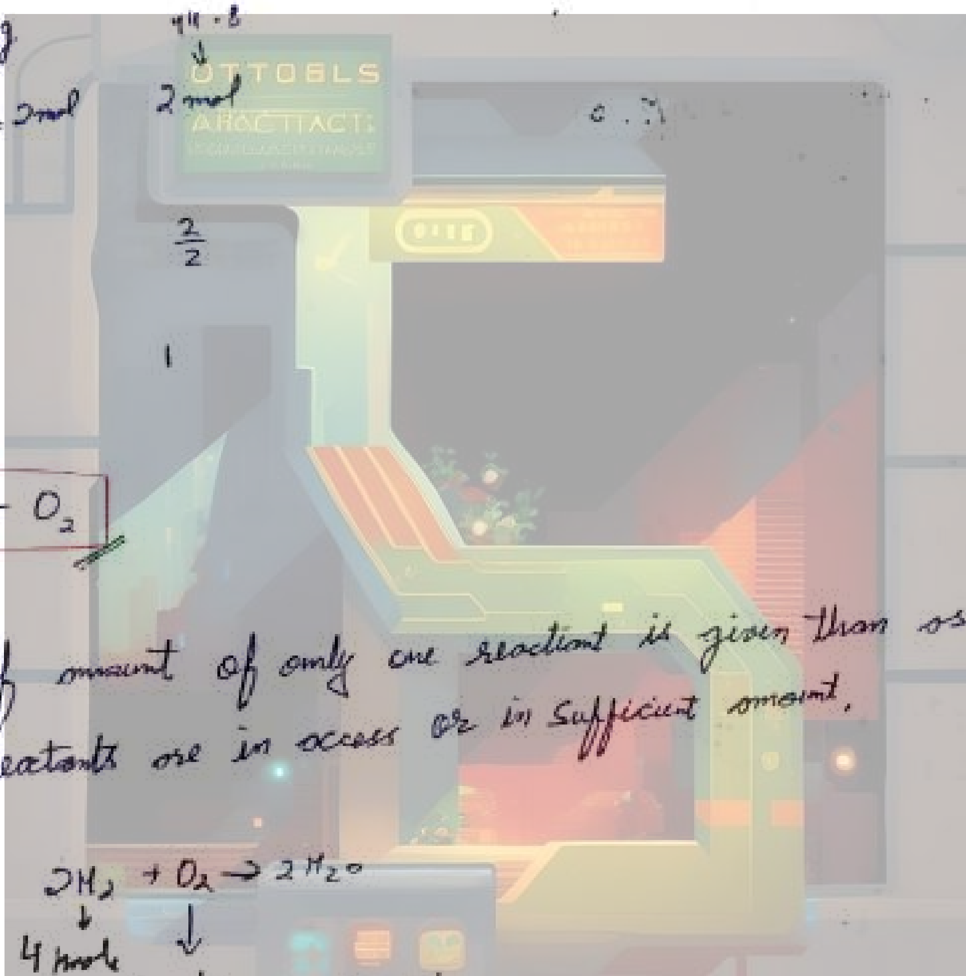
Q 59. $H_2 + I_2 \longrightarrow 2HI$

4 mol 4 mol

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

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

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



32 g ↓ 44.8

$\frac{32}{16} = 2$ mol    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 → 4 mole

(not given)

(required)

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

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

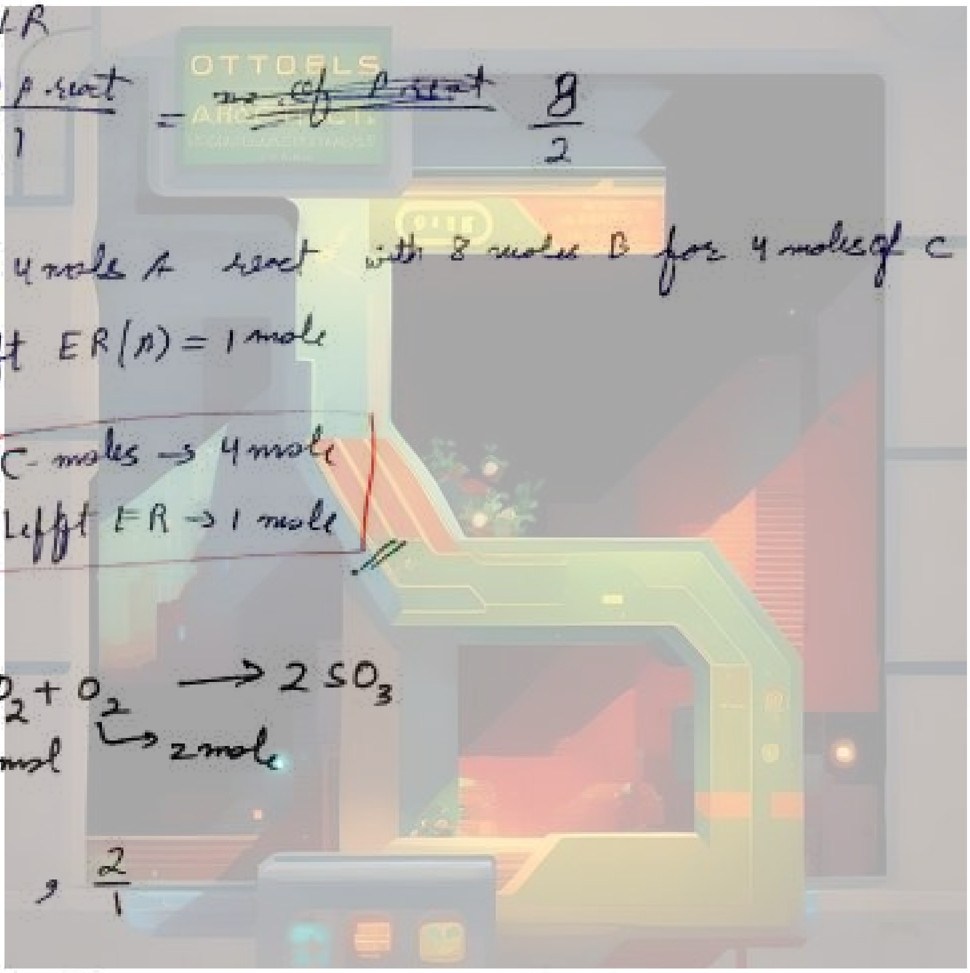
for A given reactions 5 ~~mol~~ mole of A react with 8 ~~mass~~ moles of B, then calculate amount of the moles of C produced and also the amount of ER. left.

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

5 , 4

B → LR

$\frac{\text{no. of p. react}}{1} = \cancel{\text{no. of P. react}} \; \frac{8}{2}$



⇒ 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 → 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

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

42

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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

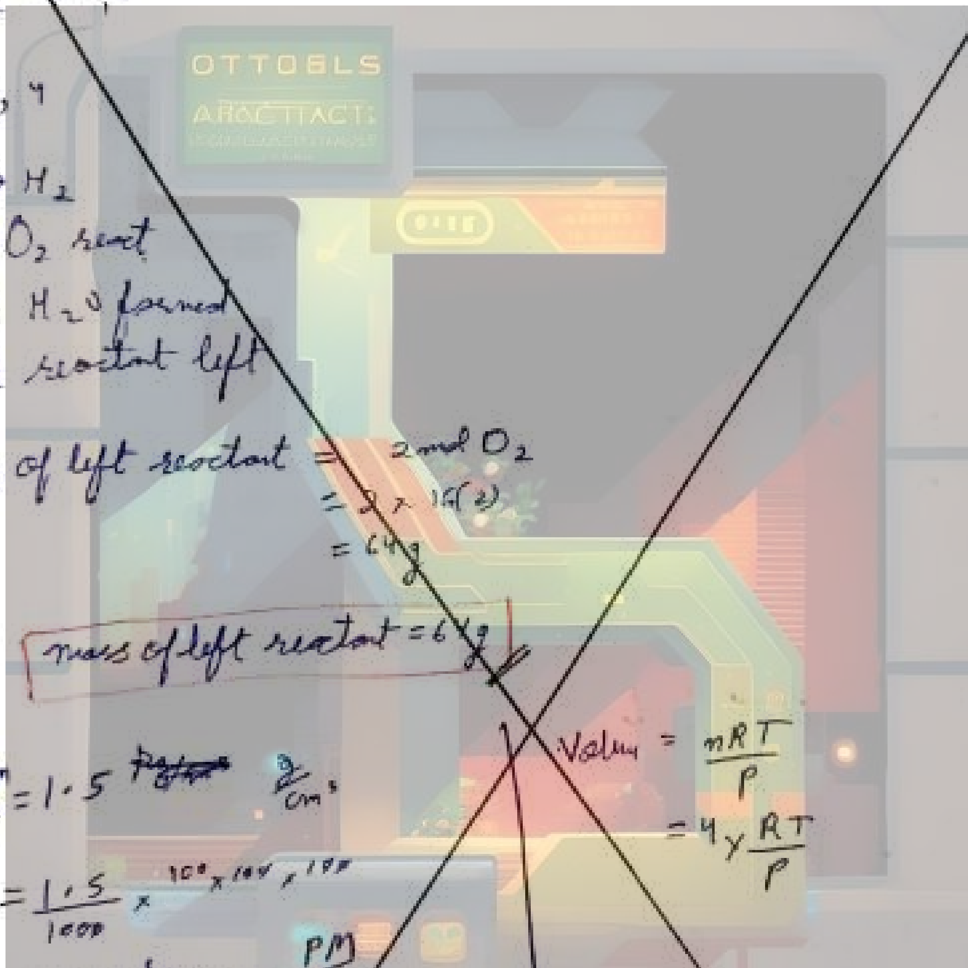
2 mol reactant left

mass of left reactant = 2 mol $O_2$

= 2 × 16(2)

= 64 g

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




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

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

$\frac{PM}{RT} = 1.5 \; \cancel{kg/m^3} \; g/cm^3$

$= \frac{1.5}{1000} \times 10^2 \times 10^2 \times 10^2$

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

~~= 1500 × 0.~~

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

(43)

Scanned with CamScanner

$2H_2 + O_2 \rightarrow 2H_2O$

$4g \quad 4g$

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

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

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

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

$\frac{4.5}{1.5} \times \cancel{100} = \boxed{\cancel{6.75}\ 3\ ml}$

# % 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

$\% H = \frac{2}{18} \times 100 = 11.11\%$

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

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

Total mass $= 63.5 + 32 + 64 + 10 + 80$
$= 249.5\,g$

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

$\boxed{= 25.8}$

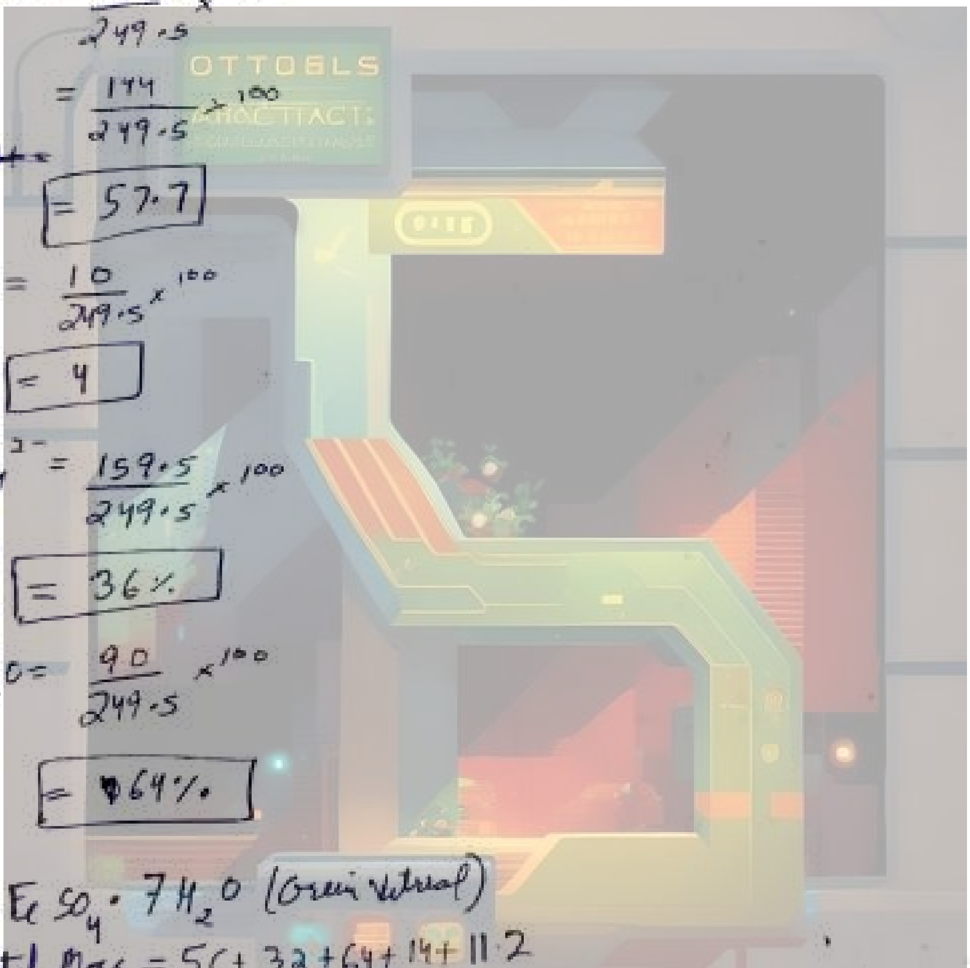
$\% S = \frac{32}{249.5} \times 100$

$\boxed{= 12.82}$

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

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

$\boxed{= 57.7}$



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

$\boxed{= 4}$

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

$\boxed{= 36\%}$

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

$\boxed{= 64\%}$

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

Total Mass $= 56 + 32 + 64 + 14 + 112$
$= 278$

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

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

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

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

# 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 + $CO_2\uparrow_{(g)}$

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

↓

$(Mg, Ca, \ldots)$

Bicarbonates

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

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

↳ $Li_2O_{(s)} + CO_{2(g)}$

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

↳ $MgO_{(s)} + CO_{2(g)}$

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

↳ $2Ag + \frac{1}{2}O_{2(g)}$

④ $Hg_2CO_{3(s)} \xrightarrow{\Delta} Hg_2O + CO_{2(g)} \Rightarrow Hg + \frac{1}{2}O_{2(g)} + CO_{2(g)}$

↳ $Hg + \frac{1}{2}O_{2(g)}$

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 → Nitrate of Li disassociate like alkali 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 nitrides

→ 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 $M_3N_2$

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

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

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

200g

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

$CaO$: 2 mole (112g)

$CO_2$: 2 mole (88g)

closed container

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

200g → 200g

open container

$$\boxed{200g \; CaCO_{3(s)}} \xrightarrow{\Delta} \boxed{CaO_{(s)} \; 112g \quad CO_2 \; 88g}$$

release in atmosphere

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

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

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

| $2KHCO_3$ | $K_2CO_3$ | $H_2O$ | $CO_2$ |
|---|---|---|---|
| 2 mole | 1 mole | 1 mole | 1 mole |
| 200g | 122g | 18g | 44g |

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

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

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

$Li_2CO_3 \xrightarrow{\Delta} Li_2O_{(s)} + CO_2$

n mole, 74 g → 30 g, 44 g

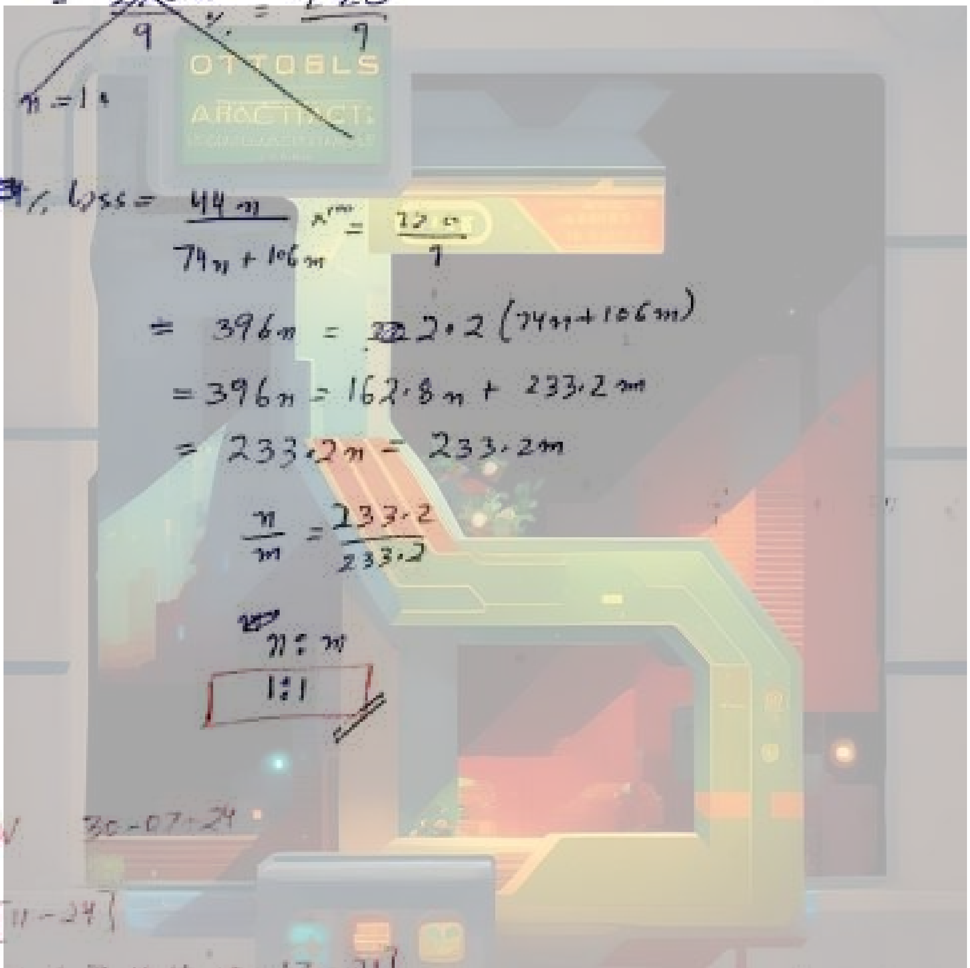
$Na_2CO_3 \xrightarrow{\Delta} X$

m mole, 106 g

~~% loss = $\frac{44}{180} \times 100$~~

~~$= \frac{2200}{9}\% = \frac{220}{9}$~~

~~n = 1~~



% 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 stoichiometric ratio.

Mixtures - It is suggested to write balanced chemical reaction for all components of mixture which participate 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°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

$C_2H_4 + O_2 \rightarrow 2CO_2 + 2H_2O$

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 → $M_A$ gram

B → $M_B$ 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, 8.8g $CO_2$ & 4.14g $H_2O$. Calculate mass%. of Butane. (60.83%)

Q69. A 2g mixture of $Na_2CO_3$ & $NaHCO_3$ losses 0.248g 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 1.84g. on heating leaves a residue 0.96 g. Calculate %. of each in mixture (54.34%)

Ans-68.

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

$x$ g

$\frac{x}{44}$ mol

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

$8.8 - x$ g

$\frac{8.8-x}{44}$ mol

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

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

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

$= \frac{58}{820} - \frac{29x}{2238}$

total moles $= \frac{58}{\cancel{8}20} - \frac{22x}{2238} = 2.86$

$= \frac{x}{4} = \frac{58}{820} - 2.86$

$\frac{x}{4} = \frac{58 - 14.3}{20} 2\, 0.04$

$\frac{x}{4} = 6.74\, 0.04$

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

$=$

$x = 0.16$

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

$= \frac{216}{2.86 \times 22} \times 100$

$= \frac{56}{1573} \times 100$

$= \frac{5600}{1573}$

$=$

52

Ans 68.

$$\underset{x \text{ mol}}{C_4H_8} + 6O_2 \longrightarrow \underset{4x}{4H_2O} + \underset{4x}{4CO_2}$$

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

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

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

$$176(x+y) = 8.8g \quad \text{—(2)}$$

$$4x+4y = x+y = 0.05$$

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

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

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

$$y = 0.03$$

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

$$\boxed{= 60.83}$$

Ans 69.

$$2NaHCO_3 \xrightarrow{\Delta} Na_2CO_3 + \underset{\substack{x \\ \downarrow \\ 44x}}{CO_2} + \underset{\substack{x \\ \downarrow \\ 18x}}{H_2O} \text{ mole}$$

$$44x + 18x = 0.248$$

$$62x = 0.248$$

$$x = \frac{248}{62 \times 1000}$$

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

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

~~% NaHCO₃~~

~~mass of Na₂~~

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

$$= 100 - 33.6$$

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

53

Ans. loss of heating $= 1.84 - 0.96$

$= 0.88\,g$

$$CaCO_{3(s)} \xrightarrow{\Delta} CaO_{(s)} + CO_2\uparrow_{(g)}$$

$100x\,g$    $x$ mol    $44x\,g$

$$MgCO_{3(s)} \xrightarrow{\Delta} MgO_{(s)} + CO_2\uparrow_{(g)}$$

$84y\,g$    $y$ mol    $44y\,g$

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

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

$$x+y = 0.02$$

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

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

$$16x = 0.16$$

$$x = \frac{16}{10} \times \frac{1}{100}$$

$$x = 0.01$$

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

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

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

## Percentage Purity

→ Defined only for Reactant.

→ Pure amount of Reactant will participate in the reaction.

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

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

Total weight = 100g

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

$CaCO_{3(s)} \rightarrow CaO_{(s)} + CO_{2(g)}$ ⟶ 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 $\rightarrow \frac{200000g}{100} \times 95$

→ 190000g

$CaCO_3$ moles :- 1900 mol

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

moles of CaO :- = 1900 mol

mass :- $1900 \times 56$

= 106400 g

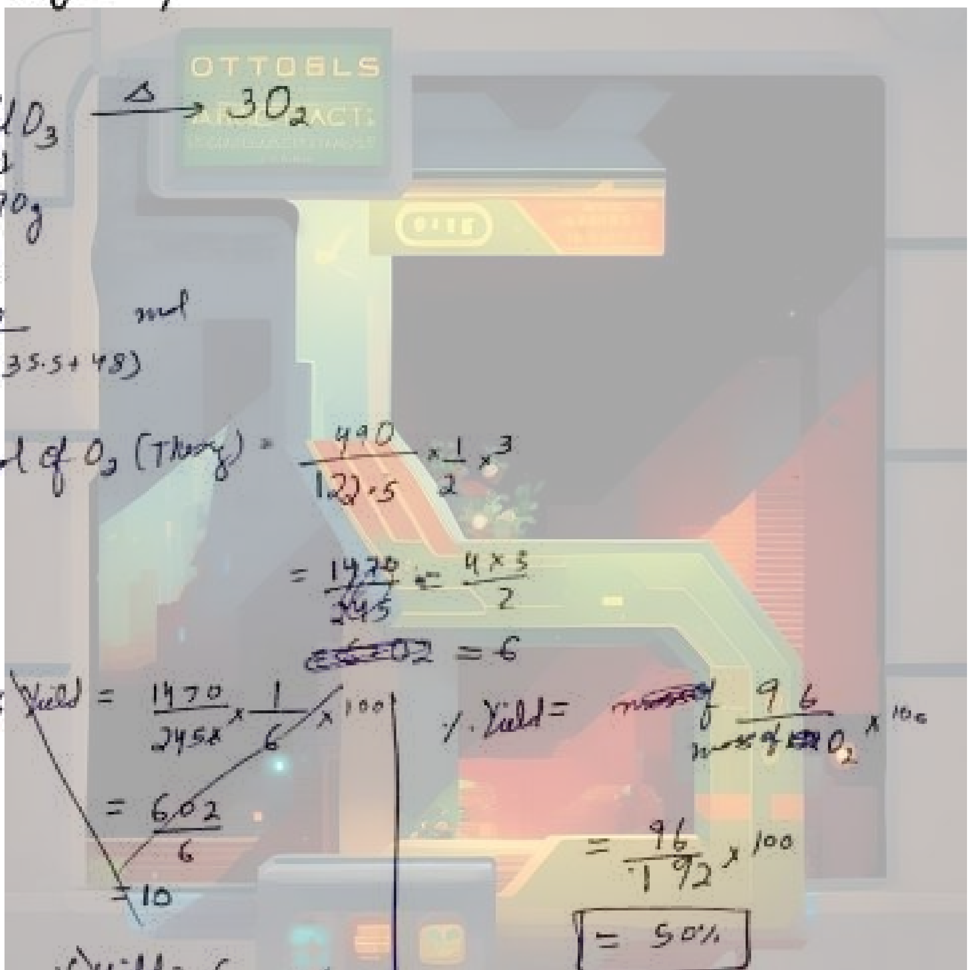
$\boxed{= 106.4\ kg}$

% 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) $= \frac{490}{122.5} \times \frac{1}{2} \times 3$

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

$= \cancel{6.02} = 6$

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

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

$\boxed{= 50\%}$

$\boxed{= 50\%}$

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 = $\frac{\text{mass of } SO_2}{64} \times 100$~~

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

160 ~~256~~ = mass of $SO_2$

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

$= 5$ mol

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

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

~~48 g~~
$= 300$

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

Total mass $= \frac{300000}{5}$

$= 600000$ g

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

(57)

H.W 2-5-24

Race 2, 27

57. 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) $2KClO_3 \xrightarrow{\Delta} 2KCl + 3O_2$

$KCl \rightarrow 1.49\,g$

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

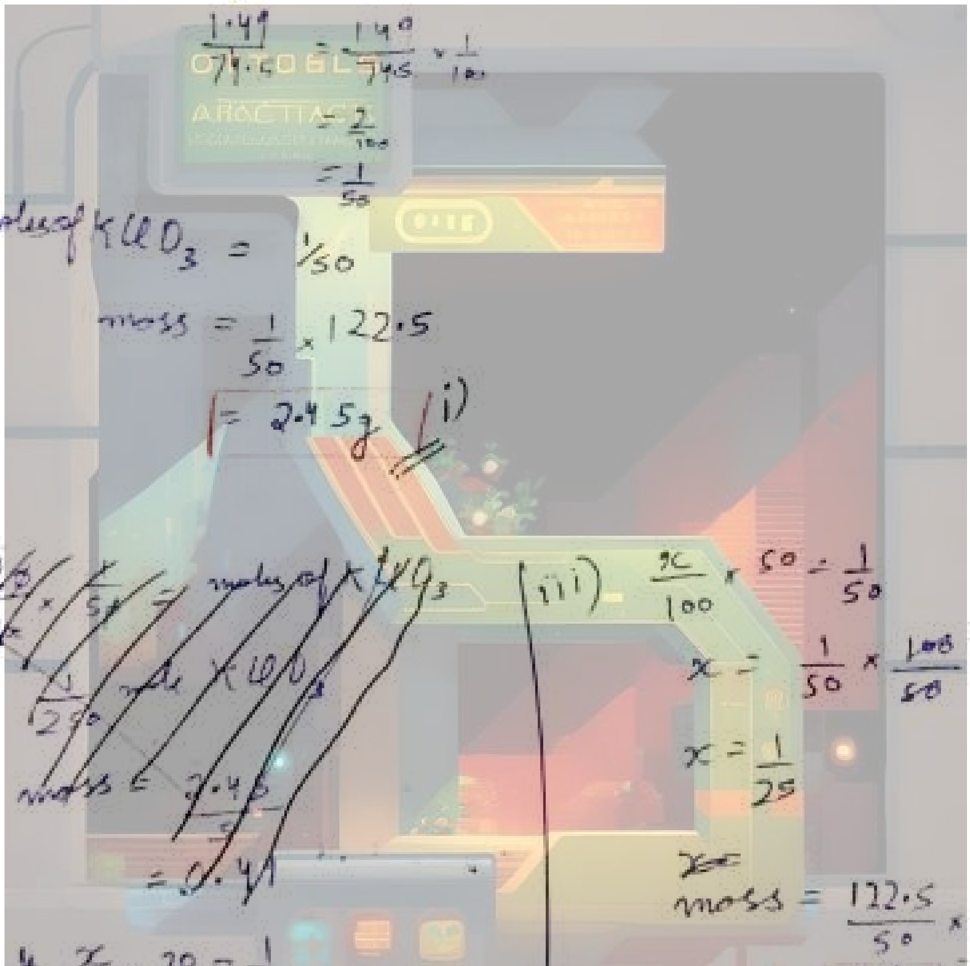
$= \frac{2}{100}$

$= \frac{1}{50}$

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

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

$\boxed{= 2.45\,g}$ (i)



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) ($\alpha$) :-

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

% Dissociation = $\alpha \times 100$

$0\% \leq \alpha \leq 100\%$

$0 \leq \alpha \leq 1$

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 $\alpha$

| | | | |
|---|---|---|---|
| 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

$$2A \longrightarrow B + 3C$$
$$\downarrow \qquad \downarrow \qquad \downarrow$$
$$3\text{ mol} \quad 1.5\text{ mol} \quad 4.5\text{ mol}$$

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 there initially & moles of B formed after dissociation is 6 then calculate: i) $\alpha$ ii) moles of C formed.

$$2A \longrightarrow 3B + 4C$$
$$\downarrow$$
$$6\text{ mol}$$

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 & $\alpha$ 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

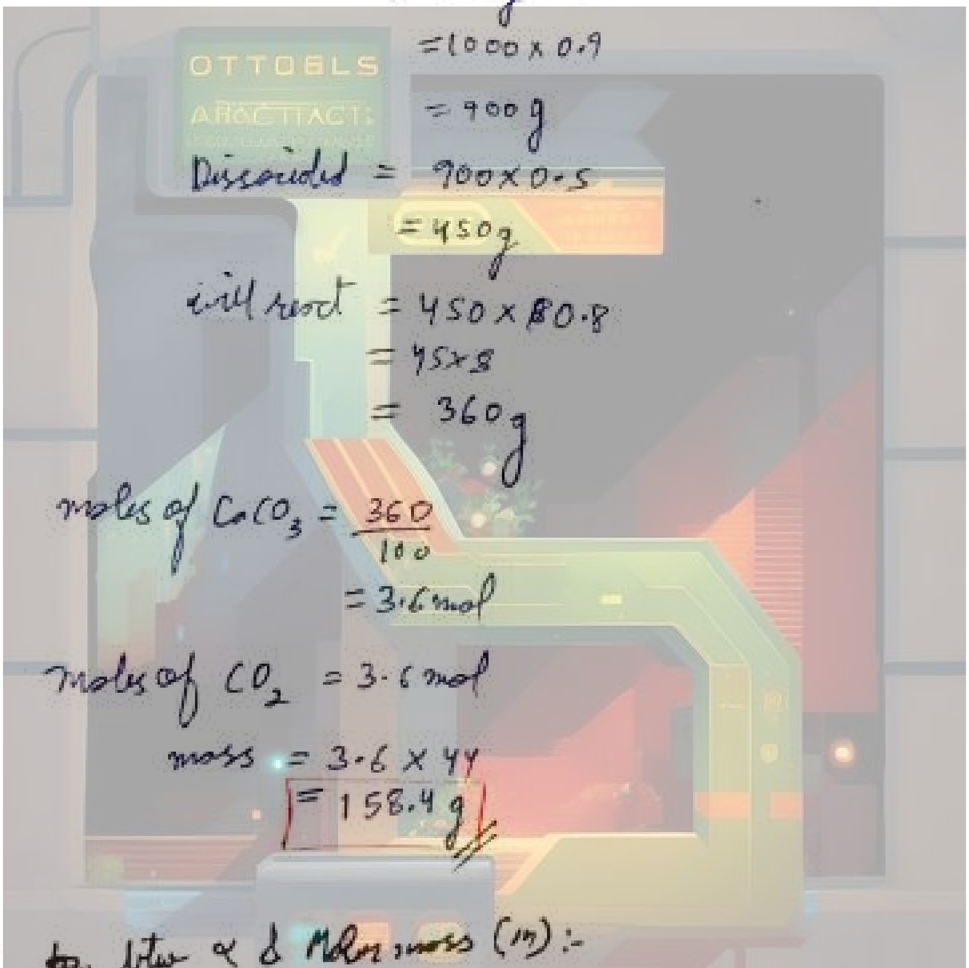
moles of C formed $= \boxed{3.2 \text{ mol}}$

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

$\boxed{= 158.4\text{ g}}$

# Relation b/w $\alpha$ & Molar mass (m) :-

$A \longrightarrow nB$

| | | |
|---|---|---|
| t = 0 | a | 0 |
| t = t | a − a$\alpha$ | n (a$\alpha$) |

$M_i = M_f$

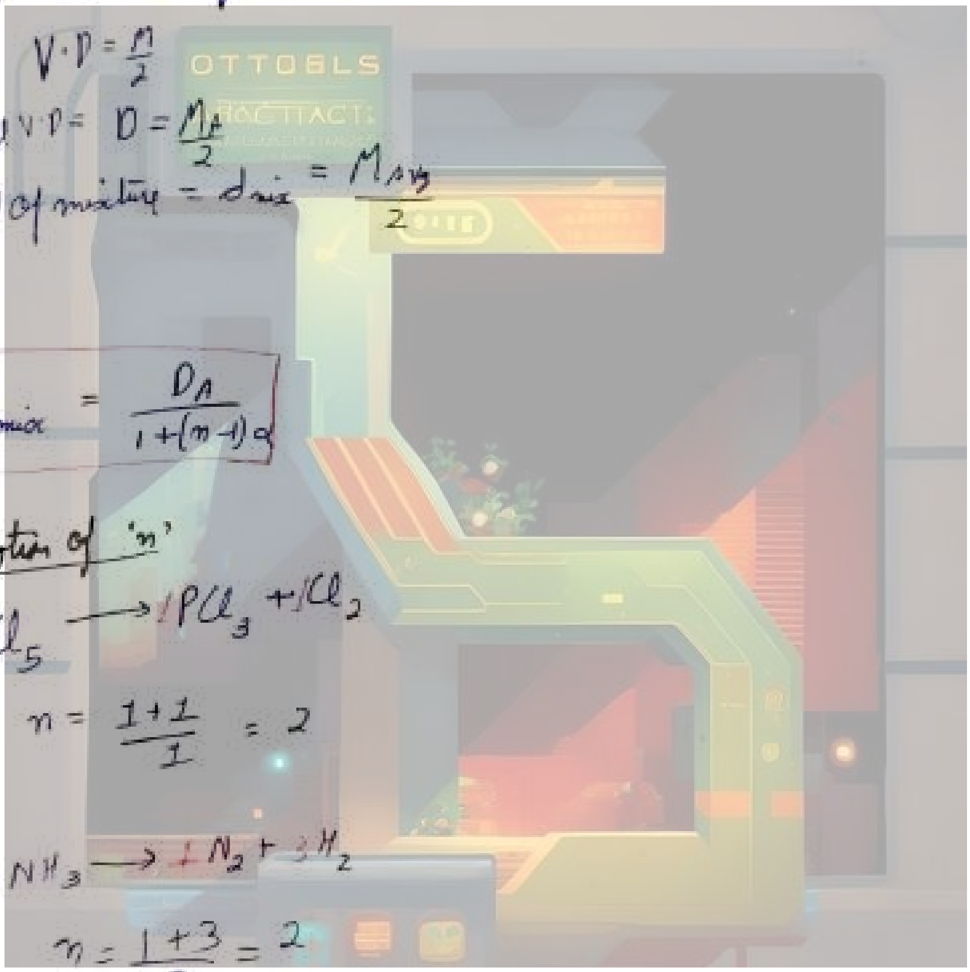
~~for $M_A$~~

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

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

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

$M_A$ - 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) $2NH_3 \longrightarrow 1N_2 + 3H_2$

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

Q80. Calculate $\alpha$ if molar mass of mixtures is 13.6.

$2NH_3 \longrightarrow N_2 + 3H_2$

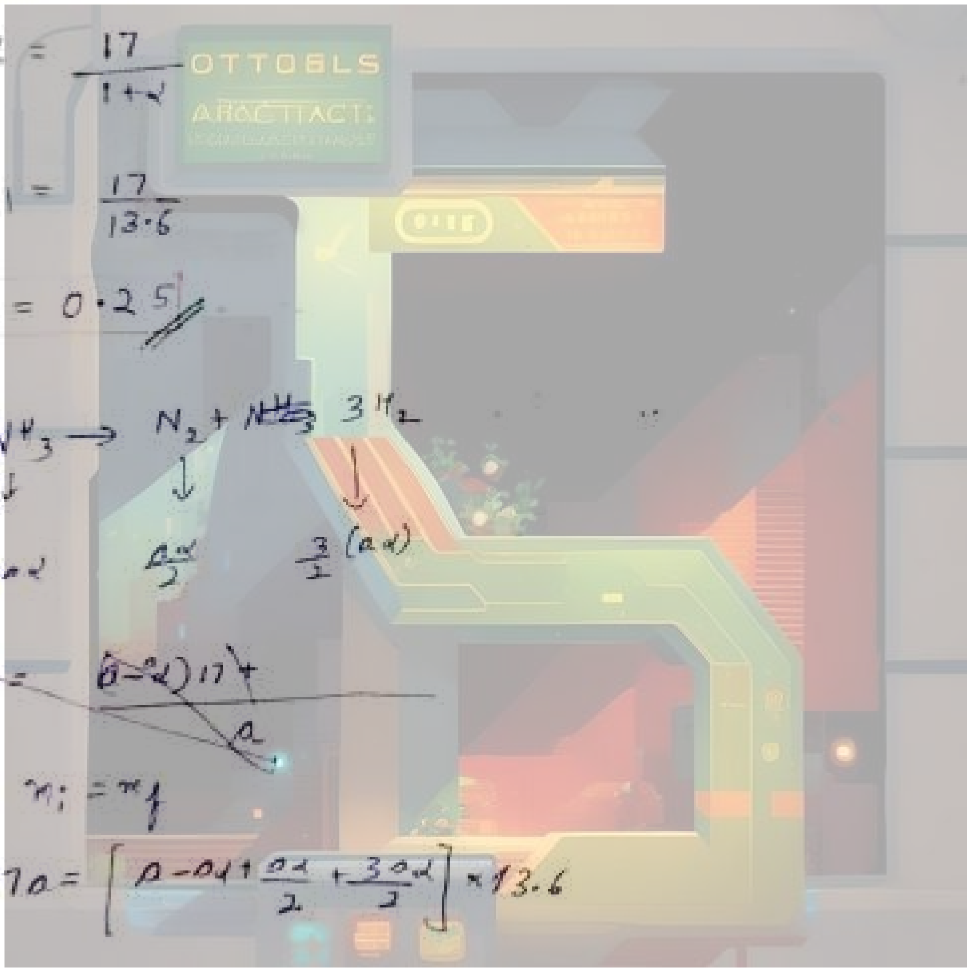
M.I

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

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

$M_{mix} = 13.6$

$M_{NH_3} = 17$



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

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

$\boxed{\alpha = 0.25}$

M.II

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

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

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

$m_i = m_f$

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

$\boxed{\alpha = 0.25}$

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

$n = 2$

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

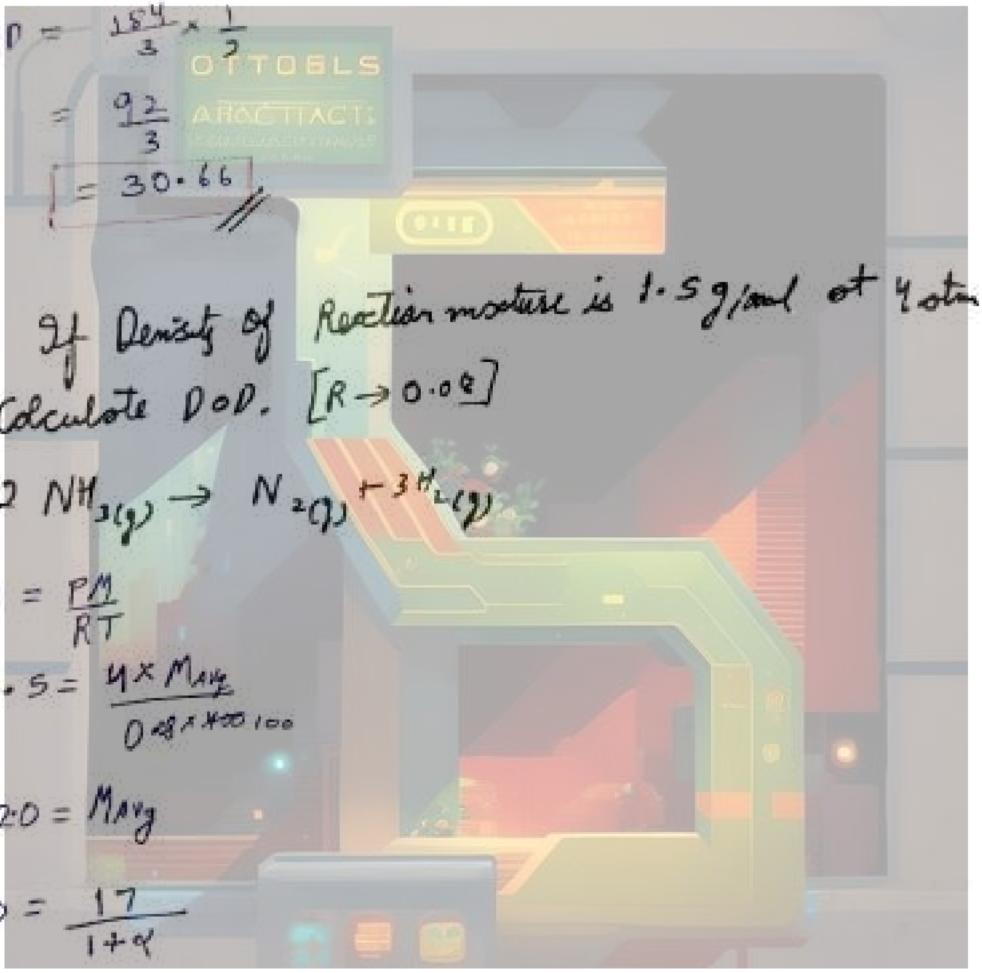
$$M_{mix} = \frac{92}{1.5}$$

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

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

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

$$\boxed{= 30.66}$$



Q82. If Density of Reaction mixture is 1.5 g/ml at 4 atm 400 K Calculate DOD. [$R \rightarrow 0.08$]

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

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

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

$$12.0 = M_{Avg}$$

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

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

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

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

Q.8. Density of partially dissociated sample of $SO_3$ is 2.5 g/L at 0°C 1 atm. find degree of dissociation of $SO_3$.

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

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

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

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

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

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

$$\cancel{M = 0.056}$$

$$M = 0.56$$

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

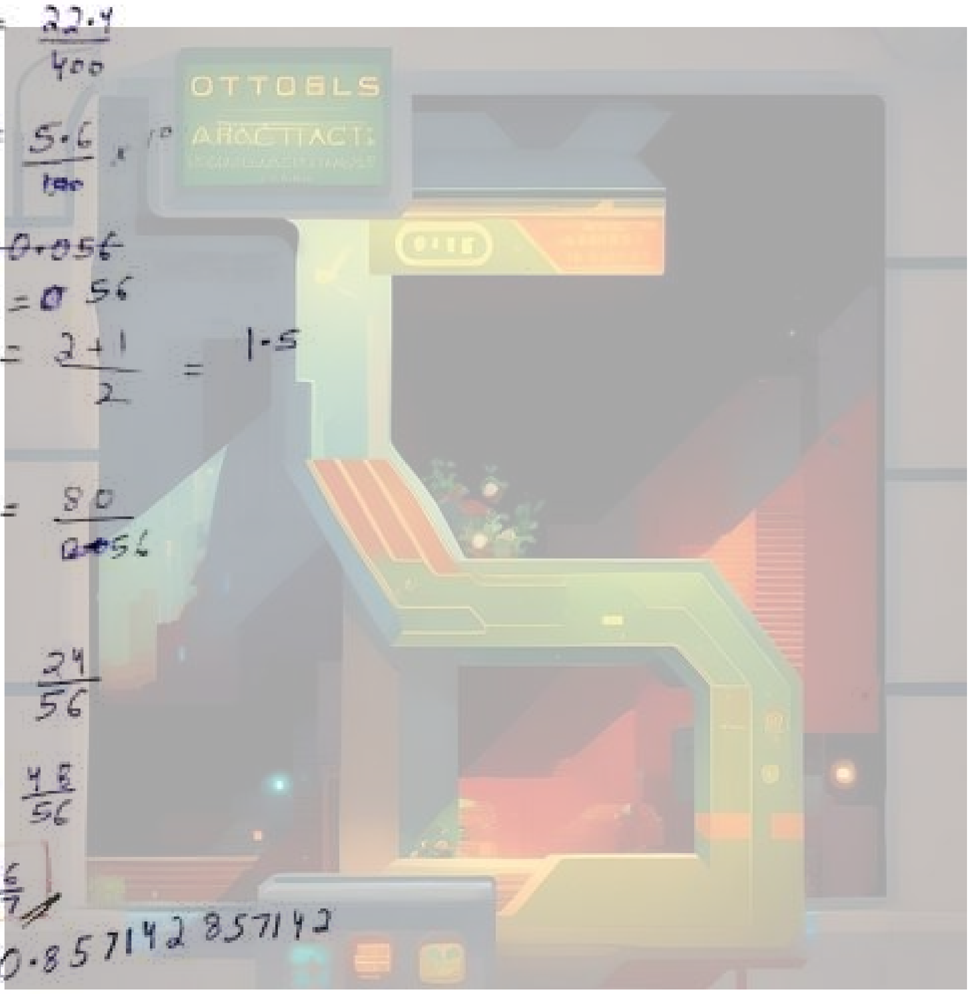
$$\frac{\alpha}{2} + 1 = \frac{80}{0.56}$$

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

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

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

$$\alpha = 0.857142857142$$



## Sequential Reaction

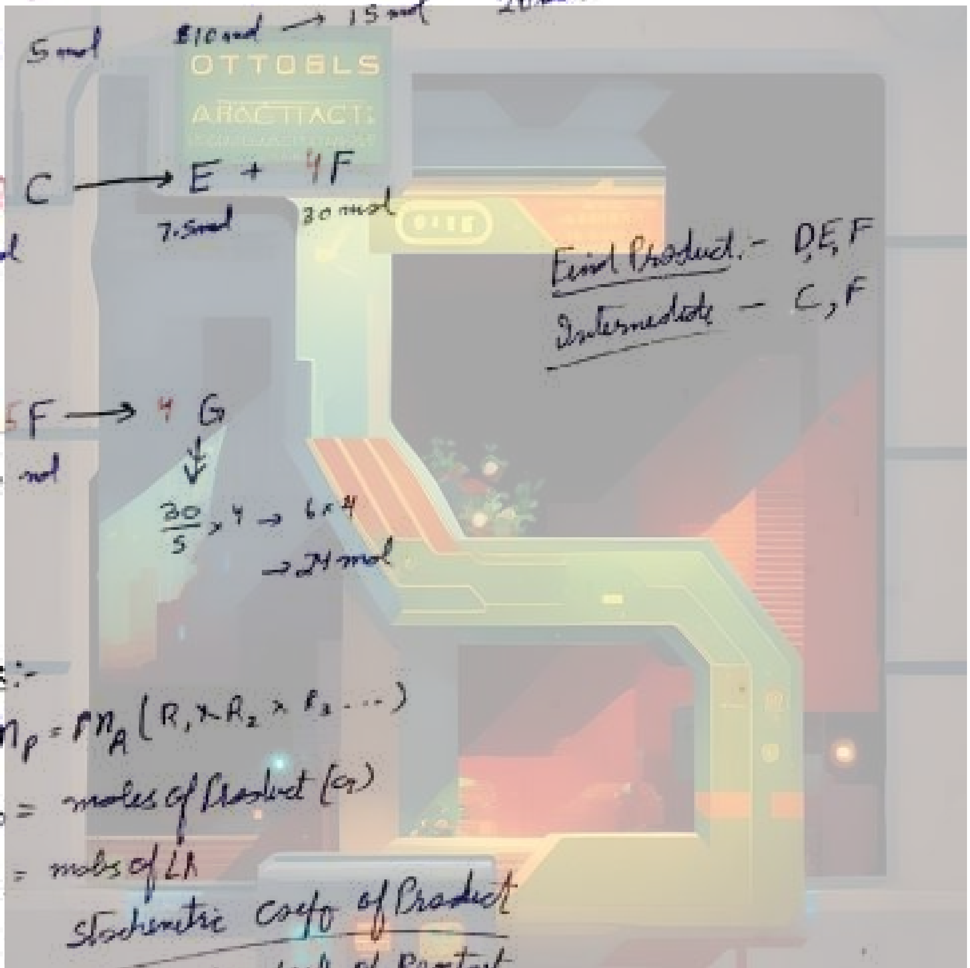
→ Such reaction occurs in multiple steps, such that at least one of the product of a particular step acts as reactant in next step.

eg $A + 2B \rightarrow 3C + 4D$

given 5 mole, 15 mole

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

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



$2C \rightarrow E + 4F$

15 mol, 7.5 mol, 30 mol

End Product :- D, E, F

Intermediate - C, F

$5F \rightarrow 4G$

30 mol

$\frac{30}{5} \times 4 \rightarrow 6 \times 4 \rightarrow 24$ mol

Trick:-

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

$n_P$ = moles of Product (G)

$n_A$ = moles of LR

R: $\frac{\text{Stoichiometric coeff of Product}}{\text{Stoichiometric coeff of Reactant}}$

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

$n_G = 24$ 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.

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

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

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

10 mol

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

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

$= 10 \times 4$

$= 40$

mols 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)

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:- $NH_3 = 22.5\,g = \frac{25.5}{17}$ g mol

$CH_4 = 32\,g = 2$ g mol

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

$= \frac{25.5}{17}$

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.

$$n_p = n_R (R_1 \times R_2 \times R_3 \dots) \times \frac{y_1}{100} \times \frac{y_2}{100} \times \frac{y_3}{100}$$

$y_1, y_2, y_3 \Rightarrow$ % 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

moles of $K_3[Cu(CN)_4] = 0.1$

moles of $Cu_2(CN)_2 = x$

$50 = \frac{0.1}{2x} \times 100$

$\frac{2x \times 50}{100} = 0.1$

$x = \frac{0.2}{2}$

$x = 0.1$

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 $CuSO_4 = z$

$80 = \frac{0.4}{z} \times 100$

$z = \frac{0.4}{0.8}$

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

$z = 1/2$

moles of $CuSO_4 = 1/2$

moles of $(CN)_2 = 0.42$

volume $= 22.4 \times 0.4$

Volume =

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 [25-31]

O-1 [22-27]

Rocc [4, 5]

## Parallel Reactions

→ Two or more reactions involving same reactants & forms different products in the same container.

$\boxed{A \rightarrow B,\ A \rightarrow C}$

$N_2 + 3H_2 \longrightarrow 2NH_3$

$N_2 + 2H_2 \longrightarrow N_2H_4$

Q87. 6 mole $KClO_3$ dissociates as following & form 22.7 lit $O_2$ at STP. find mole of $KClO_4$ produced.

$2KClO_3 \rightarrow 2KCl + 3O_2$ — (1)

$4KClO_3 \rightarrow 3KClO_4 + KCl$ — (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 $KClO_4 = \frac{16}{3} \times \frac{3}{4} = \boxed{4\,mol}$

Q 58. $160\,g\ O_2$ & $72\,g$ Carbon reacted to form $CO, CO_2$ find moles of $CO$ & $CO_2$ in the final mixture.

$$5O_2 + 6C \longrightarrow 4CO_2 + 2CO$$

$$\begin{array}{cc} O_2 & C \\ \downarrow & \downarrow \\ 160\,g & 72\,g \\ \downarrow & \downarrow \\ 5\,mol & 6\,mol \end{array}$$

$$C + \frac{1}{2}O_2 \longrightarrow CO$$

$$\begin{array}{ccc} C & \frac{1}{2}O_2 & CO \\ \downarrow & \downarrow & \downarrow \\ 6\,mol & 5\,mol & 6\,mol \end{array}$$

$O_2$ left $= 2\,mol$

$$CO + \frac{1}{2}O_2 \longrightarrow CO_2$$

$$\begin{array}{ccc} CO & \frac{1}{2}O_2 & CO_2 \\ \downarrow & \downarrow & \downarrow \\ 6\,mol & 2\,mol & \boxed{4\,mol} \end{array}$$

$CO$ left $= 6\,mol - 4\,mol$

$\boxed{= 2\,mol}$

Note:- when combustion of Carbon $C + \frac{1}{2}O_2 \rightarrow CO$

① if $O_2$ is LR $\rightarrow C, CO$

② if $C$ is LR $\rightarrow CO, O_2$
will react further

$$CO + \frac{1}{2}O_2 \rightarrow CO_2$$

③ if $CO_2$ is LR $\rightarrow CO_2, O_2$

④ if $O_2$ is LR $\rightarrow CO, CO_2$

Q89. 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

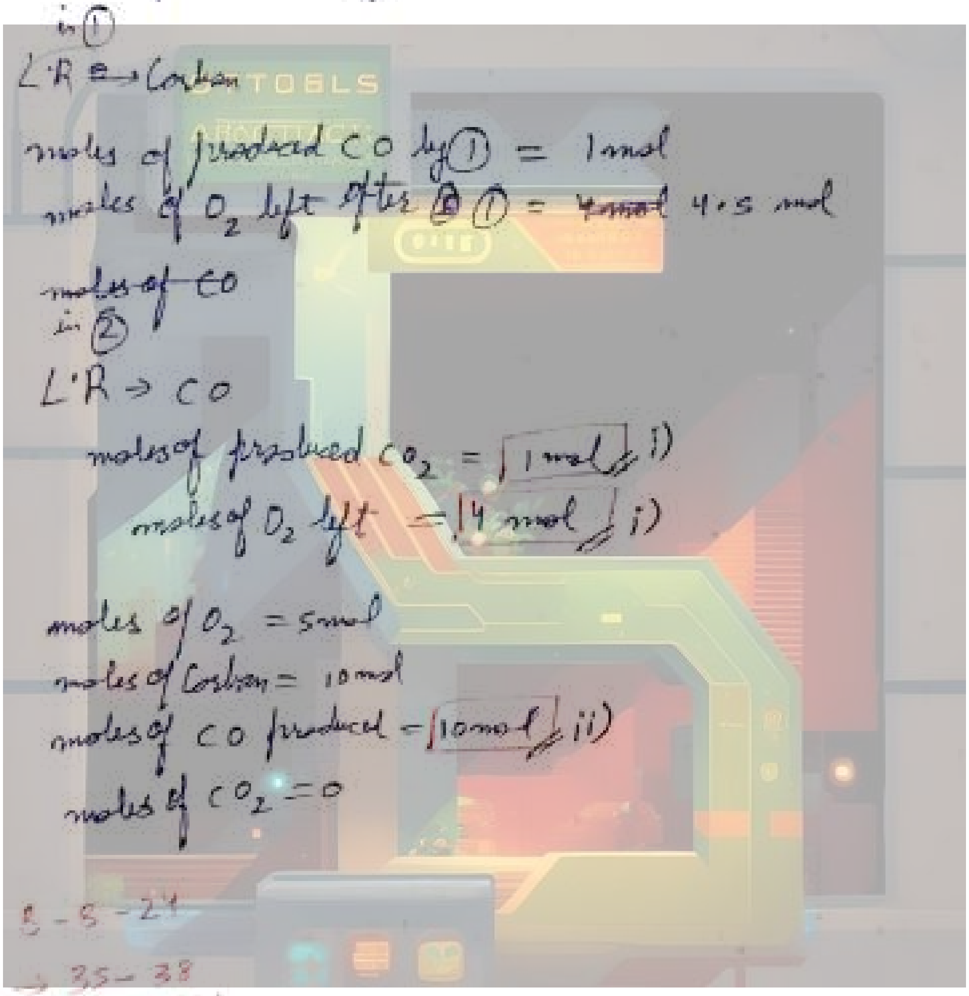
ii) 120 g carbon

$C + \frac{1}{2}O_2 \rightarrow CO$ ①

$CO + \frac{1}{2}O_2 \rightarrow CO_2$ ②

i) moles of $O_2 = \frac{160}{32} = 5$ mol

moles of Carbon $= \frac{12}{12} = 1$ mol



in ①

L.R ⇒ 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 → CO

moles of produced $CO_2$ = $\boxed{1 \text{ mol}}$ i)

moles of $O_2$ left = $\boxed{4 \text{ mol}}$ i)

ii) moles of $O_2$ = 5 mol

moles of Carbon = 10 mol

moles of CO produced = $\boxed{10 \text{ mol}}$ ii)

moles of $CO_2$ = 0

H.W. 8-5-24

S-1 → 35-38

O-1 → 28-31

S-M → 5, 9, 18, 20, 21

S-2 → 1, 2, 4, 5, 7-11

O-2 → 5-11, 16-19, 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 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.

Q70. All carbon present in 1016 g $KH_3(C_2O_4)_2 \cdot 2H_2O$ is converted to $CO_2$. find mass of $CO_2$

$(\text{moles of } C)_{Left} = (\text{moles of } C)_{Right}$

i.e. $8 \times (\text{moles of } KH_3(C_2O_4)_2) = \text{moles of } CO_2$

$\text{moles of } CO_2 = 4 \text{ moles of } KH_3(C_2O_4)_2$

$\cancel{= 4 \times \frac{1016}{218}}$

$\cancel{= \frac{2032}{109}}$

$\cancel{\text{mass of } CO_2 = \frac{2032}{109} \times 44}$

$= 4 \times \frac{1016}{254}$

$= 16$

$\text{mass of } CO_2 = 16 \times 44$

$\boxed{= 704 \text{ g}}$

Q71. $K_2CO_3$ 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 $= \frac{1}{6} \times 698 = \boxed{116.3 \text{ g}}$

73

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 $C_2H_4$.

$$\text{moles of C in RHS} = \frac{44}{3} \times \frac{1}{44} = \frac{1}{3}\text{ mol}$$

$$\text{moles of C in LHS} = \underbrace{\text{moles of } CH_4}_{x \text{ mol}} + 2\underbrace{\text{moles of } C_2H_4}_{y \text{ mol}} = \frac{1}{3}$$

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

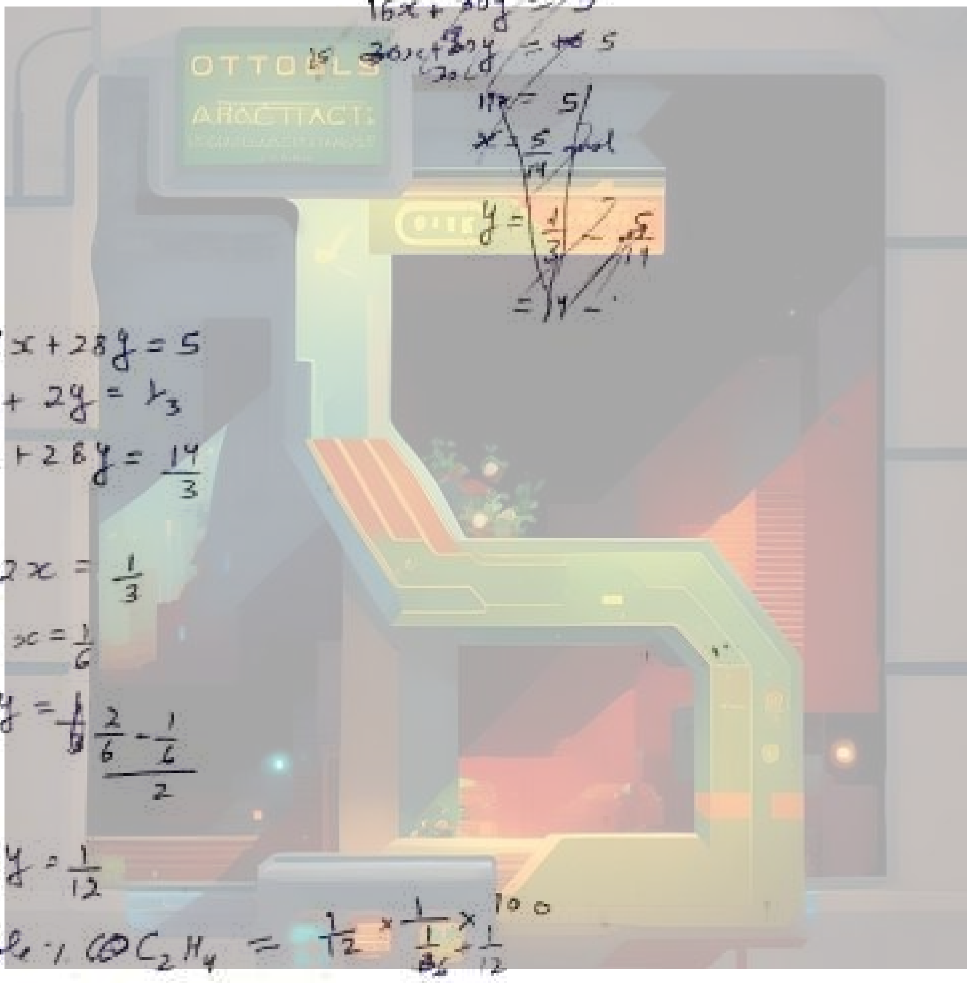
$$\cancel{16x + 30y = 5}$$

$$\cancel{30x + 30y = 5}$$

$$\cancel{14x = 5}$$

$$\cancel{x = \frac{5}{14}\text{ mol}}$$

$$\cancel{y = \frac{1}{3} - \frac{5}{14}}$$



$$16x + 28y = 5$$

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

$$14x + 28y = \frac{14}{3}$$

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

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

$$y = \frac{\frac{2}{6} - \frac{1}{6}}{2}$$

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

$$\text{mole \% of } C_2H_4 = \frac{1}{12} \times \frac{1}{\frac{1}{6} + \frac{1}{12}} \times 100$$

$$= \frac{1}{3} \times 100$$

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

## (2) Problems of Parallel reaction. → All reactors ~~...~~ 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 & $CO_2$.

$(\text{moles of Carbon})_{\text{left}} = \frac{72}{12} = 6 \text{ mol}$

$(\text{moles of O})_{\text{left}} = \frac{160}{16} = 10 \text{ mol}$

$$\underset{6\text{ mol}}{C} + \underset{5\text{ mol}}{O_2} \longrightarrow \underset{x}{CO} + \underset{y}{CO_2}$$

$x + y = 6$ (POAC on C)

$x + 2y = 10$ (POAC of O)

$y = 4$

$x = 2$

$\boxed{\text{moles of } CO = 2}$

$\boxed{\text{moles of } CO_2 = 4}$

Q99. ~~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-2

$$\underset{1\text{ mol}}{P_4} + \underset{4\text{ mol}}{O_2} \longrightarrow \underset{x\text{ mol}}{P_4O_6} + \underset{y\text{ mol}}{P_4O_{10}}$$

$4x + 4y = 4$ $\qquad$ $3x + 5y = 4$

$x + y = 1$ $\qquad$ $3(1-y) + 5y = 4$

$3 + 2y = 4$

$2y = 1$

$\boxed{y = 1/2}$

$\boxed{x = 1/2}$

$P_4 + 3O_2 \longrightarrow P_4O_6$

1 mol   4 mol     1 mol

L.R = L.R = $P_4$

moles $O_2$ left = $\frac{4}{1} - 3 = 1$ 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~~ 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.

$$O.C.(X) \xrightarrow[HNO_3]{AgNO_3} AgX\downarrow \text{(PPT)}$$

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 = $\frac{141 \times 80}{188 \times 250} \times 100$

= $\frac{1128}{47}$

$\boxed{= 24\%}$

79

Q96. In Sulfur Estimation, 0.32 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 $= \frac{46}{233} \times \frac{1}{100} \times 32$

$\% S = \frac{46 \times 32}{233 \times 100} \times \frac{1}{0.32} \times 100$

$= \frac{4600}{233}$

$\boxed{= 19.41}$

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]

$$\underset{(N)}{\text{Organic Compound}} \xrightarrow[CuSO_4/Hg]{H_2SO_4} (NH_4)_2SO_4$$

$$(NH_4)_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + H_2O + 2NH_3$$

$$NH_3 + \text{Suitable Acid} \rightarrow \text{Product}$$

Q79. A sample of 0.5g of an organic compound was treated according to Kjeldahl's method. The Ammonia evolved was absorbed by 2.45g $H_2SO_4$. The residual acid requires 1.2 g NaOH for neutralisation. Find % Nitrogen in organic compound.

~~$2NH_3 + H_2SO_4 \rightarrow (NH_4)_2SO_4$~~

~~$\frac{2.45}{49}$ mol, 2.45g, $\frac{2.45}{98}$~~

~~$(NH_4)_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + H_2O + 2NH_3$~~

~~$\frac{2.45}{98}$ mol~~

$$H_2SO_4 + 2NaOH \longrightarrow Na_2SO_4 + 2H_2O$$

$H_2SO_4$: $\frac{1.2}{80}$ mol

NaOH: 1.2 g, $\frac{1.2}{40}$ mol

$$H_2SO_4 \text{ left} = \frac{2.45}{98} - \frac{1.2}{80} = \cancel{0.0185\text{ mol}}\ 0.01 \text{ mol}$$

moles of $NH_3$ = 0.02 mol

moles of N = 0.02 mol

mass = 0.02 × 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.

→ 80 g $CaCO_3$

→ $\frac{80}{100}$ mole

→ $\frac{80}{100} \times 40$ g Ca

→ $\frac{80 \times 40}{100} \times \frac{1}{\cancel{100}} \times \cancel{100} = \frac{3200}{100} = \boxed{32\%}$

Q101. Find % composition of C in Urea Sample 60% ~~to~~ Purity

Urea - $NH_2CONH_2$

$N_2H_4CO$

~~in 100% Pure :- $\frac{28}{60} \times 100$~~

~~in 60% Pure :- $\frac{28}{60} \times \frac{1}{100} \times 60 \times 100$~~

~~$= 28$~~

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.

~~$\frac{Dx}{12+Dx} \times 100$~~

$\frac{2x \times 100}{12+2x} = 40$

$20x = 48 + 8x$

$12x = 48$

$\boxed{x = 4}$

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 Emperical/Moleculer Formula:

→ Moleculer 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.

| Sn | 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 | $C_6H_6$ | $CH$ |

Moleculer Formula = n × ~~Molecu~~ Emperical Formula

$$\boxed{MF = n\,EF}$$

~~Moleculer weight = n × Moleculer~~

Moleculer 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.

| | (M.F) | (E.F) |
|---|---|---|
| Acetic Acid ($CH_3COOH$) | $C_2H_4O_2$ | $CH_2O$ |
| Glucose | $C_6H_{12}O_6$ | $CH_2O$ |

~~Ques.~~ 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.

mass ratio = $\overset{C}{38.8} : \overset{H}{16} : \overset{N}{45.2}$

mole ratio = $\frac{38.8}{12} : \frac{16}{1} : \frac{45.2}{14}$

$\frac{97}{3} : \frac{160}{1} : \frac{226}{7}$

$32.3 : 160 : 32.3$

$1 : 5 : 1$

$\boxed{E.F - CH_5N}$ i)

$62 = 12 + 5 + 14 \cdot x$

$62 = 31x$

$x = 2$

$62 = 31n$

$n = 2$

$\boxed{M.F = C_2H_{10}N_2}$ ii)

Q106. An organic compound contain 49.3% C, 6.84% of 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)

{n = 2}

MF - $\boxed{C_6H_{10}O_4}$ ii)

Q107. Find E.F of mineral $ASO_4$ 28% $H_2O$ 72% (A = 16 u)

Q108. EO 25% $DO_2$ 25% $H_2O$ 50% {E = 29 u, D = 13 u}

Ans 107

| | $ASO_4$ | $H_2O$ |
|---|---|---|
| mass | 28 | : 72 |
| moles | $\frac{28}{112}$ | : $\frac{72}{18}$ |

$\frac{1}{4}$ : 4 × 4

~~4 : 64~~

~~7 : 122~~

~~$A(ASO_4)_7(H_2O)_{122}$~~

1 : 16

$\boxed{ASO_4 \cdot 16H_2O}$

Ans 108.

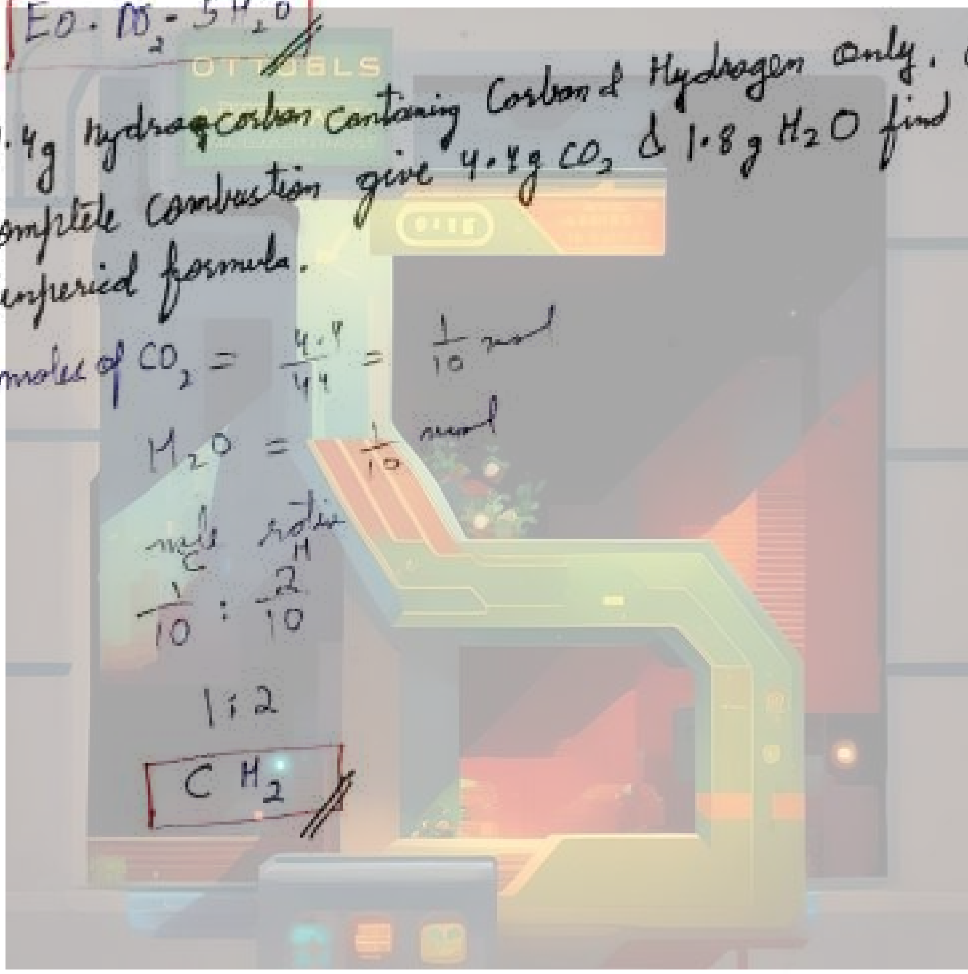
| EO | DO$_2$ | $H_2O$ |
|---|---|---|
| 25 | 25 | 50 |
| $\frac{25}{45}$ 5/9 | $\frac{25}{45}$ 5/9 | $\frac{50}{18}$ 25/9 |

5 : 5 : 25

1 : 1 : 5

~~EO-DO$_2$~~

$\boxed{EO \cdot DO_2 \cdot 5H_2O}$ //



Q107. 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 Eudiometry 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.

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

1 mol → 3 mol → 2 mol

$V = n\frac{RT}{P}$ $V = n\frac{RT}{P}$ $V = n\frac{RT}{P}$

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 |

$V_i = \cancel{20}\ 20$ 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

$V_f = 10 \text{ ml} + 30 \text{ ml} = 40$ ml

$V_{expansion} = V_f - V_i$

$\boxed{V_{expansion} = 20 \text{ ml}}$

Q112. 10 ml ~~each~~ $N_2$ & ~~8~~40 ml $H_2$ sent 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 $\longrightarrow$ 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 volume contraction / Expansion.

$$CH_4 + 2O_2 \longrightarrow 2H_2O_{(l)} + CO_2$$

| $CH_4$ | $2O_2$ | $2H_2O_{(l)}$ | $CO_2$ |
|---|---|---|---|
| 10 ml | 40 ml | 0 | 0 |
| 0 ml | 20 ml | 20 ml (ignore) | 10 ml |

$V_i = 50$ ml

$V_f =$ ~~50 ml~~ 30 ml

$V_{contraction} = 50 - 30$

$\boxed{= 20 \text{ ml}}$

Common reactions

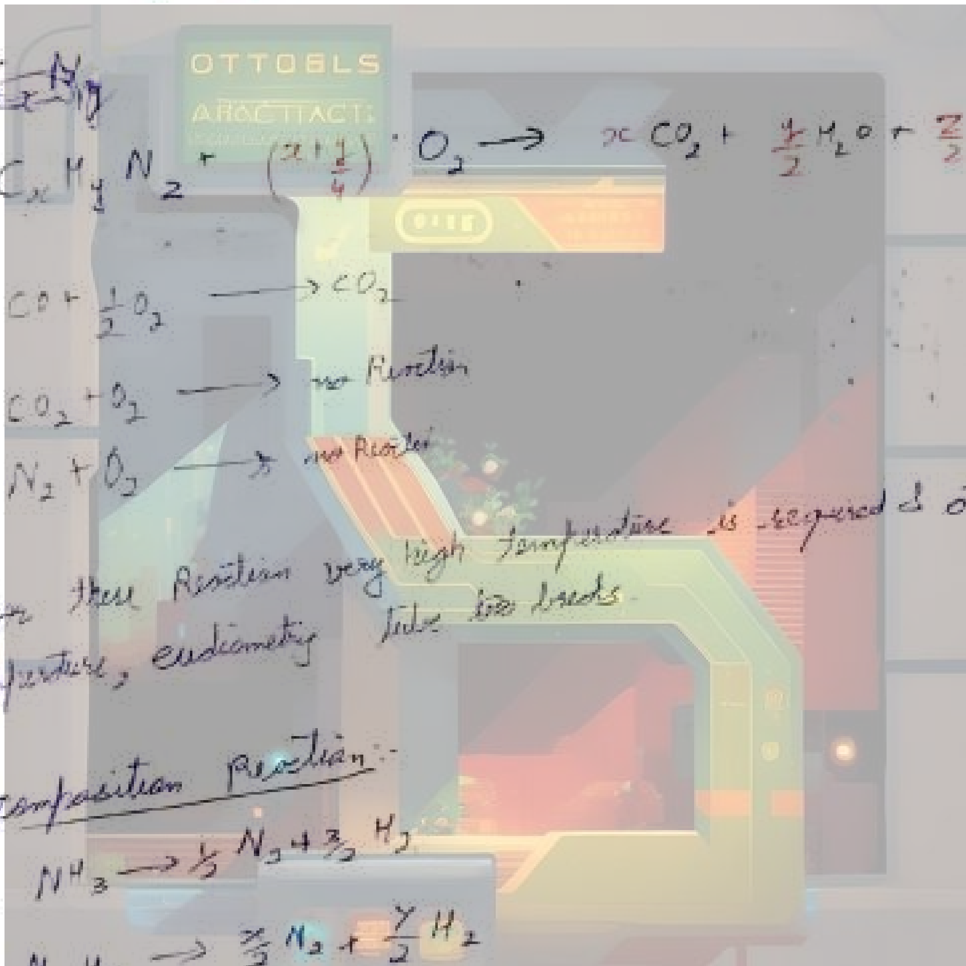
① Combustion Reaction:-

$C_xH_y + O_2$

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. $N_2 + O_2 \not\longrightarrow$ 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. $O_3 \longrightarrow \frac{3}{2}O_2$

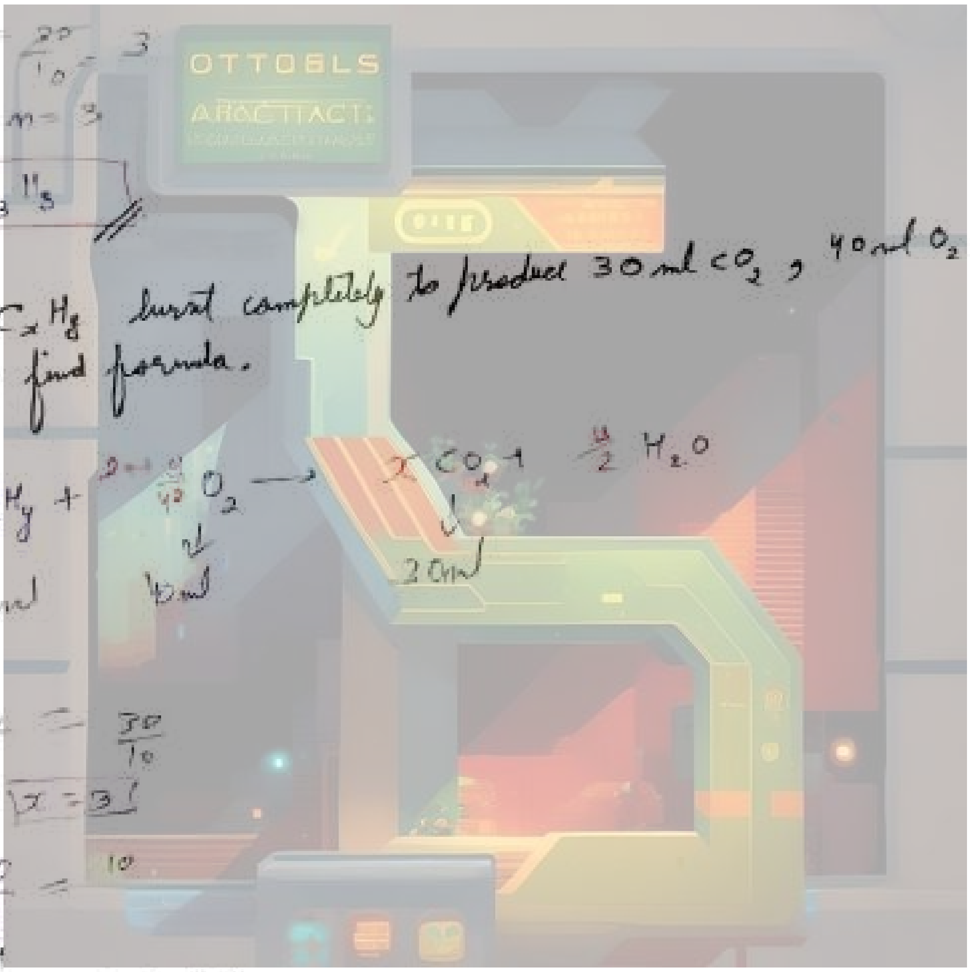
4. $O_x \longrightarrow \frac{x}{2}O_2$

Q114. 10 ml Alkane on complete combustion give 30 ml $CO_2$ & same $H_2O$. 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    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.

$$C_xH_y + \left(x+\frac{y}{4}\right) O_2 \longrightarrow x\,CO_2 + \frac{y}{2} H_2O$$

10 ml    40 ml    30 ml

$x = \frac{30}{10}$

$\boxed{x = 3}$

$\frac{40}{x+\frac{y}{4}} = 10$

$40 = 30 + \frac{10y}{4}$

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

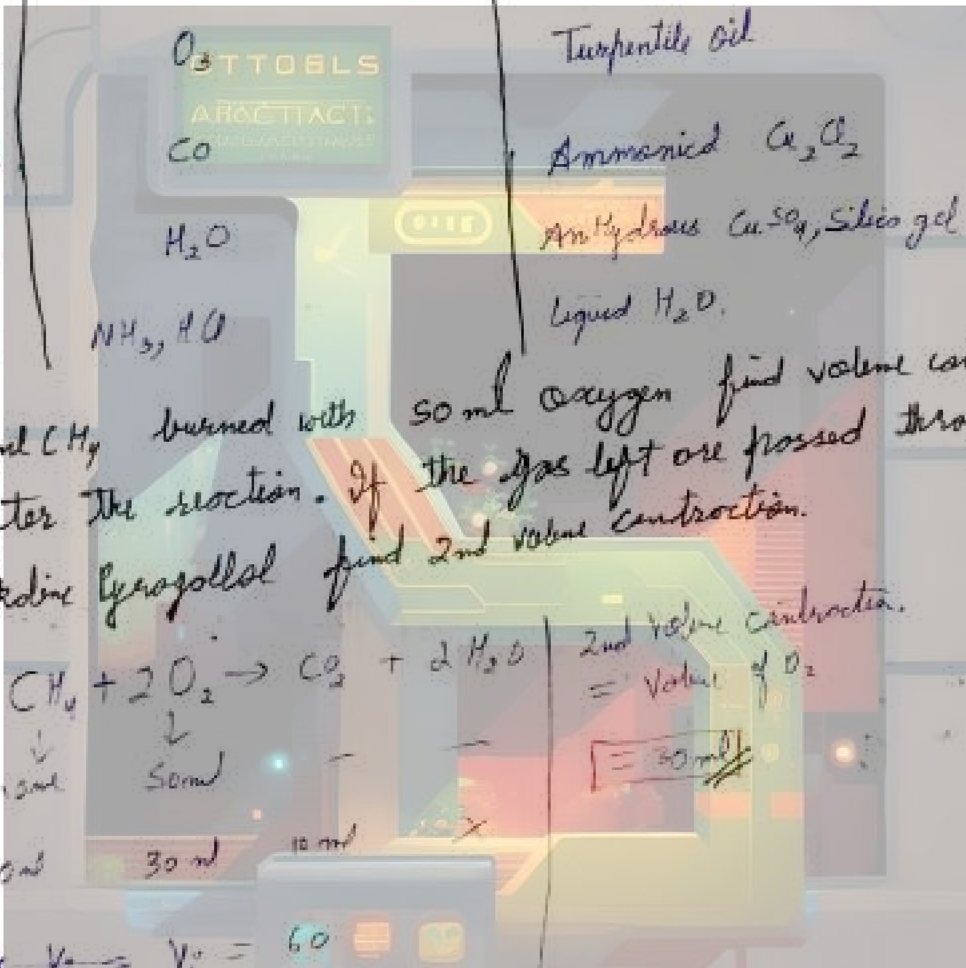
$40 = 10y$

$\boxed{y = 4}$

$\boxed{C_3H_4}$

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 as 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. 10 ml $CH_4$ burned with 50 ml oxygen find volume contraction after the reaction. If the gas left are passed through Alkaline Pyrogallol find 2nd volume contraction.

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

| | $CH_4$ | $O_2$ | $CO_2$ | $H_2O$ |
|---|---|---|---|---|
| initial | 10 ml | 50 ml | – | – |
| final | 0 ml | 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 $O_2$ gave the remaining gas after reaction occupies of 70 ml. Then volume becomes 50 ml on passing through KOH sol.. find $C_xH_y$ formula

$$C_xH_y + \left(x+\frac{y}{4}\right)O_2 \longrightarrow x\,CO_2 + \frac{y}{2}H_2O$$

10 ml    80 ml    ~~30 ml~~ 20 ml

Volume of $CO_2$ = 70 ml − 50 ml = ~~30~~ 20 ml

Volume of $O_2$ = 50 ml (left)

$\frac{20}{x} = 10$

$\boxed{x = 2}$

$\frac{80}{x+\frac{y}{4}} = 10$

$80 = 20 + \frac{10y}{4}$

$y = 4$

$\boxed{y = 4}$

$\boxed{C_2H_4}$

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

$$C_xH_y + \left(x+\frac{y}{4}\right)O_2 \longrightarrow x\,CO_2 + \frac{y}{2}H_2O$$

20 ml    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) notes

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.

$\cancel{CH_4 + C_2H_4 + CO_2 + O_2 \longrightarrow CO_2 + H_2O}$

$CH_4 + CO_2 \longrightarrow C_2H_4$

$C_2H_4 + O_2 \longrightarrow CO_2$

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

$x$ ml   $2x$   $x$ ml

$C_2H_4 + 3O_2 \longrightarrow 2CO_2 + 2H_2O$

$y$ ml   $3y$   $2y$ ml

$x + 2y + z = 14$

$z = 10 - (x+y)$

$x + 2y + 10 - x - y = 14$

$y = 14 - 10$

$\boxed{y = 4 \text{ ml}}$

$V_i = x + 2x + y + 3y + 10 - (x+y)$

$V_f = x + 2y + 10 - x - y$

$V_i - V_f = 17$

$3x + 4y - x - 2y = 17$

$2x + 2y = 17$

$2x = 9$

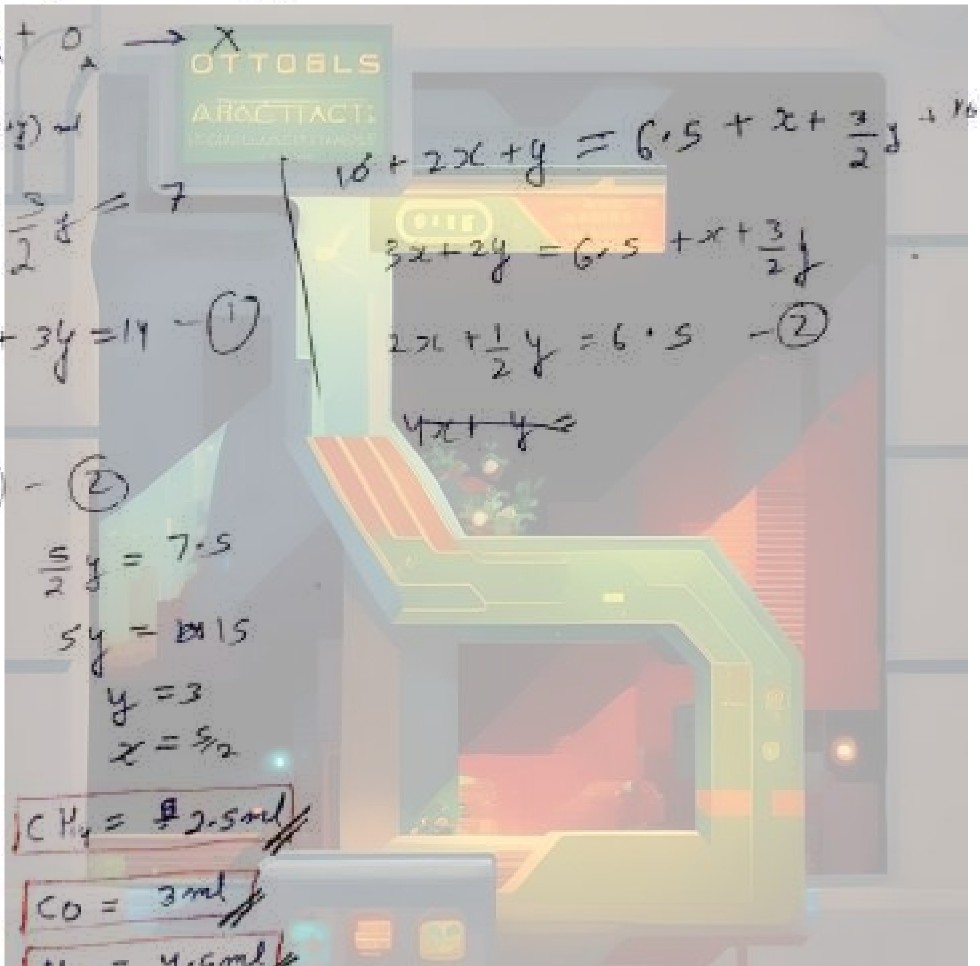
$\boxed{x = 4.5}$

Volume of $CH_4 = x = \boxed{4.5 \text{ ml}}$

Q120. 10ml mixture of $CH_4$, CO, $N_2$ exploded with $O_2$. first vol contraction was observed 6.5ml & the remaining gases passes through KOH sol. so another 7ml vol contraction. find the Vol of $CH_4$, CO & $N_2$ in the mixture.

$$\underset{x\,ml}{CH_4} + \underset{2x\,ml}{2O_2} \rightarrow \underset{x\,ml}{CO_2} + 2H_2O$$

$$\underset{y\,ml}{CO} + \underset{y\,ml}{O_2} \rightarrow \underset{\frac{3}{2}y\,ml}{\frac{3}{2}CO_2}$$



$$\underset{10-(x+y)\,ml}{N_2} + O_2 \rightarrow \times$$

$$10 + 2x + y = 6.5 + x + \frac{3}{2}y + 10 - (x+y)$$

$$x + \frac{3}{2}y = 7$$

$$3x + 2y = 6.5 + x + \frac{3}{2}y$$

$$2x + 3y = 14 \quad -①$$

$$2x + \frac{1}{2}y = 6.5 \quad -②$$

~~$4x + y =$~~

① - ②

$$\frac{5}{2}y = 7.5$$

$$5y = 15$$

$$y = 3$$

$$x = 5/2$$

$\boxed{CH_4 = 2.5ml}$

$\boxed{CO = 3ml}$

$\boxed{N_2 = 4.5ml}$

94

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Laws of chemical Combination

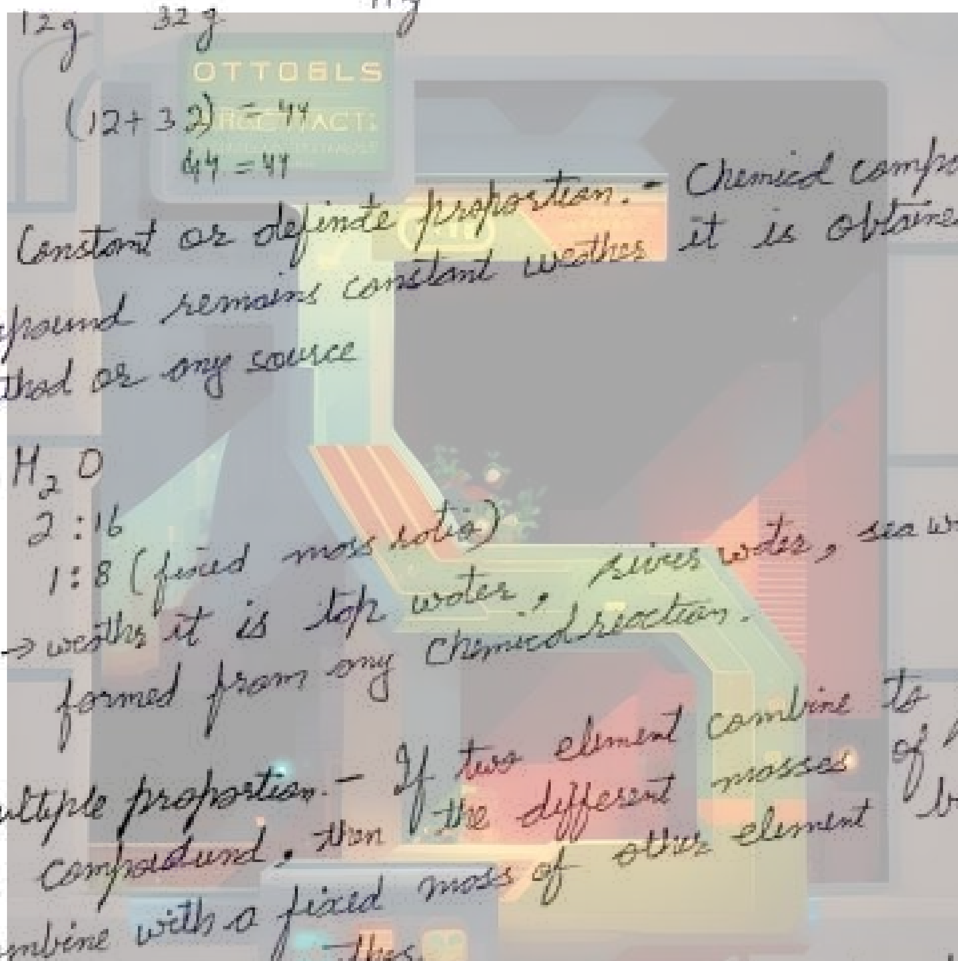
① Law of conservation of mass - In all Physical or chemical process, the total mass of the system remains constant.

[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 weather it is obtained by any method or any source

Eg. $H_2O$

2 : 16

1 : 8 (fixed mass ratio)

→ weather 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 compound.

| CO | $CO_2$ |
|---|---|
| 12 : 16 | 12 : 32 |
| 3 : 4 | 3 : 8 |

(1) Law of gaseous ~~vol~~ 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 & ~~te~~ temp.

Eg $N_{2(g)} + 3H_{2}(g) \longrightarrow 2NH_{3(g)}$ } at same Temp & Pressure

1 vol + 3 vol $\longrightarrow$ 2 vol


OTTOBLS
ARACTTACT:


OTTOBLS
ARACTTACT:


OTTOBLS
ARGCTTACT:

# ☆ Concentration Terms ☆

Solution → A solution is a homogenous mixture (uniform composition) of two or more components.

Homogenous Mixture → Uniform composition throughout the mixture

eg. $H_2O$ + Salt
$H_2O$ + Sugar
$H_2O$ + Alcohol

components of Solution – The substance that make up a ~~s~~ homogenous mixture of solution is called components of solution.

→ There are two types of components
① solvent
② Solute

→ ① Solvent – The component of solution that dissolves the other components is called solvent.

→ ② Solute – The component of solution which dissolve in solution is called solute.

| no. of components | components | name |
|---|---|---|
| 2 | 1 solute + 1 solvent | Binary solution |
| 3 | 2 solute + ~~1~~ 1 solvent | Ternary solution |
| 4 | 3 solute + 1 solvent | Quadnary Solution |

Case 1 –

| | | | |
|---|---|---|---|
| $Sugar_{(s)}$ + | $H_2O_{(l)}$ | $Sugar_{(s)}$ + | $H_2O_{(l)}$ |
| 50g | 100g | 100g | 50g |
| solute | Solvent | Solute | Solvent |

→ Here the two phase that are mixed, are different, hence the phase of the final solution decide the solvent.

Case 2:-

$Alcohol_{(l)} + H_2O_{(l)}$

100 g    50 g

Solvent    Solute

$Alcohol_{(l)} + H_2O_{(l)}$

50 g    100 g

Solute    Solvent

→ For the two components in the same phase, Hence the component in 'larger amount is the solvent.'

Concentration Terms :-

① $\%\left(\frac{w}{W}\right)$ or % mass → Percentage mass of solute wrt mass of solution

① $$\boxed{\%\left(\frac{w}{W}\right) = \frac{\text{wt of solute}}{\text{wt of solution}} \times 100}$$

wt of solution = wt of solute + wt of solvent

eg. ① 10% $\left(\frac{w}{W}\right)$ of NaCl solⁿ → 100g of solⁿ contains 10g NaCl

② 15% $\left(\frac{w}{W}\right)$ of NaOH solⁿ → 100g of solⁿ contains 15g NaOH

↳ mass of solⁿ = 100 g

mass of solute (NaOH) = 15 g

mass of solvent = 100 − 15

= 85 g

→ This is Temp independent term

Q1. 10g NaOH is present in 100g solvent $H_2O$ find $\%\frac{w}{W}$

mass of solⁿ = 100+10 = 110 g

$\%\frac{w}{W} = \frac{10}{110} \times 100 = \frac{100}{11} = \boxed{9.09\%}$

② $\% \frac{w}{v}$

② $\boxed{\% \frac{w}{v} = \frac{\text{wt of solute (g)}}{\text{Vol of Sol}^n \text{(ml)}} \times 100}$

Eg. $10\% \frac{w}{v}$ NaOH(aq) Sol$^n$

10 g NaOH in 100 ml Sol$^n$

Eg. $x\% \frac{w}{v}$ solute solution

100 ml Sol$^n$ contain $x$ g solute.

→ It is Temp. Dependent.

# Rel. b/w $\% \frac{w}{v}$ & $\% \frac{w}{w}$

$$\% \frac{w}{v} = \frac{\text{wt of solute (g)}}{\text{Vol of Sol}^n \text{(ml)}} \times 100 \longrightarrow ①$$

$$\% \frac{w}{w} = \frac{\text{wt of solute (g)}}{\text{wt of sol}^n \text{(g)}} \times 100 \longrightarrow ②$$

① ÷ ②

$$\frac{\% \frac{w}{v}}{\% \frac{w}{w}} = \frac{\text{wt of sol}^n \text{(g)}}{\text{Vol of sol}^n \text{(ml)}}$$

③ $\boxed{\% \frac{w}{v} = \% \frac{w}{w} \times \text{Density}_{sol^n} \text{(in g/ml)}}$

Q2. The concentration of solution is $8\% \frac{w}{w}$ and $10\% \frac{w}{v}$ calculate density of the solution.

M-I

$$\text{Density} = \frac{\% \frac{w}{v}}{\% \frac{w}{w}}$$

$$= \frac{10}{8} \text{ g/ml}$$

$\boxed{= 1.25 \text{ g/ml}}$

M-II

let density = d

$10\% \frac{w}{v} \Rightarrow 10$ g solute in 100 ml Sol$^n$

$d = \frac{m}{100}$

$m = 100\,d$

$\% \frac{w}{w} = 8 = \frac{10}{100d} \times 100$

$d = \frac{10}{8}$

$\boxed{d = 1.25 \text{ g/ml}}$

Q3. density $= 1.05\,g/ml$, $\%\frac{w}{v}$ find if $\%\frac{w}{w} = 10$

(M I)

$\%\frac{w}{w} = 10\% \Rightarrow$ 10 g solute in 100 g Solⁿ

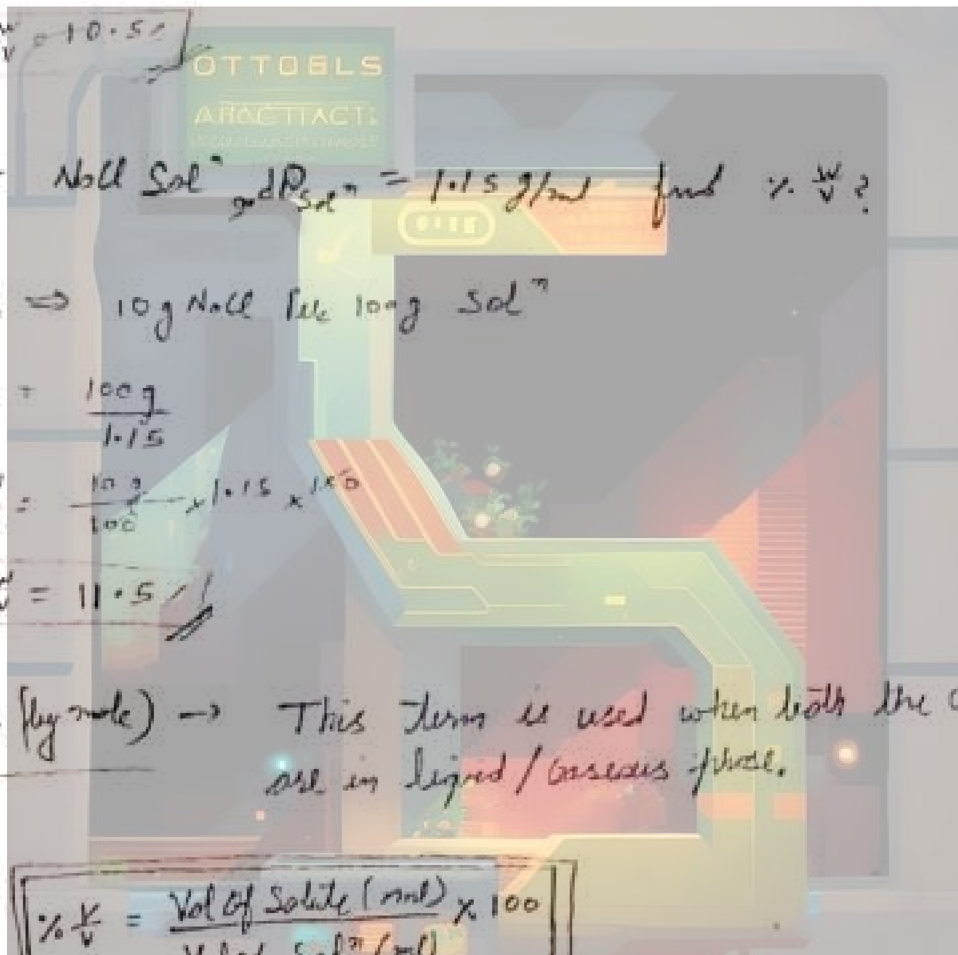
$\text{Volume} = \frac{100}{1.05}$

$\%\frac{w}{v} = \frac{10}{100} \times 1.05 \times 100 = \boxed{10.5\,\%}$

(M II) $\%\frac{w}{v} = \%\frac{w}{w} \times \text{Density}$

$\%\frac{w}{v} = 10 \times 1.05$

$\boxed{\%\frac{w}{v} = 10.5\%}$



Q4. $10\%\frac{w}{w}$ NaCl Solⁿ and $D_{sol^n} = 1.15\,g/ml$ find $\%\frac{w}{v}$?

$10\%\frac{w}{w} \Rightarrow$ 10 g NaCl per 100 g solⁿ

$\text{Vol} = \frac{100\,g}{1.15}$

$\%\frac{w}{v} = \frac{10\,g}{100} \times 1.15 \times 100$

$\boxed{\%\frac{w}{v} = 11.5\,\%}$

(3) $\%\frac{V}{V}$ or % (by mole) → This term is used when both the components are in liquid / gaseous phase.

(4) $$\boxed{\%\frac{V}{V} = \frac{\text{Vol of Solute (ml)}}{\text{Vol of Sol}^n\text{ (ml)}} \times 100}$$

eg. $10\%\frac{V}{V}$ Ethanol aq Solⁿ

→ 100 ml solⁿ contains 10 ml $C_2H_5OH$ (Ethanol)

→ Temp dependent term

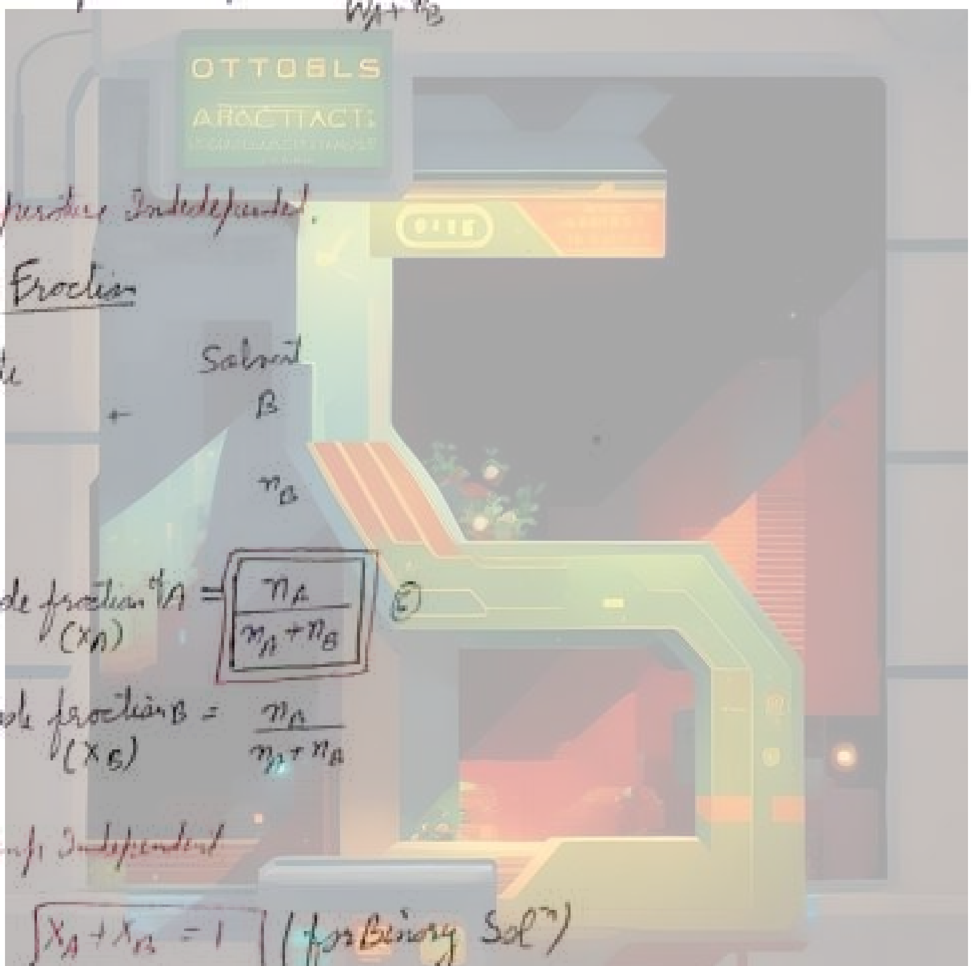
## (4) Mass fraction

A → $W_A$ → Solute

B → $W_B$ → Solvent

$$\text{mass fraction of } A = \frac{\text{mass } A}{\text{Total}} = \boxed{\frac{W_A}{W_A + W_B}}$$ (5)

$$\text{mass fraction of } B = \frac{W_B}{W_A + W_B}$$



→ Temperature Indedependent.

## (5) Mole Fraction

Solute A → $n_A$

Solvent B → $n_B$

$$\text{mole fraction of } A \ (X_A) = \boxed{\frac{n_A}{n_A + n_B}}$$ (6)

$$\text{mole fraction } B \ (X_B) = \frac{n_B}{n_A + n_B}$$

→ Temp. Independent

$\boxed{X_A + X_B = 1}$ (for Binary Solⁿ)

$\Sigma x_i = 1$ (always)

Q 5. Given $CO_2 = 44g$, $H_2 = 6g$, $N_2 = 56g$ find mole fraction each.

$\downarrow$ 1 mol $\quad \downarrow$ 3 mol $\quad \downarrow$ 2 mol

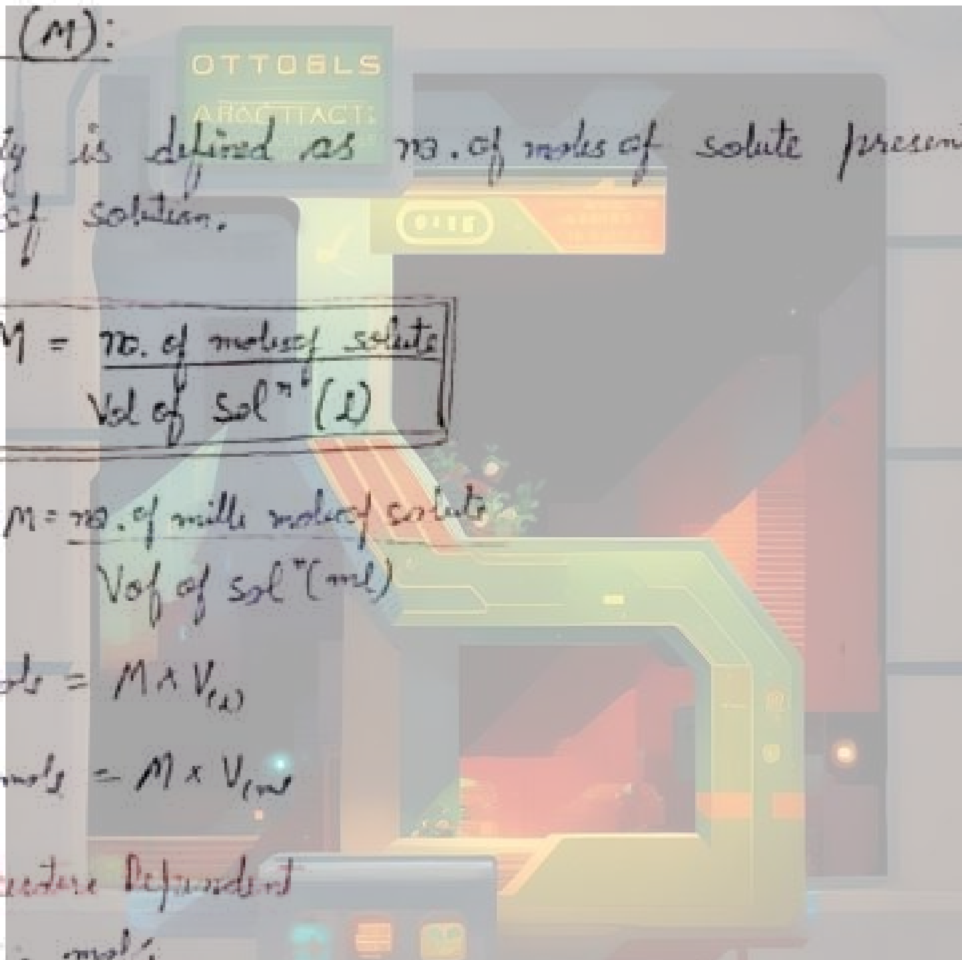
Total $n = 1 + 3 + 2 = 6$ mol

mole fraction $CO_2$ = $\boxed{X_{CO_2} = \frac{1}{6}}$

$\boxed{X_{N_2} = \frac{1}{2}}$

$\boxed{X_{H_2} = \frac{1}{3}}$

## ⑥ Molarity (M):



→ Molarity is defined as no. of moles of solute present in per liter of solution.

① $$\boxed{M = \frac{\text{no. of moles of solute}}{\text{Vol of sol}^n (l)}}$$

$$M = \frac{\text{no. of milli moles of solute}}{\text{Vol of sol}^n (ml)}$$

→ moles $= M \times V_{(l)}$

→ m. mole $= M \times V_{(ml)}$

→ Temperature Dependent

→ Unit - mol/l

eg 1. 3M NaOH ⇒ 3 Molar NaOH

⇒ 3 moles of NaOH is present in 1 l of sol$^n$

eg 2. 5M $H_2SO_4$ aq. soln

⇒ 1 lit Soln contain 5 mole of $H_2SO_4$

Note Molar Solution ⇒ M = 1 → Molarity = 1

Semi Molar Solⁿ → $M = 1/2$

Deci Molar Solⁿ → $M = \frac{1}{10}$

Centi Molar Solⁿ ⇒ $M = \frac{1}{100}$

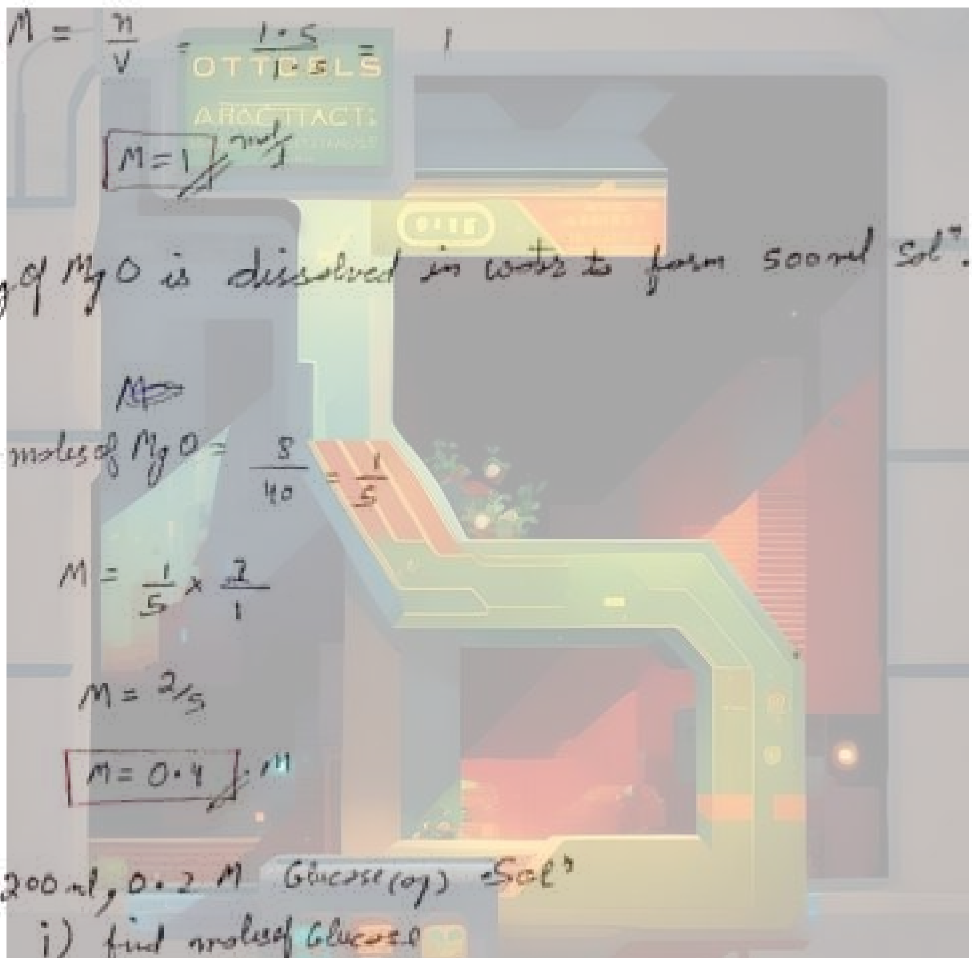
Q6. $n_{NaCl} = 1.5$

$V_{sol^n} = 1500$ ml

~~Morlarity~~ Molarity = ?

$M = \frac{n}{V} = \frac{1.5}{1.5} = 1$

$\boxed{M = 1}$ mol/L



Q7. 8g of MgO is dissolved in water to form 500ml Solⁿ. find M.

moles of MgO = $\frac{8}{40} = \frac{1}{5}$

$M = \frac{1}{5} \times \frac{2}{1}$

$M = 2/5$

$\boxed{M = 0.4}$ M

Q8. 200 ml, 0.2 M Glucose(aq) Solⁿ

i) find moles of Glucose

ii) no. of C-atom

i) $0.2 = \frac{n}{0.2}$

$\boxed{n = 0.04 \text{ moles}}$ i)

ii) no of C = $0.24 \times 6.022 \times 10^{23}$

$\boxed{= 1.44528 \times 10^{23}}$ ii)

Q9. 5.85g NaCl & 11.1 g $CaCl_2$ to form 600 ml Solⁿ in water.

i) Find Molarity

ii) find $CaCl_2$ molarity.

$n_{NaCl} = \frac{5.85}{58.5} = 0.1$ mol

$n_{CaCl_2} = 0.1$ mol

$n = 0.2$ mol

i) $M = \frac{0.2}{0.6} = \frac{1}{3}$

$\boxed{M = 0.33...}$ i) M

ii) $M_{CaCl_2} = \frac{0.1}{0.6} = 0.166..$

A=0

$\boxed{M_{CaCl_2} = 0.166...}$ ii) M

Q10. ~~10~~ 18g $C_6H_{12}O_{6(s)}$ is dissolved in $H_2O$. Find Solⁿ have Value of 100ml find Molarity of Solⁿ.

$n = \frac{18}{180} = 0.1$

$M = \frac{0.1}{0.1}$

$\boxed{M = 1 \text{ mol}/l}$

Q11. 58.5g NaCl dissolved in 741.5g $H_2O$ to Yield sol of density 1g/ml find molarity of sol

Molarity $= \frac{1 \text{ mol}}{0.8 l}$ → Yield mass of solⁿ & Density given

$= \frac{10}{8}$

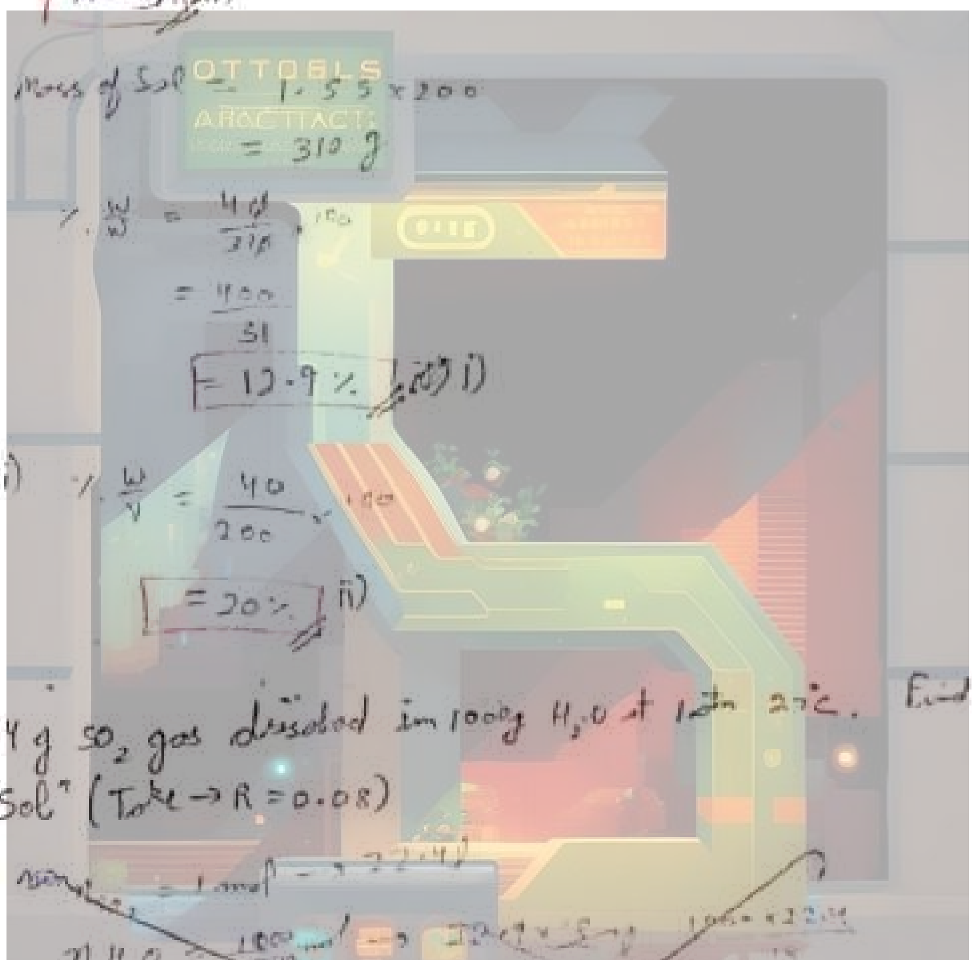
$\boxed{= 1.25M}$

Q12. 40g $MgO_{(s)}$ is dissolved in $H_2O$ to form 200 ml sol$^n$ given
$d_{sol^n} = 1.55$ g/ml
i) $\% \frac{w}{w}$ ii) $\% \frac{w}{v}$ iii) M

i) Moles $MgO = \frac{40}{40} = 1$ mol

$M = \frac{1}{0.2} = \frac{10}{2}$

$\boxed{M = 5M}$ (iii)



i) Mass of Sol$^n$ $= 1.55 \times 200$
$= 310$ g

$\% \frac{w}{w} = \frac{40}{310} \times 100$
$= \frac{400}{31}$
$\boxed{= 12.9\%}$ (i)

iii) $\% \frac{w}{v} = \frac{40}{200} \times 100$
$\boxed{= 20\%}$ (ii)

Q13. 64 g $SO_2$ gas dissolved in 1000g $H_2O$ at 1 atm 27°C. Find molarity of sol$^n$ (Take → R = 0.08)

~~$n_{SO_2} = 1$ mol $\rightarrow 22.4$ l~~
~~$n_{H_2O} = \frac{1000}{18}$ mol $\rightarrow \frac{1000 \times 22.4}{18}$~~

~~Vol Sol$^n$ $= \frac{22400 + 403.2}{1000}$~~ ~~Vol Sol$^n$ $= \frac{403.2 + 22400}{18}$~~
~~$= \frac{22803.2}{1000}$~~ ~~$= \frac{22803.2}{18}$~~

~~$M = \frac{1000}{22803.2}$~~ ~~$M = \frac{18}{22803.2}$~~

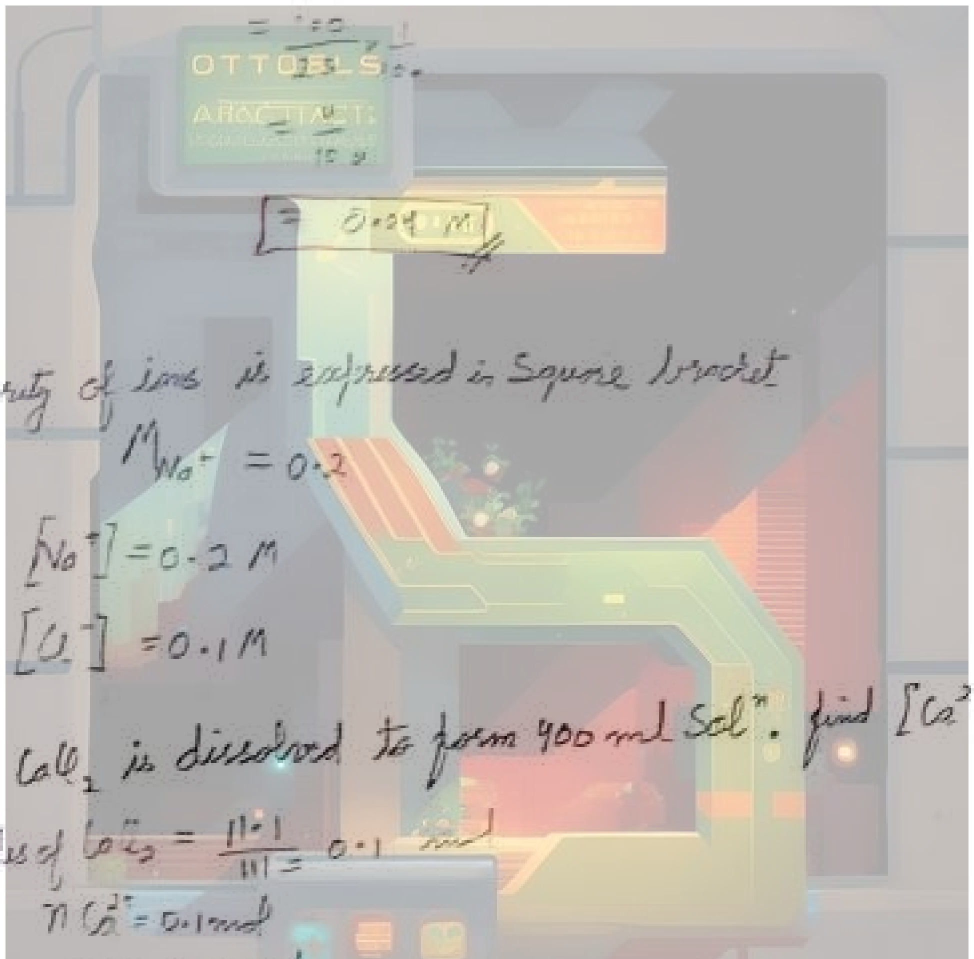
Ans 13.

$n_{SO_2} \to 1$ mol $\to$ 22.4 l = 24 l

$n_{H_2O} \to V_{H_2O} = 1$ l

$$M = \frac{1}{1 + 22.4 \approx 24 l}$$

$$= \frac{1}{23.4} = \frac{10}{234} \qquad = \frac{1}{1+24} = \frac{1}{25}$$



$$= \frac{100}{25} \times \frac{1}{100}$$

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

$$\boxed{= 0.04\ M}$$

Note:- Molarity of ions is expressed in Square bracket

$M_{Na^+} = 0.2$

eg. $[Na^+] = 0.2\ M$

$[Cl^-] = 0.1\ M$

Q14. 11.1 g $CaCl_2$ is dissolved to form 400 ml Soln. find $[Ca^{2+}]$ & $[Cl^-]$

moles of $CaCl_2 = \frac{11.1}{111} = 0.1$ mol

$n_{Ca^{2+}} = 0.1$ mol

$n_{Cl^-} = 0.2$ mol

$$[Ca^{2+}] = \frac{0.1}{0.4} = \boxed{0.25\ M}$$

$$[Cl^-] = \frac{0.2}{0.4} = \boxed{0.5\ M}$$

Q15. 100 ml, 0.1 Molar $AlCl_3$ Solⁿ. find $Cl^-$ ion moles.

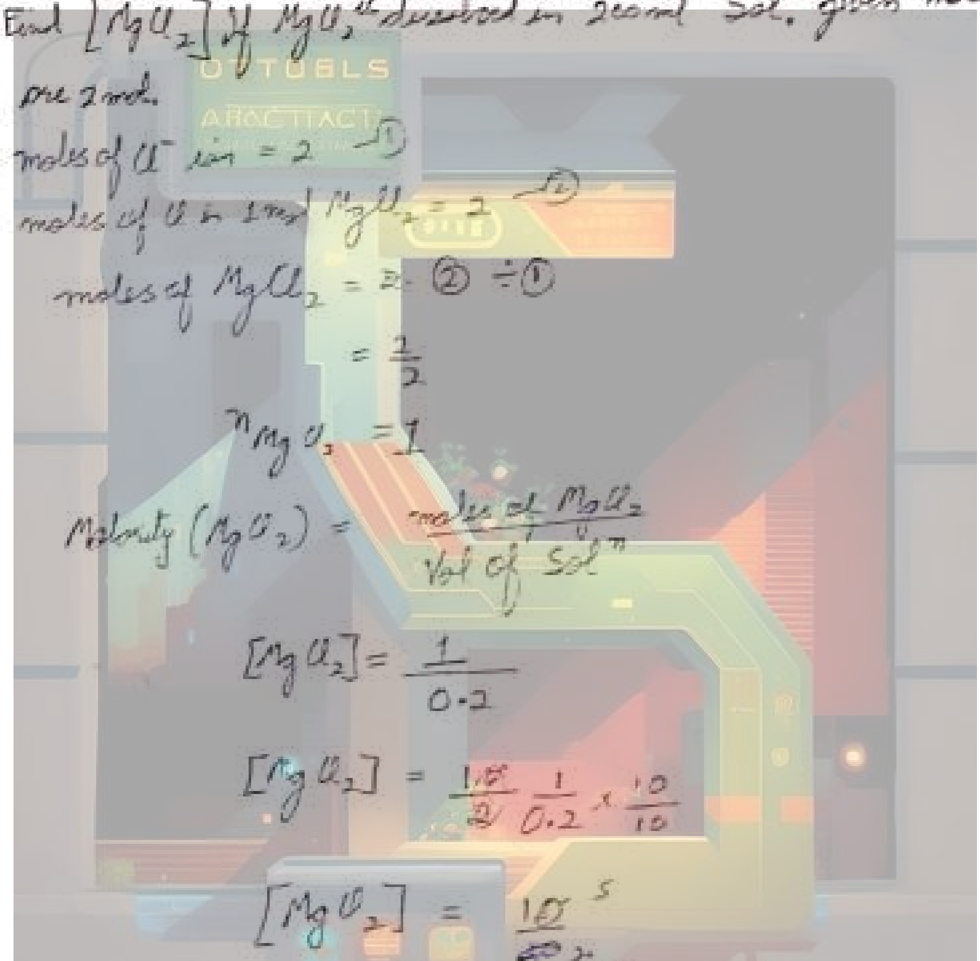
$$0.1 = \frac{n_{AlCl_3}}{0.1}$$

$$0.01 = n_{AlCl_3}$$

$$n_{Cl^-} = 0.01 \times 3$$

$$\boxed{= 0.03 \text{ mol}}$$

Q16. Find $[MgCl_2]$ if $MgCl_2$ dissolved in 200ml Solⁿ given moles of $Cl^-$ ion are 2 mol.



moles of $Cl^-$ ion $= 2$ —(1)

moles of Cl in 1 mol $MgCl_2 = 2$ —(2)

moles of $MgCl_2 = 2$ — (2) ÷ (1)

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

$$n_{MgCl_2} = 1$$

$$\text{Molarity } (MgCl_2) = \frac{\text{moles of } MgCl_2}{\text{Vol of Sol}^n}$$

$$[MgCl_2] = \frac{1}{0.2}$$

$$[MgCl_2] = \cancel{\frac{10}{2}} \frac{1}{0.2} \times \frac{10}{10}$$

$$[MgCl_2] = \frac{\cancel{10}^{5}}{\cancel{2}}$$

$$\boxed{[MgCl_2] = 5M}$$

# Relation btw $\% \frac{w}{v}$ & $M$

$\% \frac{w}{v} = x \qquad M = ?$

$\downarrow$

$100\,ml\ sol^n = x\,g$ solute

mass of solute $= x\,g$

moles of solute $= \frac{x}{M \cdot M_{(solute)}}$

Vol of Sol$^n$ $= 100\,ml$

$= 0.1\,l$

$M = \frac{\text{moles of Solute}}{Vol^n\,(l)}$

$M = \frac{\% \frac{w}{v}}{M \cdot M_{(solute)}} \times \frac{1}{0.1}$

(8) $\boxed{M = \frac{\% \frac{w}{v} \times 10}{(M \cdot M)_{solute}}}$

# Relation btw $\% \frac{w}{w}$ & $M$

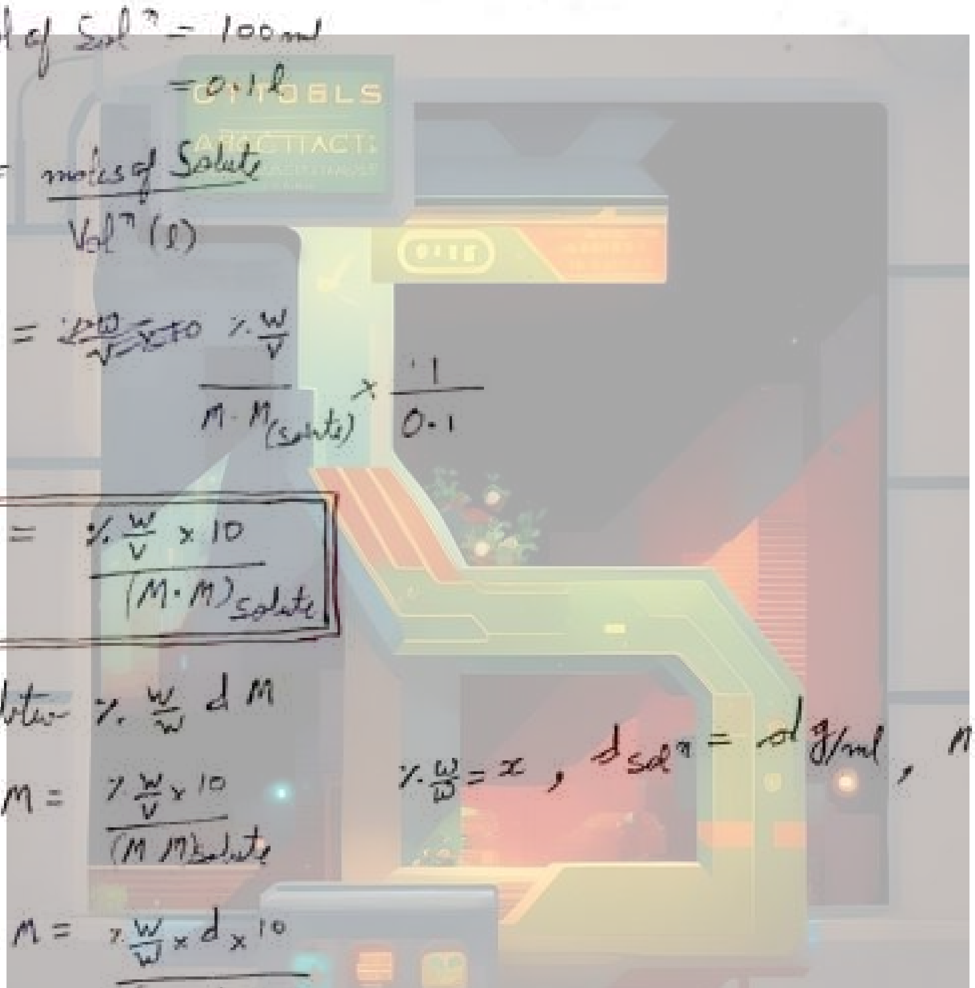
$\% \frac{w}{w} = x, \quad d_{sol^n} = d\ g/ml, \quad M = ?$

M13

$M = \frac{\% \frac{w}{v} \times 10}{(M\,M)_{solute}}$

$M = \frac{\% \frac{w}{w} \times d \times 10}{(M \cdot M)_{solute}}$

(9) $\boxed{M = \frac{\% \frac{w}{w} \times 10d}{(M \cdot M)_{solute}}}$



M II

100 g Sol$^n$ contains $x$ g solute

$$\text{moles of Solute} = \frac{x}{(M\cdot M)_{solute}}$$

$$\text{Vol}^n \text{ of Sol} = \frac{\text{mass}}{\text{density}}$$

$$= \frac{100}{d}\ ml$$

$$= \frac{100}{d \times 1000}\ l$$

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

$$\text{Molarity} = \frac{\text{moles of solute (g)}}{\text{Vol}^n \text{ of Sol}^n (l)}$$

$$= \frac{x}{(M\cdot M)_{solute}} \times \frac{1}{\frac{1}{10d}}$$

$$= \frac{x \times 10d}{(M\cdot M)_{solute}}$$

$$\boxed{M = \frac{\%\frac{w}{w} \times 10d}{(M\cdot M)_{solute}}}$$

Q17. 10% $\frac{w}{w}$ glucose of sol$^n$, $d_{sol^n} = 1\cdot2$ g/ml. Find molarity & mole fraction of the solute.

$$M = \frac{10 \times 1\cdot2 \times 10}{180}$$

$$M = \frac{120}{180}$$

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

$$\boxed{M = 0\cdot66}$$

$$\text{mole fraction} = \frac{\text{mole of solute}}{\text{mole of sol}^n}$$

$$\text{mole of Solute} = \frac{10x}{180}$$

$$\text{mole of Solution} = \frac{100x}{M\cdot M}$$

## (7) Molality :- (m)

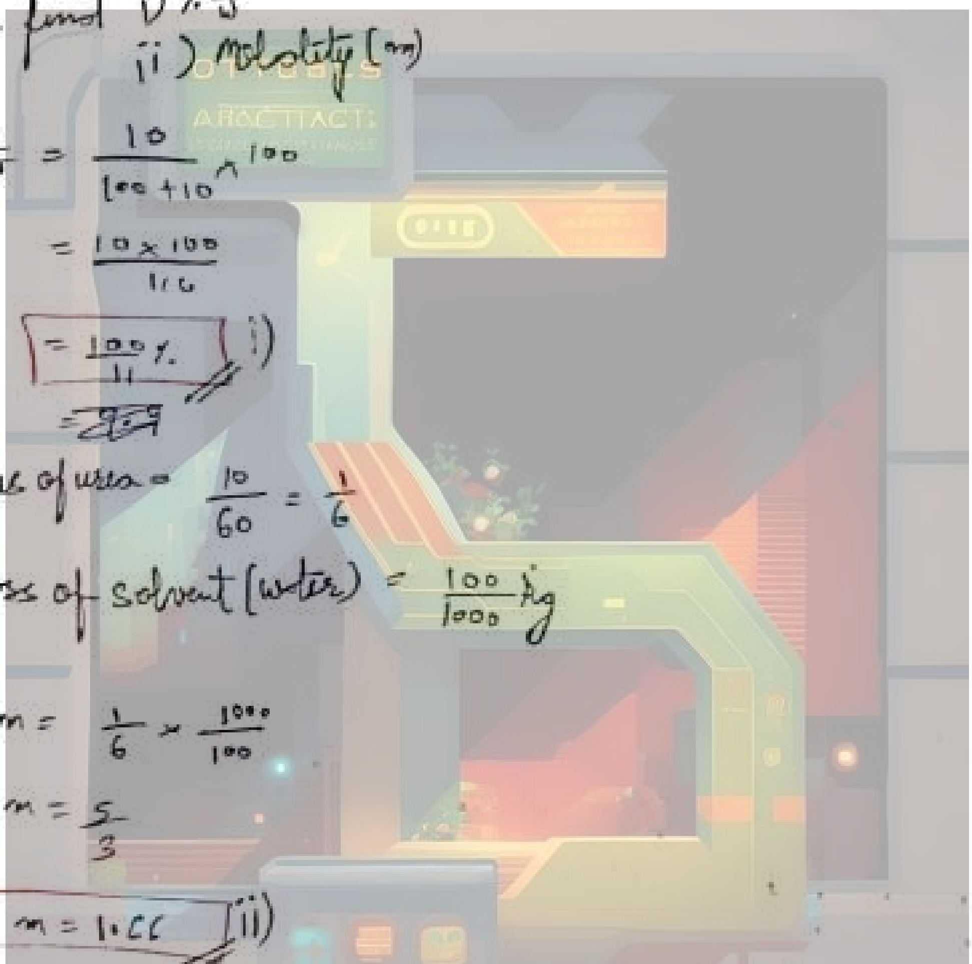
→ It is defined as the moles of solute per kg of solvent.

(10) $$\boxed{m = \frac{\text{moles of solute}}{\text{mass of solvent (kg)}}}$$

→ It is temperature independent.

Q18. 10 g urea ($NH_2CONH_2$) is dissolved in 100 g water to form a solⁿ. find i) % $\frac{w}{w}$

ii) Molality (m)



i) $\% \frac{w}{w} = \frac{10}{100+10} \times 100$

$= \frac{10 \times 100}{110}$

$\boxed{= \frac{100}{11} \%}$ (i)

$= \cancel{9.09}$

ii) moles of urea $= \frac{10}{60} = \frac{1}{6}$

mass of solvent (water) $= \frac{100}{1000}$ kg

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

$m = \frac{5}{3}$

$\boxed{m = 1.66}$ (ii)

Q19. find the molality of 10% $\frac{w}{w}$ aqueous glucose solⁿ.

↓

10 g glucose in 100 g solⁿ

mass of glucose = 10 g

moles of glucose $= \frac{10}{180} = \frac{1}{18}$ mol

mass of water/solvent $= \frac{90}{1000}$ kg

$m = \frac{1}{18} \times \frac{1000}{90} \Rightarrow \boxed{m = \frac{50}{81}}$

Q20. If an aqueous sol$^n$ of NaOH is 20%. Mass calculate its molality.

mass of NaOH = 20 g

moles = $\frac{1}{2}$ mol

mass of solvent = $\frac{80}{1000}$ kg

$m = \frac{1}{2} \times \frac{1000}{80}$

$m = \frac{100}{16}$

$\boxed{m = \frac{25}{4} \text{ molal}}$

Q 21. Density of 4 m HF sol$^n$ is 0.8 g/ml find conc$^n$ in diff ways.

i) % $\frac{w}{w}$  ii) M  iii) $x_{solute}$ (mole ~~mass~~ fraction)

i) ~~mass of HF =~~

moles of HF = 4 mol

mass of water = 1000 g

mass of HF = $4 \times 20$

= 80

$\% \frac{w}{w} = \frac{80}{1080} \times 100$

$\boxed{\% \frac{w}{w} = \frac{800}{108} \%}$ i)

ii) vol of water = $\frac{1080}{0.8} = \frac{10800}{8}$ ml

$M = \frac{4 \times 8}{10800} \times 1000$

$\boxed{M = \frac{80}{27} M}$ ii)

~~iii) mass of HF = 80~~

~~mass of $H_2O$ = 1000 g~~

iii) moles of HF = 4

moles of $H_2O$ = $\frac{1000}{18}$

moles of sol$^n$ = $\frac{1000}{18} + 4$

$= \frac{1072}{18}$ mol

$\boxed{x_{solute} = \frac{4 \times 18}{1072}}$ iii)

Conversion of various concentration terms :-

(1) relation b/w molality & molarity

given :- Molarity = M

$Density_{sol^n} = d\ g/ml$

Molecular wt of solute ⇒ $(M\cdot w)_{solute}$

moles of solute = M

vol of $sol^n$ = 1 l = 1000 ml

mass of $sol^n$ = 1000 d g

mass of solute = M (M·w)

mass of solvent = 1000d − M (M·w)solute

(ii) $$\boxed{m = \frac{1000\,M}{1000d - M(M\cdot w)_{solute}}}$$

Q22. what volume (ml) of 0.2 M KOH is required to react with 0.98 g $H_3PO_4$

$$3KOH + H_3PO_4 \longrightarrow K_3PO_4 + 3H_2O$$

$H_3PO_4$: 0.98 g → 1/100 mol

$$Vol = \frac{1}{100} \times \frac{1}{0.2} \times 3$$

$$Vol = \frac{3}{20}\ l$$

$$\boxed{Vol = 150\ ml}$$

Q23. How many grams of NaOH must be dissolved in $H_2O$ to form 400 ml ~~sol~~ & 2M $Sol^n$?

$Vol = 400\ ml = 0.4\ l$

$M = 2M$

$n_{NaOH} = 2 \times 0.4$

$n_{NaOH} = 0.8$

mass of NaOH $= 0.8 \times 40$

$\boxed{= 32\ g}$

(2) <u>Relation btw mole fraction & Molarity</u>

given:- mole fraction of solute $= X_{solute}$

mol wt of solute $\Rightarrow (M.w)_{solute}$

mol. wt of solvent $- (M.w)_{solvent}$

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

moles of solute $= x$ mol

moles of solvent $= (1-x)$ mol

mass of $sol^n = (M.w)_{solute} \times x + (M.w)_{solvent} \times (1-x)$

$$Vol\ of\ sol^n = \frac{(M.w)_{solute} \times x + (M.w)_{solvent}(1-x)}{1000\ d}\ l$$

(12) $$\boxed{M = \frac{1000 \times x \times d}{(x \times M.w_{solute}) + ((1-x)(M.w\ solvent))}}$$

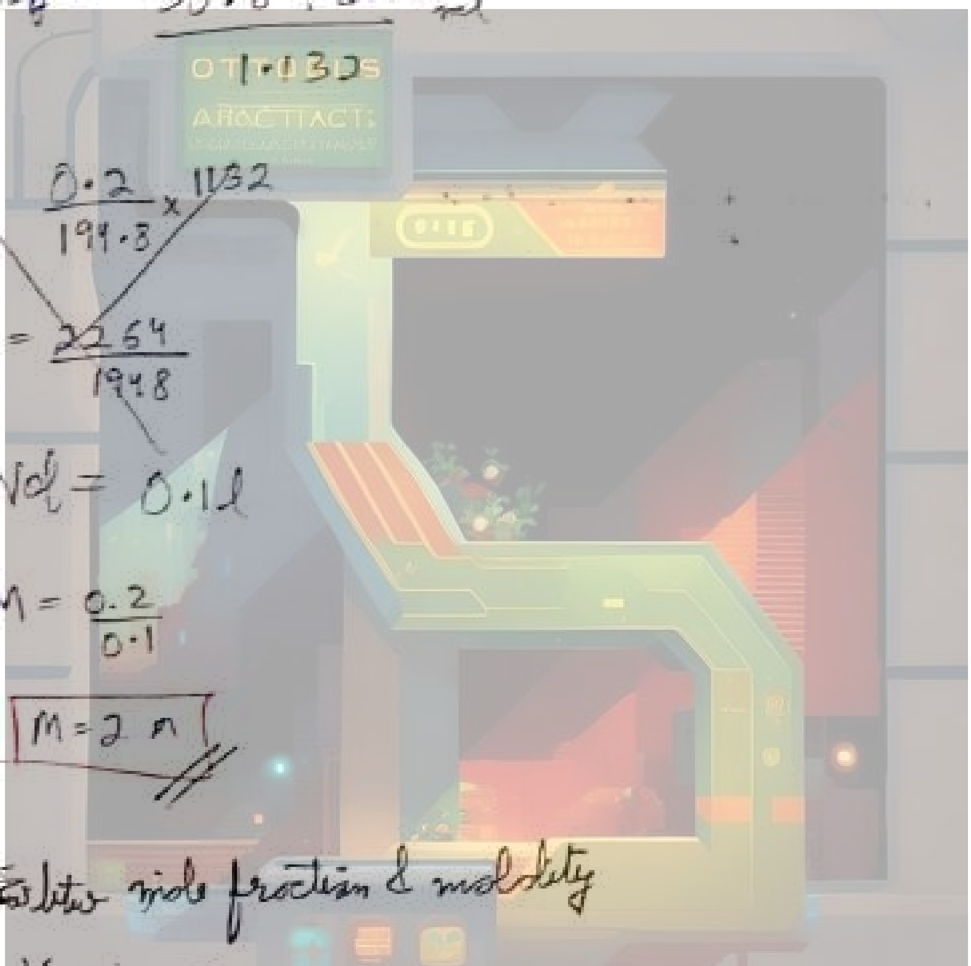
Q21. A solⁿ contains $I_2$ in benzene. The mole fraction of $I_2$ is 0.2. find molarity of solⁿ, if density of solⁿ is 1.132 g/ml

moles of $I_2$ = 0.2

moles of Benzene = 0.8

$$\text{Vol of sol}^n = \frac{(0.2)(254) + (0.8)(78)}{1.132}$$

$$\text{Vol} = \frac{50.8 + (2.4)}{1.132}$$



$$M = \frac{0.2}{194.8} \times 1132$$

$$M = \frac{226.4}{194.8}$$

$$\text{Vol} = 0.1\,l$$

$$M = \frac{0.2}{0.1}$$

$$\boxed{M = 2\,M}$$

(3) Relation between mole fraction & molality

given:- $X_{solute} = x$

moles of solute = $x$

~~mass of solute~~

moles of solvent = $(1-x)$

mass = $(1-x)\,(M.W)_{solvent}$ g

(13) $$\boxed{m = \frac{X_{solute} \times 1000}{(1-x)\,(M.W)_{solvent}}}$$

Q25. mole fraction of solute in its 1m aqueous solution.

1 molal

$$1 = \frac{1000x}{(1-x)(18)}$$

$$18 - 18x = 1000x$$

$$18 = 1018x$$

$$\boxed{x = \frac{18}{1018}}$$

Q26. Calculate molarity of 6.25 molal NaOH aqueous solⁿ ($d_{sol^n} = 1.2\ g/ml$).

moles of NaOH = 6.25

mass of solvent = 1000 g

~~vol of solvent~~

mass of solute = 6.25(40) = 250 g

mass of solⁿ = 1250 g

vol of solⁿ = $\frac{1250}{1.2}$ ml

$$M = \frac{6.25}{1250} \times 1.2 \times 1000$$

$$M = \frac{625 \times 1.2}{125}$$

$$M = 1.2 \times 5$$

$$\boxed{M = 6M}$$

Q27. mole fraction of urea ($NH_2CONH_2$) in aqueous sol$^n$ is 0.02. calculate M & m. ($d_{sol^n} = 0.99\ g/ml$)

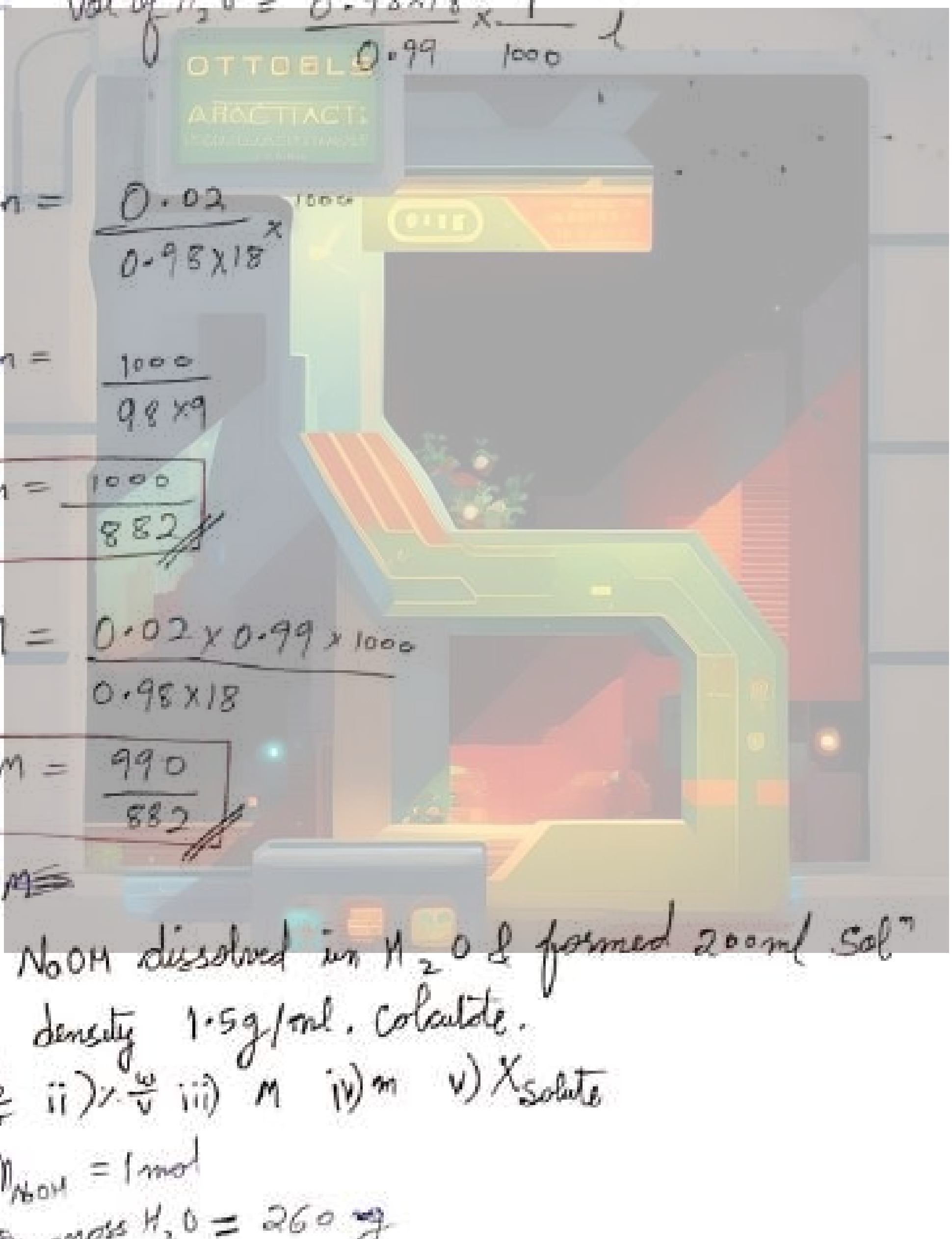
moles of urea = 0.02 mol

moles of $H_2O$ = 0.98 mol

mass of $H_2O$ = $0.98 \times 18$ g

$= \frac{0.98 \times 18}{1000}$ kg

~~Vol of~~ Vol of $H_2O = \frac{0.98 \times 18}{0.99} \times \frac{1}{1000}$ l



$m = \frac{0.02}{0.98 \times 18} \times 1000$

$m = \frac{1000}{98 \times 9}$

$\boxed{m = \frac{1000}{882}}$

$M = \frac{0.02 \times 0.99 \times 1000}{0.98 \times 18}$

$\boxed{M = \frac{990}{882}}$

Q28. 40g NaOH dissolved in $H_2O$ & formed 200ml sol$^n$ having density 1.5g/ml. calculate.

i) % $\frac{w}{w}$ ii) % $\frac{w}{v}$ iii) M iv) m v) $X_{solute}$

$n_{NaOH} = 1$ mol

mass $H_2O = 260$ g

$n_{H_2O} = \frac{260}{18}$

$\% \frac{w}{V} = \frac{40}{200} \times 100$

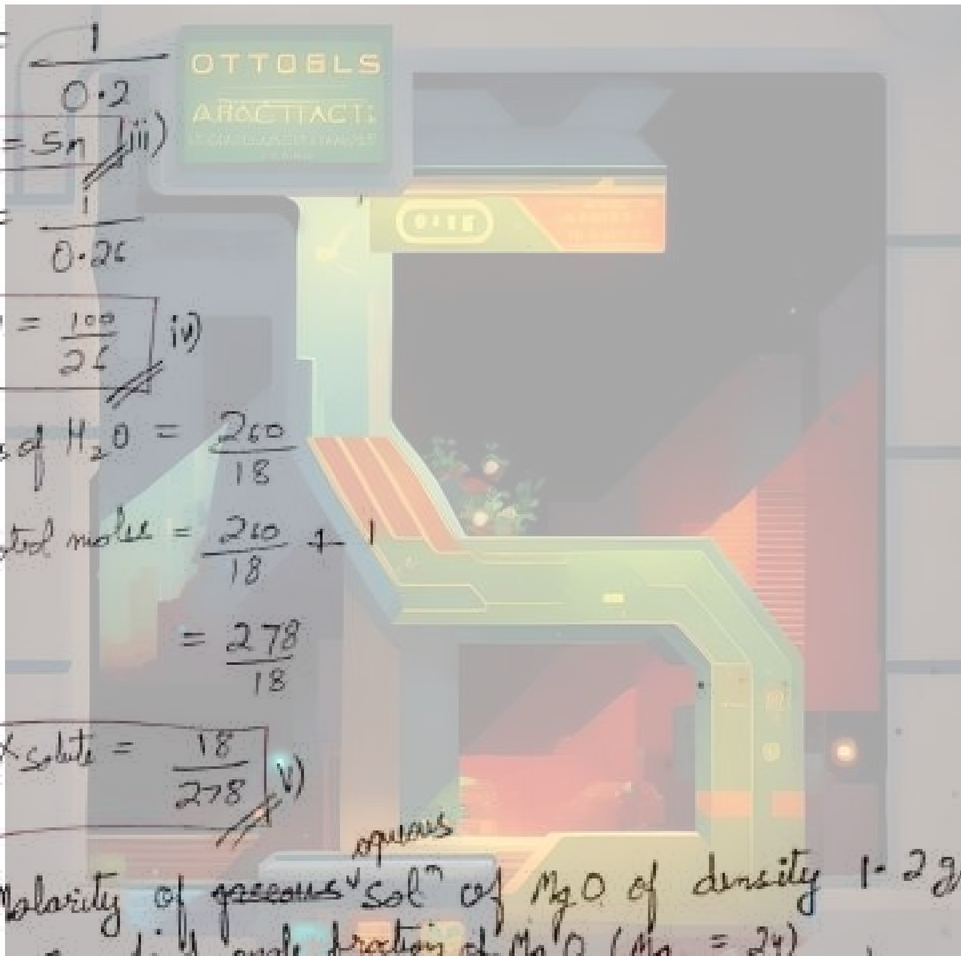
$\boxed{\% \frac{w}{V} = 20\%}$ ii)

$\cancel{\% \frac{w}{w} = \frac{40}{260} \times 100}$

$\cancel{\% \frac{w}{w} = \frac{200}{13}}$

$\% \frac{w}{w} = \frac{40}{300} \times 100$

$\boxed{\% \frac{w}{w} = \frac{40}{3} \%}$ i)



$M = \frac{1}{0.2}$

$\boxed{M = 5M}$ iii)

$m = \frac{1}{0.26}$

$\boxed{m = \frac{100}{26}}$ iv)

moles of $H_2O = \frac{260}{18}$

Total moles $= \frac{260}{18} + 1$

$= \frac{278}{18}$

$\boxed{X_{solute} = \frac{18}{278}}$ v)

Q29. Molarity of ~~gaseous~~ aqueous sol$^n$ of MgO of density 1.2 g/ml is 3M. find mole fraction of MgO. (Mg = 24)

moles of MgO = 3 mol → 72 g

Vol of sol$^n$ = 1 l = 1000 ml

~~moles of sol$^n$~~

mass of sol$^n$ = 1200 g

~~moles — 1200~~

moles $H_2O = \frac{1080}{18}$

$\cancel{X_{solute} = \frac{3}{1125}}$

$X_{solute} = \frac{3}{\frac{1080}{18} + 3}$

$\boxed{X_{solute} = \frac{1}{21}}$

# Parts Per Million (PPM)

→ This concentration term is used for very dilute solⁿ

** For very dilute solⁿ, mass of solvent ≃ mass of solⁿ.

(14) $$\boxed{PPM = \frac{\text{mass of solute}}{\text{mass of solvent / mass of sol}^n} \times 10^6}$$

# Parts Per Billion (PPB)

→ Used for very very. dilute solⁿ.

(15) $$\boxed{PPB = \frac{\text{mass of solute}}{\text{mass of sol}^n\text{ / mass of solvent}} \times 10^9}$$

# Dilution of Solⁿ

→ addition of solvent is called dilution

→ when a solⁿ is diluted, the moles of solute do not change.

→ Molarity of Diluted Solⁿ is less than initial solⁿ

(16) $$\boxed{M_f = \frac{M_i V_i}{V_{added} + V_i}}$$

(Imp) → when vol is increased n times / n folds.

(17) $$\boxed{M_f = M_i \times n}$$

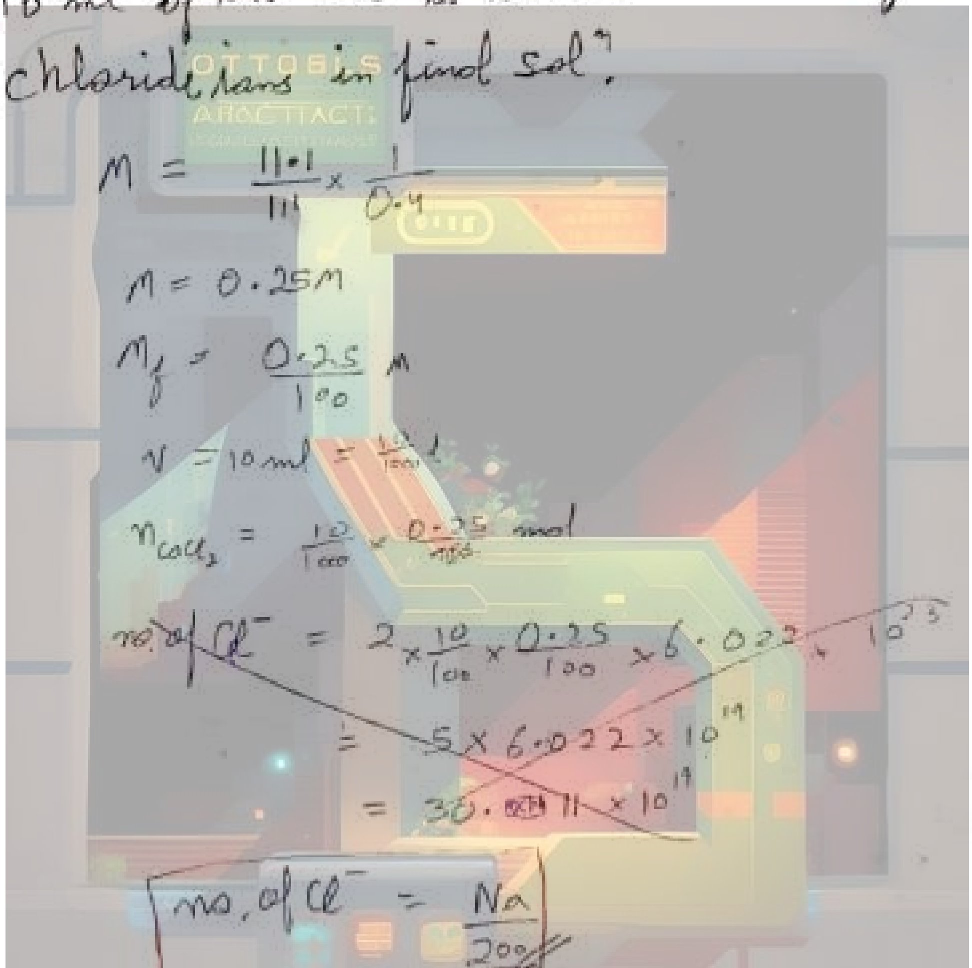
→ If some part of a solⁿ is taken out, its molarity remains same as the stock solⁿ

Q30. A solⁿ of NaOH is 1M, if solⁿ is diluted 100 times. find molarity.

$$M_f = \frac{M_i}{100}$$

$$\boxed{M_f = \frac{1}{100} M}$$

Q31. 11.1g of $CaCl_2$ is dissolved to form a solⁿ of 400ml. 10 ml of this solⁿ is diluted 100 times. find no. of chloride ions in final solⁿ.



$$M = \frac{11.1}{111} \times \frac{1}{0.4}$$

$$M = 0.25M$$

$$M_f = \frac{0.25}{100} M$$

$$V = 10\,ml = \frac{10}{1000} L$$

$$n_{CaCl_2} = \frac{10}{1000} \times \frac{0.25}{100}\ mol$$

$$\text{no. of } Cl^- = 2 \times \frac{10}{100} \times \frac{0.25}{100} \times 6.022 \times 10^{23}$$

$$= 5 \times 6.022 \times 10^{19}$$

$$= 30.11 \times 10^{19}$$

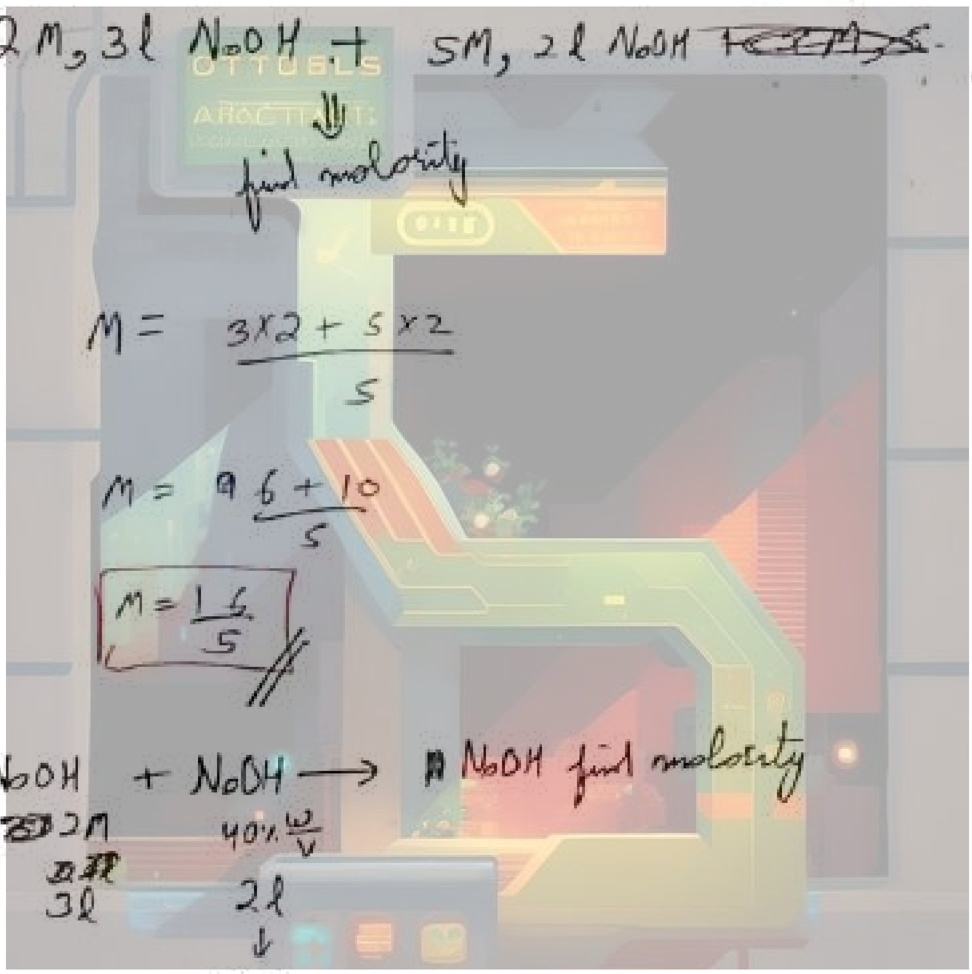
$$\boxed{\text{no. of } Cl^- = \frac{N_A}{200}}$$

# Mixing of Sol$^n$.

Case I  Non-reacting Sol$^n$

$$M = \frac{\text{Total Moles}}{\text{Total Vol}}$$

(18) $$\boxed{M = \frac{M_1V_1 + M_2V_2 + M_3V_3}{V_1 + V_2 + V_3 \dots}}$$



Q32. 2M, 3l NaOH + 5M, 2l NaOH ~~...~~

$\Downarrow$

find molarity

$$M = \frac{3\times2 + 5\times2}{5}$$

$$M = \frac{6+10}{5}$$

$$\boxed{M = \frac{16}{5}}$$

Q33. NaOH + NaOH $\longrightarrow$ NaOH find molarity

2M, 3l  40% $\frac{w}{v}$, 2l $\downarrow$ 800g $\downarrow$ 20 mol

$$\cancel{M = \frac{6 + 20}{4}}$$

$$\cancel{M = \frac{13}{2}}$$

$$M = \frac{20+6}{5}$$

$$\boxed{M = \frac{26}{5}}$$

Q34. 2M, NaOH 3l + 2M, KOH 3l

$[OH^-]$, $[Na^+]$ $[K^+]$

~~$M = \frac{6+6}{6}$~~

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

~~$[OH^-]$~~

$[OH^-] = \frac{6+6}{6}$

$\boxed{[OH^-] = 2M}$

$[Na^+] = \frac{3 \times 2}{6}$

$\boxed{[Na^+] = 1M}$

$\boxed{[K^+] = 1M}$

Q35. 2l, $10^{-3}M$ $H_2SO_4$ + 1l, $10^{-3}M$, HCl

find. $[H^+]$, $[SO_4^{2-}]$, $[Cl^-]$

$[H^+] = \frac{10^{-3} + 4 \times 10^{-3}}{3}$

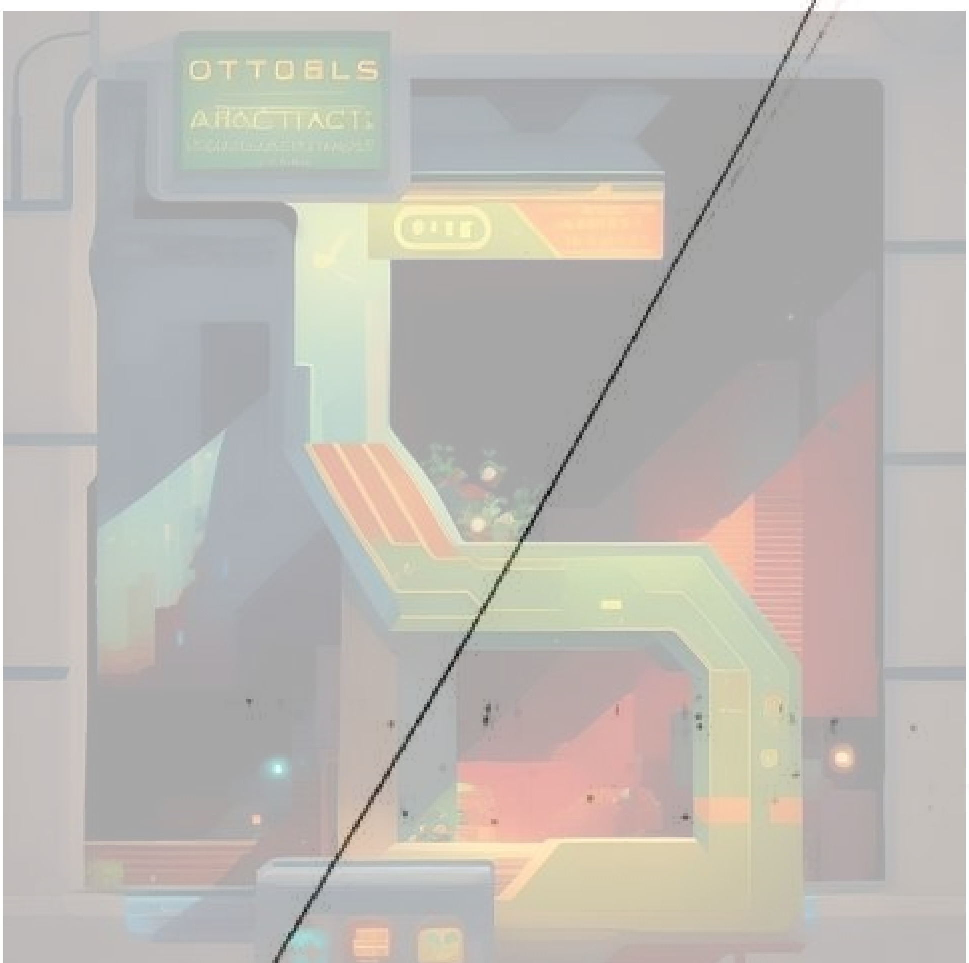
$= \frac{5}{3000}$

$\boxed{[H^+] = \frac{5}{3} \times 10^{-3}}$

$[SO_4^{2-}] = \frac{2 \times 10^{-3}}{3}$

$\boxed{[SO_4^{2-}] = \frac{2}{3} \times 10^{-3}}$

$\boxed{[Cl^-] = \frac{10^{-3}}{3}}$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~~Q 100 ml~~

Q36 100 ml of 1M $H_2SO_4$ + 98% $\frac{w}{w}$ $H_2SO_4$ 100 ml ($d_{soln}$ = 0.1 g/ml)

$n_{H_2SO_4} = 1M \times \frac{100}{1000}$ l

$= 0.1$ mol

mass = 9.8 g

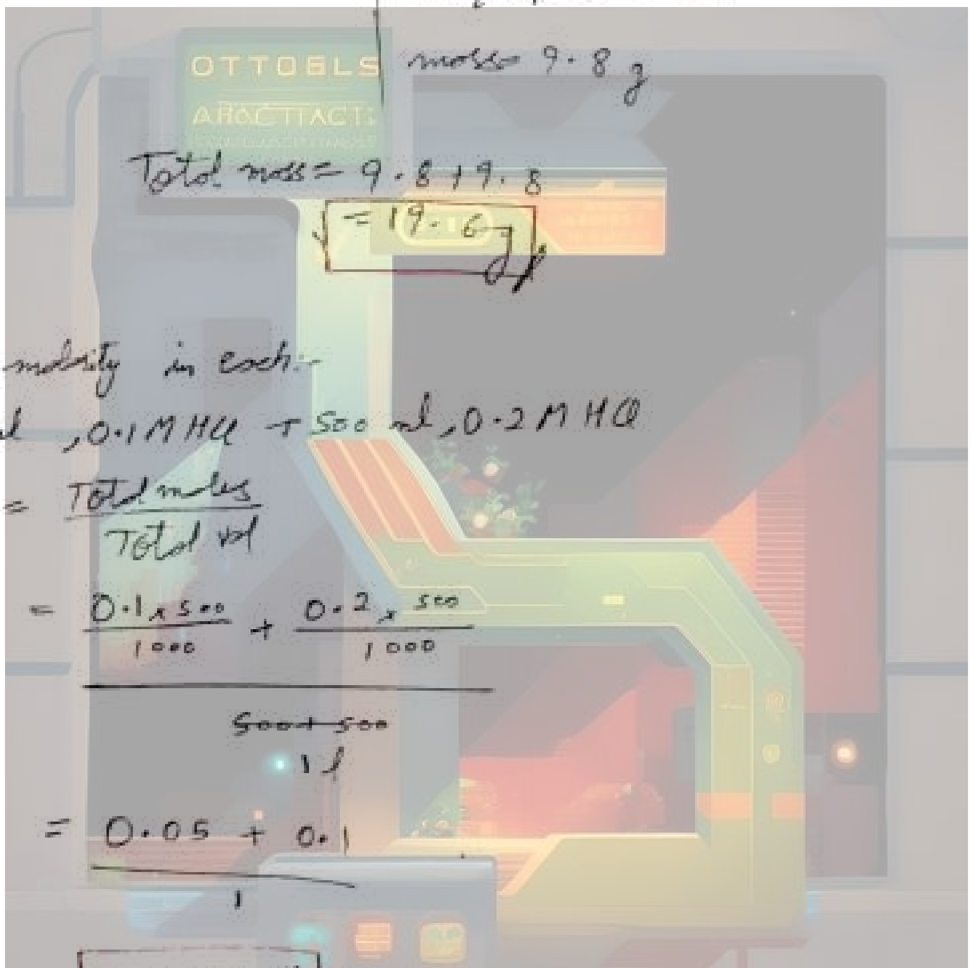
~~mass $H_2SO_4$ = 10 g~~

~~98 × 10 = w~~

$M_{H_2SO_4} = \frac{98 \times 0.1 \times 10}{98}$

$= 1M$

$n_{H_2SO_4} = 0.1$ mol



mass 9.8 g

Total mass = 9.8 + 9.8

$\boxed{= 19.6\ g}$

Q.37 find final molarity in each:-

① 500 ml, 0.1M HCl + 500 ml, 0.2M HCl

$M = \frac{\text{Total moles}}{\text{Total vol}}$

$= \frac{\frac{0.1 \times 500}{1000} + \frac{0.2 \times 500}{1000}}{\cancel{500 + 500}\ 1\ l}$

$= \frac{0.05 + 0.1}{1}$

$\boxed{= 0.15\ M}$

② 50 ml, 0.1M HCl + 150 ml, 0.3 M HCl + 300 ml $H_2O$

$M = \frac{\text{moles}}{\text{vol}}$

$M = \frac{\frac{0.1 \times 50 + 150 \times 0.3}{1000}}{0.5}$

$M = \frac{5 + 45}{500}$

$M = \frac{50}{500}$

$\boxed{M = 0.1}$

③ $4.9g\ H_2SO_4 + 250\ ml\ H_2O + 250\ ml\ 0.1\ M\ H_2SO_4$

$$M = \frac{\frac{1}{20} + \frac{0.1}{4}}{250+250} \times 1000$$

$$M = \frac{\frac{1}{20} + \frac{0.5}{20}}{500} \times 1000$$

$$M = \frac{1.5}{\cancel{200}\ 500} \times 1000$$

$$M = \frac{1.5}{10000} \times 1000$$

$$\cancel{M = 1.5 \times 10^{-4} M}$$

$$\boxed{M = 0.15 M}$$

Case II Reacting solution.

① No PPT formed –

→ write the equation & balance

→ Find the moles or milimoles of reactants

→ find the LR & decide the amount of product accordingly

Q 38 0.1 M, 200 ml $H_2SO_4$ is mixed with 0.2 M, 200 ml NaOH find.

a) Nature of Resultant Soln

b) $[Na^+]$ $[SO_4^{2-}]$

$$H_2SO_4 + 2NaOH \longrightarrow 2H_2O + Na_2SO_4$$

$$\begin{array}{cccc} \downarrow & \downarrow & \downarrow & \downarrow \\ 0.02 & 0.04 & 0.04 & 0.02 \end{array}$$

NO LR

a) $\boxed{\text{(a) Neutral}}$

$[Na^+] = \dfrac{0.04}{0.4}$

$\boxed{[Na^+] = 0.1\ M}$ b)

$[SO_4^{2-}] = \dfrac{0.02}{0.4}$

$\boxed{[SO_4^{2-}] = 0.05 M}$ 1)

Q 37 2M, 200 ml NaOH + 2M, 400 ml $H_2SO_4$ find $[H^+]$, $[SO_4^{2-}]$ $[Na^+]$ in final solⁿ & nature of solⁿ.

$$\begin{array}{cccc} H_2SO_4 + & 2\,NaOH \longrightarrow & 2H_2O + & Na_2SO_4 \\ \downarrow & \downarrow & \downarrow & \downarrow \\ 0.8 & 0.4 & 0 & 0 \\ \downarrow & \downarrow & \downarrow & \downarrow \\ 0.6 & 0 & 0.4 & 0.2 \end{array}$$

A) $\boxed{\text{Acidic}}$ 0)

b) $Vol = 0.2 + 0.4 = 0.6\,l \rightarrow H_2O_{(l)}$ from the reaction the contraction/expansion of volume is very less

$[H^+] = \dfrac{1.2}{0.6}$

$\boxed{[H^+] = 2\,M}$ b)

$\boxed{[SO_4^{2-}]} = \dfrac{0.8}{0.6}\ \boxed{= \dfrac{4}{3} M}$ 1)

$[Na^+] = \dfrac{0.4}{0.6} = \dfrac{4}{6} = \boxed{\dfrac{2}{3} M}$ 1)

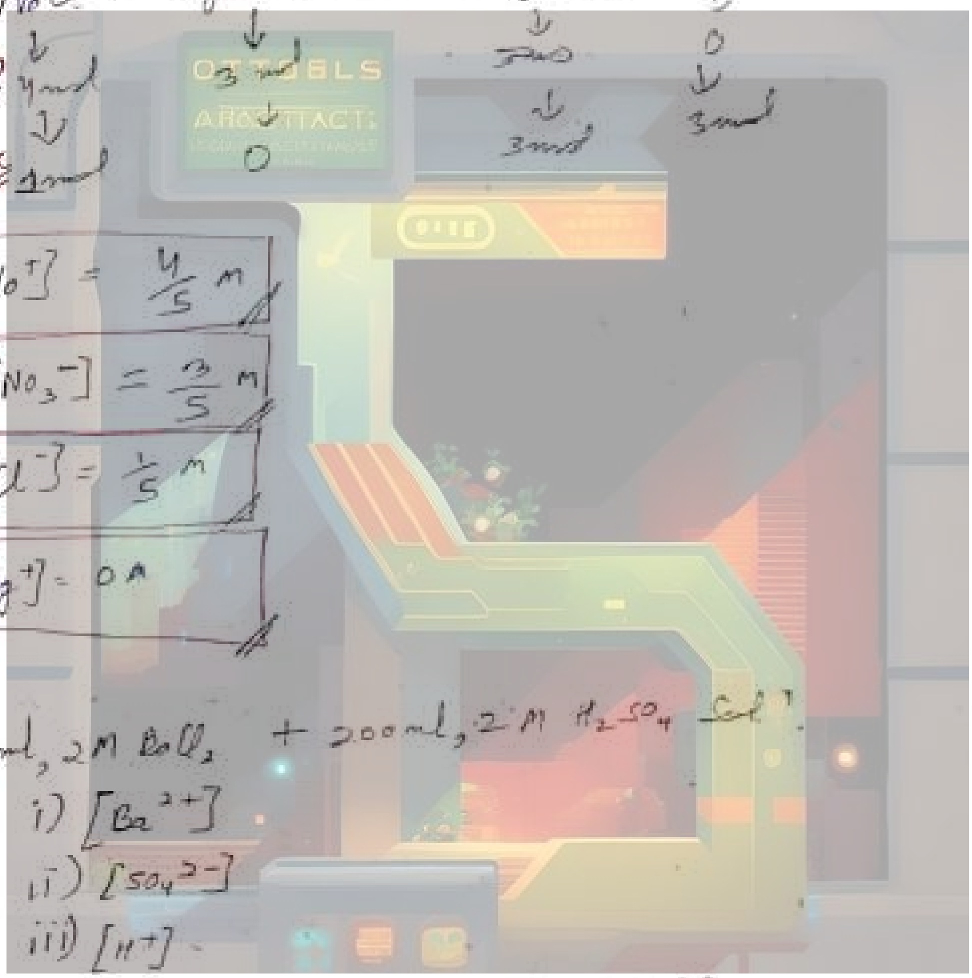
② PPT is formed :-

→ PPT is that substance which does not dissociate into its ions upon dissolution

eg. $AgCl, AgBr, AgI, CaCO_3, BaSO_4$, etc.

Q 40 2l, 2M NaCl + 3l, 1M $AgNO_3$

find $[Na^+]$ $[Cl^-]$ $[Ag^+]$ $[NO_3^-]$




$$NaCl + AgNO_3 \longrightarrow AgCl_{(s)}\downarrow + NaNO_3$$

PPT

t=0: 4 mol, 3 mol, 0, 0

t=t: 1 mol, 0, 3 mol, 3 mol

$\boxed{[Na^+] = \frac{4}{5} M}$

$\boxed{[NO_3^-] = \frac{3}{5} M}$

$\boxed{[Cl^-] = \frac{1}{5} M}$

$\boxed{[Ag^+] = 0 M}$

Q41. 100 ml, 2M $BaCl_2$ + 200 ml, 2M $H_2SO_4$ sol$^n$.

find i) $[Ba^{2+}]$

ii) $[SO_4^{2-}]$

iii) $[H^+]$

$$BaCl_2 + H_2SO_4 \longrightarrow 2HCl + BaSO_4$$

0.2, 0.4, 0, 0

0, 0.2, 0.4, 0.2

i) $[H^+] = \frac{0.8}{0.3} = \boxed{\frac{8}{3} M}$

ii) $[SO_4^{2-}] = \frac{0.2}{0.3} = \boxed{\frac{2}{3} M}$

iii) $[Ba^{2+}] = \cancel{\frac{0.2}{0.3}} \; \boxed{= 0}$ PPT

## Molarity & Molality of Pure liquid.

Solute = Pure liquid

Solvent = Pure liquid

Sol$^n$ = Pure liquid

density of pure liquid = d g/ml

1 lit Pure sol$^n$

mass of sol$^n$ = $(1000 \times d)$ g

mass of pure liquid (solute) = $1000 \times d$

moles of solute = $\dfrac{1000 \times d}{(M.w)_{\text{Pure liquid}}}$

(i) $$\boxed{M = \frac{mol}{Vol(l)} = \frac{1000 \times d_{\text{Pure liquid}}}{M.w_{\text{pure liquid}}}}$$

$$\boxed{m = \frac{1000}{(M.w)_{\text{Pure liquid}}}}$$

eg. $H_2O$

$M = \dfrac{1000}{18} \times 1$

$M = 55.55$

$m = \dfrac{1000}{18} = 55.55$

Note :- It is not true that for a pure liquid $M = m$ (Always) as it depends upon density of liquid.

→ But for $H_2O$ liquid, $M = m$ always cause its density is 1 g/ml

Note :- For a very dilute aqueous solution, Molarity of sol$^n$ is approx equal to molality.

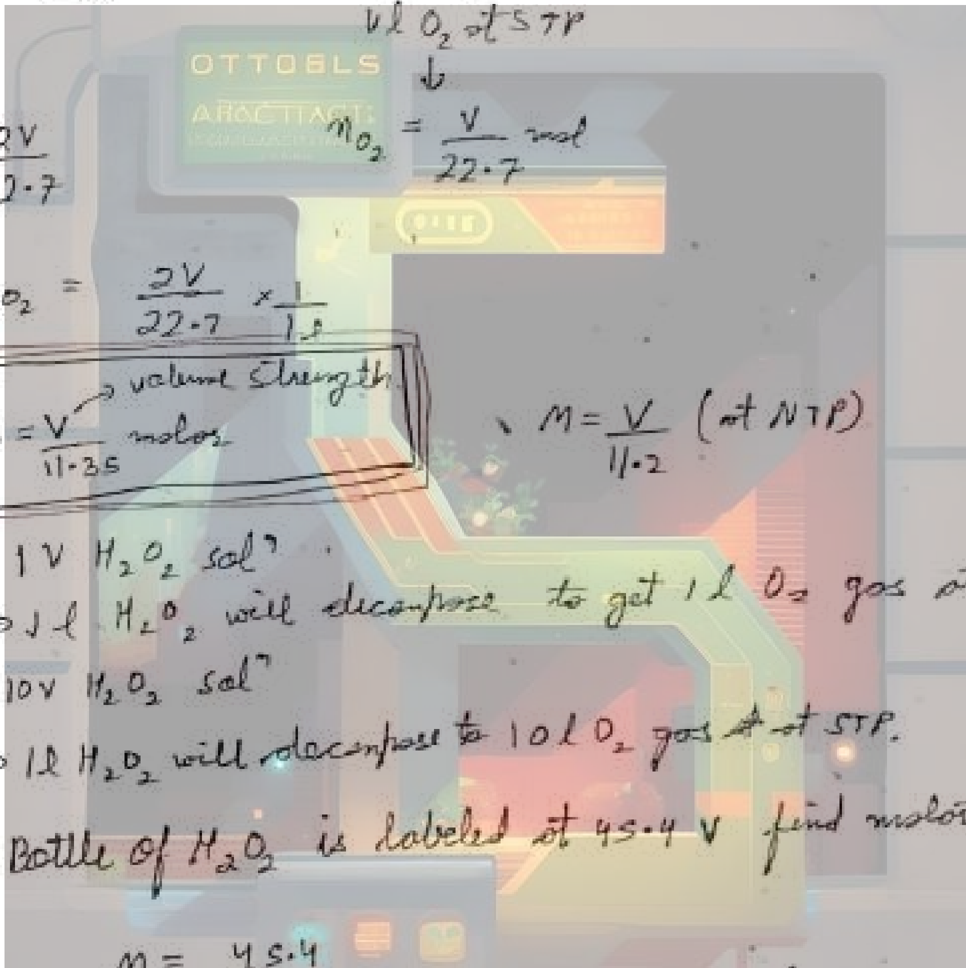
# Volume Strength (V) of $H_2O_2$ solⁿ :-

→ It is defined as the volume in $l$ of oxygen gas evolved at STP by decomposition of 1 L $H_2O_2$ solⁿ aqueous solⁿ.

Solute = $H_2O_2$
Solvent = $H_2O$

$H_2O_2(aq) \longrightarrow H_2O + \frac{1}{2}O_2(g)$

1 $l$ ↓      V $l$ $O_2$ at STP ↓



$n_{H_2O_2} = \dfrac{2V}{22.7}$     $n_{O_2} = \dfrac{V}{22.7}$ mol

$M_{H_2O_2} = \dfrac{2V}{22.7} \times \dfrac{1}{1 l}$

$\boxed{M = \dfrac{V}{11.35} \text{ molar}}$ → volume strength     , $M = \dfrac{V}{11.2}$ (at NTP)

eg. 1 V $H_2O_2$ solⁿ
→ 1 $l$ $H_2O_2$ will decompose to get 1 $l$ $O_2$ gas at STP.

eg. 10 V $H_2O_2$ solⁿ
→ 1 $l$ $H_2O_2$ will decompose to 10 $l$ $O_2$ gas at STP.

Q42. A Bottle of $H_2O_2$ is labeled at 45.4 V find molarity.

$M = \dfrac{45.4}{11.35}$

$\boxed{M = 4 \text{ molar}}$ //

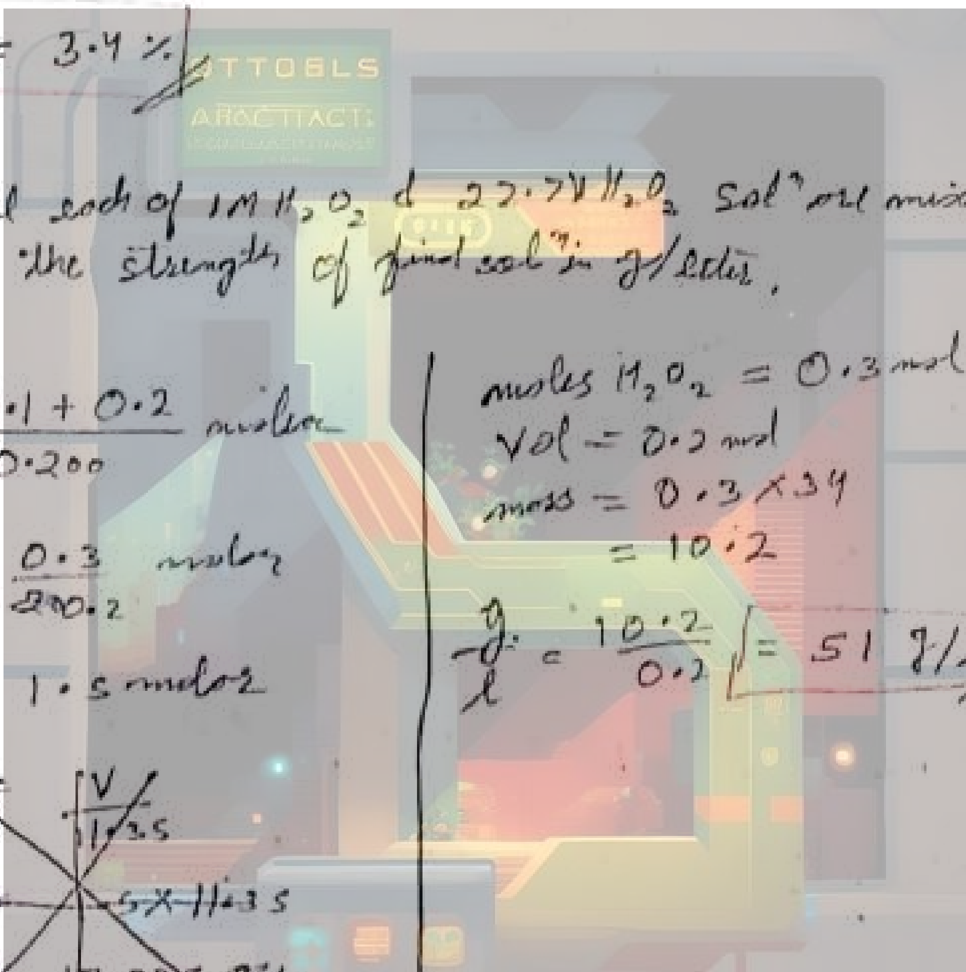
Q43. A sol$^n$ of $H_2O_2$ labelled at 11.35 V. calculate its concentration % w/v.

$M = 1$ molar

$$M = \frac{\% \frac{w}{v} \times 10}{M \cdot M_{solute}}$$

$$\frac{1 \times 34}{10} = \% \frac{w}{v}$$

$$\boxed{\% \frac{w}{v} = 3.4\%}$$



Q44. 100 ml each of 1M $H_2O_2$ & 22.7V $H_2O_2$ sol$^n$ are mixed. find the strength of final sol$^n$ in g/litre.

$$M = \frac{0.1 + 0.2}{0.200} \text{ molar}$$

$$M = \frac{0.3}{\cancel{200}\,0.2} \text{ molar}$$

$M = 1.5$ molar

$$M = \frac{V}{11.35}$$

$V = 1.5 \times 11.35$

$V = 17.025$ g/l

moles $H_2O_2 = 0.3$ mol

Vol $= 0.2$ ml

mass $= 0.3 \times 34$

$= 10.2$

$$\frac{g}{l} = \frac{10.2}{0.2} \boxed{= 51 \text{ g/l}}$$

Q45. In a particular $H_2O_2$ sol$^n$, $X_{H_2O_2} = 0.2$. If $d_{sol^n} = 1$ g/ml find
i) molarity of $H_2O_2$ ii) volume strength.

$n_{H_2O_2} = 0.2$

$n_{H_2O} = 0.8$

mass Total $= 34(0.2) + 18(0.8)$

$= 6.8 + 14.4$

$= 21.2g$

~~Vol = $\frac{21.2}{1}$~~

~~Vol = 2~~

~~Molarity = molality =~~

Molality $= \frac{0.2}{21.2} \times 1000$

$M = \frac{1}{106}$ molal $\times 1000$

$\boxed{M = 9.434 \text{ molal}}$ (i)

~~Vstrength = $\frac{9.4 \times 22.7}{2}$~~

~~$= \frac{213.38}{2}$~~

~~$\boxed{= 106.69V}$ (ii)~~

Volume strength $= \frac{1000}{106} \times 11.35$

$= \frac{11350}{106}$

$\boxed{= 107.07 V}$ (ii)

Q.46. 45.4 V $H_2O_2$ solⁿ 500 ml is dissociated, DOD = 0.2.

find i) New vol strength of $H_2O_2$ solⁿ

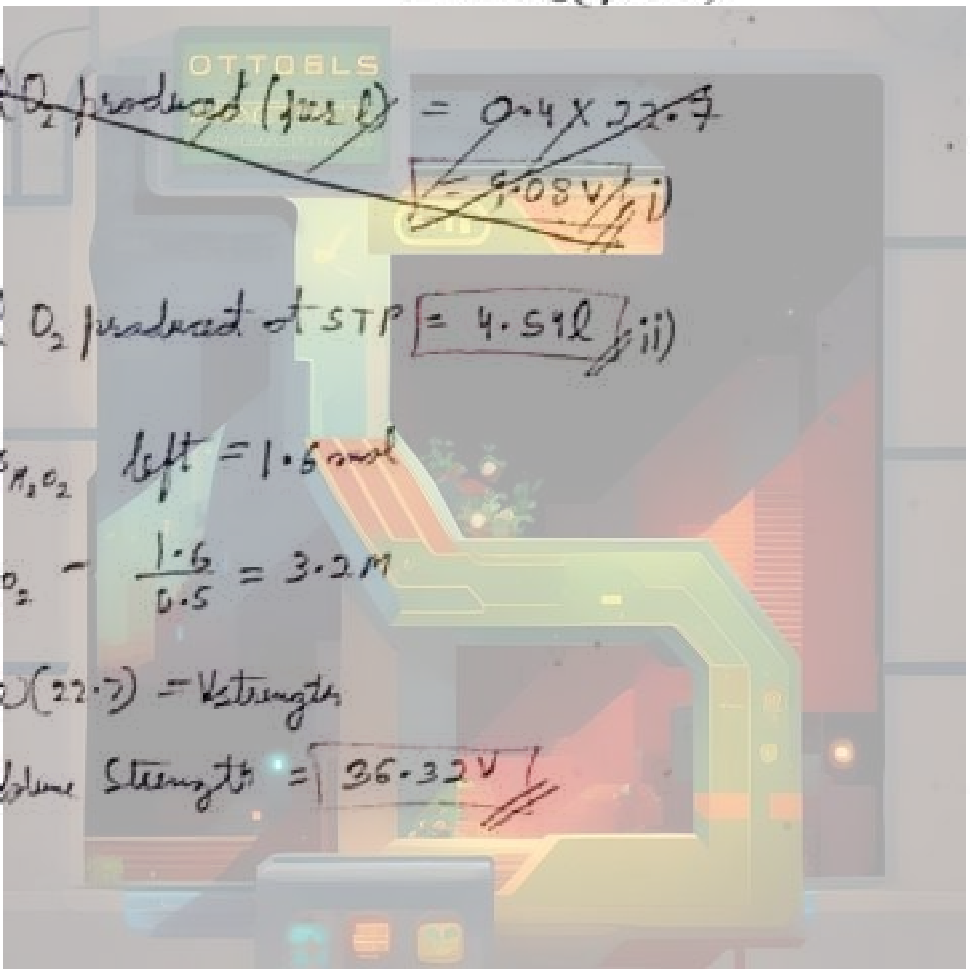
ii) Volⁿ of $O_2$ at STP produced.

given:- During Dissociation, vol of solⁿ not change.

moles of $H_2O_2$ = 2 mol

moles of $O_2$ produced = 0.2 mol (500 ml)

= 0.4 mol (per l)



~~Vol $O_2$ produced (per l) = 0.4 × 22.7~~

~~$\boxed{= 9.08 V}$ i)~~

Vol $O_2$ produced at STP $\boxed{= 4.54 l}$ ii)

moles$_{H_2O_2}$ left = 1.6 mol

$M_{H_2O_2} = \frac{1.6}{0.5} = 3.2M$

(3.2)(22.7) = Vstrength

Volume Strength = $\boxed{36.32 V}$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# ☆ Redox Reaction & Equivalent concept *

## # Redox Reaction

Reduction ⟶ oxidation

→ Reaction in which both oxidation as well as reduction occur simultaneously is called redox reaction.

| Oxidation | Reduction |
| --- | --- |
| old concept | old concept |
| i) Gain of oxygen | i) loss of oxygen |
| $Mg + \frac{1}{2}O_2 \rightarrow MgO$ | $MgO \rightarrow Mg + \frac{1}{2}O_2$ |
| ii) loss of Hydrogen | ii) gain of Hydrogen |
| $CH_3OH \rightarrow HCHO$ | $HCHO \rightarrow CH_3OH$ |
| new concept | new concept |
| iii) Loss of $e^-$ is oxidation | iii) Gain of $e^-$ is Reduction |
| $Zn \longrightarrow Zn^{2+} + 2e^-$ | $Zn^{2+} + 2e^- \rightarrow Zn$ |
| oxidation of Zn | reduction of Zn |
| iv) oxidation no. is increased | iv) oxidation no. is decreased. |

<u>Oxidising Agent</u> → (Oxidant) — Those substance/species which oxidise others & reduce itself. In a redox reaction, the oxidation no. of oxidant decreases.

<u>Reducing Agent</u> (Reductant) — Those substance/species which reduces others & oxidise itself. In a redox reaction, the oxidation no. of reductant increases.

Eg. $\overset{0}{Zn}_{(s)} + \overset{+2}{Cu}SO_4 \longrightarrow \overset{+2}{Zn}SO_4 + \overset{0}{Cu}_{(s)}$

Zn → oxidation no. ↑ → Reducing Agent.

Cu → oxidation no. ↓ → Oxidising agent.

eg 2.

$$\overset{+7}{MnO_4^-} + \overset{-1}{H_2O_2} \xrightarrow{H^+} \overset{+2}{Mn^{2+}} + \overset{0}{O_2}$$

Oxidation

Reduction

$MnO_4^- \rightarrow$ Oxidising Agent

$H_2O_2 \rightarrow$ Reducing Agent

Oxidation Number - Hypothetical charge on a ~~com~~ compound if each bond is considered as ionic.

(1) The oxidation ~~no~~ of any atom in uncombined state or combined state with itself is zero.

eg. $Na, Mg, Al, Zn, Cu, H_2, F_2, Cl_2$ etc.

(2) The Algebric sum of oxidation no. of all atoms in a molecule ~~&~~ must be equal to net charge on molecule.

eg. (1) $SO_3$

$(O.S)_S + (-6) = 0$

$(O.S)_S = 6$

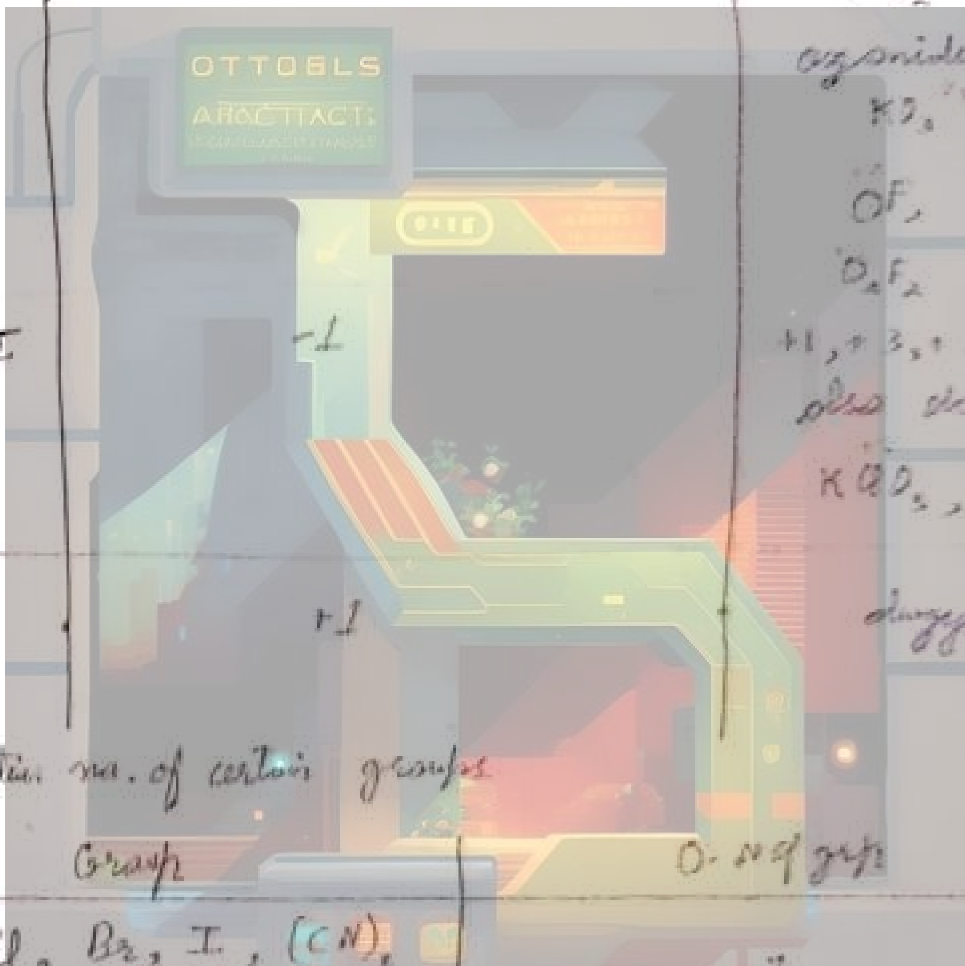
(2) $NH_4^+$

$(O.S)_N + 4 = +1$

$(O.S)_N = -3$

| Atom | O.N of atom | Remark (exception) |
|---|---|---|
| (1) Alkali Metals (Li, Na, K, Rb, Cs) | +1 | always |
| (2) Alkali Earth metal (Be, Mg, Ca, Sr, Ba | +2 | always |

| | | | |
|---|---|---|---|
| (3) | $Al$ | $+3$ | always |
| (4) | $F$ | $-1$ | always |
| (5) | $H$ | $+1$ If attached with non-metals | $-1$ in metal Hydrides eg $NaH$ |
| (6) | $O$ | $-2$ (Normally) | Peroxide $H_2O_2$, $Na_2O_2$ Superoxide $KO_2$ ozonides $KO_3$ $OF_2$ $O_2F_2$ |
| (7) | $Cl, Br, I$ | $-1$ | $+1, +3, +5, +7$ also observed $KClO_3$, $KClO_4$ |
| (8) | $Ag$ | $+1$ | always |



# Oxidation no. of certain groups

| Group | O.N of grp |
|---|---|
| $F$, $Cl$, $Br$, $I$, $(CN)$, $(SCN)$ | $-1$ |
| $CO$, $NH_3$, $H_2O$ | $0$ |
| $CO_3$, $SO_4$, $C_2O_4$ | $-2$ |

Q1. find oxidation no.

① $K_4[Fe(CN)_6]$

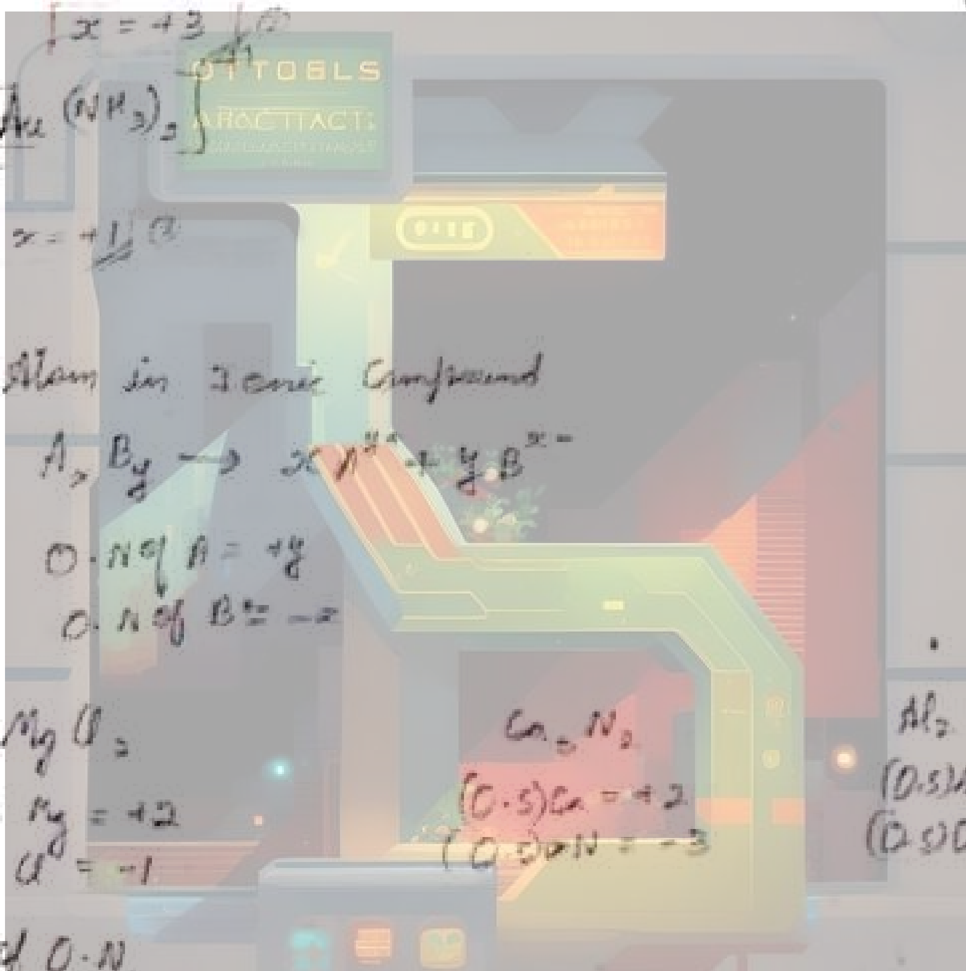
$x - 6 = -4$

$\boxed{x = +2}$

② $[Cr(NH_3)_5Cl]Cl_2$

$x + 0 - 1 = +2$

$\boxed{x = +3}$



③ $[Ag(NH_3)_2]$

$\boxed{x = +1}$

* O.N of atom in Ionic Compound

A) $A_x B_y \rightarrow x A^{y+} + y B^{x-}$

O.N of A = $+y$

O.N of B = $-x$

e.g.

$MgCl_2$

O.S Mg = +2

O.S Cl = −1

$Ca_3N_2$

(O.S)Ca = +2

(O.S)N = −3

$Al_2O_3$

(O.S)Al = +3

(O.S)O = −2

** Range of O.N.

for p-block non-metals

Range(O.N) = (N−8) to N

where N = no. of valence e⁻

| | | | |
|---|---|---|---|
| B | −5 to +3 | Cl, Br, I | −1 to +7 |
| C/Si | −4 to +4 | F | 0, −1 |
| N/P | −3 to +5 | | |
| S/Se/Te | −2 to +6 | | |
| O | −2 to +2 (exceptional) | | |

Q.2 find O.N of all atoms.

(1) $SO_2$
(2) $SO_4^{2-}$
(3) $ClO_4^-$
(4) $CH_3MgBr$
(5) $H_2PO_2^-$
(6) $SCN^{\ominus}$
(7) $Na_2S_4O_6$
(8) FeO
(9) $Fe_3O_4$
(10) $C_2H_5OH$
(11) $FeS_2$
(12) $CS_2$
(13) $N_2O_5$
(14) HCN
(15) $N_2O_3$
(16) $H_2S_2O_7$
(17) $H_2S_2O_8$
(18) $H_2SO_5$
(19) $(NH_4)_2SO_4$
(20) $CaOCl_2$
(21) $Ba[H_2PO_2]_2$
(22) ~~OsO~~ $OsO_4$
(23) $Ba_2XeO_6$

(1) O.S (S) = +4
O.S (O) = −2

(2) O.S (S) = +6
O.S (O) = −2

(3) O.S (Cl) = +7
O.S (O) = −2

(4) O.S (H) = +1
O.S (C) = −4
O.S (Mg) = +2
O.S (Br) = −1

(5) O.S (O) = −2
O.S (H) = +1
O.S (P) = +1

(6) O.S (C) = +4
O.S (S) = −2
O.S (N) = −3

(7) O.S (Na) = +1
O.S (S) = $+\frac{5}{2}$
O.S (O) = −2

(8) O.S (O) = −2
O.S (Fe) = +2

(9) O.S (O) = −2
O.S (Fe) = $\frac{8}{3}$ (3, 2)

(10) O.S (H) = +1
O.S (O) = −2
O.S (RC) = −4

(11) O.S (Fe) = ~~+4~~ +2
O.S (S) = ~~−2~~ −1

(12) O.S (S) = −2
O.S (C) = +4

(13) O.S (O) = −2
O.S (N) = ~~+3~~ +5

(14) O.S (H) = ~~+3~~ +1
O.S (N) = −3
O.S (C) = +2

(15) O.S (O) = −2
O.S (N) = 3 (+, 2)

(16) O.S (O) = −2
O.S (S) = +6
O.S (H) = +1

(17) O.S (H) = +1
O.S (S) = +6
O.S (O) = −2, −1 = $-\frac{7}{4}$

(18) O.S (S) = +6
O.S (H) = +1
O.S (O) = −2, −1 = $-\frac{8}{5}$

(19) O.S (O) = −2
O.S (H) = +1
O.S (S) = −2
O.S (N) = 6

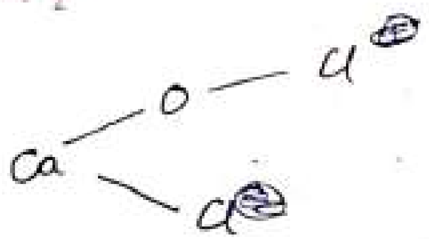
(20) O.S (O) = −2
O.S (Ca) = +2
O.S (Cl) = 0 (+1, −1)

(21) O.S (Ba) = +2
O.S (H) = +1
O.S (O) = −2
O.S (P) = +1

(22) O.S (O) = −2
O.S (Os) = +8

(23) O.S (Ba) = +2
O.S (O) = −2
O.S (Xe) = 8

eg. $CaOCl_2$



(24) $KMnO_4$

(25) $MnO_2$

(26) $MnO_4^{2-}$

(27) $K_2Cr_2O_7$

(28) $Cr^{3+}$

(29) $HClO_4$

(30) $HCl$

(31) $ClO_3^-$

(32) $H_2SO_4$

(33) $H_2S$

(34) $SO_3$

(35) $SO_4^{2-}$

(36) $HNO_3$

(37) $NH_3$

(38) $CO_2$

(39) $H_2C_2O_4$

(40) $HCHO$

(41) $H_2SO_5$

(42) $H_2S_4O_6$

(43) $HCN$

(44) $HNC$

(45) $Cu_3P$

(46) $P_4S_3$

(47) $CrI_3$

(48) $PH_3$

(49) $Na_2S_2O_3$

(50) $Ca_5P_3O_{12}F$

(51) $MgH_2P_2O_5$

(52) $(NH_4)_6Mo_7O_{24}$

(53) $YBa_2Cu_3O_7$

(54) $Cs_3[Re_3Cl_2]$

(55) $Ba_{1-x}K_xBiO_{3-y}$

(56) $K_3CrO_8$

(57) $C_3O_2$

(58) $Br_3O_8$

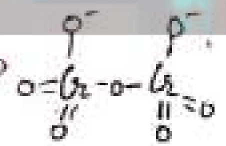
(24) $x - 8 = -1$

$\boxed{x = 7}$

(25) $\boxed{x = 4}$

(26) $\boxed{x = 6}$

(27) $\boxed{x = 6}$ →



(28) $\boxed{x = 3}$

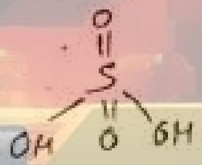
(29) $Cl = 8 - 1$

$\boxed{x = 7}$

(30) $\boxed{Cl = -1}$

(31) $\boxed{x = 5}$

(32)



$\boxed{x = 6}$

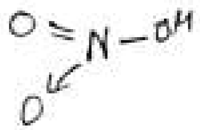
(33) $H_2S$

$\boxed{x = -2}$

(34) $\boxed{x = 6}$

(35) $\boxed{x = 6}$

(36) $\boxed{x = 5}$



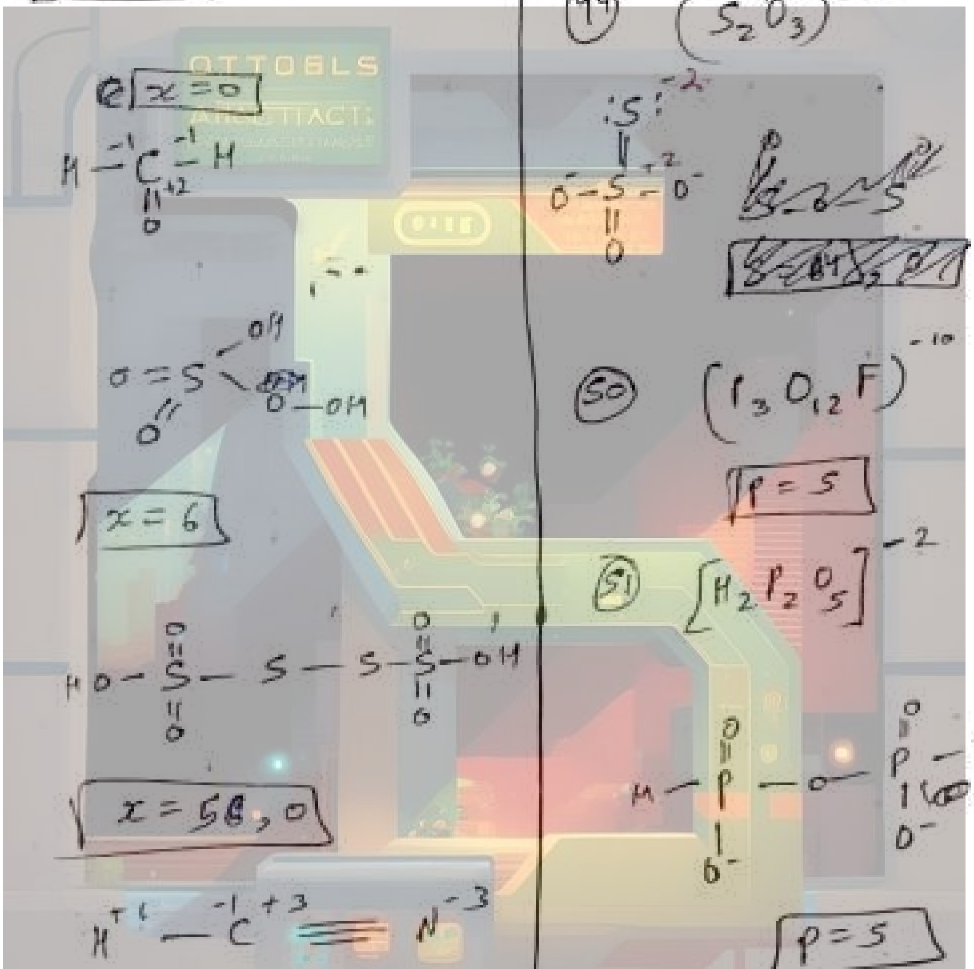
37. H — N(—H)(—H)

$\boxed{x = -3}$

38. $\boxed{C = +4}$

39. O = C(—OH) — C(—OH) = O

$\boxed{x = 3}$



40. $\boxed{x = 0}$

H — $\overset{-1}{}$C$^{+2}$ — $\overset{-1}{}$H, C = O

41. O = S(—OH)(—O—OH), S = O

$\boxed{x = 6}$

42. HO — S(=O)(=O) — S — S — S(=O)(=O) — OH

$\boxed{x = 5, 0}$

43. $H^{+1}$ — $C^{-1 +3}$ ≡ $N^{-3}$

$\boxed{x = 2}$

44. $H^{+1}$ — $N^{-1}$ ≡ $C^{-4}$

$\boxed{x = -3}$

45. $\boxed{x = +1}$

46. $4x(-6) = 0$

$x = 3/2$

P +3; P — S — P — S — P +1

$\boxed{x = +3, +1}$

47. $\boxed{x = 3}$

48. $\boxed{P = -3}$

49. $(S_2O_3)^{-2}$

$S^{-2}$ = S$^{+2}$(—O$^-$)(—O$^-$)(=O)

$\boxed{S = 6, -2}$

50. $(P_3O_{12}F)^{-10}$

$\boxed{P = 5}$

51. $[H_2P_2O_5]^{-2}$

H — P(=O)(—O$^-$) — O — P(=O)(—O$^-$) — H

$\boxed{P = 5}$

52. $[Mo_7O_{24}]^{-6}$

$7x - 48 = -6$

$7x = 42$

$\boxed{x = 6}$

(53) $3 + 4 + 3x - 14 = 0$

$3x = 7$

$\boxed{x = 7/3}$

(54) $[R_3Cl_2]^{-3}$

$3x - 2 = -3$

$\boxed{x = -1/3}$

(55)

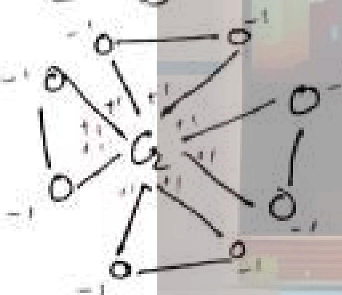
$2 - 2x + x + z - 6 + 2y = 0$

$z = 4 + 2x - 2y - x$

$z = 4 + x - 2y$

$\boxed{Bi = 4 + x - 2y}$

(56) $[CrO_8]^{-3}$



$\cancel{Cr=+8}$

$x - 8 = -3$

$\boxed{x = 5}$

(57) $C_3O_2$

$O=C=C=C=O$

$\boxed{x = 0, +2}$

(58) $Br_3O_8$

$\boxed{Br = 4, 6}$

## Types of Chemical Reaction :-

Non Redox

Oxidation no. of any element in given species do not change

Redox Reaction

Oxidation no. changes (One species is oxidised and other is reduced).

## imp Types of Redox Reaction :-

### ① Disproportionation Reaction (Auto Redox) :-

→ It is a kind of redox reaction in which same element (compound) undergoes oxidation as well as reduction.

→ The Oxidant and Reductant are same species.

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

Reduction ($-1 \to -2$), oxidation ($-1 \to 0$)

Reducing Agent → $H_2O_2$

Oxidising Agent → $H_2O_2$

eg 2. $\overset{0}{Cl_2} + KOH \longrightarrow K\overset{-1}{Cl} + K\overset{+5}{Cl}O_3 + H_2O$

reduction ($0 \to -1$), Oxidation ($0 \to +5$)

eg 3. $\overset{0}{P_4} + NaOH + H_2O \longrightarrow \overset{-3}{P}H_3 + NaH_2\overset{+1}{P}O_2$

reduction ($0 \to -3$), oxidation ($0 \to +1$)

eg 4. $\overset{0}{S_8} + NaOH \longrightarrow Na_2\overset{-2}{S} + Na_2\overset{+2}{S_2}O_3$

reduction, oxidation

eg 5. $H_3\overset{+3}{P}O_3 \longrightarrow \overset{-3}{P}H_3 + H_3\overset{+5}{P}O_4$

reduction, oxidation

eg 6. $\overset{+7}{Mn}O_4^- \longrightarrow \overset{+4}{Mn}O_2 + \overset{+2}{Mn}O$ (not disproportionation) ✗

reduction, reduction

## ② Comproportionation Reaction

→ Reverse of Disproportionation ~~reactn~~ reaction is called comproportionation reaction.

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

reduce, oxidise

eg 2. $\overset{+5}{I}O_3^- + \overset{-1}{I^-} \longrightarrow \overset{0}{I} + H_2O$

## ③ Intramolecular Redox Reaction

→ In such reaction, one atom of a molecule is oxidised while another ~~atom~~ atom of same molecule is reduced.

eg. $\overset{+1}{K}\overset{+5}{Cl}\overset{-2}{O_3} \longrightarrow \overset{+1}{K}\overset{-1}{Cl} + \overset{0}{O_2}$

oxidation, reduction

~~Cl — oxidised~~ Cl - reduced

~~O →~~ O - oxidised

eg 2. $\overset{+5}{P}\overset{-1}{Cl_5} \longrightarrow \overset{+3}{P}\overset{-1}{Cl_3} + \overset{0}{Cl_2}$ P – reduced

reduced     oxidised     Cl – oxidised

→ Oxidising Agent & Reducing agent are same

## Some other types of reactions

① Combination Reaction

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

eg 2. $\overset{0}{H_2} + \overset{0}{Cl_2} \longrightarrow H\overset{-1}{Cl}$

Redox

eg 3. $\overset{+1}{H_2}\overset{-2}{O} + \overset{+6}{S}\overset{-2}{O_3} \longrightarrow \overset{+1}{H_2}\overset{+6}{S}\overset{-2}{O_4}$ ✗ not Redox

<u>Note</u> :- It is not necessary that all combination reaction are redox reaction.

② Decomposition Reaction

→ Those reaction in which, compound does break into 2 or more components by the help of any kind of energy.

eg. $\overset{+1}{K}\overset{+5}{Cl}\overset{-1}{O_3} \xrightarrow{\Delta} \overset{+1}{K}\overset{-1}{Cl} + \overset{0}{O_2}$

eg 2. $Ca\overset{-2}{H_2}\overset{+1}{} \xrightarrow{\Delta} \overset{0}{Ca_{(s)}} + \overset{0}{H_{2(g)}}$

Redox

eg 3. $\overset{+2}{Ca}\overset{+4}{C}\overset{-2}{O_3} \xrightarrow{\Delta} \overset{+2}{Ca}\overset{-2}{O} + \overset{+4}{C}\overset{-2}{O_2}$ / not Redox

Note :- It is not necessary that all decomposition reaction are redox reaction.

③ Displacement Reaction

i) Metal Displacement:

eg. $\overset{0}{Zn}_{(s)} + \overset{+2}{Cu}SO_{4(aq)} \longrightarrow \overset{+2}{Zn}SO_{4(aq)} + \overset{0}{Cu}_{(s)}$ (Redox)

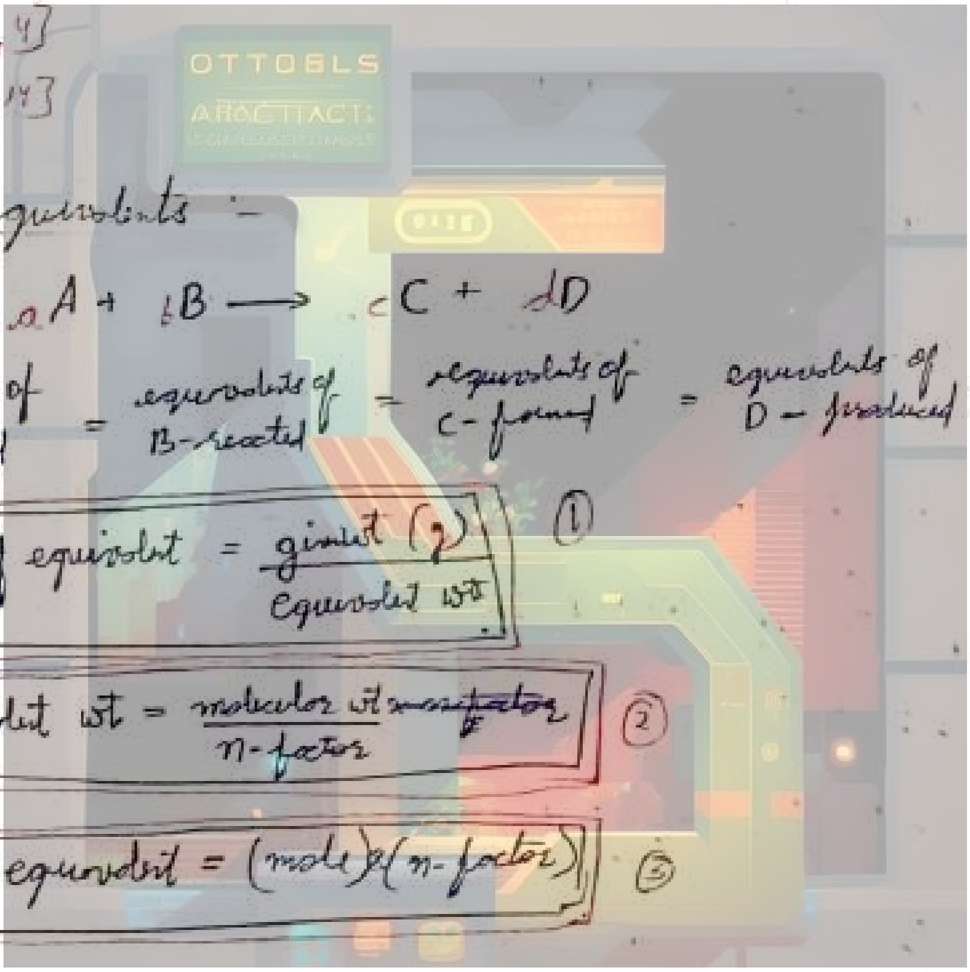
ii) Non-metal Displacement:

eg. $\overset{0}{Cl_2} + \overset{+1}{K}\overset{-1}{I} \longrightarrow \overset{+1}{K}\overset{-1}{Cl} + \overset{0}{I_2}$ (Redox)

H.W. 12-9-24

S-1 [1, 4]

O-1 [1, 14]



Law of Equivalents :-

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

Equivalents of A-reacted = equivalents of B-reacted = equivalents of C-formed = equivalents of D-produced

$$\boxed{\text{no. of equivalent} = \frac{\text{given wt (g)}}{\text{Equivalent wt}}} \quad ①$$

$$\boxed{\text{equivalent wt} = \frac{\text{molecular wt}}{\text{n-factor}}} \quad ②$$

$$\boxed{\text{no. of equivalent} = (\text{mole}) \times (\text{n-factor})} \quad ③$$

Normality (N):-

→ no. of equivalents of solute present in 1L solⁿ.

$$\boxed{N = \frac{\text{no. of equivalents}}{\text{Vol}^n \text{ of Sol}^n \text{ (L)}}} \quad ④$$

$$\boxed{\text{no. of equivalents} = N \times V_{(Lit)}} \quad (5)$$

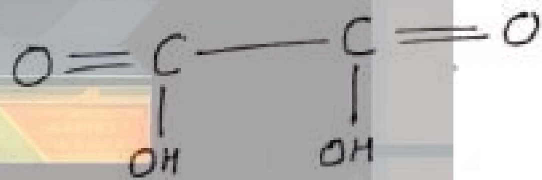
$$\text{Normality} = (\text{Molarity})(n\text{-factor})$$

$$\boxed{\text{no. of equivalents} = (M)(n\text{-factor})(V\,lit)} \quad (6)$$

Q3. find the wt in g of Oxylic Acid ($H_2C_2O_4$) if Sol^n is 500 ml and 0.5 N. (Assume n-factor = Basicity)

equivalents = (0.5)(0.5)

= 0.25



n-factor = 2

moles = $\frac{0.25}{2}$

mass = $\frac{1}{8} \times 90$

$\boxed{\text{mass} = 11.25\ g}$

# n-factor

for non-Redox :-

① Acids – n-factor is equal to the no. of replaceable $H^+$ ions or Basicity.

eg. $H_2SO_4 \rightarrow 2$

$H_3PO_4 \rightarrow 3$

$H_3PO_3 \rightarrow 2$

$HCl \rightarrow 1$

$HNO_3 \rightarrow 1$

$H_3PO_2 \rightarrow 1$

$H_2S_2O_7 \rightarrow 2$

$H_4P_2O_7 \rightarrow 4$

$H_3BO_3 \rightarrow 1$

(3) Acidic Oxide

eg. $CO_2 + H_2O \longrightarrow H_2CO_3$

$\downarrow$ $\downarrow$

$n\text{-}f = 2 \longleftrightarrow n\text{-}f = 2$

Same.

eg. 2. $SO_3 + H_2O \longrightarrow H_2SO_4$

$\downarrow$ $\downarrow$

$n\text{-}f = 2$ $n\text{-}f = 2$

eg 3. $SO_2 + H_2O \longrightarrow H_2SO_3$

$\downarrow$ $\downarrow$

$n\text{-}f = 2$ $n\text{-}f = 2$

eg 4. $N_2O_5 + H_2O \longrightarrow \cancel{2HNO_3}\ 2HNO_3$

$\downarrow$ $\downarrow$

$n\text{-}f = 1(2)$ $n\text{-}f = 1$

$n\text{-}f = 2$

Note:- If the reaction is given then n-factor is equal to no. of $H^+$ ions lost by acid molecule in a reaction.

eg. $H_3PO_4 + NaOH \longrightarrow NaH_2PO_4 + H_2O$

$\downarrow$ $1H^+$ replaced equivalent wt $= \frac{98}{1} = 98$

$n\text{-}f = 1$

eg 2. $H_3PO_4 + 2NaOH \rightarrow Na_2HPO_4 + 2H_2O$

$\downarrow$ $2H^+$ replaced equivalent wt $= \frac{98}{2} = 49$

$n\text{-}f = 2$

eg 3. $H_3PO_4 + 3NaOH \rightarrow Na_3PO_4 + 3H_2O$

equivalent wt $= \frac{98}{3} = 32.66$

$\downarrow$

$n\text{-}f = 3$ $3H^+$ replaced.

→ Equivalent wt. of a compound is not fixed, it changes as the value of n-factor changes.

② **Bases:-** n-factor of A base is equal to the no. of $OH^-$ ion lost by 1 molecule of a base In a reaction.

→ If base is lewis base then check for no. of L.P donated.

eg. $NaOH$ $\quad$ n-f = 1

$Ca(OH)_2$ $\quad$ n-f = 2

$Al(OH)_3$ $\quad$ n-f = 3

$\cancel{NH_3}$ $B(OH)_3$ $\quad$ n-f = ~~2~~ 1 (Basic acid)

$\ddot{N}H_3$ $\quad$ n-f = 1

$$\left.\begin{array}{l} CH_2 - \ddot{N}H_2 \\ \quad | \\ CH - \ddot{N}H_2 \\ \quad | \\ CH_2 - \ddot{N}H_2 \end{array}\right] \quad n\text{-}f = 3$$

$N_2H_4$ $\quad$ n-f = 2

**Basic oxides.-**

eg. $Na_2O + H_2O \longrightarrow 2\,NaOH$

$Na_2O$: n-f = 2 1 (2) = 2 $\quad$ $NaOH$: n-f = 2 1

eg2. $MgO + H_2O \rightarrow Mg(OH)_2$

$MgO$: n-f = 2 $\quad$ $Mg(OH)_2$: n-f = 2

eg3. $Al_2O_3 + 3H_2O \longrightarrow 2\,Al(OH)_3$

$Al_2O_3$: n-f = (3)(2) = 6 $\quad$ $Al(OH)_3$: n-f = 3

In Reactions

eg 1. $Al(OH)_3 + HCl \rightarrow AlCl(OH)_2 + H_2O$

$\hookrightarrow$ n-f = 1

eg 2. $Al(OH)_3 + 2HCl \rightarrow AlCl_2(OH) + 2H_2O$

$\hookrightarrow$ n-f = 2

eg 3. $Al(OH)_3 + 3HCl \rightarrow AlCl_3 + 3H_2O$

$\hookrightarrow$ n-f = 3

eg 4. $\begin{matrix} CH_2-\ddot{N}H_2 \\ | \\ CH_2-\ddot{N}H_2 \end{matrix} + HCl \longrightarrow \begin{matrix} CH_2-\overset{\oplus}{N}H_3\overset{\ominus}{Cl} \\ | \\ CH_2-\ddot{N}H_2 \end{matrix}$

$\hookrightarrow$ n-f = 1

③ **Ions:-**

n-factor on ion = ~~Cation~~ | charge of ion |.

Ex. eg. $Mg^{2+}$ n-f = 2

$Cl^-$, $I^-$, $Br^-$ n-f = 1

$PO_4^{3-}$ n-f = 3

$SO_4^{2-}$ n-f = 2

eg. Equivalent wt of $Al^{3+}$ = $\frac{M.M}{n\text{-}f}$ = $\frac{27}{3}$ = 9.

④ ionic salts :-

n-factor of ionic salt = either total ⊕ve or ⊖ve charge

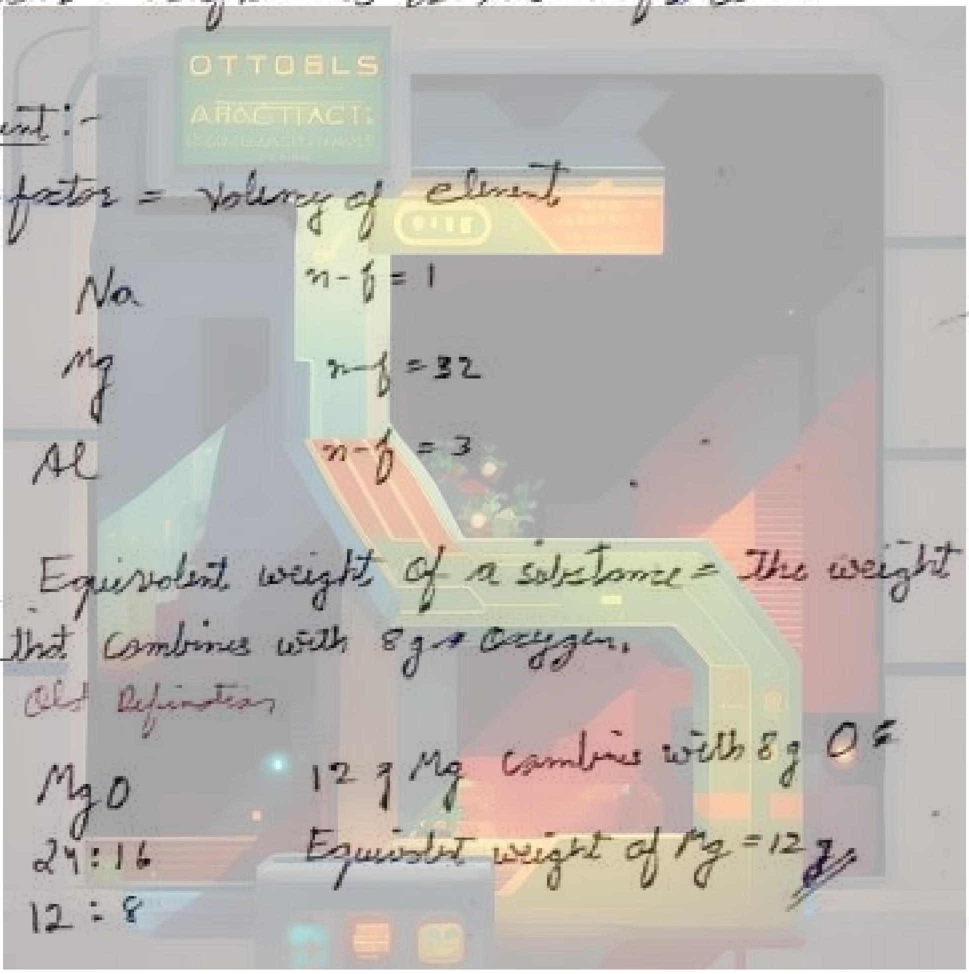
eg. $\overset{+1\ -1}{NaCl}$ n-f = 1

$\overset{+2\ \ -1}{MgCl_2}$ n-f = 2

$Al_2O_3$ n-f = 6

+3(2) −2(3)

n-factor = no. of cationic ion × O.N. of cation



⑤ Element :-

n-factor = valency of element

eg. Na n-f = 1

Mg n-f = ~~3~~2

Al n-f = 3

Note :- Equivalent weight of a substance = the weight of substance that combines with 8 g of oxygen.

Old Definition

eg. MgO 12 g Mg combines with 8 g O

24 : 16 Equivalent weight of Mg = 12 g

12 : 8

eg. $Al_2O_3$ Equivalent wt = 9

54 : 48

54/3 : 16

54/6 : 8

Q4. If $x$ g of metal combines with oxygen to form $y$ g metal oxide then find equivalent wt of metal

$$aM + bO \longrightarrow M_aO_b$$

$x$ g $\qquad$ $y$ g

$\frac{x}{m_a}$ mol $\qquad$ $\frac{y}{16b + m_a}$ mol

$$\frac{x}{a\,m_a} = \frac{y}{16b + m_a}$$

$$16bx + x m_a = y m_a$$

$$16bx = (y - x) m_a$$

$$b \to \frac{1}{2}$$

$$8x = (y - x) m_a$$

$$2M + \frac{1}{2} O \longrightarrow M_2O_{1/2}$$

$x$ g $\qquad$ 8 g $\qquad$ $y$ g

$$x + 8 = y$$

Metal + Oxygen $\longrightarrow$ metal oxide

$x$ $\qquad$ $y - x$ $\qquad$ $y$

$(y - x)$ g O combine with $x$ g metal

8 g combine with $\boxed{\frac{8x}{(y-x)}}$

(b) ion exchange reaction :-

n-factor = magnitude of charge displaced.

eg

$H_3PO_4 + 2NaOH \longrightarrow \cancel{2H}\, Na_2HPO_4 + 2H_2O$

$\downarrow$

n-f = 2

eg $K_4[Fe(CN)_6] + ZnSO_4 \rightarrow K_2Zn[Fe(CN)_6] + K_2SO_4$

n-f = 2.

( 2 K ki gohart & Zn ne le li , (Zn) +2 charge move hua)

for Redox Reactions

→ n-factor of a substance in a redox reaction is equal to the moles of $e^-$ lost or gained per mole of ~~the~~ that substance.

① n-factor of substance undergo reduction or oxidation.
(Only one ion of that substance must be undergoing change in O.N).

eg. 1. $Sn^{2+} \longrightarrow Sn^{4+}$

n-factor = 2

2. $MnO_4^- + 3e^- \longrightarrow MnO_2$

$+7 \qquad\qquad\qquad +4$

n-factor = 3 $\qquad$ n-f = 3

3. $Cr_2O_7^{2-} \longrightarrow Cr^{3+}$ — n-f = 3

$+6 \qquad\qquad +3$

n-f = 6

~~n-f~~ $\qquad$ ~~n-f=~~

$e^-$ involvement = 6 - 3 = 3

~~n-f~~

n-f = (3×2) = 6

4. $MnO_4^{-} \xrightarrow{H^+} Mn^{2+}$

$+7 \qquad +2$

n-factor $= 7-2 = 5$

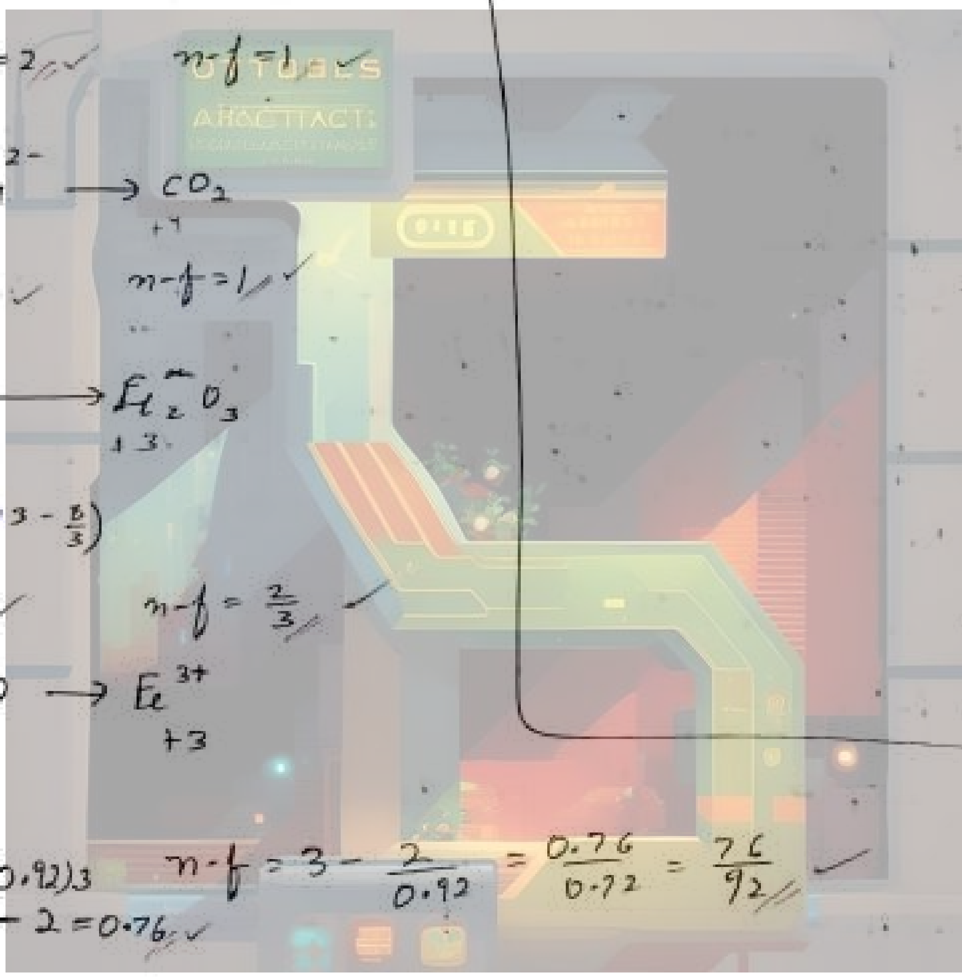
5. $P_4 \longrightarrow PH_3$

$0 \qquad -3$

n-f $= 12$ $\quad$ n-f $= 3$

6. $I_2 \longrightarrow I^-$

$0 \qquad -1$



n-f $= 2$ $\quad$ n-f $= 1$

7. $C_2O_4^{2-} \longrightarrow CO_2$

$+3 \qquad +4$

n-f $= 2$ $\quad$ n-f $= 1$

8. $Fe_3O_4 \longrightarrow Fe_2O_3$

$+\frac{8}{3} \qquad +3$

n-f $= 3\left(3-\frac{8}{3}\right)$

n-f $= 1$ $\quad$ n-f $= \frac{2}{3}$

9. $Fe_{0.92}O \longrightarrow Fe^{3+}$

$\frac{2}{0.92} \qquad +3$

n-f $= (0.92)3 - 2 = 0.76$ $\quad$ n-f $= 3 - \frac{2}{0.92} = \frac{0.76}{0.92} = \frac{76}{92}$

10. $Na_2S_2O_3 \longrightarrow Na_2S_4O_6$

$+2 \quad +2 \qquad +2 \quad +\frac{10}{4}$

~~n-f~~ n-f $= 2.5 - 2 = 0.5$

n-f $= 1$ $\quad$ n-f $= 2$

11. $(K_2C_2O_4 \cdot 3H_2C_2O_4 \cdot 4H_2O) \to CO_2$

$+3 \qquad +4$

n-f $= 8$ $\quad$ n-f $= 1$

(160)

(2) n-factor of a substance undergoing intramolecular redox reaction

→ n-factor of such cases can be determined either by oxidation or reduction.

eg. 1. $K\overset{+5}{Cl}\overset{-2}{O_3} \longrightarrow K\overset{-1}{Cl} + \overset{0}{O_2}$

n-factor = 6 (by Cl)

n-factor ~~(by O)~~
= (2)(3)
= 6 (by O)

n-f (KCl) = 6
n-f ($O_2$) = 4

2. $\overset{+7}{Cl_2}\overset{-2}{O_7} \longrightarrow \overset{0}{Cl_2} + \overset{0}{O_2}$

n-f = 14

n-f ($Cl_2$) = 14

n-f ($O_2$) = 4

3. $2\overset{+1}{H}\overset{-1}{Cl} \longrightarrow \overset{0}{H_2} + \overset{0}{Cl_2}$

~~n-f~~ ~~n-f (H) = 1~~
~~n-f (Cl) = 1~~
~~n-f~~

n-f (HCl) = 1
n-f ($H_2$) = 2
n-f ($Cl_2$) = 2

(3) n-factor of ionic compound in which both cation and anion are oxidised or reduced.

(n-factor) (ionic compound) = $n_1 + n_2$

$n_1$ → n-factor for cation
$n_2$ → n-factor for anion.

eg. $\overset{+1}{Cu_2}\overset{-2}{S} \longrightarrow \overset{+2}{Cu} + \overset{+6}{SO_4^{2-}}$

oxidised    oxidised.

$n_1$(CuCu) = 1×2 = 2
$n_2$(S) = 8

n-factor = 8 + 2 = 10

eg: $Cu_3P \longrightarrow Cu^{2+} + PO_4^{3-}$

$n_1 = 1 \times 3 = 3$

$n_2 = 8$

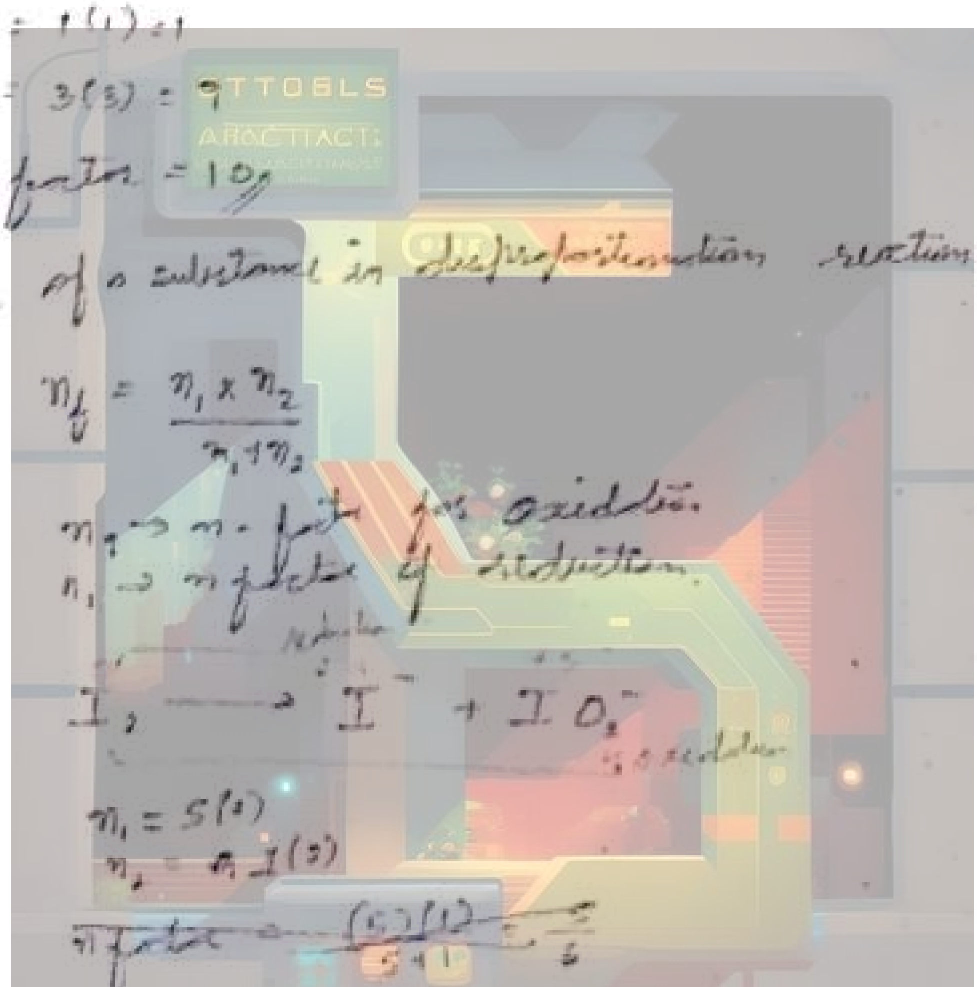
n-factor = 11

eg: $Fe(NO_3)_3 \longrightarrow Fe^{2+} + NO$

$n_1 = 1(1) = 1$

$n_2 = 3(3) = 9$

n-factor = 10



(4) n-factor of a substance in disproportionation reaction.

$$n_f = \frac{n_1 \times n_2}{n_1 + n_2}$$

$n_2 \to$ n-factor for oxidation

$n_1 \to$ n-factor of reduction.

eg: $I_2 \xrightarrow{\text{reduction}} I^- + IO_3^-$ oxidation

$n_1 = 5(2)$

$n_2 = 1(2)$

~~n-factor = $\frac{(5)(1)}{5+1} = \frac{5}{6}$~~

n-factor $= \frac{(10)(2)}{12} = \frac{20}{12} = \frac{10}{6} = \frac{5}{3}$

eg: $H_2O_2 \longrightarrow H_2O + O_2$

$n_1 = 2$

$n_2 = 2$

$n = \frac{2 \times 2}{2+2} = \frac{4}{4} = 1$

eg: $P_4 + NaOH \longrightarrow PH_3 + H_2PO_2^-$ (n-f of $P_4$)

$n_1 = 3(4) = 12$

$n_2 = 5(4) = 20$

$n\text{-}f(P_4) = \frac{20 \times 12}{20+12} = \frac{240}{32} = \frac{15}{2}$

eg: $H_3PO_3 \longrightarrow PH_3 + H_3PO_4$

$n_1 = 6(1) = 6$

$n_2 = (2)(1) = 2$

$n\text{-}f(H_3PO_3) = \frac{12}{8} = \frac{3}{2}$

(5) n-factor of species in which one element is either oxidised or reduced in more than one oxidation state

eg. $2Mn^{+7} \longrightarrow Mn^{2+} + Mn^{3+}$

$Mn^{+7} + 5e^- \longrightarrow Mn^{2+}$

$Mn^{+7} + 4e^- \longrightarrow Mn^{3+}$

$2Mn^{+7} + 9e^- \longrightarrow Mn^{2+} + Mn^{3+}$

$n\text{-}factor\ (Mn^{+7}) = \frac{9}{2} = 4.5$

eg: $3Mn^{4+} \longrightarrow 2Mn^{7+} + Mn^{5+}$

$e^-$ involved $= 19 - 12 = 7$

$n\text{-}f(Mn^{4+}) = 7/3$

$n\text{-}f(Mn^{7+}) = 7/2$

$n\text{-}f(Mn^{+5}) = 7$

Q4. find equivalent wt of underlined species.

(1) $\underline{H_2SO_4} + NaOH \longrightarrow NaHSO_4 + H_2O$

$\downarrow$

n-f = 1

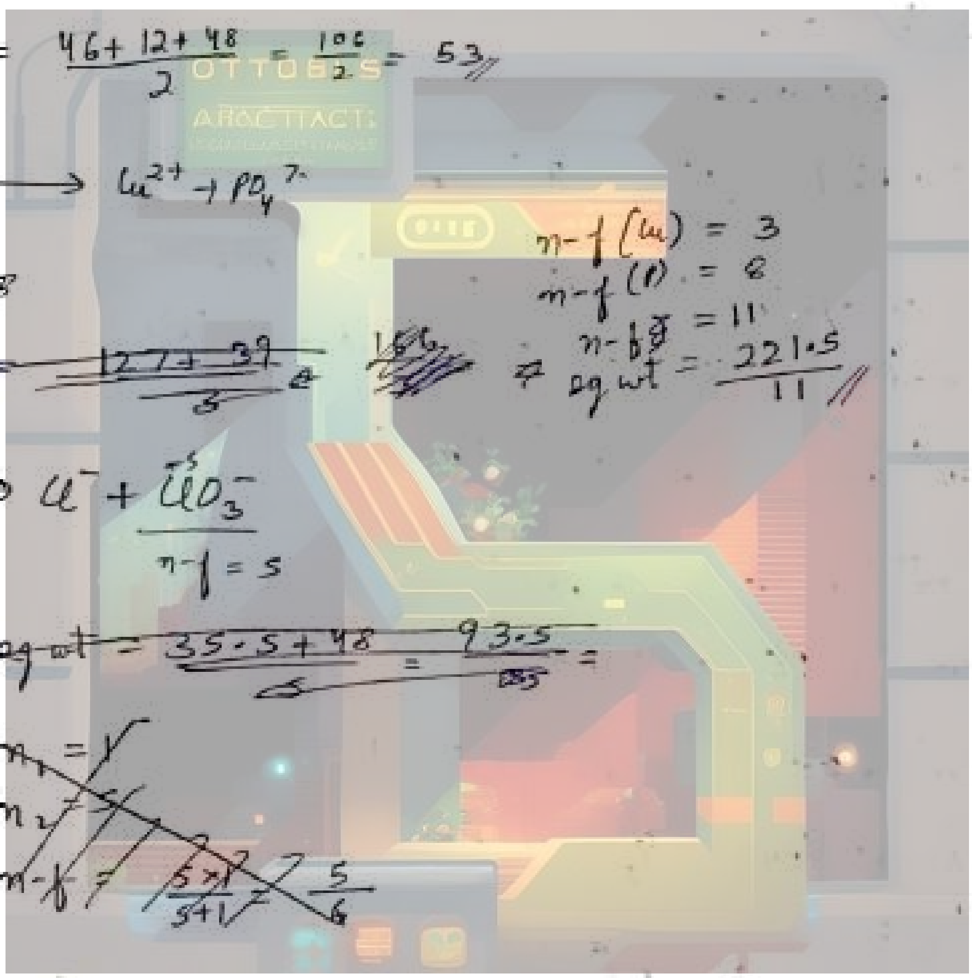
$eq\ wt = \frac{98}{1} = 98$

(2) $\underline{Na_2CO_3} + 2HCl \longrightarrow H_2CO_3 + 2NaCl$

$\downarrow$

n-f = 2

$eq\ wt = \frac{46+12+48}{2} = \frac{106}{2} = 53$



(3) $\underline{Cu_3P} \longrightarrow Cu^{2+} + PO_4^{3-}$

$\downarrow$

~~n-f = 8~~

$\cancel{eq\ wt = \frac{127+31}{8}}$

n-f (Cu) = 3

n-f (P) = 8

n-f = 11

$eq\ wt = \frac{221.5}{11}$

(4) $Cl_2 \longrightarrow Cl^- + \underline{\overset{+5}{Cl}O_3^-}$

n-f = 5

$\cancel{eq\ wt = \frac{35.5+48}{5} = \frac{93.5}{}}$

$\cancel{n_1 = 1}$

$\cancel{n_2 = 5}$

$\cancel{n\text{-}f = \frac{5\times1}{5+1} = \frac{5}{6}}$

$eq\ wt = \frac{93.5}{5} = 16.7$

Q5. Calculate n-factor for each reactant & Product in a balanced chemical reaction.

① $\overset{+1}{K_2}\overset{+6}{Cr_2}\overset{-2}{O_7} + 14\,HCl \longrightarrow 2KCl + 2CrCl_3 + 3Cl_2 + 7H_2O$

n-f = 6, n-f = $\frac{3}{7}$, n-f = 3, n-f = 3, n-f = 2, n-f = $\frac{6}{7}$

no. of $e^-$ involved = (3)(2) = 6

② $4\overset{0}{Zn} + 10\,HNO_3 \longrightarrow 4Zn(NO_3)_2 + NH_4NO_3 + 3H_2O$

2, $\frac{4}{5}$, 2, 8, $\frac{8}{3}$

no. of $e^-$ involved = (2)(4) = 8

③ $2K\overset{+7}{Mn}O_4 + 5K_2C_2O_4 + 16HCl \rightarrow 2\overset{+2}{Mn}Cl_2 + 10CO_2 + 12KCl + 8H_2O$

5, 2, $\frac{5}{8}$, 5, 1, $\frac{5}{6}$, $\frac{5}{4}$

no. of $e^- \rightarrow$ (5)(2) = 10

# Balancing of Redox Reaction

1. In Acidic Medium.

Ⓐ Ion-Electron / Half Reaction method

Q6. Balance the reaction in Acidic medium.

$$Fe^{2+} + Cr_2O_7^{2-} \longrightarrow Fe^{3+} + Cr^{3+} + H_2O$$

Step 1 → Break the reaction into two half reaction.

Oxidation half          Reduction Half

$Fe^{2+} \longrightarrow Fe^{3+}$ [Oxidation Half]

$Cr_2O_7^{2-} \longrightarrow Cr^{3+}$ [Reduction Half]

Step 2- Balance other atoms except H & O.

$$Fe^{2+} \longrightarrow Fe^{3+} \quad \text{[Oxidation Half]}$$

$$Cr_2O_7^{2-} \longrightarrow 2Cr^{3+} \quad \text{[Reduction Half]}$$

Step 3- Balance O atoms by adding $H_2O$.

$$Fe^{2+} \longrightarrow Fe^{3+} \quad \text{[Oxidation half]}$$

$$Cr_2O_7^{2-} \longrightarrow 2Cr^{3+} + 7H_2O \quad \text{[Reduction Half]}$$

Step-4 - Balance H atoms by adding $H^+$

$$Fe^{2+} \longrightarrow Fe^{3+} \quad \text{[Oxidation half]}$$

$$Cr_2O_7^{2-} + 14H^+ \longrightarrow 2Cr^{3+} + 7H_2O \quad \text{[Reduction Half]}$$

Step-5 Balance Charge on both eq

$$Fe^{2+} \longrightarrow Fe^{3+} + e^- \quad — (1) \quad \text{[Oxidation Half]}$$

$$\underset{(-2)}{Cr_2O_7^{2-}} + \underset{(+14)}{14H^+} + \underset{(-6)}{6e^-} \longrightarrow \underset{(+6)}{2Cr^{3+}} + 7H_2O \quad — (2) \quad \text{[Reduction Half]}$$

Step-6 Multiply both half Reaction by suitable factor to remove $e^-$.

$$6 \times (Fe^{2+} \longrightarrow Fe^{3+} + e^-) \quad \text{[Oxidation Half]}$$

$$1 \times (Cr_2O_7^{2-} + 14H^+ + 6e^- \longrightarrow 2Cr^{3+} + 7H_2O) \quad \text{[Reduction Half]}$$

$6 \times ① + 1 \times ②$

$6Fe^{2+} + Cr_2O_7^{2-} + 14H^+ + 6e^- \to 6Fe^{3+} + 6e^- + 2Cr^{3+} + 7H_2O$

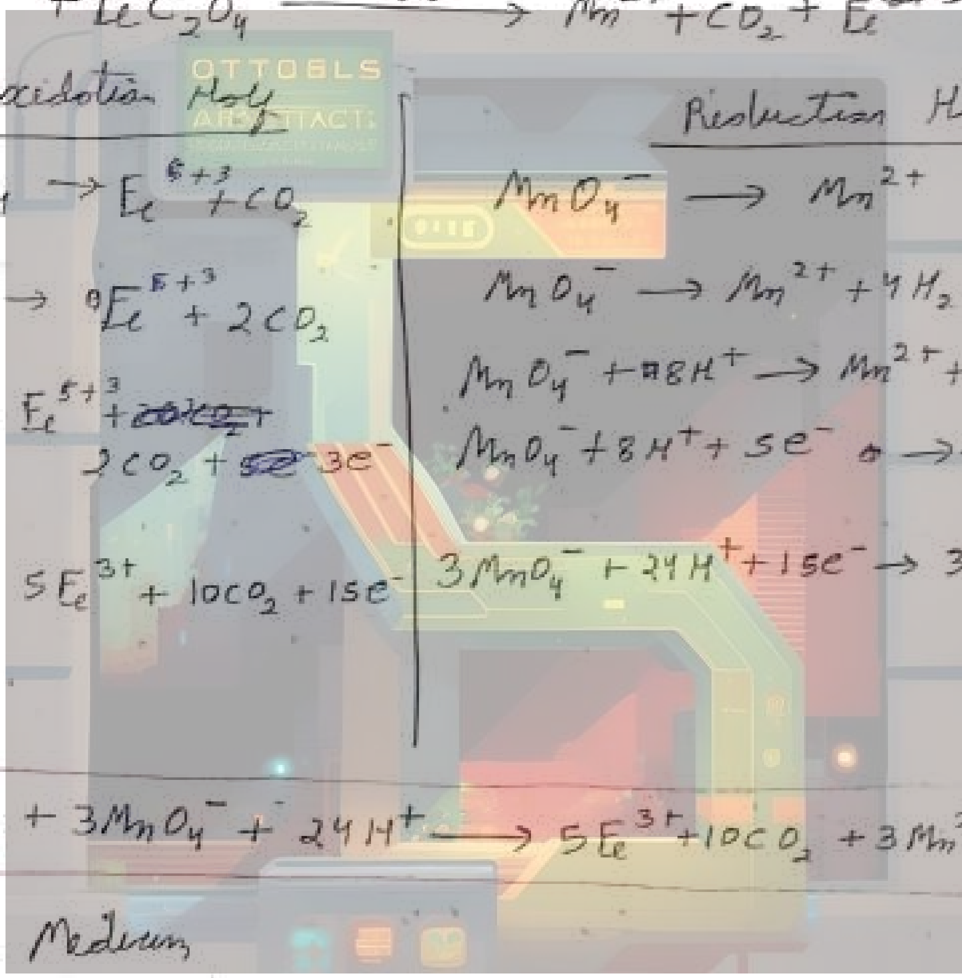
Acidic Medium

$$\boxed{6Fe^{2+} + Cr_2O_7^{2-} + 14H^+ \to 6Fe^{3+} + 2Cr^{3+} + 7H_2O}$$

Q7: Balance by Half Reaction method

In acidic medium

$\overset{+7}{Mn}O_4^- + \overset{+2}{Fe}C_2O_4 \xrightarrow{H^+} Mn^{2+} + CO_2 + Fe^{\cancel{5}+3}$



Oxidation Half

$FeC_2O_4 \to Fe^{\cancel{5}+3} + CO_2$

$FeC_2O_4 \to Fe^{\cancel{5}+3} + 2CO_2$

$FeC_2O_4 \to Fe^{\cancel{5}+3} + \cancel{2CO_2} + 2CO_2 + \cancel{5e^-}\,3e^-$

$5FeC_2O_4 \to 5Fe^{3+} + 10CO_2 + 15e^-$

Reduction Half

$MnO_4^- \to Mn^{2+}$

$MnO_4^- \to Mn^{2+} + 4H_2O$

$MnO_4^- + 8H^+ \to Mn^{2+} + 4H_2O$

$MnO_4^- + 8H^+ + 5e^- \to Mn^{2+} + 4H_2O$

$3MnO_4^- + 24H^+ + 15e^- \to 3Mn^{2+} + 12H_2O$

$$\boxed{5FeC_2O_4 + 3MnO_4^- + 24H^+ \to 5Fe^{3+} + 10CO_2 + 3Mn^{2+} + 12H_2O}$$

## 2. Basic Medium

Step1:- Balance the reaction in Acidic Medium

Step2:- Add $(OH^-)$ on both sides equal to no. of $H^+$ present on any side.

Step3:- Addition of $H^+$ & $OH^-$ will give $H_2O$

Step 4:- $OH^-$ will appear in final expression (which represent reaction is in basic medium).

H.W. 17-9-24

S-1

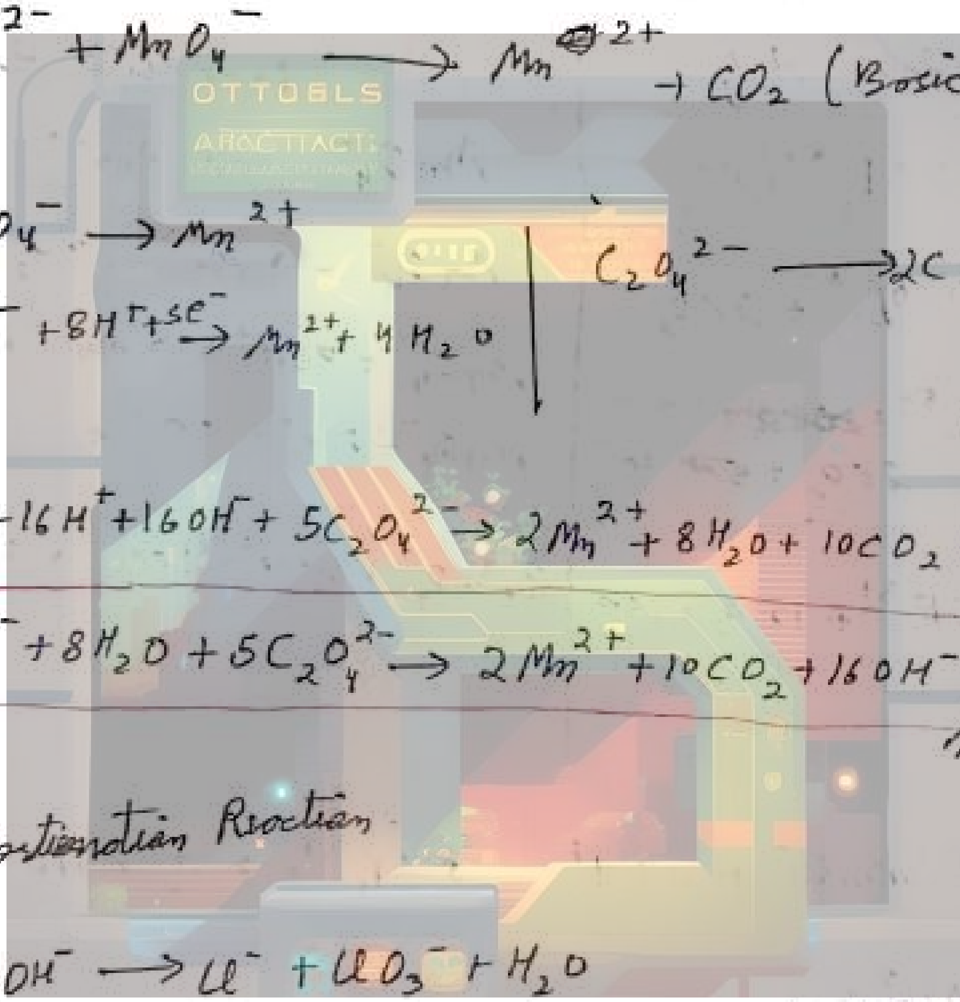
Q 6, 7, 8, 9, 10 – 15

O-1

~~16-27~~

21–27

Q8. $C_2O_4^{2-} + MnO_4^- \longrightarrow Mn^{2+} + CO_2$ (Basic Medium)



$MnO_4^- \longrightarrow Mn^{2+}$

$MnO_4^- + 8H^+ + 5e^- \longrightarrow Mn^{2+} + 4H_2O$

$C_2O_4^{2-} \longrightarrow 2CO_2 + 2e^-$

$2MnO_4^- + 16H^+ + 16OH^- + 5C_2O_4^{2-} \longrightarrow 2Mn^{2+} + 8H_2O + 10CO_2 + 16OH^-$

$$\boxed{2MnO_4^- + 8H_2O + 5C_2O_4^{2-} \longrightarrow 2Mn^{2+} + 10CO_2 + 16OH^-}$$

(B) Disproportionation Reaction

Q9. $Cl_2 + OH^- \longrightarrow Cl^- + ClO_3^- + H_2O$

Oxidation

$Cl_2 + 6H_2O \longrightarrow 2ClO_3^- + 12H^+ + 10e^-$

Reduction

$Cl_2 + 2e^- \longrightarrow 2Cl^-$

$6Cl_2 + 6H_2O \xrightarrow{+12OH^-} 2ClO_3^- + 10Cl^- + 12H^+ + 12OH^-$

$6Cl_2 + 12OH^- \longrightarrow 2ClO_3^- + 10Cl^- + 6H_2O$

$$\boxed{3Cl_2 + 6OH^- \longrightarrow ClO_3^- + 5Cl^- + 3H_2O}$$

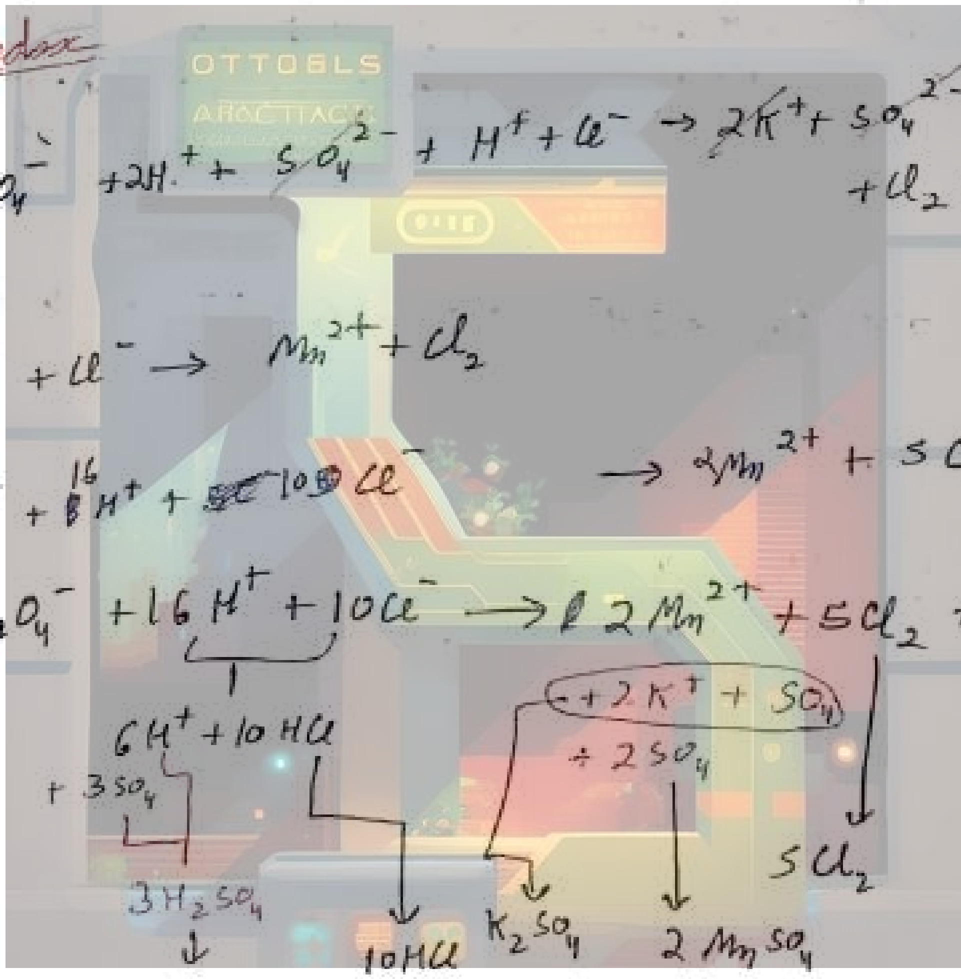
Q10. $KMnO_4 + \underline{H_2SO_4} + HCl \longrightarrow K_2SO_4 + MnSO_4 + Cl_2 + H_2O$

↳ Acidic Medium

~~Oxidation~~ ~~Reduction~~

~~$KMnO_4$~~

**Note** :- convert into ionic form & element's species which donot undergo redox



$K^+ + MnO_4^- + 2H^+ + SO_4^{2-} + H^+ + Cl^- \rightarrow 2K^+ + SO_4^{2-} + Mn^{2+} + SO_4^{2-} + Cl_2 + H_2O$

$MnO_4^- + Cl^- \rightarrow Mn^{2+} + Cl_2$

$2MnO_4^- + 16H^+ + \cancel{5Cl}\ 10Cl^- \rightarrow 2Mn^{2+} + 5Cl_2 + 8H_2O$

$2MnO_4^- + \underbrace{16H^+ + 10Cl^-}_{6H^+ + 10HCl} \longrightarrow 2Mn^{2+} + 5Cl_2 + 8H_2O$

$+2K^+ \rightarrow 2KMnO_4$

$+3SO_4$ → $3H_2SO_4$ → $3H_2SO_4$

$10HCl$

$+2K^+ + SO_4$ → $K_2SO_4$

$+2SO_4$ → $2MnSO_4$

$5Cl_2$

$8H_2O$

$$\boxed{2KMnO_4 + 3H_2SO_4 + 10HCl \longrightarrow K_2SO_4 + 2MnSO_4 + 5Cl_2 + 8H_2O}$$

Q11. $H_2SO_4 + NaI \longrightarrow Na_2SO_4 + I_2 + H_2S + H_2O$

$2H^+ + SO_4^{2-} + Na^+ + I^- \rightarrow 2Na^+ + SO_4^{-} + I_2 + 2H^+ + S^{2-} + H_2O$

$SO_4^{2-} + I^- \rightarrow I_2 + S^-$

$2I^- \longrightarrow I_2 + 2e^-$ $\qquad$ $SO_4^{2-} + 8H^+ \xrightarrow{+7e^-} S^- + 4H_2O$

$$14I^- + 2SO_4^{2-} + \cancel{8H}16H^+ \longrightarrow 7I_2 + 8H_2O + 2S^-$$
$$+14Na^+ \quad +7SO_4^{2-} \quad +2H^+ \quad +2H^+ \qquad +14Na^+ \quad +7SO_4^{2-} \quad +2H^+ \quad +2H^+$$

$$14NaI + 9H_2SO_4 + 2H^+ \longrightarrow 7NaSO_4 + 7I_2 + 2H_2S + 8H_2O$$

$e^- \rightarrow 14$

$n\text{-}f(H_2SO_4) = \frac{14}{9}$

② Oxidation No. Method.

Step-1 → Identify the atom undergoing change in oxidation no.

Step-2 → Find the n-factor of oxidation half & reduction half & cross multiply

$$\overset{+7}{Mn}O_4^- + Fe^{2+} \longrightarrow \overset{+2}{Mn}^{2+} + Fe^{3+}$$

reduction

oxidation

n-f = 5

n-f = 1

$$MnO_4^- + 5Fe^{2+} \longrightarrow Mn^{2+} + Fe^{3+}$$

Step-3 → Balance all other atoms except hydrogen & oxygens.

Step 4:- → Balance Oxygen by adding $H_2O$

Step 5 → Balance Hydrogen by adding $H^+$

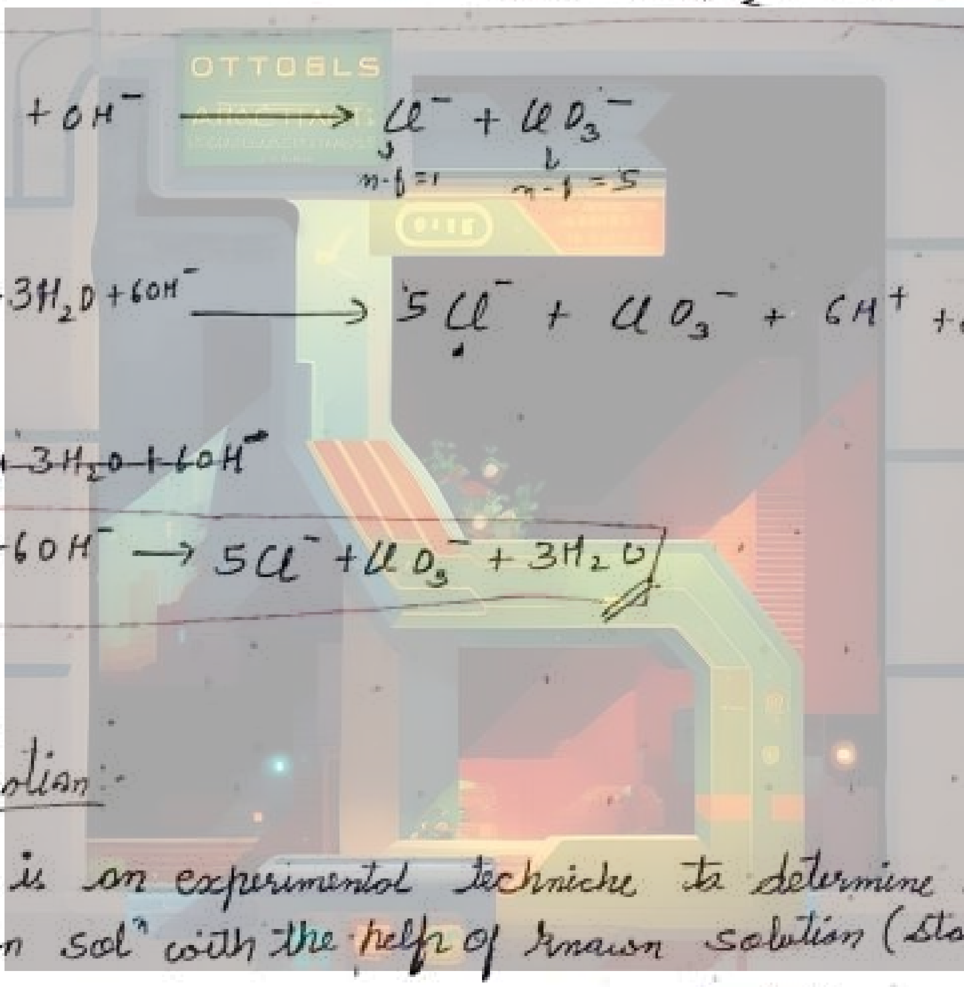
Step 6 → If the medium is basic then add $OH^-$ on Both sides equal to $H^+$ present in any side.

Q12. $Cr_2O_7^{2-} + 6I^- \xrightarrow{H^+} Cr^{3+} + I_2$

$\underset{n\text{-}f = 6}{\downarrow}$ $\quad$ $\underset{n\text{-}f = 1}{\downarrow}$

$Cr_2O_7^{2-} + 6I^- + 14H^+ \xrightarrow{H^+} 2Cr^{3+} + 3I_2 + 7H_2O$

$$\boxed{Cr_2O_7^{2-} + 6I^- + 14H^+ \xrightarrow{H^+} 2Cr^{3+} + 3I_2 + 7H_2O}$$




Q13. $Cl_2 + OH^- \longrightarrow Cl^- + ClO_3^-$

$n\text{-}f = 1 \quad n\text{-}f = 5$

$6Cl_2 + 3H_2O + 6OH^- \longrightarrow 5Cl^- + ClO_3^- + 6H^+ + 6OH^-$

~~$Cl_2 + 3H_2O + 6OH^-$~~

$$\boxed{3Cl_2 + 6OH^- \longrightarrow 5Cl^- + ClO_3^- + 3H_2O}$$

# Titration

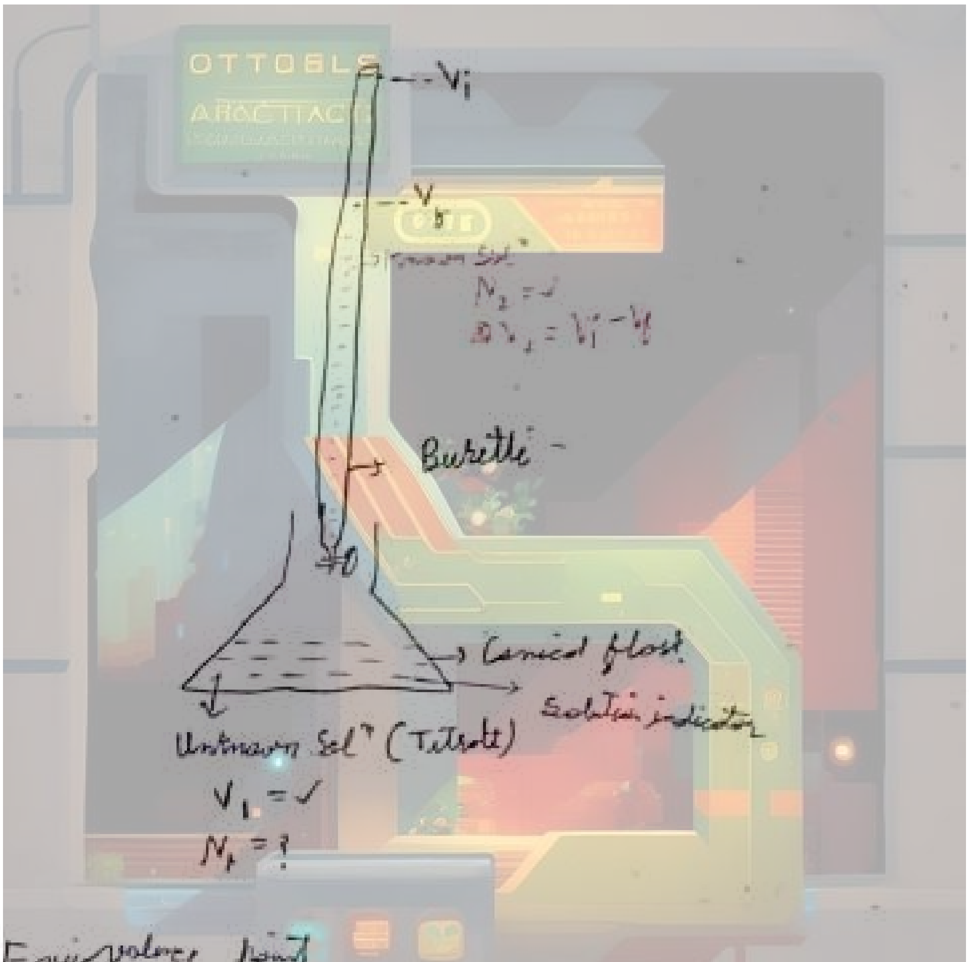
- Titration is an experimental techniche to determine the concentration of unknown sol$^n$ with the help of known solution (Standard Sol$^n$).
- These reactions are based on law of equivalent

$aA + bB \to cC + dD$

no. of equivalent of A reacted = equivalents of B reacted = equivalents of C formed = equivalents of D formed

Procedure:-

- A given amount of unknown solⁿ (Titrate) is taken in a conical flask & standard solⁿ (Titrant) is added drop by drop from Burette, reaction takes place between these two solⁿs.
- At the equivalence point (when reaction is completed), the indicator changes its color & volume of ~~sto~~ standard solⁿ used in the reaction is measured.




At Equivalence point

Eq. of Titrant = equivalents of Titrate

$$N_1 V_1 = N_2 V_2$$

$$\boxed{N_1 = \frac{N_2 V_2}{V_1}}$$

Titration

Acid - Base Titration

Acid + Base $\rightarrow$

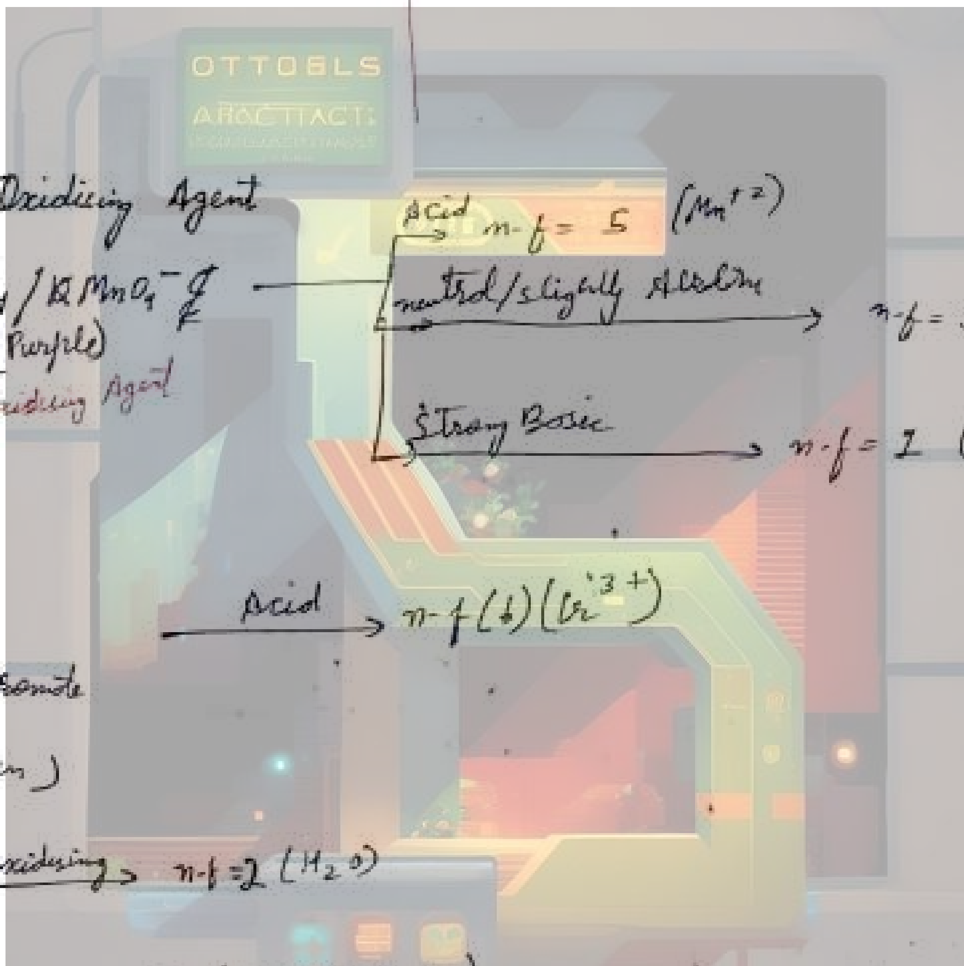
no. of equivalents of Base = no. of equivalents of Acid

Redox ~~Re~~ Titration

$O \cdot A + R \cdot A \rightarrow$

at equivalence Point

$(eq)_{O \cdot A} = (eq)_{R \cdot A}$




Common Oxidising Agent

① ~~KM~~ $KMnO_4 / KMnO_4^-$

~~Colours~~ (Purple)

Strongest oxidising Agent

$\xrightarrow{\text{Acid}}$ $n\text{-}f = 5$ $(Mn^{+2})$

$\xrightarrow{\text{neutral/slightly Alkaline}}$ $n\text{-}f = 3$ $(MnO_2)$

$\xrightarrow{\text{Strong Basic}}$ $n\text{-}f = 1$ $(MnO_4^{2-})$

② $K_2Cr_2O_7$ (Potassium Dichromate or Dichromate ion) $\xrightarrow{\text{Acid}}$ $n\text{-}f\ (6)\ (Cr^{3+})$

③ $H_2O_2$ $\xrightarrow{\text{Oxidising}}$ $n\text{-}f = 2$ $(H_2O)$

④ $XO_3^- \longrightarrow X^-$ $(X \rightarrow Cl, Br, I)$

$n\text{-}f = 6$

⑤ $PbO_2 \longrightarrow Pb^{2+}$

$n\text{-}f = 2$

⑥ $CrO_4^{2-} \xrightarrow{\text{Acidic}} Cr^{3+}$
(Chromate ion)
$n\text{-}f = 3$

⑦ $O_3 \xrightarrow{H^+} O_2 + H_2$
$n\text{-}f = 2$

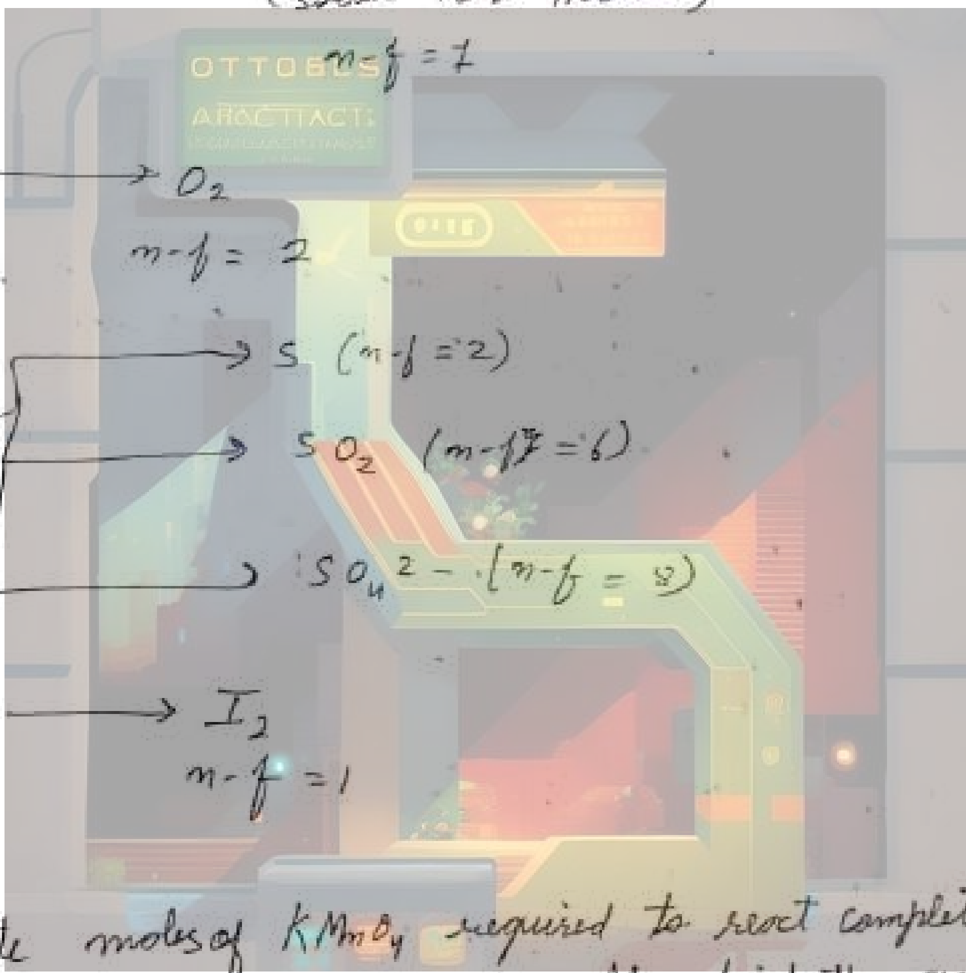
## Common Reducing Agents

① $C_2O_4^{2-} \xrightarrow{\text{Acidic}} CO_2$
(Oxalate ion)
$n\text{-}f = 2$

② $Na_2S_2O_3 / S_2O_3 \longrightarrow Na_2S_4O_6$
(Hypo sol$^n$) (Sodium Tetra Thionate)
$n\text{-}f = 1$

③ $H_2O_2 \longrightarrow O_2$
$n\text{-}f = 2$

④ $H_2S$ (Acidic)
$\longrightarrow S \quad (n\text{-}f = 2)$
$\longrightarrow SO_2 \quad (n\text{-}f = 6)$
$\longrightarrow SO_4^{2-} \quad (n\text{-}f = 8)$



⑤ $KI \longrightarrow I_2$
$n\text{-}f = 1$

Q14. Calculate moles of $KMnO_4$ required to react completely with 90g $H_2C_2O_4$ in Acidic medium. Also find the volume (lit) of $CO_2$ produced at STP.

equivalents of $H_2C_2O_4$ = 2

equivalents of $KMnO_4$ = 2

moles = $2/5$

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

$MnO_4^- + H_2\overset{+3}{C_2}O_4 \xrightarrow{H^+} Mn^{2+} + \overset{+4}{C}O_2$

equivalents of $CO_2$ = 2

moles = 2

Vol = $\boxed{44.8\ l}$

Q15. Calculate vol$^n$ (in ml) of 0.1 M $KMnO_4$ sol$^n$ to completely react with 50 ml, 0.1 M $H_2S$ in acidic medium, $H_2S$ is oxidised to $SO_2$.

$$MnO_4^- + H_2\overset{-2}{S} \xrightarrow{H^+} Mn^{2+} + \overset{+4}{S}O_2$$

$$\underset{n\text{-}f=5}{\downarrow} \quad \underset{n\text{-}f=6}{\downarrow} \quad \underset{n\text{-}f=5}{\downarrow} \quad \underset{n\text{-}f=6}{\downarrow}$$

$$(0.1)(5)(V) = (50)(0.1M)(6)$$

$$V = \frac{50 \times 6}{5}$$

$$\boxed{V = 60 ml}$$

Q16. Find the mass (g) of $Fe_3O_4$ that will react completely with 25 ml, 0.3 M $K_2Cr_2O_7$. (max possible oxidation state of iron is +3) (At wt Fe = 56)

$$\overset{+1}{K_2}Cr_2\overset{-2}{O_7} + \overset{+8/3}{Fe_3}O_4 \longrightarrow \overset{+3}{Cr^{3+}} + \overset{+3}{Fe^{3+}}$$

$$n\text{-}f = 6 \qquad n\text{-}f = 3\left(3 - \frac{8}{3}\right) = 3 = 1$$

$$\text{equivalents}(Cr_2O_7^{-2}) = (0.025)(0.3)(6)$$

$$eq\ Fe_3O_4 = 0.045$$

~~mass = 0.045 × 56 (120)~~

~~mass = 2.520~~

~~mass =~~

$$mass = (0.045)(232)$$

$$\boxed{= 10.44}$$

Q17. Calculate of NaOH required to react completely with 1 mol HCl and 3 mole $H_3PO_4$.

~~$NaOH + HCl \longrightarrow NaCl + H_2O$~~

equivalents of $(HCl) = 1$

equivalents of $(H_3PO_4) = (3)(3) = 9$

equivalents of $(NaOH)$ = moles of NaOH
= equivalents of HCl + equivalents of $H_3PO_4$

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

Q18. An Equimolar mixture of FeO & $Fe_{0.95}O$ reacts completely with 0.5 l, 1 M $KMnO_4$ in acidic medium find total moles of FeO & $Fe^{3+}$ ion produced.

$\overset{+7}{MnO_4^-} + \overset{+2}{Fe}O + Fe_{0.95}O \longrightarrow Fe^{3+} + Mn^{+2}$

n-f = 5 | n-f = 1 | n-f = $\frac{17}{19}$ | n-f = $\frac{\frac{17}{19}}{\frac{36}{19}} = \frac{17}{36}$

no. of equivalents = 2.5

no. of equivalents of FeO = 2.5 − equivalents of $Fe_{0.95}O$

$\boxed{\cancel{\text{moles FeO} = 2.5}}$ $x = 2.5 - \frac{17x}{36}$

~~no. of equivalents~~

$36x = 90 - 17x$

$x = \frac{90}{53}$

moles $Fe^{3+}$ $= \frac{2.5}{17} \times 36$

$= \frac{18 \times 5}{17}$

$= \frac{90}{17}$

$MnO_4^- + FeO + Fe_{0.75}O \longrightarrow Fe^{3+} + Mn^{2+}$

$\downarrow$ n-f = 5 $\quad$ $\downarrow$ n-f = 1 $\quad$ $\downarrow$ n-f = $\left(3 - \frac{2}{0.75}\right) 0.75$

$\frac{0.85 \times 1}{1.85} = \frac{85}{185} = \frac{17}{37}$

n-f = 2.25 - 2

n-f = 0.25

equivalents ($MnO_4^-$) = 2.5

eq($MnO_4^-$) = eq(FeO) + eq($Fe_{0.75}O$)

$x = 2.5 - 0.85x$

$1.85x = 2.5$

$x = \frac{2.5}{18.5}$

$x = \frac{5}{3.7}$

$\boxed{x = 1.35}$

~~$n_{Fe^{3+}} \left(\frac{17}{37}\right) = 2.5$~~

~~$n_{Fe^{3+}} = \frac{2.5 \times 37}{17}$~~

~~$n_{Fe^{3+}} = \frac{185}{34}$~~

~~$n_{Fe^{3+}} = 5.4$~~

POAC

$x + 0.75x = n_{Fe^{3+}}$

$\boxed{n_{Fe^{3+}} = \frac{1.75 \times 2.5}{1.85}}$

Q19. find Molarity of $H_2O_2$ soln if 20ml react complete with 20ml 2M $KMnO_4$ in Acidic Medium.

$MnO_4^- + H_2O_2 \longrightarrow Mn^{2+} + H_2O$

n-f = 5 $\quad$ n-f = 2

no. of eq = $\frac{20 \times 2 \times 5}{1000}$ = 2 × mole ($H_2O_2$)

0.1 = mole ($H_2O_2$)

$M = \frac{0.1}{0.02}$

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

$\boxed{M = 5 \text{ molar}}$

Q20. 6.96 g of mixture $Fe_2O_3$ & $FeO$ reacts completely with 1.58 g $KMnO_4$ in Acidic Medium find the weight of (g) of $FeO$ present in sample. (wt Atom Fe = 56, K = 39, Mn = 55)

$MnO_4^- + Fe_2O_3 + FeO \longrightarrow Mn^{2+} + Fe^{3+}$

$\downarrow$ n-f = 5 $\quad$ $\downarrow$ n-f = 0 $\quad$ $\downarrow$ n-f = 1

equivalents of $MnO_4^- = \frac{1.58}{158} \times 5 = 5$

~~moles of FeO = $\frac{158 \times 5}{119}$~~

~~mass FeO = $\frac{158 \times 5}{119}$~~

~~moles = 5~~

mass FeO = 5 × 72

= 360 g

Q21. 40 ml of 0.5 M $Ce^{4+}$ is required to completely react 10 ml of 1 M $Sn^{2+}$ to $Sn^{4+}$ what is O.S. of Cerium in reduction product

Q22. 6 mole of sol$^n$ $A^{n+}$ requires 2 mole $Cr_2O_7^{2-}$ ions for oxidation of $A^{n+}$ to $AO_3^-$ in Acidic Medium. The value n is?

Q23. 50 ml of Acidic Sol$^n$ 0.25 M $K_2Cr_2O_7$, 30 ml of 0.4 M $K_2C_2O_4$ and 120 ml of 0.2 M $Fe^{3+}$ are added together. Compute the Molarities of $Fe^{3+}$ ions & $Cr_2O_7^{2-}$ ions in the final sol$^n$?

Q24. 5.1 g sample of $H_2O_2$ solⁿ containing x% $H_2O_2$ by wt. requires x ml of $K_2Cr_2O_7$ solⁿ for complete oxidation under acidic medium. What is the molarity of $K_2Cr_2O_7$ solⁿ.

H.W. 21-7-24

Race. 12-13

S-1 1 to 31

S-2 1 to 4

5 to 18

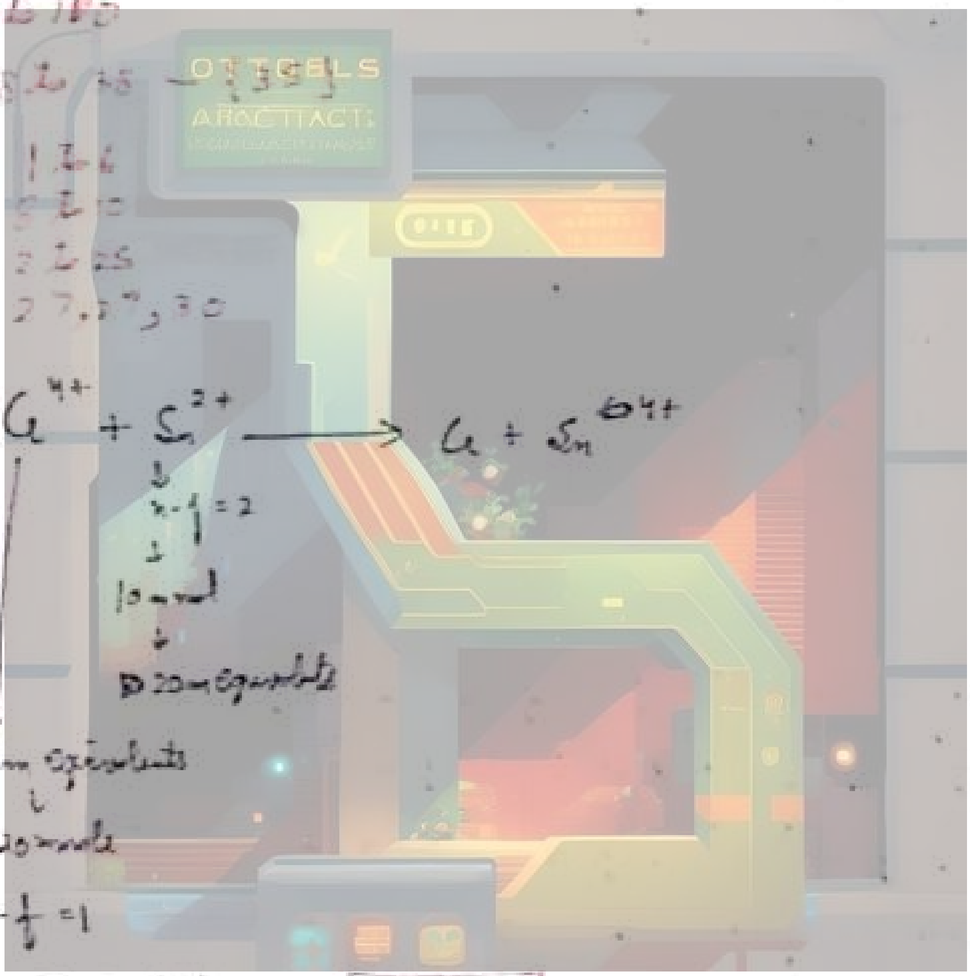
O-1 28 to 35

JM - 1 to 6

8 to 10

22 to 25

27, 29, 30



Ans 21

$$Cr^{4+} + Sn^{2+} \longrightarrow Cr + Sn^{4+}$$

n-f = 2

10 mol

20 m equivalents

20 m equivalents

20 moles

n-f = 1

O.S in product = $\boxed{+3}$

Ans 22

$$A^{n+} + Cr_2O_7^{2-} \longrightarrow \overset{+5}{A}O_3^- + Cr^{3+}$$

n-f = 6

equivalents = 12

$A^{n+}$ = (6)(n-f) = 12

n-f = 2

+5 - n = 2

5 - 2 = n

$\boxed{n = 3}$

150

Ans 23.

$$K_2Cr_2O_7 + K_2\overset{+3}{C_2}O_4 + Fe^{2+} \longrightarrow Cr^{3+} + Fe^{3+} + \overset{+4}{C}O_2$$

$n\text{-}f = 1$

$n\text{-}f = 2$

$(12.5 \times 6)$ m equivalents

24 m equivalents

24 m mol

$V_f = 200$ ml

End $K_2Cr_2O_7 = 51$ m equivalents $= \frac{51}{6}$ m mol $= \frac{27}{6}$ m mol

$Fe^{3+} = 24$ m mol

$[Fe^{3+}] = \frac{24}{200} = \boxed{0.12\,M}$

$[K_2Cr_2O_7] = \frac{27}{6 \times 200} = \boxed{0.0225\,M}$

Ans 24.

wt $H_2O_2 = \frac{5.1x}{100}$ g

$$K_2Cr_2O_7 + H_2O_2 \longrightarrow O_2$$

$n\text{-}f = 6$ $n\text{-}f = 2$

~~mol $K_2Cr_2O_7$ = 1 mol $H_2O_2$~~

mol $H_2O_2 = \frac{5.1x}{100} \times \frac{1}{34} \times 2$

mol $K_2Cr_2O_7 = \frac{5.1x}{3400 \times 6} \times 2$

$[K_2Cr_2O_7] = \frac{5.1x}{3400 \times 6} \times \frac{1000}{x} \times 2$

$= \frac{51}{204} = \frac{1}{4} = \boxed{0.25\,M}$

# Back Titration

→ This titration method is used to determine the excess reagent. It is also used to determine the % Purity of substance.


eq (Acid) = eq (Base)

eq($H_2SO_4$) + eq(HCl) → eq (NaOH)

Q25. 10g $CaCO_3$ was dissolved in 250ml of 1M HCl, what volume of 2M KOH would be required to neutralize excess HCl.

equivalents HCl = 250 mili eq = 0.25

equivalents $CaCO_3$ = 0.1 (2) = 0.2

equivalents KOH = 0.05

moles = 0.05

volume = $\frac{0.05}{2}$ = 0.025 l

= 25ml

MII

$CaCO_3$ + HCl

$(eq)_{CaCO_3} = (eq)_{HCl\ used}$

mol × n f = $n_{HCl\ used}$ × nf

$\left(\frac{10}{100}\right) \times 2 = n_{HCl\ used} \times 1$

$n_{HCl\ used}$ = 0.2 mole

Total mole of HCl = 1 × 0.25 = 0.25 mol

eq (Remaining of HCl) = (eq) KOH

(0.05) (1) = 2 × $V_{(l)}$ × 1

$V_{ml} = \frac{0.05}{2} = \frac{50}{2} = \boxed{25\ ml}$

Q26. 20g sample of ~~BaSO~~ $Ba(OH)_2$ is dissolved in 10ml of 0.5N HCl sol$^n$. The excess of HCl was titrated with 0.1 N NaOH. Volume of NaOH used is 20 $cm^3$. Calculate % $BaSO_4$ in sample. ($Ba = 137u$)

$\cancel{\left(\frac{20}{171}\times 2\right)}+\Big[$

$HCl = 5\ meq$

$NaOH = 2\ meq$

$Ba(OH)_2 = 3\ meq$

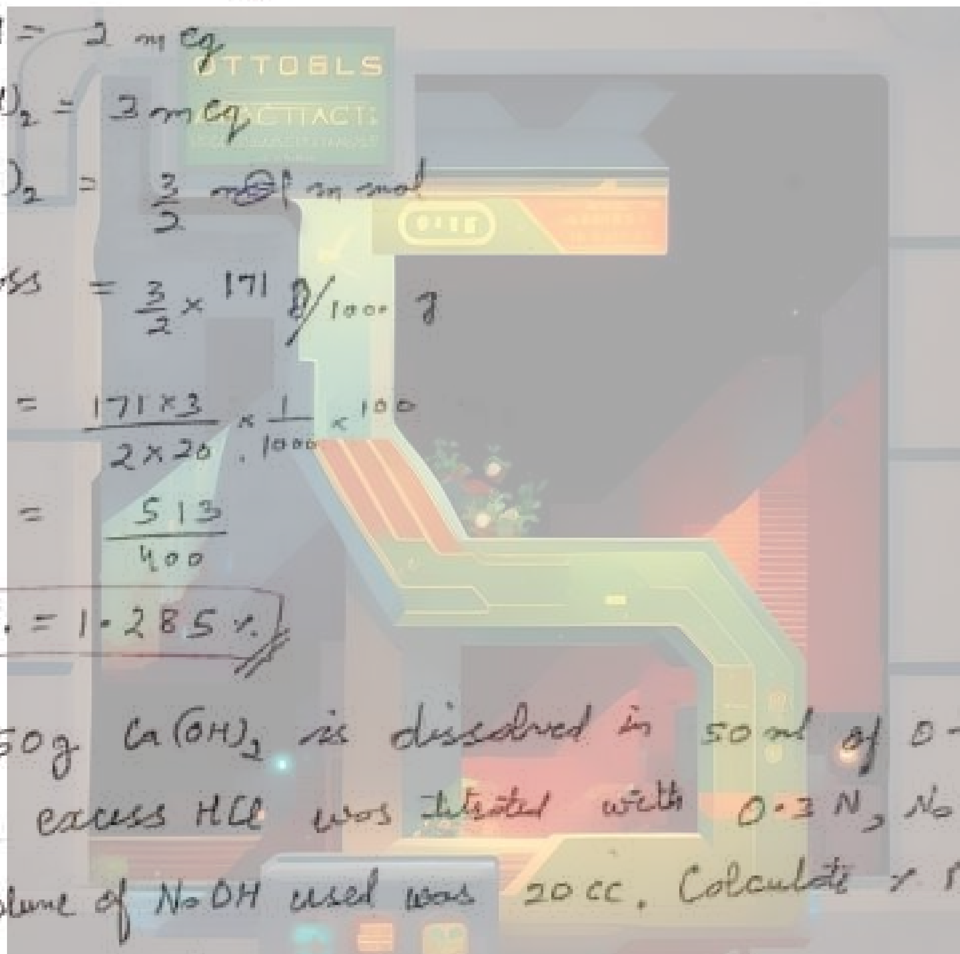
$Ba(OH)_2 = \frac{3}{2}\ m\ mol$

$mass = \frac{3}{2}\times 171/1000\ g$

$\% = \frac{171\times 3}{2\times 20}\times\frac{1}{1000}\times 100$

$\% = \frac{513}{400}$

$\boxed{\% = 1.285\%}$



Q27 50g $Ca(OH)_2$ is dissolved in 50ml of 0.5N HCl sol$^n$ the excess HCl was titrated with 0.3 N, NaOH. The Volume of NaOH used was 20cc. Calculate % purity of $Ca(OH)_2$

$NaOH = 6\ meq$

$HCl = 25\ meq$

$Ca(OH)_2 = 19\ meq$

$Ca(OH)_2 = \frac{19}{2}\ m\ mol$

$Ca(OH)_2 = \frac{19}{2}\times 74$

$\% = \frac{19\times 37}{50\times 1000}\times 100$

$\% = \frac{703}{500} = \boxed{1.405\%}$

// Estimation of Iodine

① Iodimetry

→ Used to find out the amount of Reducing Agent (R.A)

$$RA + I_2 \longrightarrow I^- + \text{Product}$$

i) $I_2$ is taken in excess

ii) Left $I_2$ from above reaction is estimated by Hypo sol$^n$ ($Na_2S_2O_3$)

$$\underset{n=2}{I_2} + Na_2\overset{+2}{S_2}O_3 \longrightarrow NaI + Na_2\overset{+2.5}{S_4}O_6$$

$n=1$

Q) 8. when $Na_2C_2O_4$ (Sodium Oxalate) reacted with 3 moles of $I_2$, left $I_2$ requires 0.5M, 2 L $Na_2S_2O_3$ sol$^n$. find moles of $Na_2C_2O_4$ initially taken.

$Na_2S_2O_3 = 1\ eq$

$I_2 = 3\ mol$

$I_2$ left $= 3 - (1)(2)$

$= 6 - 1$

$= 5\ eq$

$Na_2C_2O_4 = 5\ eq$

$= \frac{5}{2}$ mol

$\boxed{= 2.5\ mol}$

H.W. 24-9

S1 - Back Titration

JA

② Iodometry

→ used to determine amount of O.A (Oxidising Agent)

$$O.A + I^- \longrightarrow I_2 + \text{Product}$$

$I^-$: n-f = 1; $I_2$ (formed)

formed

$$I_2 + Na_2S_2O_3 \longrightarrow NaI + Na_2S_4O_6$$

$I_2$: n-f = 2; $Na_2S_2O_3$: n-f = 1

Q.27. 50 ml $KMnO_4$ solⁿ is mixed with excess of KI solⁿ. The liberated $I_2$ requires 30 ml, 0.1 M $Na_2S_2O_3$ for titration. find Normality of $KMnO_4$ solⁿ used.

equivalents($Na_2S_2O_3$) = $30 \times 0.1 \times 1$
= 3 meq

equivalents $I_2$ = 3 meq

equivalents $KMnO_4$ = 3 meq

$N = \frac{3}{50}$ N

$\boxed{= 0.06\,N}$

Q. A certain amount of $KIO_3$ (O.A) reacts with excess KI. The liberated $I_2$ requires 50 ml 2M hypo solⁿ for titration. Find moles of $KIO_3$ used.

$$\overset{+5}{KIO_3} + \overset{-1}{KI} \longrightarrow \overset{0}{I_2}$$

$KIO_3$: $n_f = 5$, $x$ moles; KI: $n_f = 1$

$n_f = \frac{10+2}{12} = \frac{5}{3}$

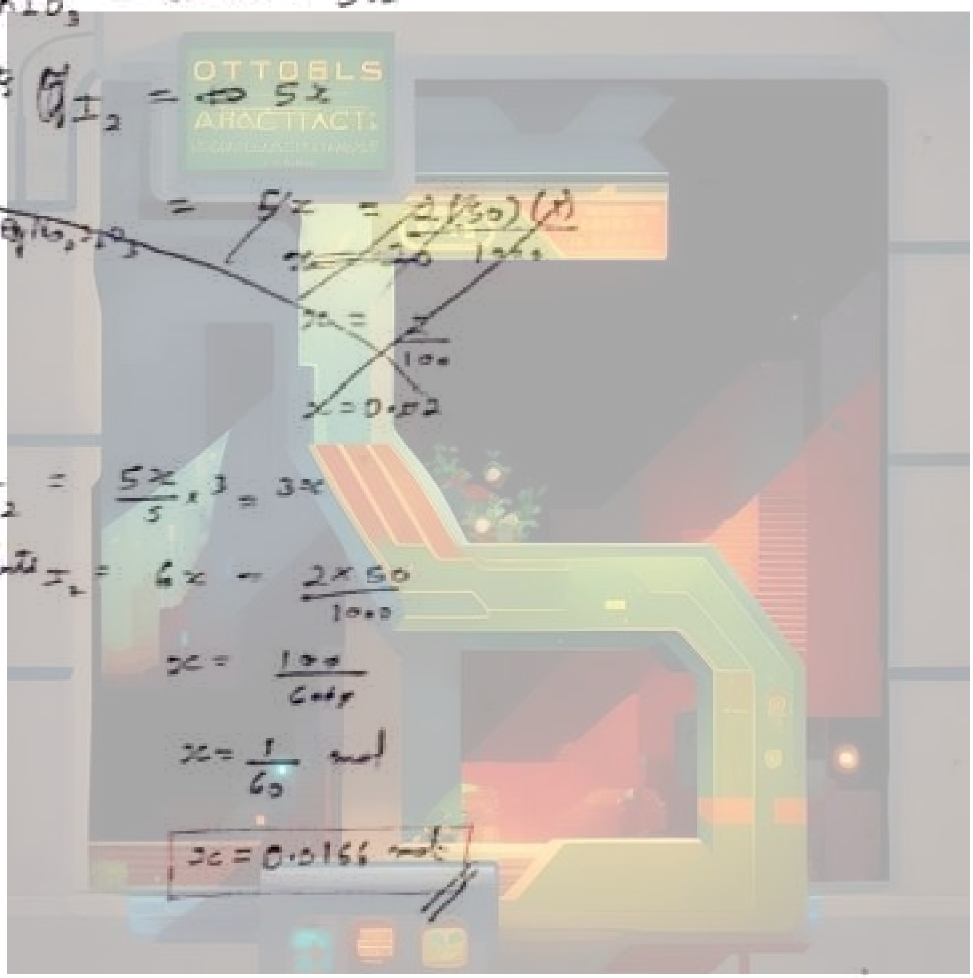
$\text{equivalents}_{KIO_3} = (x)(5) = 5x$

$\text{equivalents of } I_2 = 5x$

~~equivalents $= 5x = \frac{2(50)(x)}{1000}$~~

~~$x = \frac{2}{100}$~~

~~$x = 0.52$~~




moles $n_{I_2} = \frac{5x}{5} \times 3 = 3x$

$\text{equivalents}_{I_2} = 6x = \frac{2 \times 50}{1000}$

$x = \frac{100}{6000}$

$x = \frac{1}{60}$ mol

$\boxed{x = 0.0166 \text{ mol}}$

## Hardness of Water

→ A sample of water containing soluble salt of calcium or magnesium is called Hard water.

→ Hard water does not give lather with soap it forms scum or precipitate.

$$2C_{17}H_{35}COO^-Na^+ + Ca^{2+} \longrightarrow (C_{17}H_{35}COO)_2Ca + 2Na^+$$

Scum or PPt

or $Mg^{2+}$

$$\longrightarrow (C_{17}H_{35}COO)_2Mg + 2Na^+$$

Hardness of water

**Temporary Hardness**

→ It is due to the presence of bicarbonates of 'Ca' & 'Mg'

→ It can be easily removed by

a) ~~By~~ Boiling :-

~~Ca(HCO₃)₂~~

$$Ca(HCO_3)_2 \xrightarrow{\Delta} CaCO_3 \downarrow + CO_2 + H_2O_{(l)}$$

white PPt

(Separated by Filter)

$$Mg(HCO_3)_2 \xrightarrow{\Delta} MgCO_{3(s)} \downarrow + CO_2 + H_2O$$

white PPt

↳ filter

b) Clark's process → To remove temporary hardness on large scale

$$Ca(HCO_3)_2 + CaO \rightarrow 2CaCO_3 + H_2O$$

$$Ca(HCO_3)_2 + Ca(OH)_2 \rightarrow 2CaCO_3 \downarrow + 2H_2O$$

**Permanent Hardness**

→ It is due to presence of sulphates $(SO_4^{2-})$ ~~or~~ & Chlorides $(Cl^-)$ of Ca & Mg

→ Cannot be removed by simple boiling

→ It can be removed in industries by

A) washing soda :-

$$CaCl_2 + Na_2CO_3 \rightarrow CaCO_3 \downarrow + 2NaCl$$

$$CaSO_4 + Na_2CO_3 \rightarrow CaCO_3 \downarrow + Na_2SO_4$$

$$Ca(HCO_3)_2 + Na_2CO_3 \rightarrow CaCO_3 + 2NaHCO_3$$

b) Calgon :-

Calgon is a commercial name of Sodium Hexa meta phosphate which may be represented by as $Na_2[Na_4(PO_3)_6]$

$$2Ca^{2+} + Na_2[Na_4(PO_3)_6] \rightarrow Na_2[Ca_2(PO_3)_6] + 4Na^+$$

$$\downarrow$$

$$2Na^+ + [Ca(PO_3)]$$

c) Permutit or (Zeolite)

→ Permutit is the name of Sodium Aluminium ortho silicate $[Na_2Al_2Si_2O_8 \cdot xH_2O]$

Permanent Hardness:-

$$Na_2Al_2Si_2O_5 \cdot xH_2O + Ca^{2+} \rightarrow CaAl_2Si_2O_8 \downarrow + 2Na^+ + xH_2O$$

Q.31. Calculate wt of CaO required to remove the hardness of 1000 l ($1 m^3$) of $H_2O$ with 1.62 g $Ca(HCO_3)_2$ per lit.

wt of $Ca(HCO_3)_2 = 1.62 \times 1000$
$= 1620$ g

$n_{Ca(HCO_3)_2} = \frac{1620}{162} = 10$ mol

$n$ CaO $=$ 10 mol

wt CaO $= 10 \times 56$

$\boxed{= 560 \text{ g}}$

Note:- Permanent Hardness

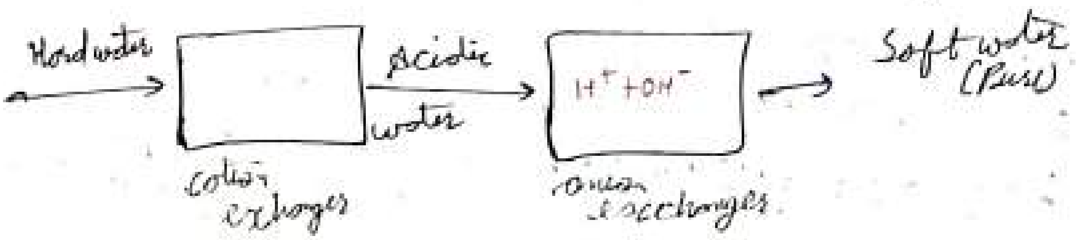
d) Ion-exchange Resin

Cation exchanger → Has giant Organic molecule have $-SO_3H$, $-COOH$ grp.

→ removes cations like $Ca^{2+}$, $Mg^{2+}$, $Na^+$ replaces it to it with $H^{\oplus}$

Anion exchanger → has giant Organic molecule have $-NH_2$, $-OH$ grp

→ removes anions such as $Cl^-$, $SO_4^{2-}$ & replace with $OH^-$



# Degree of Hardness of water (EHAS) ($\eta$)

→ Measure in terms of PPM of $CaCO_3$

→ It is defined as number of parts of $CaCO_3$ by mass Resist in $10^6$ parts of mass of water whose equivalent is equal to the gram equivalent of various calcium and magnesium salts.

$$\eta = \frac{\text{wt of } CaCO_3}{\text{wt of water sample}} \times 10^6$$

note:- If wt of water is not given the assume density of water to be 1 g/ml if volume is given.

Q.32. ~~1l of water of~~ 1l sample of water contains 9.5 mg of $MgCl_2$, 16.2 mg of $Ca(HCO_3)_2$ and 5.85 mg of NaCl, find.

i) Degree of Temporary Hardness

ii) Degree of ~~[illegible]~~ Hardness.

equivalents of $\cancel{MgCl_2} = Ca(HCO_3)_2 = \frac{16.2}{162} = 0.1$ meq

mass of $CaCO_3 = 100 \times 0.1 = 10$ mg $= 10^{-2}$ g

$\cancel{\eta(\text{temp}) = \frac{10}{1000} \times 10^6 = 10^6 \times 10^{-2} = 10^4}$

$\eta(\text{temp}) = 10^{-2} \times 10^6 \times 10^{-3} = \boxed{10\ PPM}$ i)

$\eta(\text{permanent}) = \boxed{10\ PPM}$

$\eta = 10 + 10 = \boxed{20\ PPM}$ ii)


OTTOBLS
ARACTTACT:


OTTOBLS


OTTOBLS
ARACTTACT: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OTTOBLS

# ☆ Ideal Gas ☆

Characteristics of gases :-

- The Gaseous state is characterised by following physical properties.

1. Gases are <u>Highly compressible.</u>
2. Gases exerts pressure equally in all directions.
3. Gases have much lower density than solid & liquid.
4. The volume & the shape of gases are not fixed. These aquire volume & shape of the container.
5. Gases mix evenly & completely in all proportions without any mechanical method.
6. Simplicity of gases is due to the fact that force of interaction between their molecules are negligible

$\boxed{PV = nRT}$ → ideal gas equation.

P = Pressure of Gas
V = Volume of ~~a~~ Gas
n = no. of moles of Gas
R = ~~Other~~ Universal Gas Constant
T = absolute Temperature (Kelvin)

① Pressure :-

SI :- Pascal or $N/m^2$

Other :- atm, mmHg, Torr, bar

$1\ atm = 1.01325 \times 10^5\ Pa$

$1\ atm = 1.01325\ Bar$

$1\ Bar = 10^5\ Pa$

$1\ Torr = 1\ mmHg$

$1\ atm = 760\ mmHg/Torr$

② Volume :-

SI unit :- $= m^3$

→ $cm^3$, CC, ml, lit

$1 m^3 = 1000\ l$

$1 m^3 = 10^6\ cm^3$ or $10^6\ CC$

$1\ lit = 1000\ ml$

$1 m^3 = 10^6\ ml$

$1\ ml = 1\ CC$ or $1\ cm^3$

③ Temperature :-

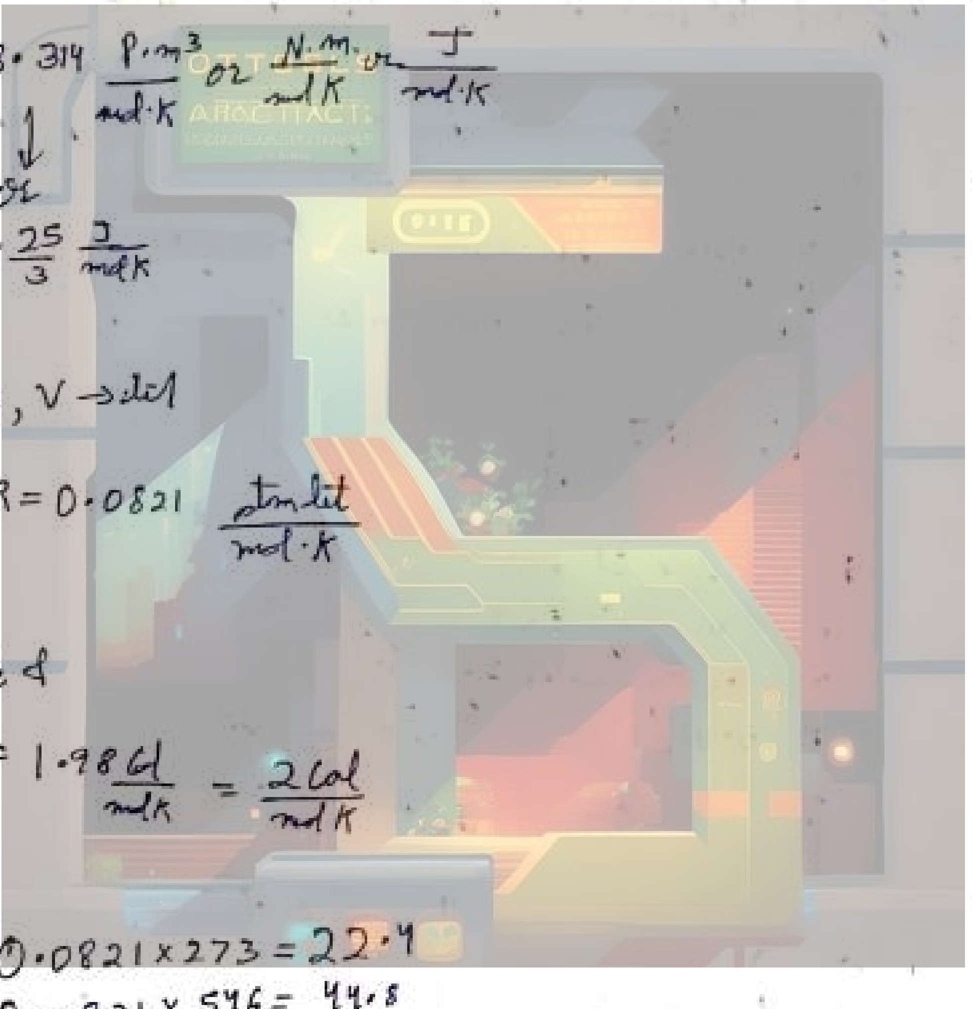
$$K = C^\circ + 273.15$$

$$C^\circ = \frac{5}{9}(^\circ F - 32)$$

④ Gas Constant (R)

SI unit :- $\frac{N}{m^2} \times m^3 \times \frac{1}{K} \times \frac{1}{mol}$

:- $\frac{Nm}{K mol}$



$R = 8.314 \frac{P \cdot m^3}{mol \cdot K}$ or $\frac{N \cdot m}{mol \cdot K}$ or $\frac{J}{mol \cdot K}$

↓

or

$R = \frac{25}{3} \frac{J}{mol K}$

① $P \to atm$, $V \to lit$

$R = 0.0821 \frac{atm \, lit}{mol \cdot K}$

② Calorie &

$R = 1.986 \frac{cal}{mol K} = \frac{2 cal}{mol K}$

Note :- $0.0821 \times 273 = 22.4$

$0.0821 \times 546 = 44.8$

$0.0821 \times 300 = 24.63$

~~At $PV = nRT$~~

NOTE:-

→ The gas which follows $PV = nRT$ is considered as an ideal gas

Experimental gas laws

① <u>Boyle's Law</u> - For a fixed mass of gas at constant temperature, volume of gas is inversely proportional to its pressure

$PV = nRT$

$n, T, R \Rightarrow$ Constant

$PV = \text{constant}$

$P = \dfrac{\text{constant}}{V}$

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

$P_1 V_1 = P_2 V_2$

② <u>Charles law</u> - For the fixed mass of gas at constant pressure, volume of gas is directly proportional to its absolute temperature

$PV = nRT$

$n, R, P \Rightarrow$ Constant

$\cancel{P} V = T \times \text{constant}$

$\dfrac{V}{T} = \text{constant}$

$$\boxed{V \propto T}$$

$$\frac{V_1}{T_1} = \frac{V_2}{T_2}$$

③ Gay-Lussac's law – (Pressure-Temp. law)

→ For the fixed mass of Gas at constant volume the pressure of gas is directly proportional to its absolute temperature.

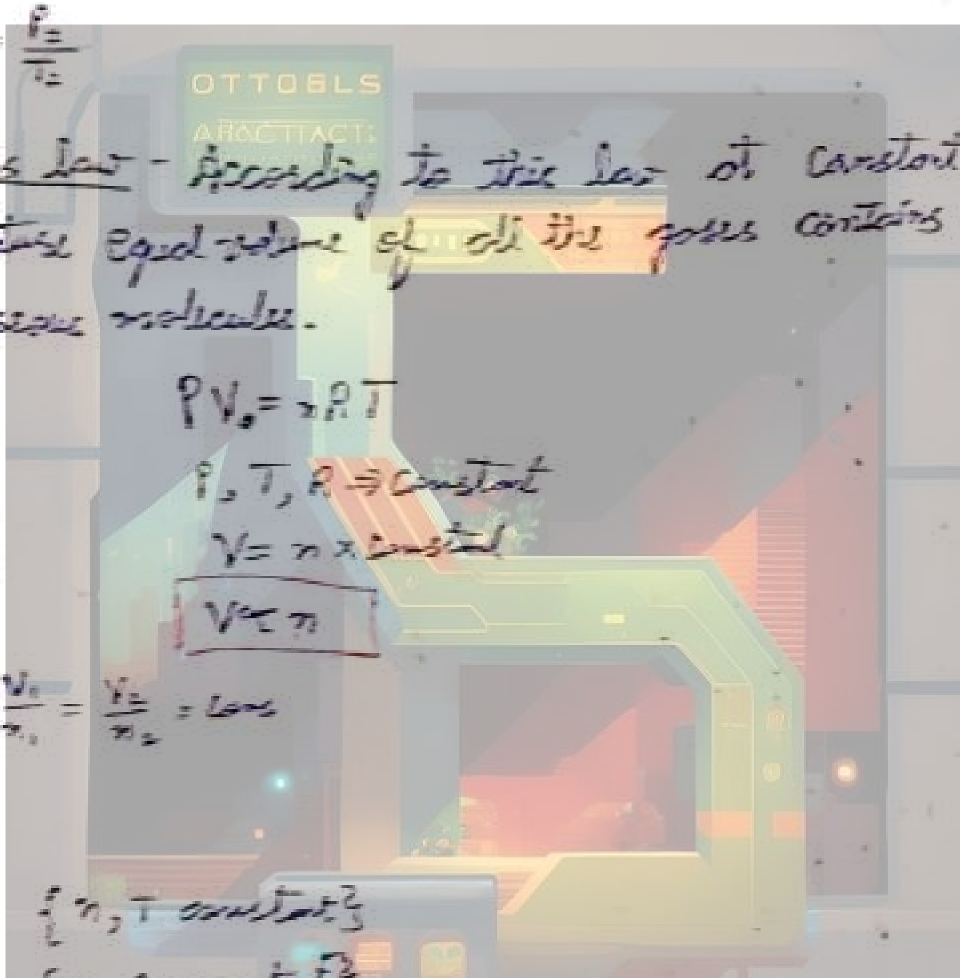
$$PV = nRT$$

$$V, n, R = \text{constant}$$

$$P = T \times \text{constant}$$

$$\boxed{P \propto T}$$

$$\frac{P_1}{T_1} = \frac{P_2}{T_2}$$



④ Avogadro's law – According to this law at constant Pressure & Temperature equal volume of all the gases contains equal no. of gaseous molecules.

$$PV_0 = nRT$$

$$P, T, R \Rightarrow \text{constant}$$

$$V = n \times \text{constant}$$

$$\boxed{V \propto n}$$

$$\frac{V_1}{n_1} = \frac{V_2}{n_2} = \text{cons}$$

Combine

① $V \propto \frac{1}{P}$ $\{n, T \text{ constant}\}$

② $V \propto T$ $\{n, P = \text{constant}\}$

③ $V \propto n$ $\{P, T \text{ constant}\}$

$$V \propto \frac{nT}{P}$$

$$VP \propto nT$$

$$\boxed{PV = nRT}$$

Q1. ~~Each~~ Certain mass of gas occupy 100 ml at 2 atm what is the volume of the gas if it is isothermally extended to 950 torr.

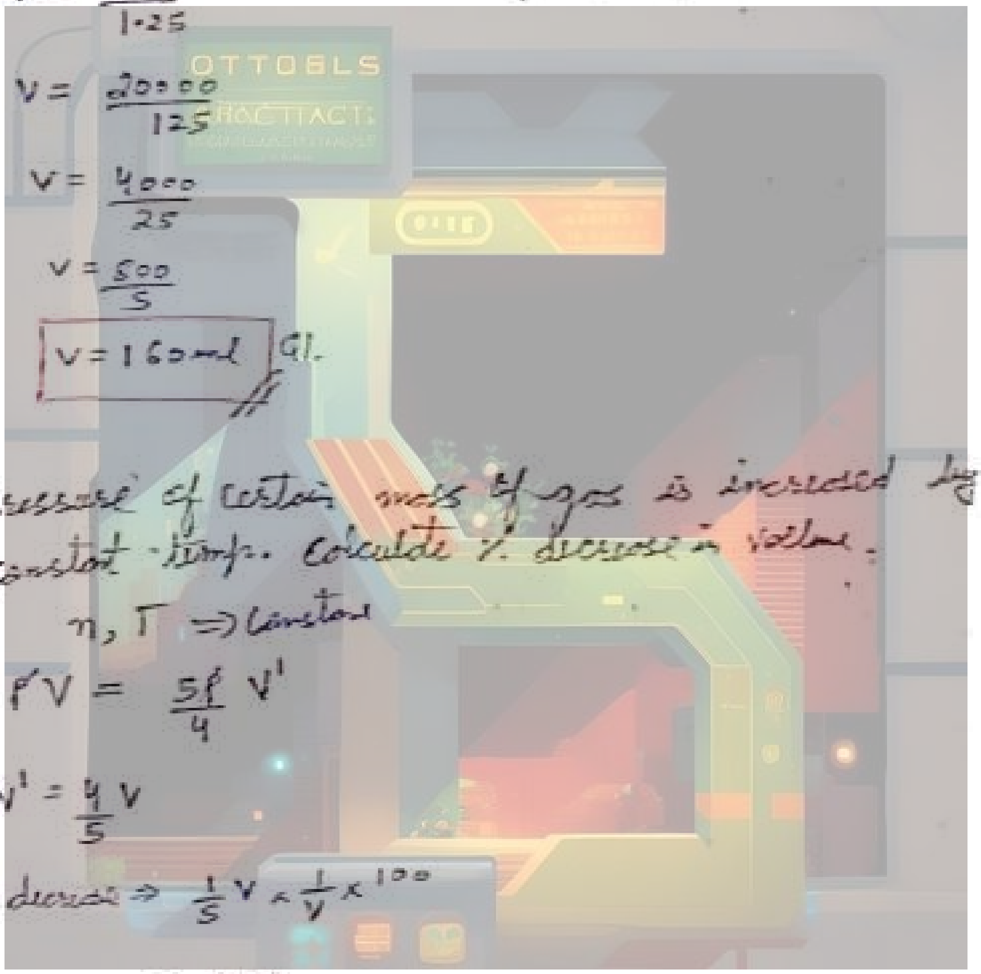
(n, T constant)

$950 \text{ torr} = \frac{950}{760} \text{ atm} = \frac{95}{76} \text{ atm} \rightarrow n, T \text{ constant}$

$= 1.25 \text{ atm}$

$100(2) = V(1.25)$

$V = \frac{200}{1.25}$




$V = \frac{20000}{125}$

$V = \frac{4000}{25}$

$V = \frac{800}{5}$

$\boxed{V = 160 \text{ ml}}$ Q1. //

Q2. The pressure of certain mass of gas is increased by 25% at constant temp. Calculate % decrease in volume.

$n, T \Rightarrow \text{Constant}$

$PV = \frac{5P}{4} V'$

$V' = \frac{4}{5} V$

% decrease $\Rightarrow \frac{1}{5} V \times \frac{1}{V} \times 100$

$= \frac{100}{5} \%$

$\boxed{= 20\%}$ //

Q3. A vessel of 4l capacity contains some gas at 20 bar. It is connected to another evacuated vessel of irregular shape with the help of evacuated tube of capacity of 0.5 l maintaining constant temperature. If the final pressure of gas is 4 bar, what was the capacity of irregular vessel.

$$P_1V_1 = P_2V_2$$

$$(20)(4) = (4)(V_2)$$

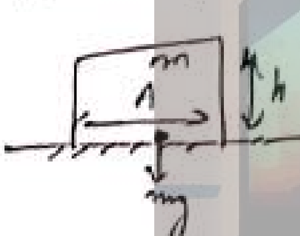
$$V_2 = 20\ l$$

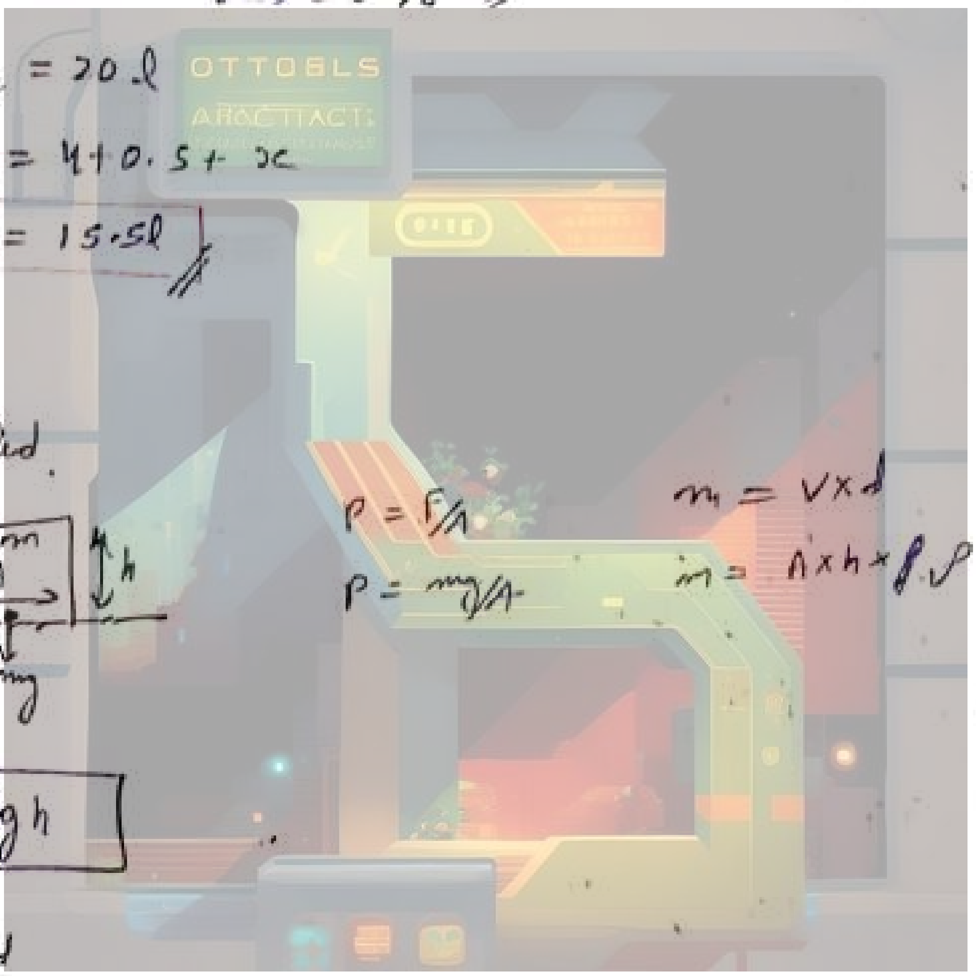
$$V_2 = 4 + 0.5 + x$$

$$\boxed{x = 15.5\ l}$$

Pressure.

for solid.




$$P = F/A$$

$$P = mg/A$$

$$m = V \times d$$

$$m = A \times h \times \rho$$

$$\boxed{P = \rho g h}$$

for liquid


$$P = \rho g h$$

$$P = 13.6\ \frac{g}{ml} \times 76\,cm \times 9.81 \times 100\ \frac{cm}{sec^2}$$

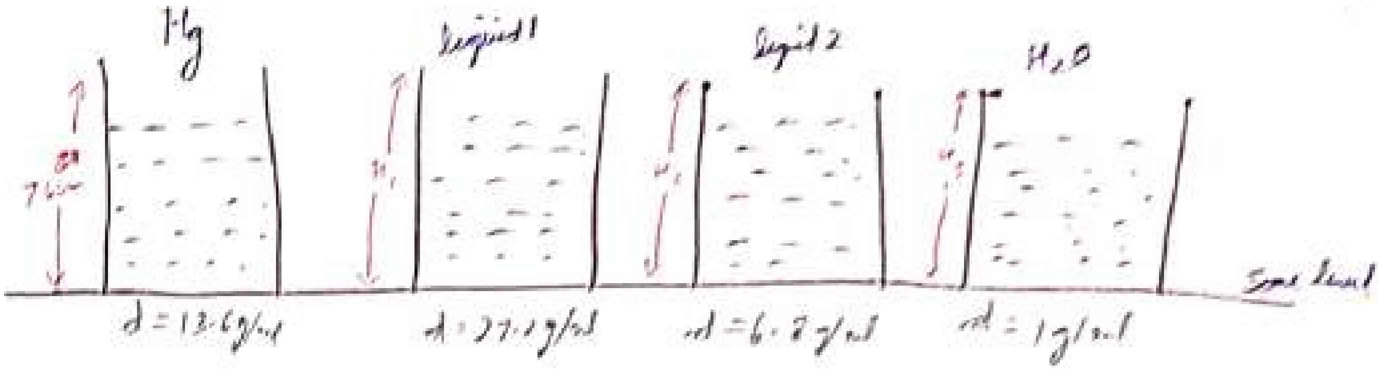
$$P = \text{---}\ dyne/cm^2$$

$$P = 1.01325 \times 10^5\ N/m^2$$

$$P = 1\ atm$$

$$\boxed{1\ atm = 76\ cm\,Hg = 760\ mm\,Hg}$$

Q.




$\underset{\text{constant}}{P} = h \times d \times g$

$$\boxed{h_1 d_1 = h_2 d_2}$$

$76 \times 13.6 \times g = h_1 \times 27.2 \times g$

$$\boxed{h_1 = 38\,cm}$$

$76 \times 13.6 \times g = h_2 \times 6.8 \times g$

$$\boxed{h_2 = 152\,cm}$$

$\frac{76 \times 13.6}{1} = h_3$

$$\boxed{h_3 = 1033.6\,cm}$$

$$\boxed{1\,atm = 10.33\,m\ H_2O}$$

Note:- In pressure measuring devices, mercury is used because it ~~has~~ is most dense ~~dog~~ liquid. Therefore, height will be less & easy to handle.

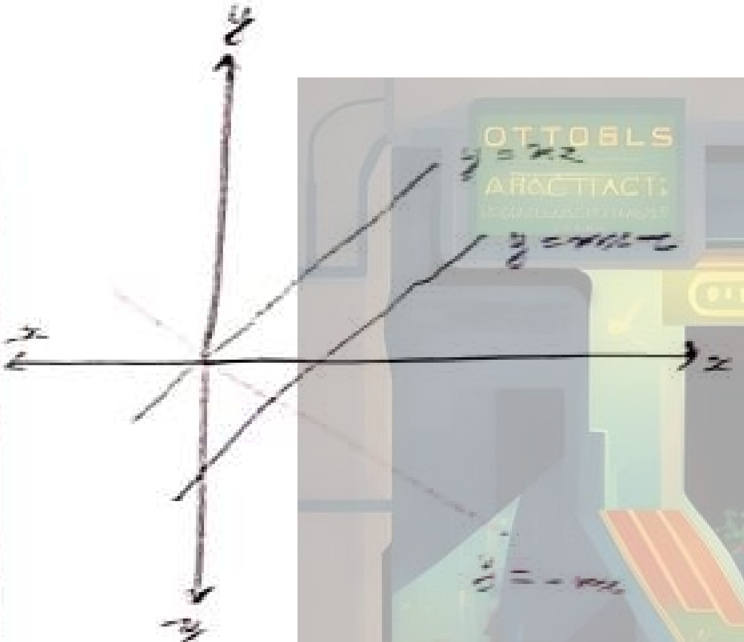
## Important graphs

### ① Straight line:-

$y = mx + c$ → intercept

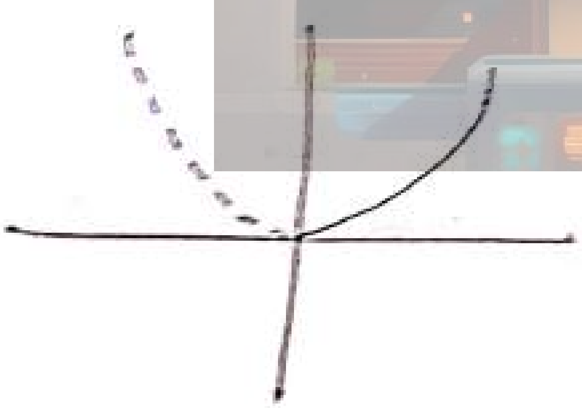
$m$ → slope

$\tan\theta = m = \frac{y}{x}$




### ② Parabola:-

$y = cx^2$

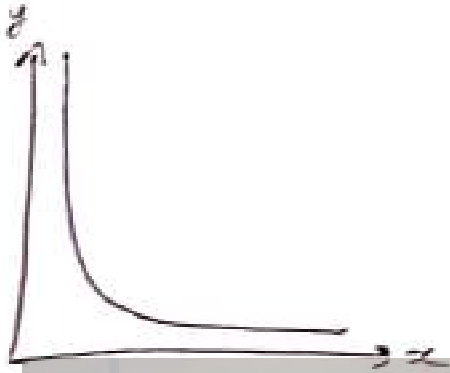


$y^2 = cx$

$y = c\sqrt{x}$

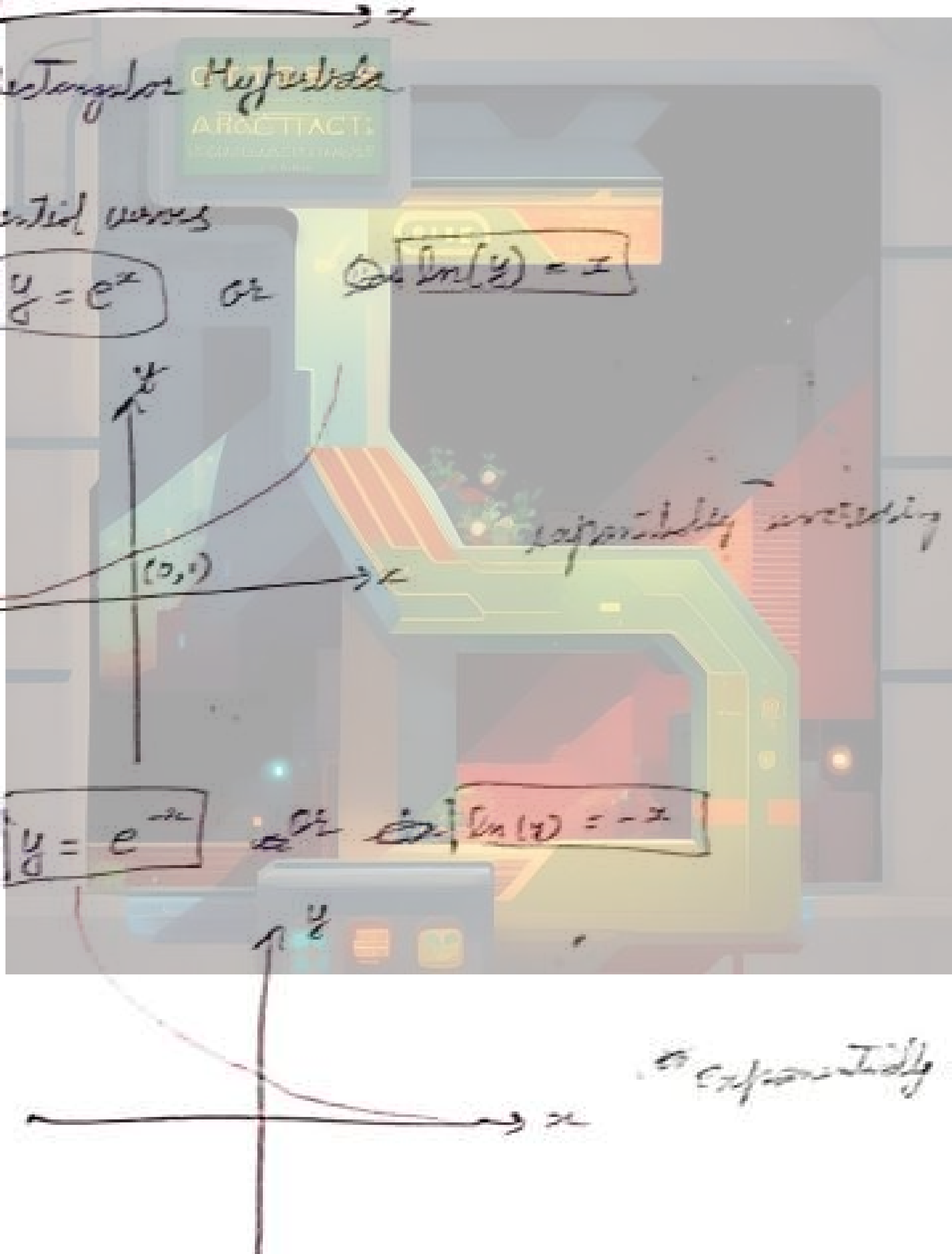
③ Hyperbola

$xy = c \Rightarrow y = c\frac{1}{x}$ [symmetric]



$\left.\begin{array}{l} x^2y = c \\ yx^3 = c \\ x^2y^3 = c \end{array}\right]$ not symmetric

Rectangular Hyperbola



④ Exponential curves

$\boxed{y = e^x}$ or $\boxed{\ln(y) = x}$

exponentially increasing

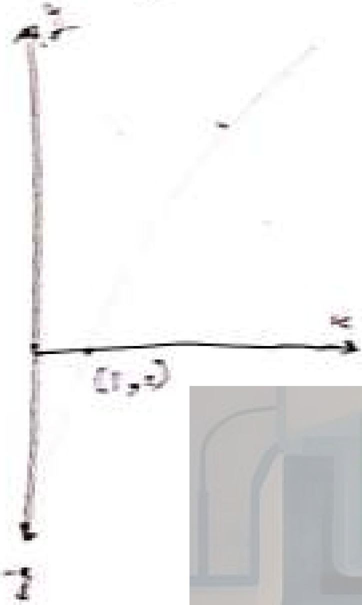
$\boxed{y = e^{-x}}$ or $\boxed{\ln(y) = -x}$

exponentially decreasing.

5 Logarithmic Curve

$y = \ln x$ or $y = \log(x)$

$x = e^y$



Graphs of experimental quantities:-

1 Boyle's Law:- $n, R, T$ constant

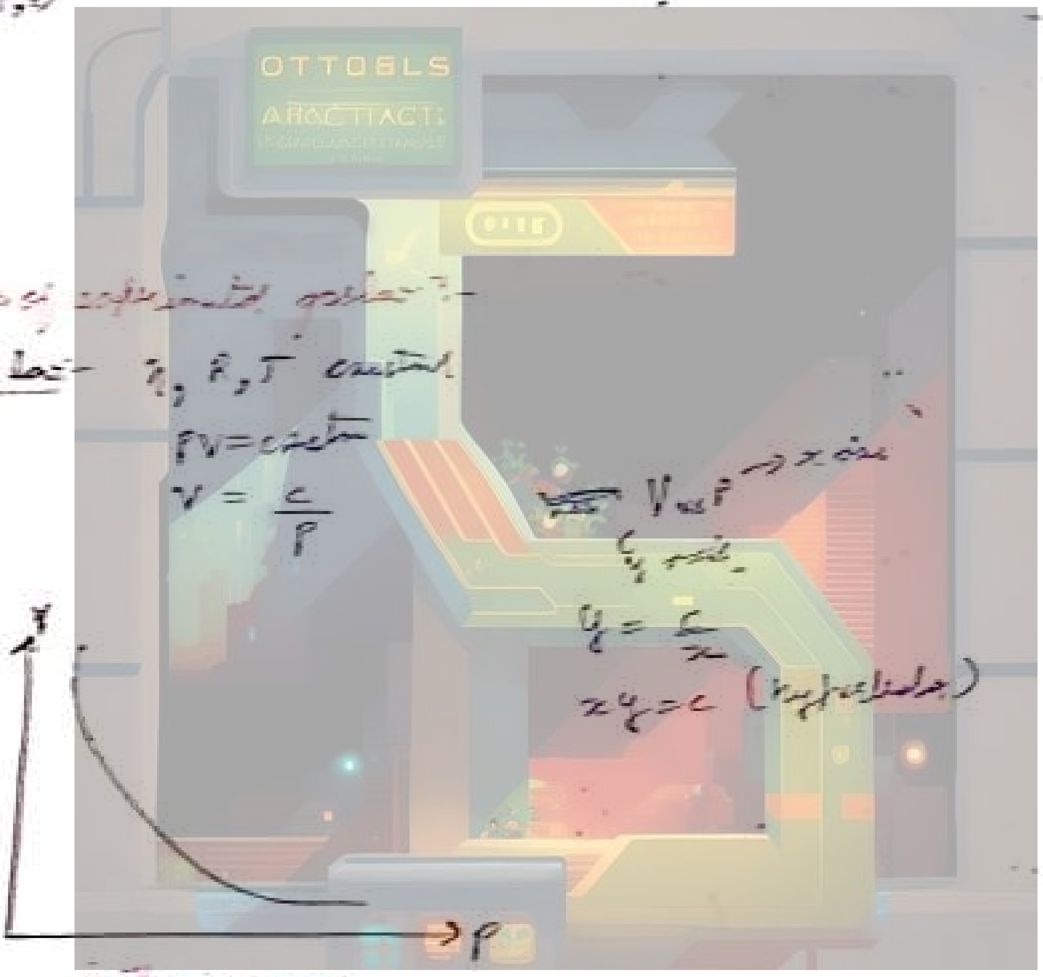
$PV = \text{constant}$

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

$V \propto \frac{1}{P}$ → x axis, y axis

$y = \frac{c}{x}$

$xy = c$ (hyperbola)



Isothermal curve

at constant temp.

eg.

$n, T \rightarrow$ constant for each curve

fix fix

$PV = nRT$

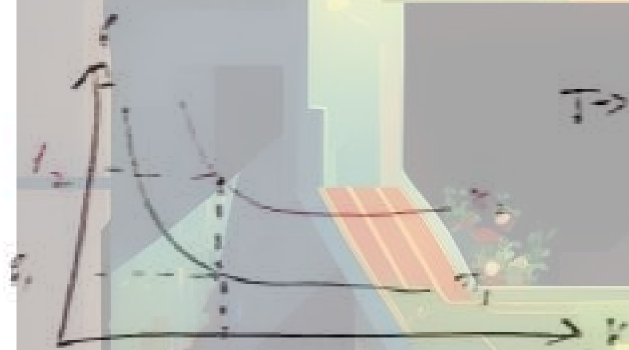
fix

$V \propto T$

$V_1 < V_2 < V_3$

$\boxed{T_1 < T_2 < T_3}$

eg2.



$T \rightarrow$ fixed

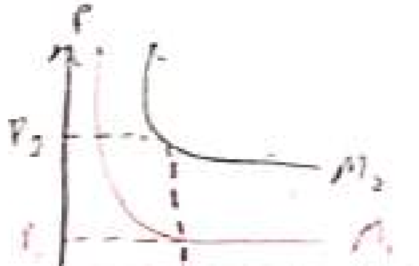
$PV = nRT$

$P \propto n$

$P_1 < P_2$

$\boxed{n_1 < n_2}$

eg.



$M \rightarrow$ molar mass

$n \propto M$

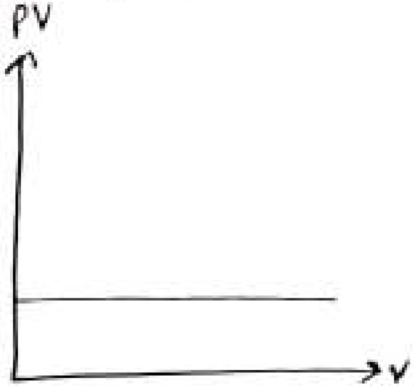
$P \propto n$

$P_2 > P_1$

$n_2 > n_1$

$\boxed{M_1 > M_2}$

Q4. ① Graph of PV vs V.



$PV = nRT$ | $\therefore PV = c$ (constant)

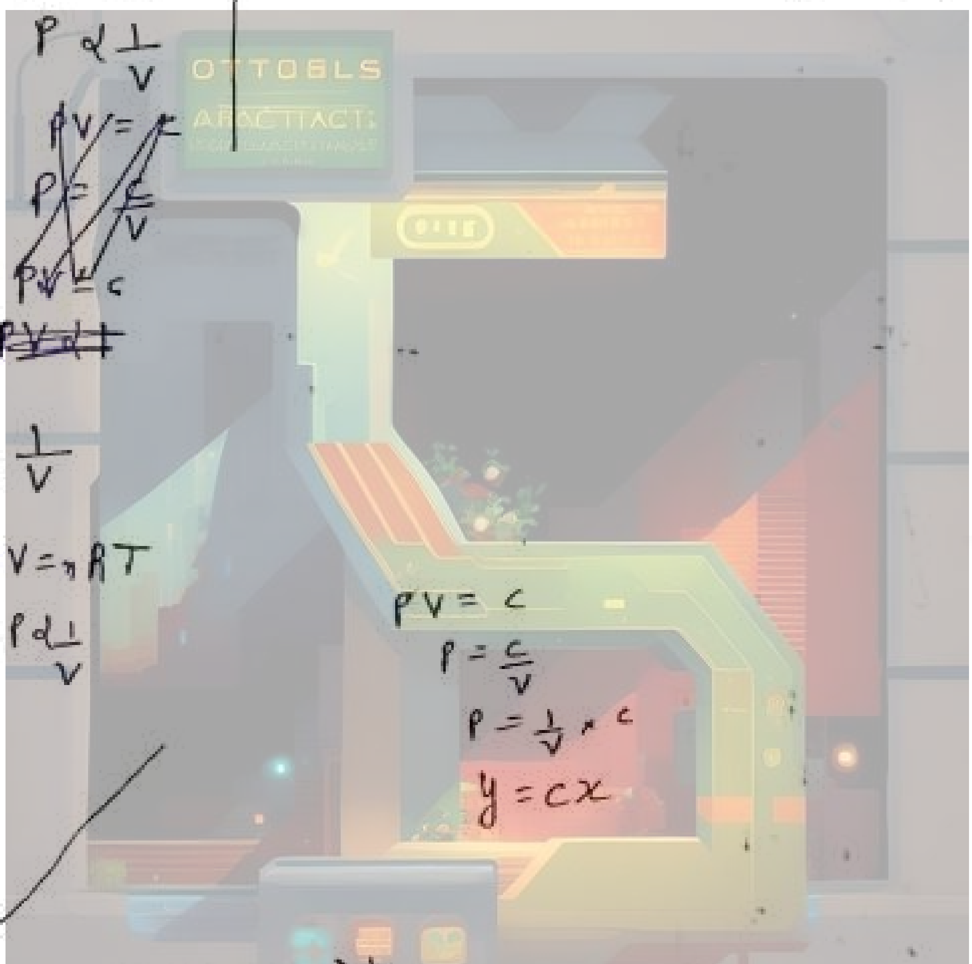
$P \propto \frac{1}{V}$

~~$PV = c$~~

~~$P = \frac{c}{V}$~~

~~$PV = c$~~

~~$PV \propto 1$~~




② $P$ vs $\frac{1}{V}$

$PV = nRT$

$P \propto \frac{1}{V}$

$PV = c$

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

$P = \frac{1}{V} \times c$

$y = cx$

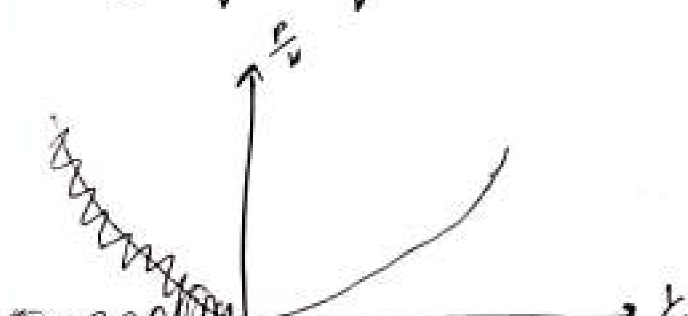
③ $\frac{P}{V}$ vs $\frac{1}{V}$

$PV = c$

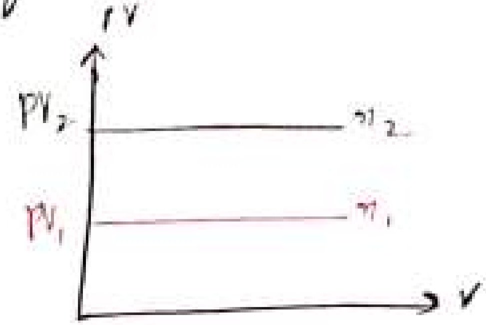
$P = \frac{1}{V} c$

$\frac{P}{V} = \left(\frac{1}{V^2}\right)^2 c$

$y = x^2 c$



Q5. find relation b/w $n_2$ & $n_1$



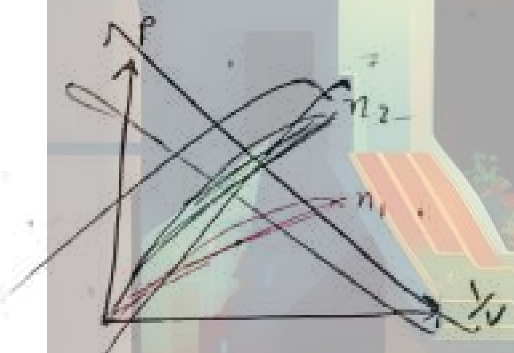

$PV = nRT$

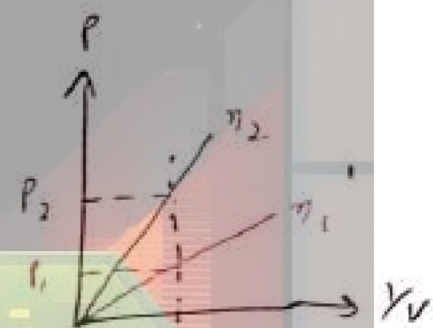
$PV \propto n$

$PV_1 < PV_2$

$\boxed{n_1 < n_2}$

Q6. relation:-




$PV \propto n$

$\frac{1}{V} = con$

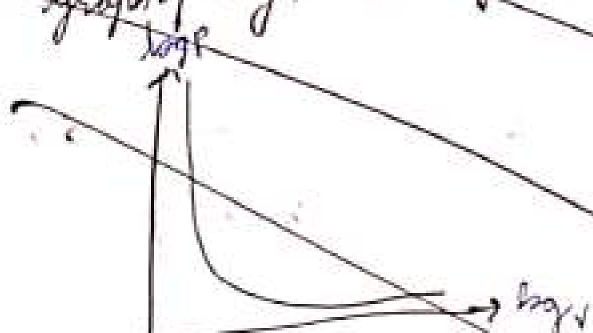
$V = const$

$P \propto n$

$P_2 > P_1$

$\boxed{n_2 > n_1}$

~~Q7. graph of log P v/s log V.~~




~~$\log P \propto \log V = c$~~

~~$\log P = \frac{c}{\log V}$~~

~~$y = \frac{c}{x}$~~

$PV = C$

$\log P + \log V = \log C$

$\log P = \log C + (\log V)$

Q7. Graph $\log P$ vs $\log V$

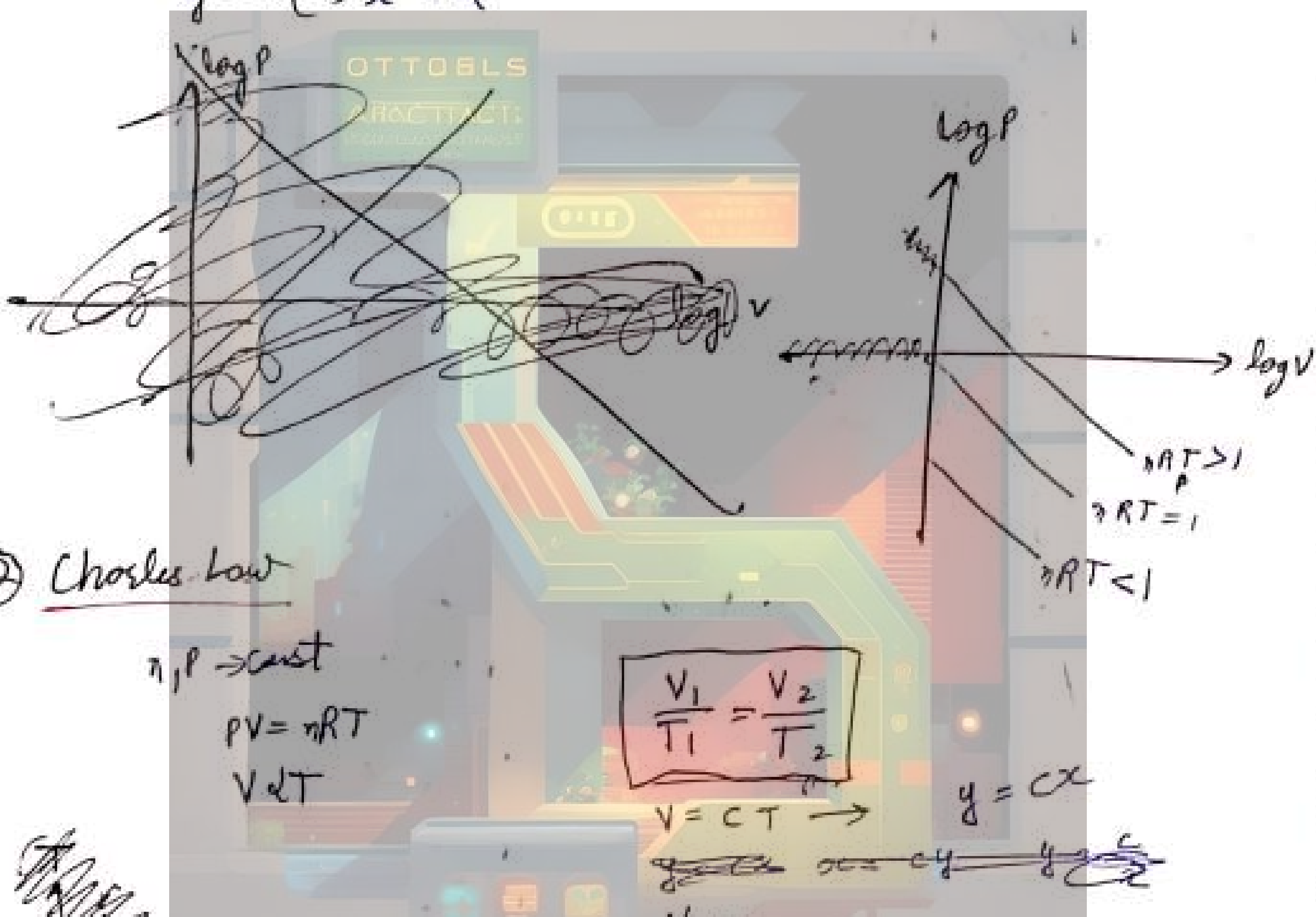
$PV = c$

$\log P + \log V = \log c$

$\log P = \alpha + (-\log V)$

$y = \alpha - x$

$y = (-1)x + \alpha$




② Charles Law

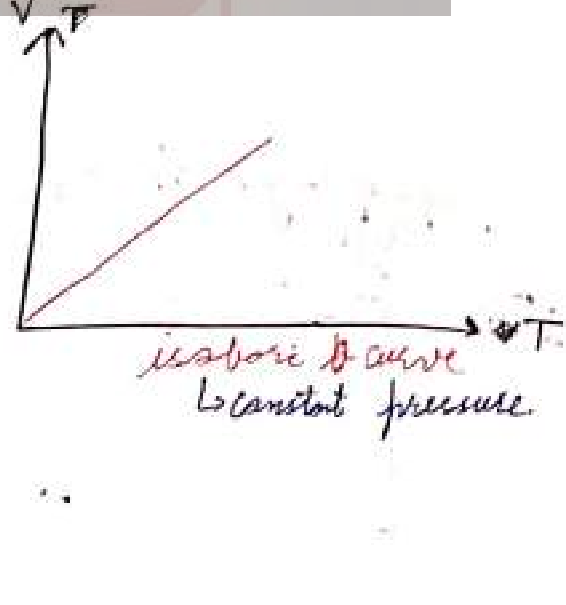
$n, P \rightarrow$ const

$PV = nRT$

$V \propto T$

$$\boxed{\frac{V_1}{T_1} = \frac{V_2}{T_2}}$$

$V = CT \rightarrow y = cx$




isobaric curve

↳ constant pressure

Q 8. Draw graphs

① V vs T (K)

② V vs T (°C)

③ VT vs T

①

$PV = nRT$

$V = \left(\frac{nR}{P}\right) T$

$y = mx$


②

$PV = nRT$

$y = mx$

$V = \left(\frac{nR}{P}\right)\left[t(°C) + 273.15\right]$

$V = \frac{nR}{P} t$

$y = mx + c$

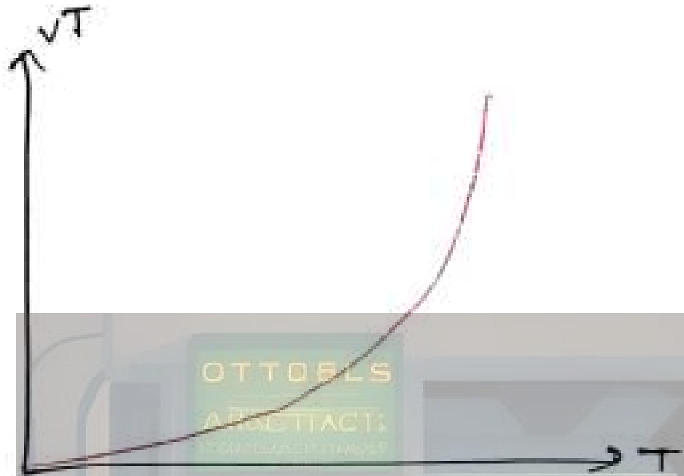
$C = \frac{nR}{P} \times 273.15$

③ $V = \left(\frac{nR}{P}\right) T$

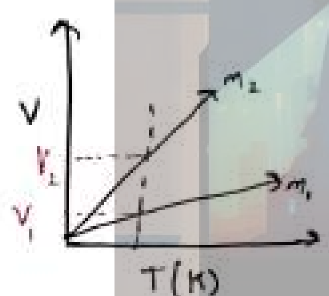
$V = cT$

$VT = cT^2$

$y = cx^2$




Q9.




$V = \left(\frac{nR}{P}\right) T$

$V_2 > V_1$

$V \propto n$

$\boxed{n_2 > n_1}$

Q10.


$V = \left(\frac{nR}{P}\right) T$

$V \propto P$

$V_2 > V_1$

$\boxed{P_2 < P_1}$

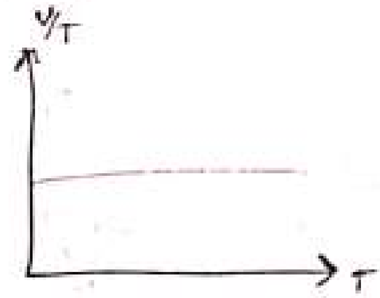
Note:- Absolute 0 (0K = 0 − 273.15 °C) is theoritically minimum possible temperature but Practically absolute zero can never be achieved.

Q11. $\frac{V}{T}$ vs $T$

$PV = nRT$

$\frac{V}{T} = \frac{nR}{P}$

$\frac{V}{T} = \text{constant}$




Q12. Graph of $\log V$ vs $\log T$

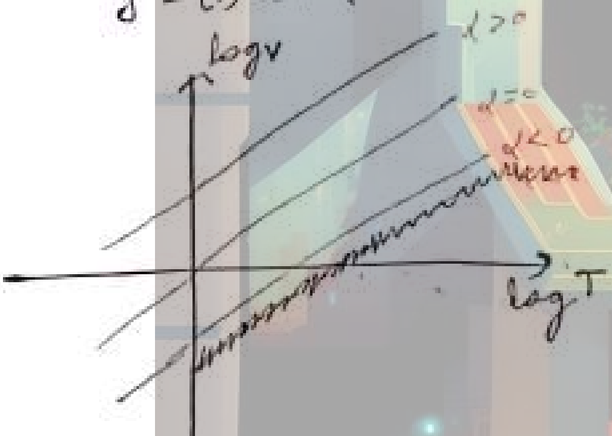
~~$PV = nR$~~

$V = CT$

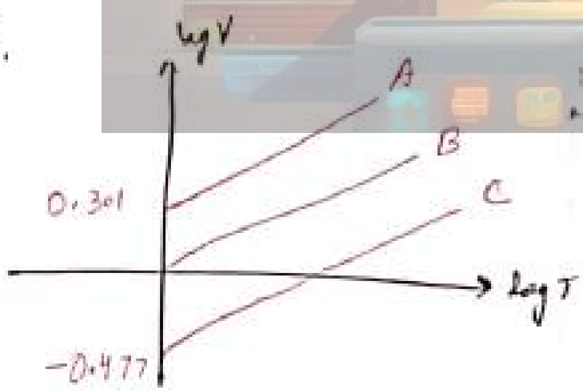
$\log V = \log C + \log T$

$y = x + \alpha$

$y = (1)x + \alpha$




Q13.




$P = 0.0821$ atm

$\log V$ vs $\log T$ graphs for 3 diff gases

find moles of each gas.

$$\boxed{\begin{aligned} \log 2 &= 0.3010 \\ \log 3 &= 0.4771 \\ \log 5 &= 0.699 \\ \log 10 &= 1 \end{aligned}}$$

$\frac{nR}{P}$ is diff for each gas

~~$\log_{10} 2 = \frac{n \times 0.0821}{0.0821}$~~

~~$\alpha = 0.301 = \frac{n \times 0.0821}{0.0821}$~~

~~$\alpha = 0.0821 =$~~

$\alpha = 0.301 = \log_{10} \frac{nR}{T}$

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

~~$n = 2$~~

$\boxed{n_A = 2}$

$\log_{10} \frac{nR}{P} = 0$

$\boxed{n_B = 1}$

$\log_{10} \frac{nR}{P} = \log_{10} 1/3$

$\boxed{n_C = 1/3}$

③ Gay Lussac's law

$n, V \Rightarrow$ constant

$PV = nRT$

$P = \left(\frac{nR}{V}\right) T$

$P \propto T(K)$

Iso chore curve

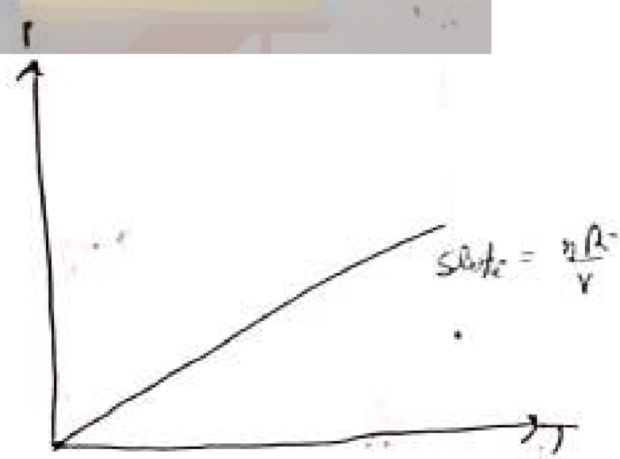
↳ constant Volume.

Q14. P vs T(K)

$PV = nRT$

$P = \left(\frac{nR}{V}\right) T$ ↳ constant

$y = mx$

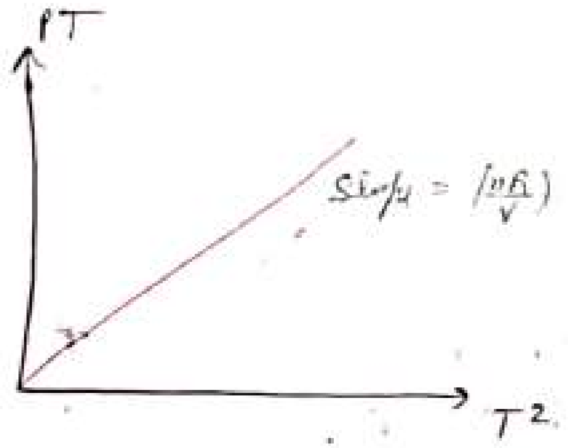


Q15. $PT$ vs $T^2$

$$P = \left(\frac{nR}{V}\right) T$$

$$PT = \left(\frac{nR}{V}\right) T^2$$

$$y = \frac{nR}{V} x$$




Q16. A gas cylinder cooking gas can withstand a pressure of 18 atm. The pressure gauge of cylinder indicates, 12 atm at 27°C. Due to sudden fire in building the temp. starts rising, at what temp will cylinder explode.

$P = 12$ atm  $P' = 18$ atm

$T = 300$ K  $T' = ?$

$$PV = nRT$$

$$P = cT$$

$$\left(c = \frac{nR}{V}\right)$$

$$\frac{P}{T} = \frac{P'}{T'}$$

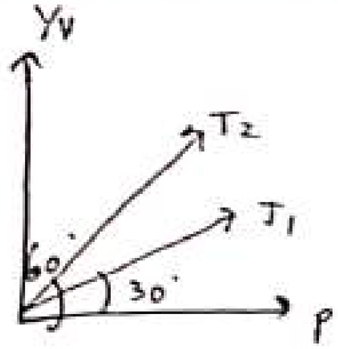
$$\frac{\cancel{12}^{2}}{300} = \frac{\cancel{18}^{3}}{T'}$$

$$T' = \frac{300 \times 3}{2}$$

$$T' = \frac{900}{2}$$

$$\boxed{T' = 450\text{ K}}$$

Q17.




find $\frac{T_1}{T_2} = ?$

$PV = nRT$

$V = \left(\frac{nR}{P}\right)$

$P \times V = C$

$P = C \times \frac{1}{V}$

$Cy = x$

$y = \frac{1}{C}(x)$ ↳ slope

$y = mx$

$\frac{1}{nRT} = m$

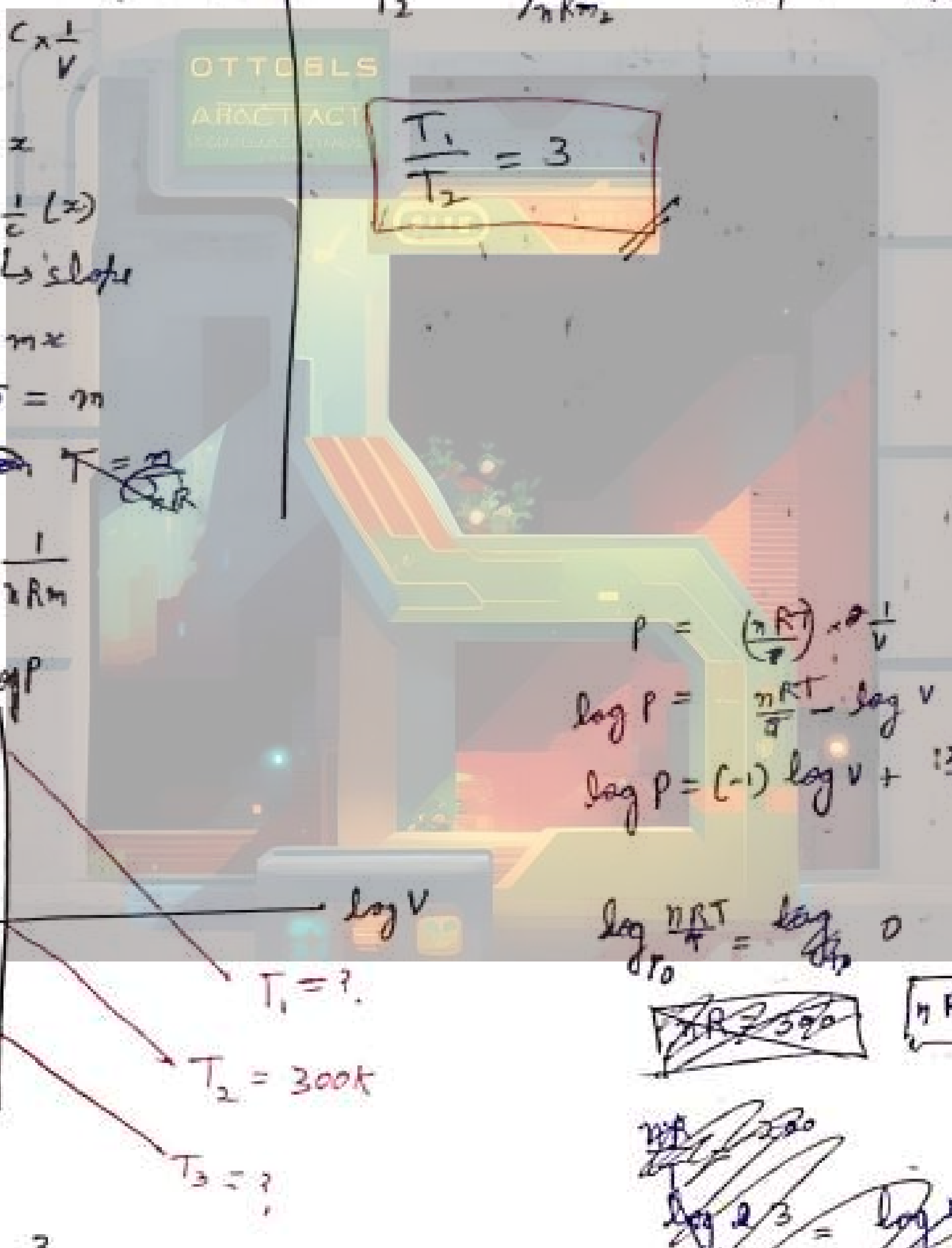
$T = \frac{m}{nR}$

$T = \frac{1}{nRm}$

$\frac{T_1}{T_2} = \frac{m_1}{m_2} = \frac{1/\sqrt{3}}{\sqrt{3}}$

$\frac{T_1}{T_2} = \frac{1/nRm_1}{1/nRm_2} = \frac{m_2}{m_1} = \frac{\sqrt{3}}{1/\sqrt{3}} = 3$

$\boxed{\frac{T_1}{T_2} = 3}$



Q18.



$P = \left(\frac{nRT}{1}\right) \times \frac{1}{V}$

$\log P = \frac{nRT}{1} - \log V$

$\log P = (-1)\log V + \log\left(\frac{nRT}{1}\right)$

$\log \frac{nRT}{1} = \log 0$

~~$nR = 300$~~ $\boxed{nR = 1/300}$

$\frac{nRT_1}{1} = 3$

$\boxed{T_1 = 900\ K}$

$T_2 = \frac{1}{2} \times 300$

$\boxed{T_2 = 150\ K}$

Ⓒ Avogadro's law

$P, T = \text{constant}$

$PV = nRT$

$V \propto n$

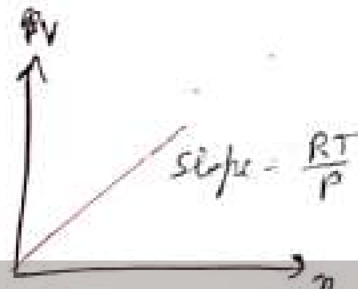
$$\boxed{\frac{V_1}{n_1} = \frac{V_2}{n_2}}$$

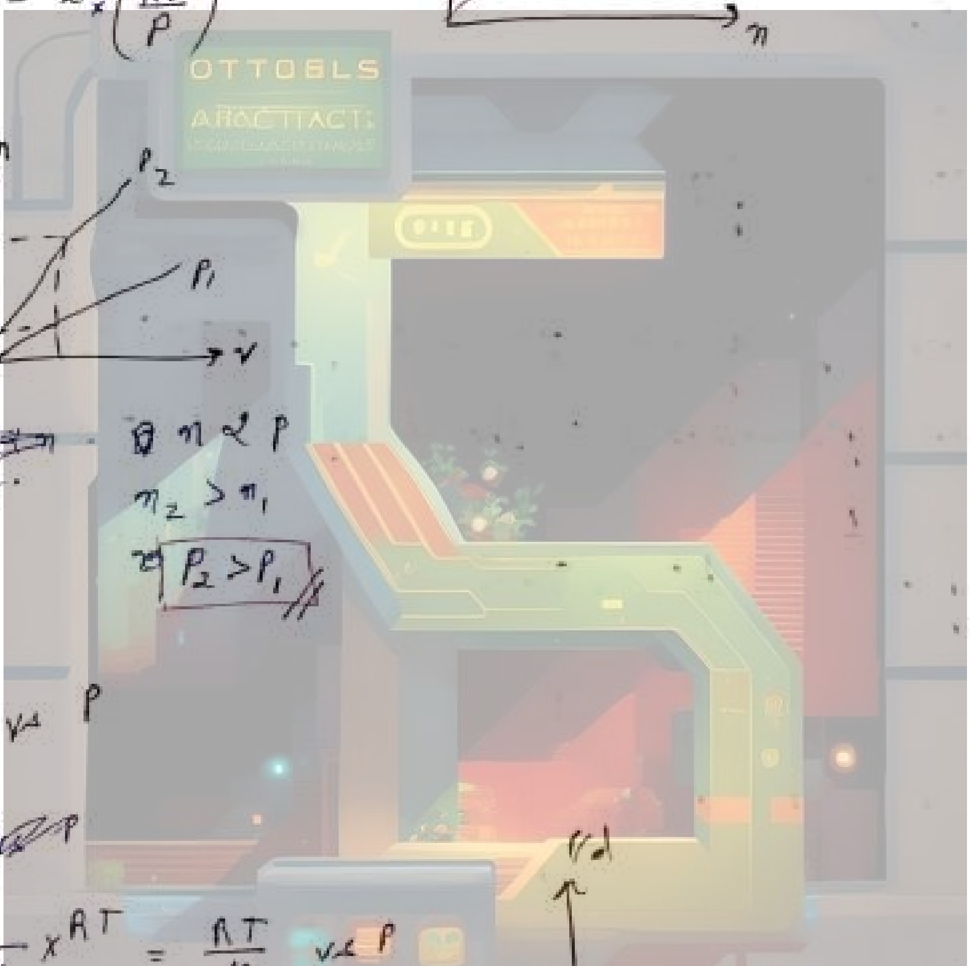
Q19. $V$ vs $n$

$PV = nRT$

$VPy = xRT$

$y = x \times \left(\frac{RT}{P}\right)$




Q20.

$\cancel{\frac{V}{n_2}}$ $\therefore n \propto P$

$n_2 > n_1$

$\therefore \boxed{P_2 > P_1}$

Q21. $\frac{P}{d}$ vs $P$

$\cancel{PV = \frac{mass}{M} RT}$

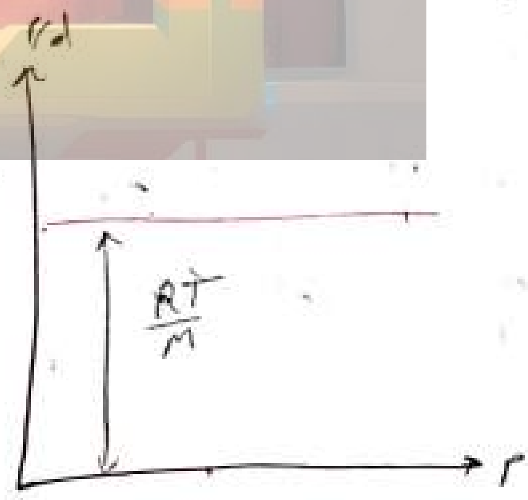
$\frac{P}{PM} \times RT = \frac{RT}{M}$ vs $P$

↳ constant

$\cancel{\frac{PV}{n} = \frac{xRT}{M}}$

$\cancel{x\frac{V}{M} = nRy}$

$\cancel{y = \frac{V}{PM_n} x}$



Q22 5g $SO_2$ gas occupy 800 ml at 87°C, find temperature at which 10g $SO_2$ gas will occupy 600 ml at same pressure.

$$PV = nRT$$

$$\frac{nT}{V} = \text{constant}$$

$$\frac{\frac{5}{64} \times 360}{800} = \frac{\frac{10}{64} \times T}{600}$$

$$\frac{3 \times 360}{2 \times 4} = T$$

$$\boxed{T = 135\,K} \qquad \boxed{T = -138°C}$$

Q23. The density of ideal gas is 2.5 g/L at 2 bar & 27°C. At what pressure at 227°C the density is 5 g/L.

$$\cancel{PV = nRT}$$

$$\cancel{d = \frac{PM}{RT}} \qquad \cancel{\frac{PV}{nT} = \text{constant}}$$

$$\cancel{\frac{2.5 \times V}{2 \times 300} = \frac{P \times V}{500}}$$

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

$$\frac{dT}{P} = \text{constant}$$

$$\frac{2.5 \times 300}{2} = \frac{5 \times 500}{P}$$

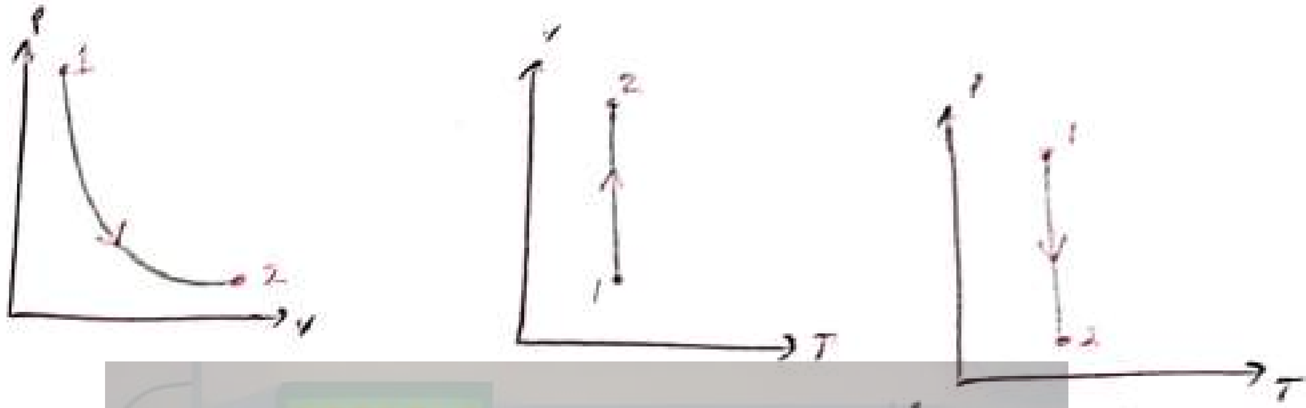
$$P = \frac{500 \times 2 \times 2}{3 \times 250}$$

$$\boxed{P = \frac{20}{3}\ \text{Bar}}$$

# Graph Conversions

① Isotherms/ Isothermal curve

$T, n =$ constant



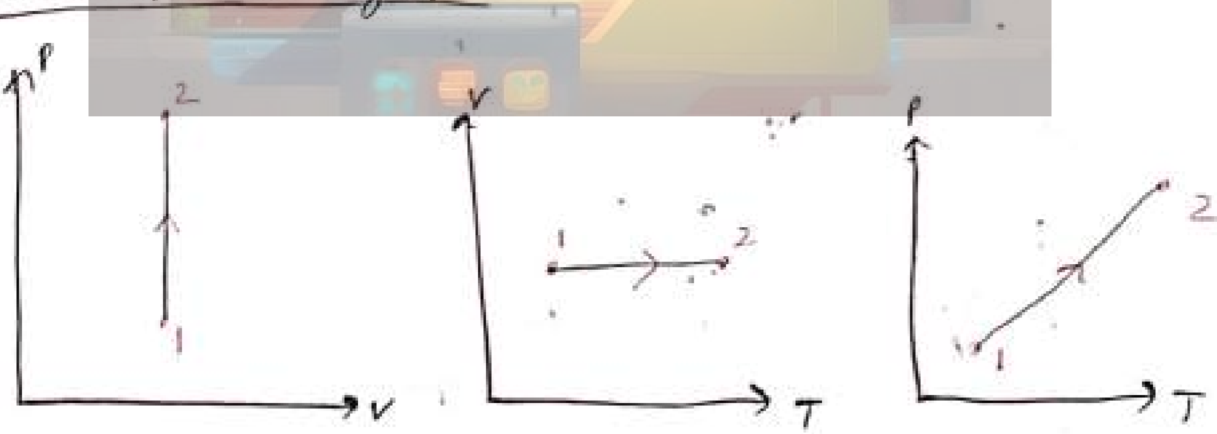

② Isobars/Isobaric graphs

$n, P$ constant


$PV = nRT$

$V \propto T$

③ Isochors/Isochoric graphs.




$n, V \Rightarrow$ const

$PV = nRT$

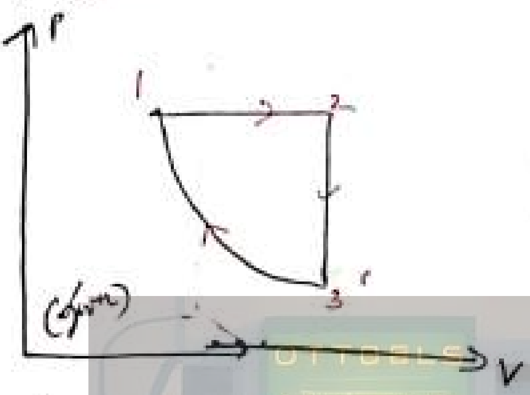
$P \propto T$

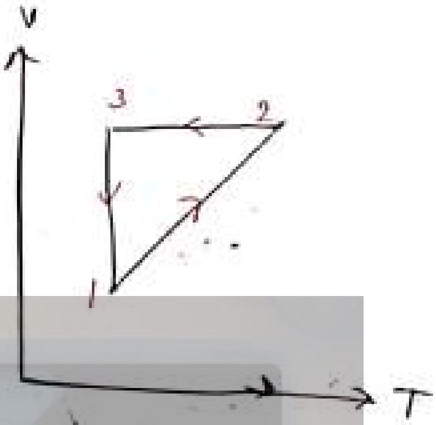
H.W 30-7-24

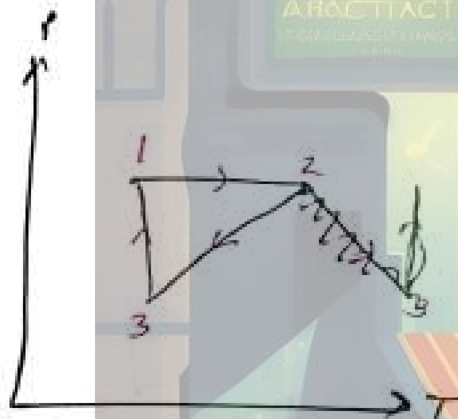
O1 [1-25] [26-33]

S-1 [1-23] [24-33]

Q.24. n-constant







$PV = nRT$

Q.25. 1→2 expansion or contraction? n-constant

~~$PV = nRT$~~

~~$P = \left(\frac{nR}{V}\right)T$~~

$PV = nRT$

$P = \left(\frac{nR}{V}\right) T$

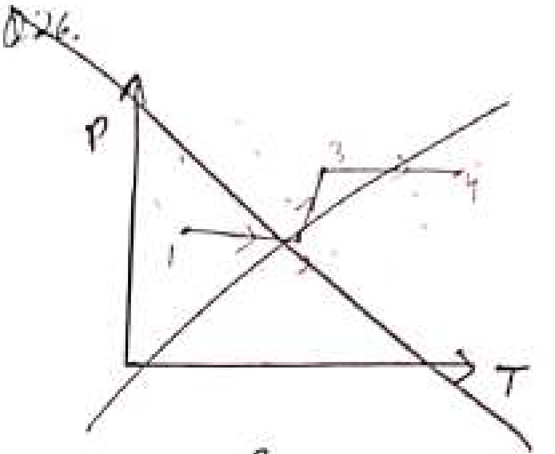
$y = mx$

$m_1 > m_2$

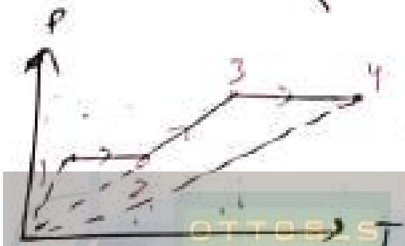
$\frac{nR}{V_1} > \frac{nR}{V_2}$

$\boxed{V_2 > V_1}$ expansion

Q26.



Q26.



find order $V_1$ $V_2$ $V_3$ & $V_4$.

$PV = nRT$

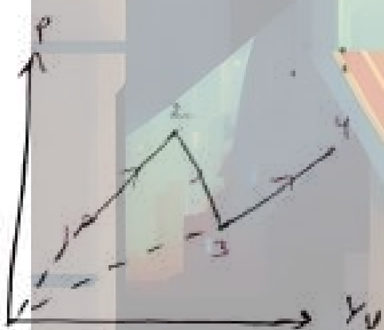
$P = \frac{nR}{V} T$

$y = mx$

$m_1 > m_2 = m_3 > m_4$

$\boxed{V_1 < V_2 = V_3 < V_4}$

Q27.



find order of $T_1$ $T_2$ $T_3$ & $T_4$

$PV = nRT$

$P = (nRT) \cdot \frac{1}{V}$

$y = mx$

~~$m_1 = m_2 > m_3 = m_4$~~

~~$T_1 = T_2 > T_3 = T_4$~~

$m_1 = m_2 > m_3 = m_4$

$\boxed{T_1 = T_2 > T_3 = T_4}$

# Dalton's law of partial pressure :-

(1) Concept of partial pressure. - In a mixture of non reacting gases, partial pressure of any component gas is defined as the pressure exerted by individual gas, if the whole of the ~~total~~ volume of the mixture had been occupied by this component gas only.

$n_A$

$V, T$

Partial pressure of gas A ⇒ $P_A = \frac{n_A RT}{V}$ — (1)

Partial pressure of gas B ⇒ $P_B = \frac{n_B RT}{V}$ — (2)

Partial pressure of gas C ⇒ $P_C = \frac{n_C RT}{V}$ — (3)

$n_A + n_B + n_C$

$V, T$

$$P_T V = n_T RT$$

$$P_T V = (n_A + n_B + n_C) RT \quad \text{— (4)}$$

$$\boxed{P_T = P_A + P_B + P_C}$$

(2) Dalton's law -

→ In a mixture of non-reacting gases, the total pressure is equal to the sum of partial pressure or individual pressure at same temperature and same volume.

$$\frac{(I)}{(IV)} = \frac{P_A}{P_T} = \frac{n_A}{n_A + n_B + n_C}$$

$$\boxed{P_A = X_A P_T}$$

$P_B = X_B P_T$

$P_C = X_C P_T$

$$\boxed{\text{Partial pressure of compt} = \text{mole fraction} \times P_T}$$

Note:- Partial pressure of any gas remains ~~not~~ unchanged. by the addition of any other gas. Any non reacting gas.

Q26. find the total pressure & partial pressure of each gas if 2 moles of A & 3 moles of B are kept in a container of a volume 8.21 l at 300 K.

$$P_A = n_A \times \frac{0.0821 \times 300}{8.21}$$

$$P_A = 3 n_A$$

$$\boxed{P_A = 6}$$

$$\boxed{P_B = 9}$$

$$\boxed{P_T = 15}$$

Q27. If 2 lit of gas A at 1.5 atm & 3 lit of gas B at 2 atm are mixed and kept at 5 l container. find total pressure & partial pressure of A & B [Assume the temp is constant].

$$n_A RT = 3$$

$$n_B RT = 6$$

$$n_T RT = 9$$

$$\boxed{P_T = 9/5 \text{ atm}}$$

$$\boxed{P_A = \frac{3}{5} \text{ atm}}$$

$$\boxed{P_B = \frac{6}{5} \text{ atm}}$$

Q:30. 2 moles of $N_2$ gas & 6 mol $H_2$ gas are taken in a container of volume 8.21 l and 300K. Where they react to form $NH_3$ gas. find partial pressure of $N_2$ & $H_2$ if partial pressure of $NH_3$ after some time is 6 atm.

$$P_T(\text{final}) = \frac{n_T \times 0.0821 \times 300}{8.21}$$

$$P_T = 3n_T$$

$$\frac{6}{3} = n_T$$

$$\boxed{n_T = 2}$$

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

1 mused    3 used

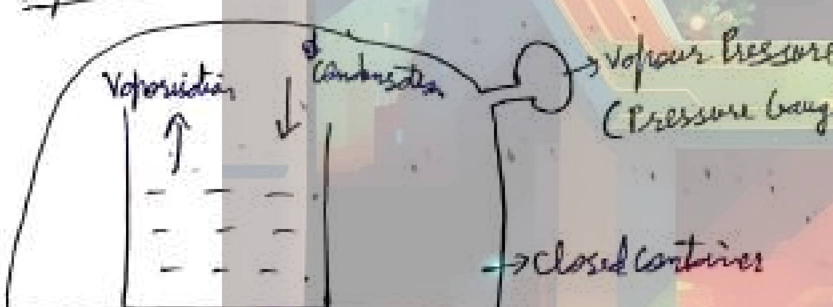
$n_{N_2} = 1$ mol

$n_{H_2} = 3$ mol

$\boxed{P_{N_2} = 3 \text{ atm}}$

$\boxed{P_{H_2} = 9 \text{ atm}}$

## Vapour Pressure




at absolute temp = T(K)

(Rate of Vaporisation) = (Rate of Condensation)

$$H_2O_{(l)} \underset{\text{Condition}}{\overset{\text{Vaporisation}}{\rightleftharpoons}} H_2O_{(g)}$$

→ In a closed container, the pressure exerted by the ~~liquid~~ vapour at equilibrium is called as vapour pressure of that liquid.

rate of vaporisation = rate of condensation

→ Vapour liquid pe jo pressure exert karegi.

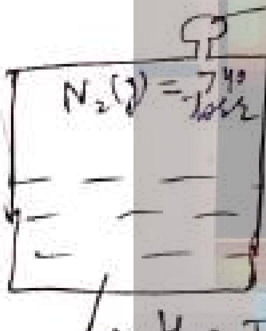
→ In case of $H_2O$ Vapour Pressure (V.P.) is also known as aqueous tension. 760 torr at 100°C

→ It depends only upon absolute temperature as long as temperature is same vapour pressure will not change.

↳ vapour pressure do not depend on volume & amount of liquid taken.

→ It has been observed that gases are generally collected over water therefore they are moist.

Note




$P_{Total} = P_{N_2} + P_{H_2O}$ (g)
↳ aq tension

$= 740 + 20$

$\boxed{= 760 \text{ torr}}$

aq tension = 20 torr

$$\boxed{P_{moist\ gas} = P_{dry\ gas} + P_{aqueous\ tension}}$$

→ Aqueous tension depends only upon temperature. therefore it varies with temperature 760 mmHg at 100°C

Q 31. A closed container contains $O_2$ gas & some $H_2O_{(l)}$ at $P_T = 640$ mm Hg. If Aqueous Tension of water at this and temp is 40 mm Hg. Find the total pressure in mm Hg.

i) Volume of container is doubled at same temp

ii) volume of container is halved at same temp.

i) $P_T = P_{O_2} + P_{H_2O}$

$640 = P_{O_2} + 40$

$P_{O_2} = 600$ mm Hg

Volume of $O_2 = V$

mole of $O_2$

$PV = nRT$

$\frac{600\,V}{RT} = n$

~~at Pressure doubles~~

at double Volume,

$PV = nRT$

$P \times 2\cancel{V} = \frac{600\cancel{V}}{\cancel{RT}} \times \cancel{RT}$

$P = \frac{600}{2}$

$P_{O_2} = 300$ mm Hg

$P_T = P_{O_2} + P_{H_2O}$

$P_T = 300 + 40$

$\boxed{P_T = 340 \text{ mm Hg}}$

ii) at half volume

$P \times \frac{V}{2} = \frac{600\,V}{RT} \times RT$

$P = \frac{600 \times 2 \times V}{V}$

$P_{O_2} = 1200$ mm Hg.

$P_T = P_{O_2} + P_{H_2O}$

$P_T = 1200 + 40$

$\boxed{P_T = 1240 \text{ mm Hg}}$

Q.32. If 4 moles of each $H_2$ & $O_2$ react in a vessel of volume 1072 ml at High temperature. After the reaction vessel is maintained at 27°C. find find pressure of all gases in ATM. (Given:- ~~aq~~ aq Tension at 27°C = 0.24 atm)

$$\underbrace{H_2 + \tfrac{1}{2}O_2 \longrightarrow H_2O} \longrightarrow H_{2(g)} + \tfrac{1}{2}O_{2(g)} + H_2O_{(g)}$$

t=0 4 mol 4 mol 0 mol

t=t 0 mol 2 mol 4 mol

↳ vol$^n$ = 72 ml

$$P_{O_2} = \frac{2 \times 0.0821 \times \cancel{0.3}300}{\cancel{1.072}\,1}$$

$$P_{O_2} = 24.63 \times 2$$

$$P_{O_2} = 49.26 \text{ atm}$$

$$P_T = 49.26 + 0.24$$

$$\boxed{P_T = 49.5 \text{ atm}}$$

# Amagat's law of partial pressure

→ According ~~A~~ to this law, the total volume of non-reacting mixture of gases at constant Pressure & Temperature should be equal to the sum of individual partial volume of constituent gases.

→ at const P, T

$$V_A = \frac{n_A RT}{P} = \text{Partial volume of gas } A \quad -(1)$$

$$V_B = \frac{n_B RT}{P} = \text{Partial volume of gas } B \quad -(2)$$

$$V_C = \frac{n_C RT}{P} = \text{Partial volume of gas } C \quad -(3)$$

Rel. of Amagat's law

$$V_T = V_A + V_B + V_C$$

$$V_T = (n_A + n_B + n_C)\frac{RT}{V} \quad \text{— (4)}$$

(1) ÷ (4)

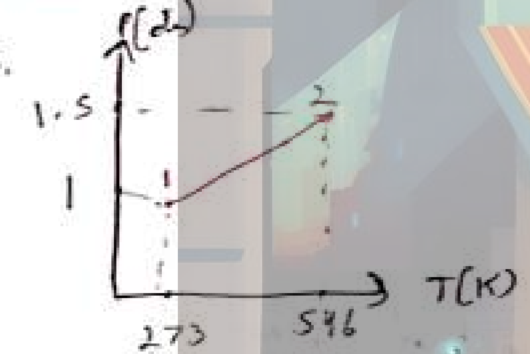
$$\frac{V_A}{V_T} = X_A \qquad \Bigg| \qquad \frac{V_B}{V_T} = X_B$$

$$\boxed{V_A = X_A V_T}$$

~~Partial Volume~~

**Partial Volume = Total Volume × mole fraction**

Q 33.




PT curve is plotted for one mole of ideal gas.

i) is the process isochoric

ii) volume of point (1)

$n = 1$

$$V_1 = \frac{1 \times R \times 273 \times 0.0821}{1} \qquad \Bigg| \qquad V_2 = \frac{1 \times 2 \cdot 546 \times 0.0821}{1.5}$$

$$\boxed{V_1 = 22.4\,l} \text{ ii)}$$

$$V_2 \neq V_1 \neq 22.4$$

**not isochoric** i)

Q.34. The best vacuum so far attained is $10^{-10}$ mm Hg. What is the no. of molecules of gas that remain per cc at 20°C in this vacuum

$PV = nRT$

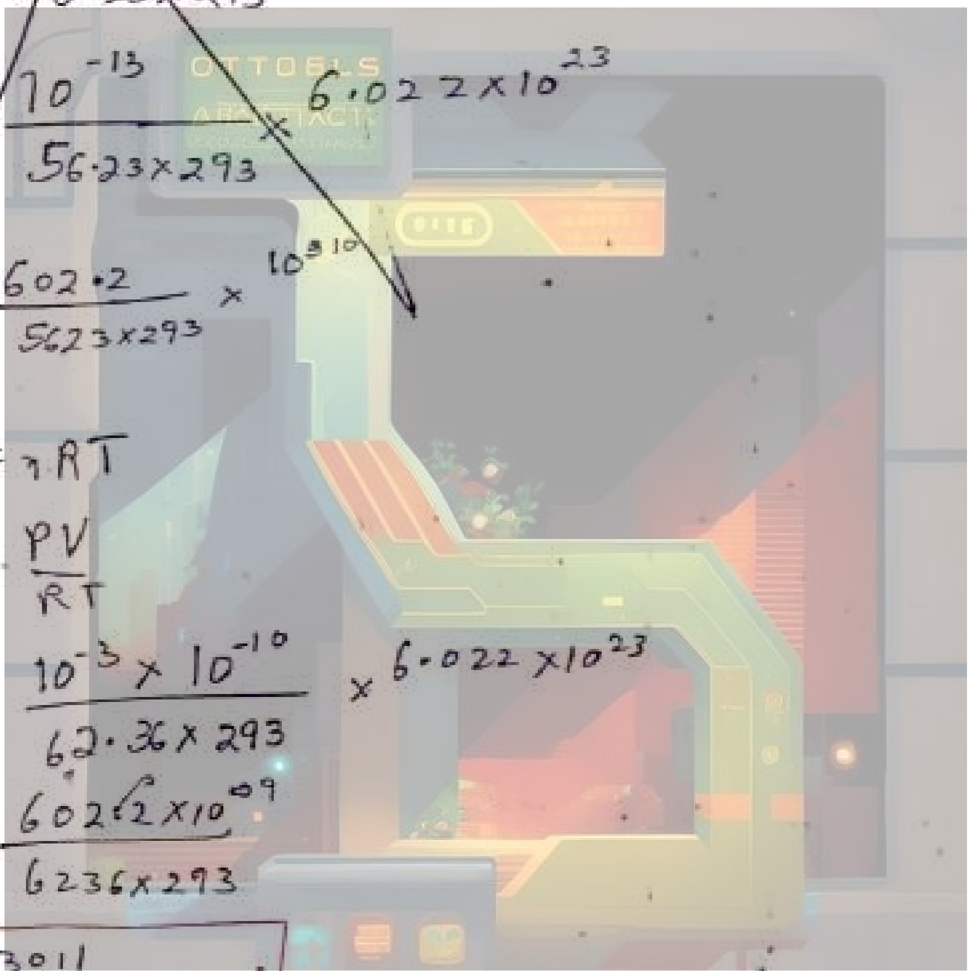
$n = \frac{PV}{RT}$

$n = 10^{-10} \times 56.23$

$n = \frac{10^{-10} \times 10^{-3}}{56.23 \times 293}$

$n = \frac{10^{-13}}{56.23 \times 293} \times 6.022 \times 10^{23}$

$n = \frac{602.2}{5623 \times 293} \times 10^{8+10}$



$PV = nRT$

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

$n = \frac{10^{-3} \times 10^{-10}}{62.36 \times 293} \times 6.022 \times 10^{23}$

$n = \frac{602.2 \times 10^{9}}{6236 \times 293}$

$$\boxed{n = \frac{3011}{3118 \times 293} \times 10^{9}}$$

$n = 3.2 \times 10^{6}$

## Problems related with diff type of containers

types of container

- closed container
  - Closed Rigid Container — $n, V$ const
  - Closed non-rigid container — $n \rightarrow$ constant, $P \rightarrow$ constant
- Open container
- connected container
  - Same Temp
  - Diff Temp

**Closed Rigid Vessel** $\quad n, V \rightarrow$ constant

$$PV = nRT$$

$$P \propto T(K)$$

$$\boxed{\frac{P_1}{P_2} = \frac{T_1}{T_2}}$$

→ On increasing temp, pressure also increases until max pressure is reached. After it explosion occur.

eg. gas cylinder

**Closed non-rigid vessel** $\quad n, P \Rightarrow$ constant

$$PV = nRT$$

$$V \propto T(K)$$

$$\cancel{\frac{V_1}{V_2} = \frac{T_1}{T_2}} \qquad \boxed{\frac{V_1}{T_1} = \frac{V_2}{T_2}}$$

⇒ On increasing temperature, volume also increases until maximum volume is attained. After this the vessel will burst.

eg. air bubble, balloon.

Q 35. A balloon is inflated one-fifth of its maximum volume at 27°c. find the temp. at which the balloon will burst.

$$\frac{V}{5} \times \frac{1}{300} = \frac{V}{T}$$

$$\boxed{T = 1500\ K}$$

<u>Open rigid container</u>

$PV = nRT$

$V, P \rightarrow$ const

$$\boxed{n_1 T_1 = n_2 T_2}$$

$V \Rightarrow$ fixed

$P \Rightarrow$ fixed maintained at 1 atm

$T \uparrow$ $\quad n_i - n_f = n_{escaped}$

$T \downarrow$ $\quad n_f - n_i = n_{entered}$

→ when air is heated in an open vessel/container, pressure is always atmospheric pressure ($P \rightarrow$ const) & volume is constant.

Q 36. An open vessel at 27°c contains air. Find the temperature upto which it should be heated so that

i) 1/3 of air in container measured initially escaped out

ii) 1/3 of air measured finally escaped out.

i) $n \times 300 = \frac{2n}{3} T_2$ $\qquad$ ii) $\frac{4n}{3} \times 300 = n \times T$

$\boxed{T = 450\ K}$ i $\qquad$ $\boxed{T = 400\ K}$ ii)

Q37. Calculate the volume of an open container. It is heated from 27°C to 227°C & volume of escaped air was

i) 200ml at 27°C

ii) 200ml at 127°

i) $n_i \times 300 = n_f \times 500$

$n_f = \frac{3}{5} n_i$

$n_{escape} = \frac{2}{5} n$

$PV = nRT$

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

$n = \frac{1 \times 0.2}{0.0821 \times 300}$

$n = \frac{0.2}{24.63}$

$n = \frac{2}{246.3}$ mol

$n_i = \frac{5}{2} \times \frac{2}{246.3} = \frac{5}{246.3}$ mol

$PV = nRT$

$V = \frac{5}{246.3} \times \frac{0.0821 \times 300}{1}$

$V = \frac{24.63 \times 5}{246.3 \times 10} = 0.5$

$\boxed{V = 500 ml}$ i)

$n = \frac{P \times V}{R \times T}$

$n = \frac{1 \times 0.2}{0.0821 \times 500}$

$n_i = \frac{5}{2} \times \frac{0.2}{0.0821 \times 500}$

$V = \frac{5 \times 0.2}{2 \times 1000} \times \frac{0.0821 \times 400}{1}$

$V = 0.1 \times 4$

$V = 0.4$ l

$\boxed{V = 400 ml}$ ii)

$V = \frac{500}{3} \times 4$

$V = \frac{2000}{3}$ l

$V = \frac{2}{3}$ ml

$\boxed{V = \frac{2000}{3} ml}$ ii)

$$n_{escape} = \frac{0.2}{0.0821 \times 400}$$

$$n_1 = \frac{0.5}{0.0821 \times 400}$$

$$V = \frac{0.5}{0.0821 \times 400} \times \frac{0.0821 \times 300}{1}$$

$$V = \frac{300}{400 \times 2}$$

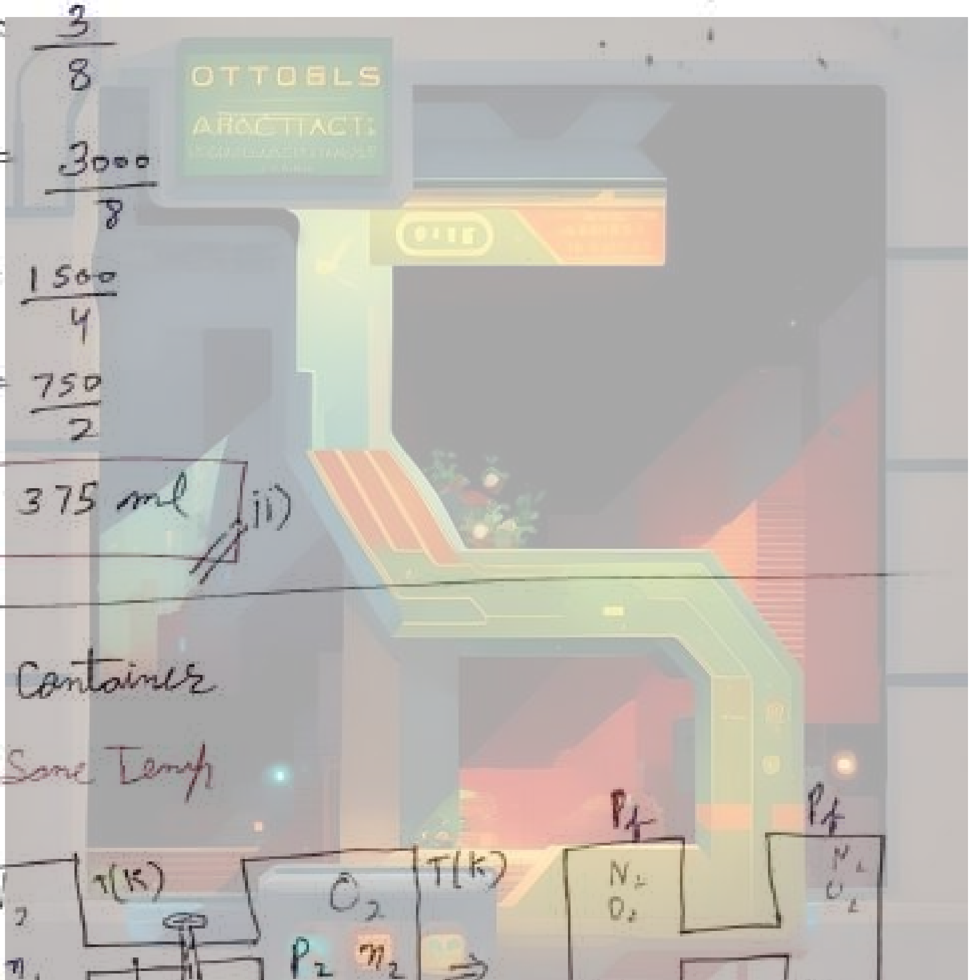
$$V = \frac{3}{8}$$

$$V = \frac{3000}{8}$$

$$V = \frac{1500}{4}$$

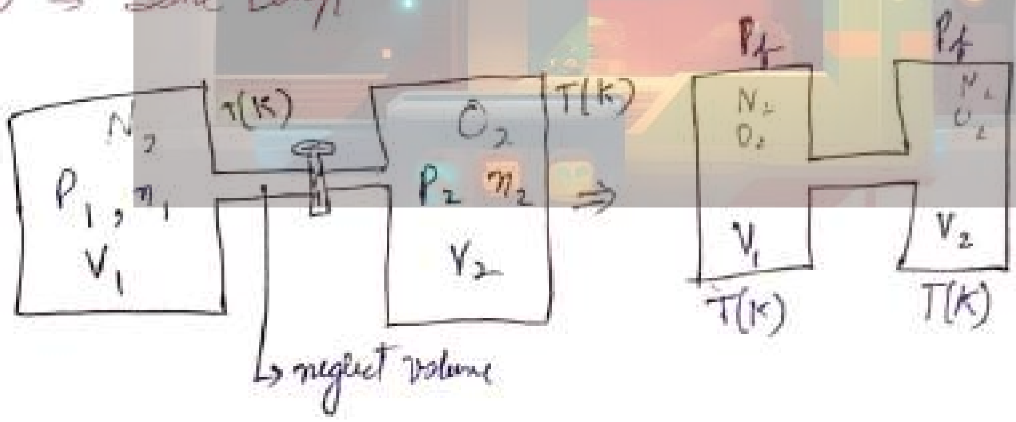
$$V = \frac{750}{2}$$

$$\boxed{V = 375\ ml}$$ (ii)



Connected container

Case ① → Same Temp




$$n_T = n_1 + n_2$$

$$\boxed{P_f V_f = P_1 V_1 + P_2 V_2}$$

$$P_{N_2} \times V_1 = (P_f)_{N_2} \times V_f$$

$$(P_f)_{N_2} = ?$$

$$P_{O_2} \times V_2 = (P_f)_{O_2} \times V_f$$

$$(P_f)_{O_2} = ?$$

$$\boxed{P_f = (P_f)_{O_2} + (P_f)_{N_2}}$$