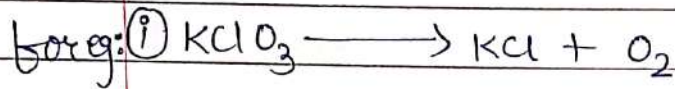




Principle of atom conservation (POAC)

- POAC method is applicable to find out product quantity in unbalanced reaction.
- generally, this method is used for complex reaction (multi-step reaction).



⇒ Apply POAC on 'K' atom.

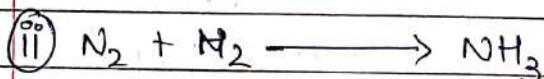
$$1 \times \text{mole of } \text{KClO}_3 = 1 \times \text{mole of } \text{KCl}$$

Apply POAC on 'Cl' atom.

$$1 \times \text{mole of } \text{KClO}_3 = 1 \times \text{mole of } \text{KCl}$$

Apply POAC on 'O' atom.

$$3 \times \text{mole of } \text{KClO}_3 = 2 \times \text{mole of } \text{O}_2$$



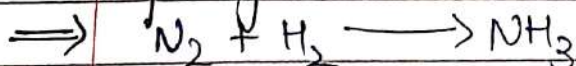
⇒ Apply POAC on 'N' atom.

$$2 \times \text{mole of } \text{N}_2 = 1 \times \text{mole of } \text{NH}_3$$

Apply POAC on 'H' atom

$$2 \times \text{mole of } \text{H}_2 = 3 \times \text{mole of } \text{NH}_3$$

Q: How much quantity of ammonia should be formed in haber process if 28gm of Nitrogen gas hydrogenated.



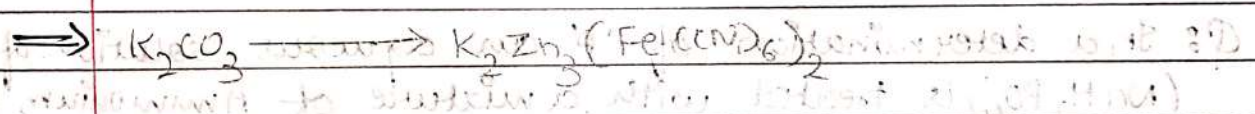
Apply POAC on 'N' atom
 $2 \times \text{mole of } N_2 = 1 \times \text{mole of } NH_3$

$$\Rightarrow \frac{2 \times 28}{28} = \frac{1 \times x}{17}$$

$$2 \times 17 = x$$

∴, 34 gm (2 moles)

Q: 27.6 gm K_2CO_3 was treated by series of reagents so as to convert all of its carbon to K_2Zn_3 , but we know $[Fe(CN)_6]_2$. calculate weight of product. (mol. wt. $K_2CO_3 = 138$
 mol. wt. $K_2Zn_3[Fe(CN)_6]_2 = 698$)



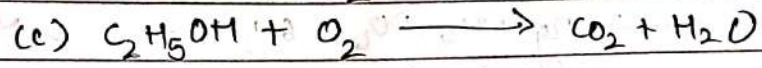
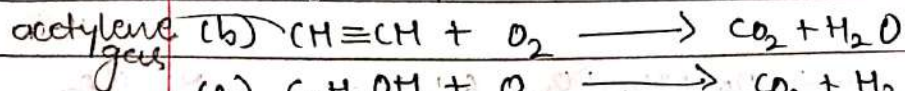
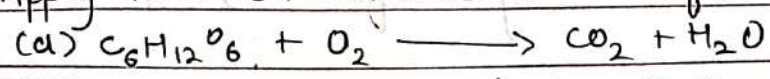
→ Apply POAC on 'C' atom of K_2CO_3
 $1 \times \text{mole of } K_2CO_3 = 12 \times \text{mole of } K_2Zn_3[Fe(CN)_6]_2$

$$1 \times \text{wt of } K_2CO_3 = 12 \times \text{wt of prod}$$

∴ wt of prod = $\frac{\text{wt of } K_2CO_3}{12}$

$$\frac{27.6 \times 698}{138 \times 12} \rightarrow \boxed{11.63 \text{ gm}}$$

Q: Apply POAC on carbon atom in following chemical rxn:



Apply POAC on 'C' atom.

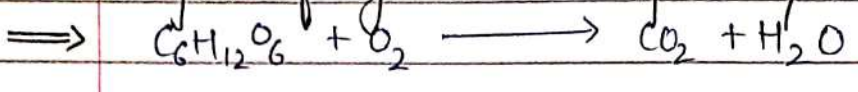
$$\Rightarrow \text{(a) } 6 \times \text{mole of } C_6H_{12}O_6 = 1 \times \text{mole of } CO_2$$

$$\text{(b) } 2 \times \text{mole of } CH \equiv CH = 1 \times \text{mole of } CO_2$$

$$\text{(c) } 2 \times \text{mole of } C_2H_5OH = 1 \times \text{mole of } CO_2$$

ethanol.

Q: How much volume of CO_2 at STP should be formed if 100gm of glucose completely combusts.



$$\text{mole} = \frac{100}{180} \Rightarrow \frac{2}{6} \times \frac{100}{180} = 1 \times \text{CO}_2$$

$$\text{vol} = \frac{\text{vol. of CO}_2}{22.4} \Rightarrow 10 = 1 \times \text{CO}_2$$

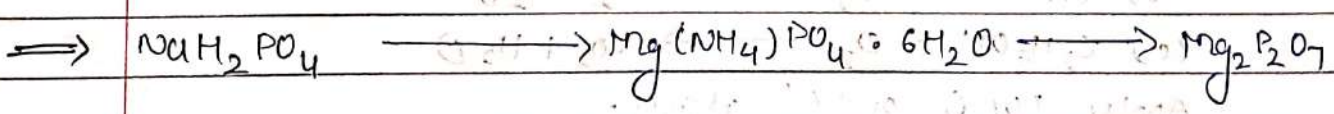
$$\Rightarrow 10 \times 22.4 = \text{CO}_2 \text{ at STP}$$

$$\frac{224}{3} = \text{CO}_2$$

Q: In a determination of 'P' an aqueous solution of $(\text{NaH}_2\text{PO}_4)$ is treated with a mixture of Ammonium & Magnesium ions to precipitate magnesium-ammonium phosphate $[\text{Mg}(\text{NH}_4)\text{PO}_4 \cdot 6\text{H}_2\text{O}]$.

- This compound is heated and decomposed into magnesium pyrophosphate $(\text{Mg}_2\text{P}_2\text{O}_7)$ which is weighted.

- A solution of $(\text{NaH}_2\text{PO}_4)$ yielded about 3.33gm of $(\text{Mg}_2\text{P}_2\text{O}_7)$. What weight of NaH_2PO_4 was present originally?



applied POC on 'P' atom:

$$1 \times \text{mole of NaH}_2\text{PO}_4 = 2 \times \text{mole of Mg}_2\text{P}_2\text{O}_7$$

$$\text{mole} = \frac{\text{given mass}}{\text{molar mass}}$$

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($\therefore \text{NaH}_2\text{PO}_4 = 120$ $\text{Mg}_2\text{P}_2\text{O}_7 = 222$)

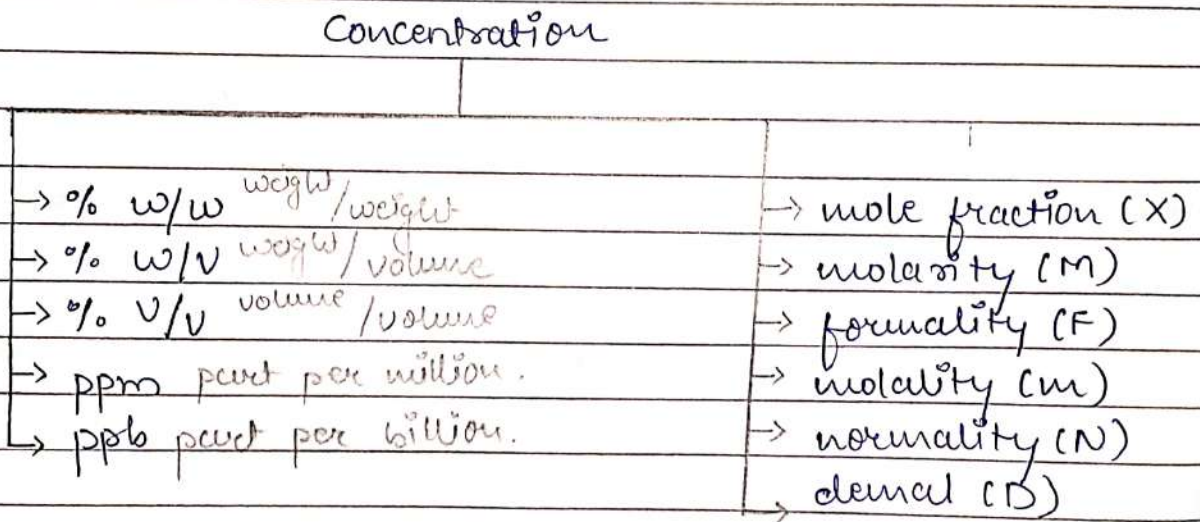
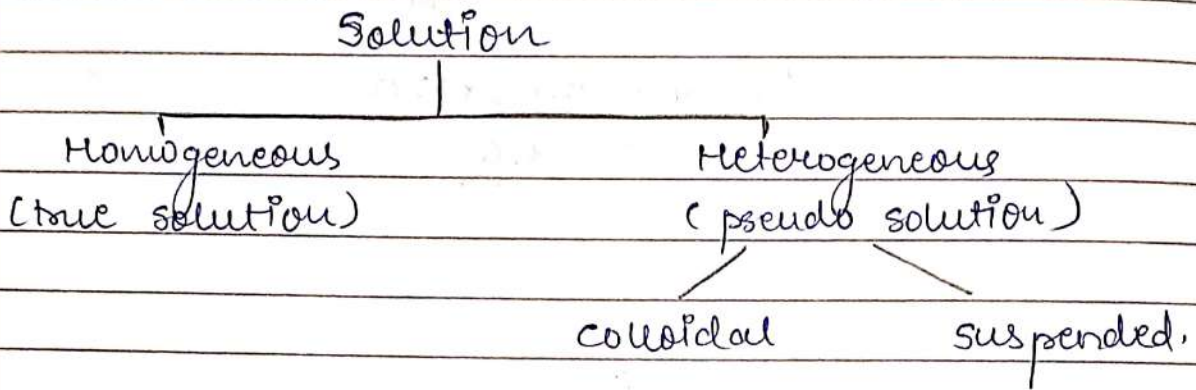
$$\Rightarrow 1 \times \frac{x}{120} = 2 \times \frac{3.33}{222}$$

$$\therefore x = 0.03 \times 120 \quad \left(\frac{3}{100} \times 120 \right)$$

$$= \underline{\underline{3.6}}$$

Concentration of solution:

- Solution = solute + solvent.
Qty: solvent > solute.



⇒ % w/w (weight/weight) solution:

- 5% w/w of NaOH solution: means 5gm of NaOH available in 100 gm of solution.

solution = solute + solvent

NaOH ⇒ 100gm = 5gm + 95gm

$$\% \text{ w/w NaOH} = \frac{\text{wt of solute (gm)}}{\text{wt. of solution (gm)}} \times 100.$$

Q: Find out the (% w/w) of NaCl if it dissolves in 1.5 gm in 35 gm of water.

$$\Rightarrow (\% \text{ w/w}) \text{ NaCl} = \frac{1.5}{35} \times 100$$

$$= \frac{300}{7} \longrightarrow \boxed{4.28\%}$$

#> % w/v (weight / volume) solution:- (²¹⁵ volume = liq.)

- $\frac{\text{weight of solute (gm)}}{\text{volume of solution (ml)}} \times 100\%$
- 5% w/v of aqueous NaOH : means 5 gm of NaOH available in 100 ml of solution

#> % v/v (volume / volume) solution:-

- $\frac{\text{volume of solute (ml)}}{\text{volume of solution (ml)}} \times 100\%$
- 5% v/v of aqueous ethanol : means 5 ml of ethanol available in 100 ml of solution

here, vol. of ethanol = 5 ml (solute)
vol. of H₂O = 100 - 5 = 95 ml

⇒ ppm : (parts per million) % : (1 ml = 10,00,000)

•
$$\text{ppm} = \frac{\text{weight of solute (gm)}}{\text{volume of solution (ml)}} \times 10^6$$

ppm $\begin{cases} \rightarrow w/w \\ \rightarrow w/v \\ \rightarrow v/v \end{cases}$ • used for diluted solution.

• 5 ppm NaOH solution : means 5 gm of NaOH available in 1 million litre ml solution.

⇒ ppb (parts per billion) % : (1 bill = 1,00,00,00,000)

•
$$\text{ppb} = \frac{\text{weight of solute (gm)}}{\text{volume of solution (ml)}} \times 10^9$$

ppb $\begin{cases} \rightarrow w/w \\ \rightarrow w/v \\ \rightarrow v/v \end{cases}$

⇒ mole fraction % : (x)

★ for a binary solution, mole fraction of component 'A' and 'B' can be written as:

$$X_A = \frac{n_A}{n_A + n_B} \quad \begin{matrix} n_A = \text{mole A} \\ n_B = \text{mole B} \end{matrix}$$

•
$$X_A = \frac{wt_A / m_A}{wt_A / m_A + wt_B / m_B}$$
wt = weight
m = molecular weight

• similarly, mole fraction of component B

$$X_B = \frac{n_B}{n_A + n_B}$$

• the total of whole (all) component mole fraction should be always one (1).

$$X_A + X_B + \dots = 1$$

• mole fraction is unit-less.

⇒ molarity (M)

☆ number of mole of solute available in one litre (l) of solution.

$$M = \frac{\text{mole of solute}}{\text{volume of solution (l)}}$$

$$\Rightarrow M = \frac{\text{wt of solute (gm)}}{\text{molecular wt of solute} \times \text{vol. of sol}^n \text{ (litre)}}$$

$$\frac{x}{y} \rightarrow \frac{x}{y \times A}$$

$$\Rightarrow M = \frac{\text{wt of solute (gm)} \times 1000}{\text{m. wt of solute} \times \text{vol. of sol}^n \text{ (ml)}}$$

concentration term

• 'Molarity' is temperature dependent.

}	Temp ↑ Volume ↑ → Molarity ↓
	Temp ↓ Volume ↓ → Molarity ↑

Q: Find molarity of 10% (w/w) NaOH solution.

⇒ 10% w/w = 10 gm NaOH
 volume = 100 ml. mol. wt of NaOH = 40.

$$\text{Molarity} = \frac{10 \text{ — wt.}}{40 \text{ — molecular wt.}}$$

$\frac{100}{1000}$ — wt. vol. for litre conversion
 $\frac{1000}{1000}$ — $\div 1000$ for litre conversion

$$M = \frac{10 \times 1000}{40 \times 100} = \frac{10}{4} \longrightarrow \boxed{2.5 \text{ mol/lit}}$$

Q: Find mole fraction of NaOH in 4% of (w/w) aqueous solution.

⇒ 4% w/w = 4 gm NaOH NaOH = 40
 Solution = 100 gm H₂O = 18.
 H₂O = 96 gm.

$$\text{mole of NaOH} = \frac{4}{40} = 0.1 \text{ mol.}$$

$$\text{mole of H}_2\text{O} = \frac{96}{18} = \frac{16}{3} \text{ mol.} \longrightarrow 5.3$$

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

$$= \frac{0.1}{0.1 + \frac{16}{3}} = \frac{0.1}{0.1 + 5.3}$$

$$= \frac{0.1}{5.4}$$

Q: In above question; find mole fraction of water.
 \Rightarrow as $X_{NaOH} + X_{H_2O} = 1.$

∴, $\frac{1}{54} - 1 = H_2O$

$\rightarrow \frac{54-51}{54}$

$\rightarrow \frac{53}{54}$

Q: Find out mass fraction of ^{NaCl} 2.5% (w/w) NaCl solution

\Rightarrow NaCl (2.5%) = 2.5 gm NaCl = 23 + 35.5 = 58.5
 H₂O = 97.5 gm mass = 100

\Rightarrow mass fraction = $\frac{2.5}{100} \times 10 \times 100 \rightarrow 0.025$

$\rightarrow \frac{1}{40}$

Q: How much quantity of KOH (potassium hydroxide) is required to prepare 200ml of 2.5 molar (2.5M) aqueous solution:

\Rightarrow KOH = 39 + 16 + 1 \rightarrow 56.

∴, $M = \frac{\text{quantity of KOH}}{\text{vol. of sol}^n}$

$2.5 = \frac{KOH}{200} \Rightarrow 0.5 \text{ mol.}$

∴, mole = at. wt.

$0.5 = \frac{KOH}{56} \rightarrow KOH = 28 \text{ gm}$