Chapter 2: Stoichiometry

Q1.

Sol: (i) $Ca \longrightarrow CaCO_3(s)$

Since 1 mole of $CaCO_3(s)$ contains 1 moles of Ca, So

1 mole of Ca will produce 1 mole of $CaCo_3(s)$.

$\therefore$ 5 mole of Ca ——— 5 mole of $CaCO_3$

(ii) $BaCl_2 \longrightarrow BaSO_4$

(moles)

5 moles of $BaCl_2$ contains 5 moles of Ba & 5 moles of Ba & can form 5 moles of $BaSO_4$; since 1 mole of $BaSO_4$ contain 1 mole of Ba.

(iii) $2\ Na \longrightarrow Na_2O$

5 moles (given)

$\because$ 2 moles produces 1 mole of Na_2O.

$\therefore 1$ ——— $\frac{1}{2}$

$\therefore 5$ ——— $5 \times \frac{1}{2} = 2.5$ moles of Na_2O.

Q2.

Ans: $Ca + \frac{1}{2}O_2 \longrightarrow CaO$ (Balanced chemical reaction)

Wt. of Ca = 40 g (Given)

So, moles of Ca = $\frac{40}{40} = 1$ moles

Now from balanced chemical reaction: 1 moles of Ca reacts with $\frac{1}{2}$ moles of O_2.

Wt of O_2 with which 40 g to Ca react = $\frac{1}{2} \times 32 = 16$ g

Ans

Q3.

Sol: $NaCl \longrightarrow Cl_2$

50 gm

If we have not to balance the chemical equation, then we have to apply POAC rule or g-equivalence rule.

By POAC (on Cl atom)

(no. of Cl atom)$_{\text{before reaction}}$ = (no. of Cl atom)$_{\text{after reaction}}$.

no. of moles of NaCl $\times N_A$ = 2 $\times$ no. of moles of $Cl_2 \times N_A$

$$\frac{50}{58.5} = 2 \times \text{moles of } Cl_2$$

moles of $Cl_2 = \frac{50}{117}$

Volume of Cl_2 at NTP = $\frac{50}{117} \times 22.4$ lit = 9.57 lit **Ans**

Q4.

Sol: Weight of Fe_2O_3 in iron ore = $\frac{94}{100} \times 2$ tons = $\frac{94}{100} \times 2000$Kg = 1880 kg.

$\therefore$ Mol. wt of Fe_2O_3 = 56 ×2 + 16 ×3 = 160 g

$\because$ 160 g of Fe_2O_3 contains 112 g of Fe

$\therefore$ 1 ——————— $\frac{112}{160}$

$\therefore$ 1880 ——————— $\frac{112}{160} \times 1880$ = 1316 kg **Ans**

Q5.

Sol: $CaC_2 \longrightarrow C_2H_2(g)$

100 gm

By POAC on C-atom

(moles of C atom) before reaction = (moles of C-atom) after reaction.

$2\times$ moles of CaC_2 = $2\times$mole of $C_2H_2(g)$

$\frac{100}{(40+2\times12)}$ = moles of C_2H_2 (g).

1.5625 = moles of C_2H_2 (g).

Volume of acetylene at NTP = 1.5625 ×22.4 lit = 35 lit

2[nd] method

$CaC_2 + H_2O \longrightarrow C_2H_2 + CaO$ (Balanced chemical reac-^{n})

moles of $CaC_2 = \frac{100}{64} = 1.5625$

$\therefore$ 1 moles of CaC_2 gives 1 mole of C_2H_2

$\therefore$ 1.5625 ——————— 1.5625 ——

$\therefore$ Volume of C_2H_2 at NTP = 1.5625 ×22. 4 lit = 35 lit

Q6.

Sol: Detonating gas is (2 mole H_2 + 1 mole O_2)

$2H_2O \longrightarrow 2H_2 + O_2$

(Detonating gas)

0.1 mole $\longrightarrow$ 0.1 mole + $\frac{1}{2}\times 0.1$mole

From reaction stoichiometry.

0.1 mole of H_2O produces 0.1 mole of H_2 + $\frac{0.1}{2}$ mole of O_2 = $\frac{0.3}{2}$ mole of donating gas.

$\therefore$ Volume of denoting gas produced = $\frac{0.3}{2} \times 22.4$ lit = 3.36 lit

Ans

Q7.

Sol: $Cu + HNO_3 \longrightarrow Cu(NO_3)_2.3H_2O$

By POAC (I don't like to balance equation). If you like you can have another method by balancing this equation and applying mole stoichiometric relationship)

(mole of Cu) $_{\text{before reaction}}$ = (mole of Cu) $_{\text{after reaction}}$

$$\frac{10}{63.5} = \text{mole of } Cu(NO_3)_2.\ 3H_2O.$$

$$\therefore \text{Wt of } Cu(NO_3)_2.\ 3H_2O = \frac{10}{63.5}(63.5+2\times62+3\times18) = \frac{10}{63.5}\times241.5 = 38\text{g}$$ **Ans**

Q8.

Sol: $KClO_3 \xrightarrow{\Delta} KCl + \frac{3}{2}O_2\uparrow$

Weight loss will be due to evolution of oxygen gas on heating.

$\because \frac{3}{2}$ mole of O_2 is produced from 1 mole of $KClO_3$

$\therefore \frac{3}{2}\times32$ g of O_2 produced from 122.5 g of KCl.

$\therefore 1$ ———————— $\frac{122.5}{48}$

$\therefore 0.384$ ———————— $\frac{122.5\times0.384}{48} = 0.98$ g

$$\therefore \%\ \text{purity} = \frac{0.98}{4.9}\times100 = 20\%$$

Q9.

Sol: $MgCO_3 + CaCO_3$. (Considered 100 g of mixture) You can actually consider any weight, but taking 100 g is easiest to solve the problems.

$MgCO_3$ ↓ X g (say)

$CaCO_3$ ↓ (100-x)g

Let wt of $MgCO_3$ = x g

$\therefore$ wt of $CaCO_3$ = (100-x) g

$MgCO_3 \xrightarrow{\Delta} MgO + CO_2\uparrow$

X gm

$\frac{x}{84}$ mole $\longrightarrow \frac{x}{84}$ mole

Wt. of CO_2 evolved = $\frac{x}{84}\times44$g

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

(100 –x) g

$\left(\frac{100-x}{100}\right)$mole $\longrightarrow \left(\frac{100-x}{100}\right)$mole

Wt. of CO_2 evolved = $\frac{100-x}{100}\times44$ g

A/q,

Wt loss = 50% (which will be due to evolution of CO_2)

$$\frac{x}{84}\times 44+\frac{100-x}{100}\times 44=50 \quad (50\% \text{ of } 100\text{ g}=50)$$

$$\frac{x}{84}+\frac{100-x}{100}=\frac{50}{44}$$

Solving for x, we have

$$X = 71.59\%$$

$$\left.\begin{array}{l}\% \text{ of } MgCO_3 = x/100\times 100 = 71.59\% \\ \% \text{ of } CaCO_3 = (100-x) = 28.41\%\end{array}\right\} \textbf{Ans}$$

Q10.

Sol: $Zn + 2Fe + 4S \longrightarrow Zn[FeS_2]_2$

Given amount: 2g 3g 4g 0

Given moles: $\frac{2}{65.4}$ $\frac{3}{56}$ $\frac{4}{32}$

From the balanced chemical equation.

1 mole of Zn $\equiv$ 2 mole of Fe

$\therefore$ 2 mole of Zn = 1 mole of Fe

$$2\times\frac{2}{65.4}=\text{mole of Fe} \quad \Rightarrow \text{Mole of Fe (required)} = \frac{4}{65.4} > \frac{3}{56} \text{ (given amount)}$$

$\therefore$ Fe will be the limiting agent between Zn & Fe ----------- (1)

Further, we have to decide the limiting reagent between Fe and Sulphur

2 mole of Fe $\equiv$ 4 mole of S

$\therefore$ 4 mole of S = 2 mole of Fe

$$2.4\times\frac{4}{32} = 2\times \text{mole of Fe} \quad \Rightarrow \therefore \text{Moles of Fe (required)} = \frac{1}{4} > \frac{3}{56}$$

$\therefore$ Between Fe & sulphur, Fe is the limiting reagent. --------------(2)

(1) & (2) $\Rightarrow$ Overall, Fe will to the limiting reagent

So, moles of Fe will determine the moles of $Zn(FeS_2)_2$ produced.

2 mole of Fe $\equiv$ 1 mole of Zn $(FeS_2)_2$

$\therefore$ 1 mole of Fe = 2 $\times$ mole of Zn $(FeS_2)_2$

$$\therefore \text{Mole of Zn } (FeS_2)_2 = \frac{\text{mole of Fe}}{2} = \frac{3}{56\times 2} \text{ moles}$$

$$\therefore \text{Wt of Zn } (FeS_2)_2 = \left[\frac{3}{112}\times 65.4 + 2\times(56+2\times 32)\right]$$

Q11.

Sol: $VO + Fe_2O_3 \longrightarrow FeO + V_2O_5$

Given amount: 2 g 5.78 g

Moles: $\frac{2}{67}$ $\frac{5.78}{160}$

Before we can know the limiting reagent, either we have to balance it or we have to apply the law of equivalence in above reaction by calculating valances factor for each species.

By balancing of equation

$2VO + 3Fe_2O_3 \longrightarrow 6FeO + V_2O_5$ (Balancing require a mathematical trick will be done in class).

$\therefore$ 2 mole of VO ≡ 3 moles of Fe_2O_3

$\therefore$ 2 moles of Fe_2O_3 = 3 moles of CO.

$$2\times\frac{5.75}{160} = 3\times \text{moles of VO}$$

$$\text{Moles of VO} = \underset{\text{(required)}}{\frac{12.50}{480}}\times\frac{2}{67} \text{ (given amount)}$$

Since given amount of VO is larger than the required amount of VO. So Fe_2O_3 will be limiting reagent.

Now from balanced chemical equation

3 moles of Fe_2O_3 ≡ 1 mole of V_2O_5

$\therefore$ 1 mole of Fe_2O_3 = 3 × mole of V_2O_5

$$\therefore \text{mole of } V_2O_5 = \frac{1}{3}\times \text{mole of } Fe_2O_3 = \frac{1}{3}\times\frac{5.75}{160} = \frac{5.75}{480}$$

$$\therefore \text{ Wt of } V_2O_5 \text{ produced} = \frac{5.75}{480}\times(182) = 2.18 \text{ gm}$$

Ans

Q12.

Sol: Let W g is the weight of mercury & iodine taken, from which x g is the weight of iodine involved in HgI_2 formation, then (w-x)g will be involved in Hg_2I_2 formation.

(1) $Hg + I_2 \longrightarrow HgI_2$

x gm

$\frac{x}{254}$ moles

$\therefore$ mole of Hg involved in this reac-^{n} = $\frac{x}{254}$

$\therefore$ wt of ________________ $\frac{x}{254}\times 200$

(2) $2Hg + I_2 \longrightarrow Hg_2I_2$

(w-x) g

$\frac{w-x}{254}$ moles

2 mole of Hg $\equiv$ 1 mole of I_2

$\therefore$ 1 mole of Hg = $2 \times \text{mole of } I_2 = 2 \times \left(\frac{w-x}{254}\right)$

$\therefore$ Wt of Hg involved in reaction (2) = $\frac{2\times(w-x)}{254} \times 200$

A/q, $\frac{200}{254}x + \frac{2(w-x)}{254} \times 200 = w.$

$x + 2(w-x) = \frac{254w}{200}$

$2w - x = 1.27w$

$x = 0.73w$

Wt of HgI_2 produced = mole of $HgI_2 \times (454) = \frac{x}{254} \times 454$

Wt of Hg_2I_2 produced = mole of $Hg_2I_2 \times (654) = \frac{w-x}{254} \times 654.$

Ratio of the weight of Hg_2I_2 & HgI_2

$$= \frac{\frac{(w-x)}{254}\times 654}{\frac{x}{254}\times 454} = \frac{w-0.73w}{0.73w} \times \frac{654}{454} = \frac{0.27}{0.73} \times \frac{654}{454} = 0.532:1.$$ **Ans**

Q13.

Sol: $W(FeSO_4.7H_2O + Fe_2(SO_4)_3.9H_2O) = 5.5$ g (given)

With $KMnO_4$ (a strong O.A.) only $FeSO_4.7H_2O$ react because Fe is in lower oxidation state here only

$KMnO_4 + FeSO_4 \longrightarrow Mn^{2} + Fe^{3+}$

From law of chemical-equivalence

gm equivalence of $KMnO_4$ = gm equivalence of $FeSO_4.7H_2O$

$\frac{5.4}{1000} \times 0.1 = \frac{wt}{Mol.wt / v.f} = \frac{wt}{278}$

$Wt = \frac{5.4 \times 278}{10^4} = 0.1501g$

$\therefore$ Wt of $Fe_2(SO_4)_3.\ 7H_2O = 5.5 - 0.15 = 5.35$ g

$\therefore$ Moles of Ferric sulphate (hydrated) = $\frac{5.35}{562}$

= 0.0095 moles; **Ans**

Q14.

Sol: $Na_2SO_4(anhy) + 10H_2O \longrightarrow Na_2SO_4.10H_2O$

$1\ g = \frac{1}{142}$ moles

moles of water with which 1 gm of Na_2SO_4 react = $\frac{10\times1}{142}$

$\therefore$ Wt of ———————————— = $\frac{10\times1}{142}\times18$

$\therefore$ Wt of 1 gm of Na_2SO_4 will increase by 1.27 g. **Ans**

Q15.

Sol: In drying only water's amount will change.

Clay	Silica	Water	Others
Original	X(say)%	12%	100-(12+x)% = 88-x%
Partially dried	50%	7%	43%

Since amount of silica &other won't change

$\therefore$ Ratio of silica to other will remain same.

$$\frac{x}{88-x} = \frac{50}{43}$$

$$43x = 50\times88 - 50x$$

$$x = \frac{50\times88}{93} = 47.3\%\ \textbf{Ans}$$

Q16.

Sol: W(NaCl + NaBr + inert substance) = 1 g

Let wt of NaCl is x g

& wt of NaBr is Y g.

$$(NaCl + NaBr) + AgNO_3 \longrightarrow (AgCl + AgBr)\downarrow$$

X g   y g   excess   0.526 g

$\frac{x}{58.5}$ $\frac{y}{103}$ $\xrightarrow{Cl_2/\Delta}$ AgCl.(0.426 g)

$\frac{x}{58.5}$ moles of NaCl will produce $\frac{x}{58.5}$ moles of AgCl

$\therefore$ ———————————— $\frac{x}{58.5}\times143.5g$

$\frac{y}{103}$ moles of NaBr will produce $\frac{y}{103}$ mole of AgBr

$\therefore$ ———————————— $\frac{y}{103}\times183g$

A/q,

$$\frac{x}{58.5}\times 143.5+\frac{y}{103}\times 183=0.526\,g \text{ ———— } (1)$$

Now when Cl_2 gas is passed over (AgCl + AgBr) mixture then AgBr will convert into AgCl.

$$AgBr + Cl_2 \longrightarrow AgCl.$$

$$\frac{y}{103}\text{ moles} \longrightarrow \frac{y}{103}\text{ moles}$$

$\therefore$ Wt of AgCl produce from AgBr = $\frac{y}{103}\times 143.5\,g$

$\therefore$ A/q, Total wt. of AgCl = 0.426 g

$$\therefore \frac{x}{58.5}\times 143.5+\frac{y}{103}\times 143.5=0.426\,g \text{ ———— } (2)$$

Solving (1) & (2), we have

X = 0.0425 g

Y = 0.232 g

$\therefore$ % of NaCl = $\frac{x}{1}\times 100=4.25\%$

% of NaBr = $\frac{y}{1}\times 100 = 23.2\%$; **Ans**

Q17.

Sol: $W(Al + Al_2O_3) = 3.9$ g

$$Al + 3NaOH \longrightarrow Na_3AlO_3 + \frac{3}{2}H_2\uparrow$$

Volume of H_2 produced = 840 ml (at NTP)

moles of H_2 ———— $= \frac{840}{22400} = 0.0375$

$\because \frac{3}{2}$ moles of H_2 is produced by 1 mole of Al

$\therefore$ 1 ———— $\frac{1}{3/2} = 2/3$ moles of Al

$\therefore$ 0.0375 ———— $\frac{2}{3}\times 0.0375 = 0.025$

$\therefore$ Wt of Al = 0.025 × 27 = 0.675 g

$\therefore$ % of Al = $\frac{0.675}{3.9}\times 100 = 17.3\%$

Ans

Q18.

Ans: $W(NaCl + NaOH) \rightarrow 2$ g

Let x g of NaCl is present in 2 g of commercial NaOH

$$NaCl + AgNO_3 \longrightarrow AgCl\downarrow + NaNO_3$$
X g   0.287 g

$$\frac{x}{58.5}\text{moles} \longrightarrow \frac{x}{58.5}\text{moles}$$

$\therefore$ Wt of AgCl produced = mole of AgCl × Mol.wt

$$= \frac{x}{58.5}\times 143.5$$

A/q, $\frac{x}{58.5}\times 143.5 = 0.287\,g$

$x = 0.117$ g; **Ans**

Q19.

Ans: $KMnO_4 + SO_2 \longrightarrow Mn^{2+} + SO_4^{2-}$

15.8 g   v.f=2

v.f = 5

gm eq. of $KMnO_4$ = gm eq. of SO_2

$$\frac{15.8}{158/5} = \frac{wt}{64/2}$$

Wt of $SO_2 = \frac{1}{2}\times 32 = 16\,g$

$$FeS_2 \xrightarrow{\text{Roasting}} SO_2$$

By POAC; mole of S in FeS_2 = mole of S in SO_2

2×mole of FeS_2 = mole of SO_2

$$= \frac{16}{64}$$

Mole of $FeS_2 = \frac{1}{8}$ $\therefore$ wt $= \frac{1}{8}\times 120 = 15\,g$ **Ans**

Q20.

Ans: $(NaCl + NaBr) + H_2SO_4 \longrightarrow Na_2SO_4$

Let (x + y) g = 1 gm is taken

Then according to question, Wt of Na_2SO_4 produced = 1 g

$$2NaCl + H_2SO_4 \longrightarrow Na_2SO_4 + 2HCl$$

$$X\,g = \frac{x}{58.5}\text{moles}$$

$\therefore$ Mole of Na_2SO_4 (produced) $= \frac{1}{2}\times\left(\frac{x}{58.5}\right)$

$\therefore$ Wt of Na_2SO_4 produced from NaCl $= \frac{x}{117}\times 142\,g$

$$2NaBr + H_2SO_4 \longrightarrow Na_2SO_4 + 2HBr$$

$$y\,g = \frac{y}{103}\text{ moles}$$

$$\text{Moles of } Na_2SO_4 \text{ (Produced)} = \frac{1}{2}\times\frac{y}{103} = \frac{y}{206}$$

$$\therefore \text{ Wt of } Na_2SO_4 \text{ Produced from NaBr} = \frac{y}{206}\times 142g$$

A/q, $$\frac{x\times142}{117} + \frac{y}{206}\times142 = 1g$$

$$\therefore \frac{x}{117} + \frac{1-x}{206} = \frac{1}{142} \qquad (x+y=1)$$

$$\frac{206x+117-117x}{206\times117} = \frac{1}{142}$$

$$89x = 169.732 - 117 \quad \Rightarrow \quad x = \frac{52.732}{89} = 0.59g$$

$\therefore$ Wt of NaBr $= 1 - x = 0.41$ g

$\therefore$ Ratio of the wt. $= 0.59/0.41 = 1.45:1$ **Ans**

Q21.

Sol: $I_2 + Cl_2 \longrightarrow ICl + ICl_3$

25.4 g 14.2 g

$\frac{254}{254} = 0.1$ $\frac{142}{710} = 0.2$

Let x moles of I_2 involved in ICl formation

$\therefore$ moles of Cl_2 involved in ICl formation = x

(1) $I_2 + Cl_2 \longrightarrow 2ICl$

x mole $\rightarrow$ x moles $\rightarrow$ 2x moles

The remaining $(0.1 - x)$ moles of I_2 will be involved in ICl_3 formation.

(2) $I_2 + 3Cl_2 \rightarrow 2ICl_3$

$(0.1 - x) \rightarrow 3(0.1 - x)$

$\therefore$ Moles of Cl_2 involved $= 3(0.1 - x)$

Now $x + 3(0.1 - x) = 0.2$ (moles of Cl_2 given)

$\Rightarrow$

$$x + 0.3 - 3x = 0.2$$

$$2x = 0.1 \quad \Rightarrow \quad x = \frac{0.1}{2}$$

(1) $\Rightarrow$ moles of ICl formed $= 2x = 0.1$ moles

(2) $\Rightarrow$ moles of ICl_3 formed $= (0.1 - x)\times 2 = 0.1$ moles. **Ans**

Q22.

Ans: $Al + 3H^+ \longrightarrow Al^{3+} + \frac{3}{2}H_2$

Nobel metals (Ag, Au, Pt, Hg Cu) doesn't react with acid/H_2O to produce H_2.

Volume of H_2 produced = 415 cm^3 $\quad \therefore$ moles of H_2 produced = $\frac{415}{22400}$

From balanced chemical reac-^{n}

$\therefore \frac{3}{2}$ mole of H_2 produced by 1 mole of Al

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

$\therefore \frac{415}{22400}$ ———————— $\frac{2}{3} \times \frac{415}{22400} = 0.01235$

$\therefore$ Wt. of Al $= 0.01235 \times 27$ g $= 0.3335$ g

$\therefore$ % of Al $= \frac{0.3335}{0.35} \times 100 = 95.3\%$ **Ans**

Q23.

Ans: Absorption rate of $CO_2 = 4.7 \times 10^{-3}$ moles of CO_2 / hr by 1 gm green algae

Starch - $(C_6H_{10}O_5)_n$

$\therefore$ For doubling the mass of green algae (1 g), it must form 1 gm of starch.

$\therefore$ Wt of $(C_6H_{10}O_5)_n = 1$g

$CO_2 \longrightarrow (C_6H_{10}O_5)_n$

moles of in CO_2 = moles of C in $(C_6H_{10}O_5)_n$

moles of $CO_2 = 6n \times$ mole of $(C_6H_{10}O_5)_n = 6n \times \frac{1}{n(162)}$

$\therefore$ Mole of CO_2 required $= \frac{6}{162}$

Rate of absorption = 4.7×10^{-3} moles/hr

Time(hr) = $\frac{6/162}{4.7 \times 10^{-3}} = 7.88$ hrs **Ans**

Q24.

Sol: $CaO + 3C \longrightarrow CaC_2 + CO$

Let x g is the weight of CaO taken, from which Y g of CaO reacts with carbon to produce CaC_2

$\therefore$ So, Wt. of CaO remained = (x-y) g

Wt of CaC_2 produced = mole of $CaC_2 \times$ Mol. wt CaC_2

$= \text{mole of CaO reacted} \times \text{M.w. } CaC_2 = \frac{y}{56} \times 64 = \frac{8y}{7}$

$\therefore$ Total weight now, $(x - y) + \frac{8y}{7} = \left(x + \frac{y}{7}\right)$g

(Wt of CaC_2 produced remained + Wt of CaO produced)

A/q, Wt of $CaC_2 = 85\%$

$$\Rightarrow \frac{8y/7}{x + y/7} \times 100 = 85 \Rightarrow \frac{8y}{7x+y} = \frac{85}{100} = \frac{17}{20}$$

$$\Rightarrow 160\,y = 119\,x + 17y \Rightarrow 143\,y = 119\,x$$

$$\Rightarrow y = \frac{119}{143}x = 0.832\,x$$

(a) Pure wt of CaC_2, $\frac{8y}{7} = 1000\,kg\,(given) \Rightarrow y = \frac{7000}{8}Kg$

$$\therefore x\,(\text{wt of CaO have to take}) = \frac{y}{0.832} = \frac{7000}{8 \times 0.832}Kg = \frac{7000}{6.657} = 1051.5Kg$$

(b)- Crude product $= (x - y) + \frac{8y}{7} = x + \frac{y}{7} = 1000\,Kg$.

$$x + \frac{0.832x}{7} = 1000 \Rightarrow \frac{7.832x}{7} = 1000\,Kg$$

$$\Rightarrow x = \frac{7000}{7.832} = 893.7Kg \quad \textbf{Ans}$$

Q25.

Sol: W (BaO + CaO) = 2.5 g

Let x g of BaO is present

Then wt of CaO = (2.5 – x) g

$$BaO + H_2SO_4 \longrightarrow BaSO_4 + H_2O$$

x g

$$\frac{x}{153}\text{moles} \longrightarrow \frac{x}{153}\text{moles} = \frac{x}{153} \times 233 = 1.523x$$

$$CaO + H_2SO_4 \longrightarrow CaSO_4 + H_2O$$

(2.5 – x) g

$$\frac{(2.5-x)}{56}\text{moles} \longrightarrow \left(\frac{2.5-x}{56}\right)\text{moles} = \frac{(2.5-x)}{56} \times 136 = (2.5-x)\,2.43\text{ g}$$

A/q, wt of $CaSO_4$ + wt of $BaSO_4 = 4.713$ g

$$(2.5 - x)\,2.43 + 1.523\,x = 4.713$$

$$6.07 - 2.43\,x + 1.523\,x = 4.713$$

$$1.358 = 0.907\,x$$

$$x = \frac{1.358}{0.907} = 1.497\,g = 1.5g$$

$$\therefore \%\text{ of BaO} = \frac{x}{2.5} \times 100 = \frac{1.5}{2.5} \times 100 = 60\% \quad \textbf{Ans}$$

Q26.

Sol: $(NaI + NaCl) + H_2SO_4 \longrightarrow Na_2SO_4 + HCl + Hg$

Let 1 g of (NaCl + NaI) is taken, in which x g of NaI is present & (1-x) g of NaCl is Present

$\therefore 2NaI + H_2SO_4 \longrightarrow Na_2SO_4 + 2Hg$

$$\frac{x}{150}\text{ moles} \longrightarrow \frac{1}{2}\times\frac{x}{150}\text{ moles}$$

$$= \frac{1}{2}\times\frac{x}{150}\times 142 = \frac{71x}{150}g$$

$2NaCl + H_2SO_4 \longrightarrow Na_2SO_4 + 2HCl$

$$\frac{(1-x)}{58.5}\text{ moles} \longrightarrow \frac{1}{2}\times\frac{(1-x)}{58.5}$$

$$= \frac{1}{2}\times\frac{1-x}{58.5}\times 142\ 71 = \frac{71}{58.5}(1-x)g$$

A/q, Wt of Na_2SO_4 produced = 1 g

$$\frac{71x}{150}+\frac{71(1-x)}{58.5} = 1 \quad \Rightarrow \frac{58.5x + 150 - 150x}{150\times 58.5} = \frac{1}{71}$$

$$150 - 91.5\,x = 123.6$$

$$91.5\,x = 26.4 \quad \Rightarrow x = \frac{26.4}{91.5} = 0.2885$$

$$\therefore \%\text{ of NaI} = \frac{x}{1}\times 100 = \frac{0.2885}{1}\times 100 = 28.85\%$$ **Ans**

Q27.

Sol: $KCl \xrightarrow[H_2SO_4]{MnO_2} Cl_2 \xrightarrow{KI} I_2$

I   II

7.46 g

By POAC (in reaction I)

mole of Cl in KCl = moles of Cl atom in Cl_2

mole of KCl = 2 × moles of I_2

$$\frac{7.46}{74.6} = 2\times\text{moles of } Cl_2$$

$$\frac{1}{10} = 2\times\text{mole of } I_2 \quad (\text{mole of } Cl_2 = \text{mole of } I_2 \text{ from IInd reac-}^n)$$

$$\text{mole of } I_2 = \frac{1}{20} \quad \Rightarrow \text{Wt of } I_2 = \frac{1}{20}\times 258 = 12.7\,g$$

Ans

Q28.

Sol: Let is consider 100 g of Carnalite

Wt of water = 38.86 g

$\therefore$ Wt of KCl + $MgCl_2$ = (100 – 38.86) g = 61.14 g

Let wt of KCl = x gm

$\therefore$ Wt of $MgCl_2 = (61.14 - x)$ g

$KCl + MgCl_2 \longrightarrow AgCl$

By POAC

mole of Cl atom before reaction = mole of Cl atom reaction

mole of Cl in KCl + mole of Cl in $MgCl_2$ = mole of Cl in AgCl

mole of KCl + 2 × mole of $MgCl_2$ = mole of AgCl

$$\frac{0.458 \times x}{100 \times 74.5} + 2 \times \frac{(61.14 - x)}{100 \times 95} \times 0.458 = \frac{0.71}{143.5}$$

$$\Rightarrow \frac{x}{74.5} + \frac{(61.14 - x)2}{95} = \frac{700}{143.5 \times 0.458} = \frac{700}{65.72}$$

Calculating x = 26.46% **Ans**

Q29.

Sol: $MoO_3 + 3H_2 \longrightarrow Mo + 3H_2O$

125 g

$\frac{125}{144}$ moles

Moles of H_2 reacts with $\frac{125}{144}$ moles of MoO_3 $= 3 \times \frac{125}{144}$

$\therefore$ Volume of H_2 required $= \frac{375}{144} \times 22.4$ lit $= 58.33$ lit **Ans**

Q30.

Sol: $(COOH)_2 \xrightarrow{H_2SO_4} CO + CO_2 + H_2O$

10 g $= \frac{10}{90}$ moles

moles of CO produced $= \frac{10}{90} = \frac{1}{9}$ $\Rightarrow$ mole CO_2 produced $= \frac{10}{90} = \frac{1}{9}$

$\therefore$ Volume of gases produced at 0^0C & 760 mm of Hg (at NTP)

$$\left(\frac{1}{9} + \frac{1}{9}\right) = \frac{2}{9} \times 22.4 \text{ lit} = 4.96 \text{ lit}$$ **Ans**

Q31.

Sol: $W(CH_4 + C_2H_6 + C_3H_8 + N_2)100g$

% by volume: CH_4 ↓ 84%, C_2H_6 ↓ 10%, C_3H_8 ↓ 3%, N_2 ↓ 3%

We know, volume % = mole % (at constant temp. and pressure)

mole % of CH_4 = 84% & mole % of C_2H_6 = 10%

mole % of C_3H_8 = 3 % & mole % of N_2 = 3%

By POAC

mole of C before reaction = mole of c after reaction

mole of C(in CH_4 + in C_2H_6 + in C_3H_8) = mole of C in C_4H_6

mole of CH_4 + 2 mole of C_2H_6 + 3×mole of C_3H_8 = 4×mole of C_4H_6

$84 + 2\times10 + 3\times3 = 4\times$ mole of C_4H_6

$84 + 20 + 9 = 4\times$ mole of C_4H_6

mole of $C_4H_6 = \frac{213}{4} = 28.25$ moles

mole of ($CH_4 + C_2H_6 + C_3H_8 + N_2$) taken (in 100 g of mixture)

$$= \frac{\text{wt}}{\text{Mol.wt}} = \frac{100}{\frac{84\times16+10\times30+3\times44+3\times28}{100}} = \frac{10000}{1860} = 5.367$$

∴ 100 moles of mixture produces 28.25 moles

∴ 1 ———————— $\frac{28.25}{100}$

∴ 5.376 ———————— $\frac{5.376\times28.25}{100}$

∴ Wt of C_4H_6 produced = mole × Mol. Wt = 1.518 × 54 = 82 g. **Ans**

Q32.

Sol: $P_4 + O_2 \longrightarrow P_4O_6 + P_4O_{10}$

2 g   2 gm

$\frac{2}{124}$ moles $\frac{2}{32}$ moles

In reaction : $P_4 + 3O_2 \longrightarrow P_4O_6$

moles of O_2 required to react with $\frac{1}{62}$ moles of P_4 Completely

$$= \frac{1}{62}\times3 = \frac{3}{62} < \frac{1}{16}$$

In reac-^{n} : $P_4 + 5O_2 \longrightarrow P_4O_{10}$

mole of O_2 required to react completely with

$$\frac{1}{62} \text{ moles of } P_4 = \frac{1}{62}\times5 = \frac{5}{62} > \frac{1}{16}$$

SO, P_4 will first react with O_2 to produce P_4O_6 & then the remaining O_2 will react with P_4O_6 to produce P_4O_{10}

$$P_4 + 3O_2 \longrightarrow P_4O_6 + 2O_2 \longrightarrow P_4O_{10}$$

$$\frac{1}{62} \longrightarrow \frac{3}{62}\text{ moles} \quad \frac{1}{62}\text{ mole} \quad \left(\frac{1}{16}-\frac{3}{62}\right)$$

Wt of P_4O_6 produced $= \frac{1}{62} \times 220\,g = 3.55\,g$

moles of O_2 (remaining) $= \frac{1}{16} - \frac{3}{62} = \frac{62-48}{62 \times 16} = 0.014133$

$P_4O_6 \;+\; 2O_2 \longrightarrow P_4O_{10}$

0.014 moles

$\therefore$ moles of P_4O_6 (reacted) $= \frac{0.014}{2} = 0.00706$

$\therefore$ moles of P_4O_6 (remained) $= \frac{1}{62} - 0.00706 = 0.00907$

moles of P_4O_{10} (produced) $= \frac{0.014113}{2} = 0.00706$

Wt of P_4O_{10} (produced) $= 0.00706 \times 284 = 2.004$ g **Ans**

Wt of P_4O_6 (Produced) $= 0.00906 \times 220 = 1.996$ g **Ans**

[Note $\rightarrow$ Please don't approximate the calculation]

Q33.

Sol: (1) $2COF_2 + F_2 \longrightarrow 2COF_3$

(2) $(CH_2)_n + 4n\,COF_3 \longrightarrow (CF_2)_n + 2nHF + 4nCOF_2$

(1)$\Rightarrow$ {1 mole of $F_2 \equiv 2$ mole of COF_3 } $\times 2n$

(2)$\Rightarrow$ 4n mole of $COF_3 \equiv 1$ mole of $(CF_2)_n$

$\therefore$ 2n mole of $F_2 \equiv 1$ mole of $(CF_2)_n$

$1 \times$ mole of $F_2 = 2n \times$ mole of $(CF_2)_n$

$= 2n \times \frac{1000\,g}{50\,n} = 40$ mole

$\therefore$ Wt of F_2 required $= 40 \times 38$ g $= 1529$ g $= 1.52$ Kg **Ans**

Q34.

Sol: (1) $2KClO_3(s) \longrightarrow 2KCl(s) + 3O_2(g)$

(2) $2KHCO_3(s) \longrightarrow K_2O(s) + H_2O(g) + 2CO_2(g)$

(3) $K_2CO_3(s) \longrightarrow K_2O(s) + CO_2(g)$.

Wt of H_2O (produced) $= \frac{1.8}{18} = 0.1$ moles

(2) Moles of $KHCO_3 = 0.1 \times 2 = 0.2$

Wt of $KHCO_3 = 0.2 \times 100 = 20$ g **Ans**

Also mole O_2 produced $= \frac{4}{32} = \frac{1}{8}$

(1) 2 moles of $KClO_3 \equiv 3$ moles of O_2

$3 \times$ moles of $KClO_3 = 2 \times$ moles of O_2

Moles of $KClO_3 = \frac{2}{3} \times \frac{1}{8} = \frac{1}{12}$ mole

$\therefore$ Wt of $KClO_3 = \frac{1}{12}\times(39+35.5+3\times16) = \frac{1}{12}\times122.5 = 10.2\,g$

Ans

Also moles of CO_2 produced $= \frac{13.2}{44}$

(2) & (3)

Moles of CO_2 produced = Mole of $KHCO_3$ + Mole of K_2CO_3

$$\frac{13.2}{44} = 0.2 + \text{mole of } K_2CO_3$$

$$\text{Mole of } K_2CO_3 = \frac{13.2}{44} - 0.2 = 0.3 - 0.2 = 0.1 \text{ moles}$$

$\therefore$ Wt of $K_2CO_3 = 0.1\times138 = 13.8$ g. **Ans**

Objection Problems

Q1. Ans:(c) Stoichiometry tells about moles or volume for gases not directly about mass.

Q2. Ans:(d)

Q3. Ans:(b) Volume of O_2 produced per volume of $H_2O_2 = \frac{50}{5} = 10$

Q4. Ans:(c) mole of $Ag_2CO_3 = \frac{2.76}{276} = 0.01$

$\downarrow$

CO_2 (0.01 moles $\rightarrow 0.01\times44 = 0.44$ g)

Q5. Ans:(c) Wt of $C_8H_{18} = 800/g\times1.425/g = 1140\,g$

$$\text{mole of } C_8H_{18} = \frac{1140}{114} = 10$$

$$\therefore C_8H_{18} + 12.5O_2 \longrightarrow 8CO_2 + 9H_2O$$

$\therefore$ Moles of O_2 (required) $10\times12.5 = 125$ mole

Q6. Ans:(b)

Q7. Ans :(b) $C_XH_Y + \left(X+\frac{Y}{2}\right)O_2 \longrightarrow XCO_2 + \frac{Y}{2}H_2O$

$$10\text{ ml} \longrightarrow 40\text{ ml} \quad 50\text{ ml}$$

$X = 4,\ \frac{Y}{2} = 5,\ Y = 10 \qquad \therefore C_4H_{10}$

Q8. Ans:(c) $CO + \frac{1}{2}O_2 \longrightarrow CO_2$

4 lit $\rightarrow$ 2lit (required)

Q9. Ans:(c) $Cu^{2+} + H_2S \longrightarrow CuS$

63.5 g

$\frac{63.5}{63.5} = 1\,\text{mole}$

mole of H_2S required = 1 moles

$\therefore Wt = 1 \times 34\,g = 34\,g$

Q10. Ans:(d) $3BaCl_2 + 2Na_3PO_4 \longrightarrow Ba_3(PO_4)_2 + 6NaCl$

0.5 moles   0.2 moles

3 mole of $BaCl_2 \equiv 2$ moles of Na_3PO_4 => $2 \times$ mole of $BaCl_2 = 3 \times$ moles of Na_3PO_4

mole of $Na_3PO_4 = \frac{2}{3} \times 0.5 = \frac{1}{3} > 0.2$

$\therefore Na_3PO_4$ is the limiting reagent

$\therefore$ moles of $Ba_3(PO_4)_2 = \frac{0.2}{2} = 0.1\,\text{moles}$

Q11. Ans: (b)

Q12.Ans:(b) $N_2 + 3H_2 \rightleftharpoons 2NH_3$

Initially moles A B 0

At eq-ᵇ **A-x** **B-x** **2x**

$2x = 2 \Rightarrow x = 1$

$A - x = 2 \Rightarrow A - 1 = 2 \Rightarrow A = 3$

$B - 3x = 2, \Rightarrow B - 3 = 2, \Rightarrow B = 5$

$$Cv = \frac{R\left(\frac{8}{2} + 3\right)}{3} = \frac{7}{3}R$$

$$\frac{R}{Y-1} = \frac{7}{3}R \quad \Rightarrow Y - 1 = \frac{3}{7} \quad \Rightarrow Y = \frac{3}{7} + 1 = \frac{10}{7} = 1.428$$