

Stoichiometry-1

SAP-4



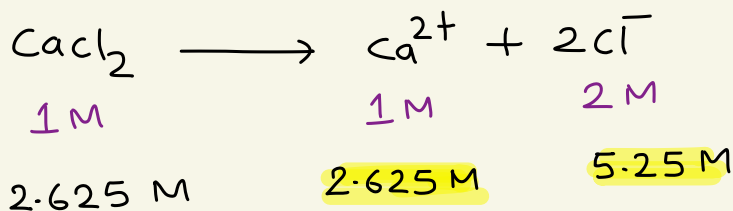
Q. If 2M, 300ml $\text{CaCl}_2(\text{aq})$ solⁿ is mixed with
3M, 500ml $\text{CaCl}_2(\text{aq})$ solⁿ.

Then find

- (i) molarity of new solⁿ
- (ii) molarity of Ca^{2+} in new solⁿ
- (iii) molarity of Cl^- ions in new solⁿ.

$$\underline{\text{Sol}^n} \rightarrow (2 \times 300) + (3 \times 500) = M_f \times 800$$

$$M_f = 2.625 \text{ mol/lit.}$$



2M of 100 ml Na_2SO_4 is mixed with 3M of 100 ml NaCl solution and 1M of 200 ml CaCl_2 solution. Then the ratio of the concentration of cation and anion.

$$\begin{aligned} \underline{\text{Sol}^n} \rightarrow & [\text{Na}^+]_1 V_1 + [\text{Na}^+]_2 V_2 + [\text{Na}^+]_3 V_3 \\ & = [\text{Na}^+]_f V_f \\ (4 \times 100) + (3 \times 100) + 0 & = [\text{Na}^+]_f \times 400 \\ [\text{Na}^+]_f & = \frac{7}{4} \text{ M} \end{aligned}$$

$$[Cl^-]_1 V_1 + [Cl^-]_2 V_2 + [Cl^-]_3 V_3 = [Cl^-]_f V_f$$

$$0 + (3 \times 100) + (2 \times 200) = [Cl^-]_f \times 400$$

$$[Cl^-]_f = \frac{7}{4} M$$

$$[SO_4^{2-}]_1 V_1 + [SO_4^{2-}]_2 V_2 + [SO_4^{2-}]_3 V_3 = [SO_4^{2-}]_f V_f$$

$$(2 \times 100) + 0 + 0 = [SO_4^{2-}]_f \times 400$$

$$[SO_4^{2-}] = \frac{2}{4} M$$

$$[Ca^{2+}]_1 V_1 + [Ca^{2+}]_2 V_2 + [Ca^{2+}]_3 V_3 = [Ca^{2+}]_f V_f$$

$$0 + 0 + (1 \times 200) = [Ca^{2+}]_f \times 400$$

$$[Ca^{2+}] = \frac{2}{4} M$$

$$\frac{[Na^+] + [Ca^{2+}]}{[SO_4^{2-}] + [Cl^-]} = \frac{\frac{7}{4} + \frac{2}{4}}{\frac{2}{4} + \frac{7}{4}} = 1 : 1$$

94. One litre of 0.15 M HCl and one litre of 0.3 M HCl is given. What is the maximum volume of 0.2 M HCl which one can make from these two solutions. No water is added. (D)

(A) 1.2 L ✓ (B) 1.5 L (C) 1.3 L (D) 1.4 L

Solⁿ →

0.15 M HCl : V_1 lit.

0.3 M HCl : V_2 lit.

$$(0.15 \times V_1) + (0.3 \times V_2) = 0.2(V_1 + V_2)$$

$$0.05V_1 = 0.1V_2$$

$$V_1 = 2V_2$$

For max. final vol. $\Rightarrow V_1 = 1$ lit., $V_2 = 0.5$ lit.

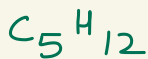
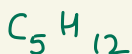
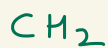
$$V_1 + V_2 = 1 + 0.5 = 1.5 \text{ lit.}$$

Empirical and molecular formula \rightarrow molecular

formula of a comp. represents actual ratio of the atoms present in the compound.

Empirical formula of a comp. represents simplest ratio of atoms present in the comp.

M.F.	E.F.
C_6H_6	CH
C_2H_6	CH_3
$C_6H_{12}O_6$	CH_2O
N_2O_4	NO_2



$$M.F. = (E.F.)_n$$

Where $n = +ve$ integer

$$= \frac{\text{molecular mass}}{\text{Empirical formula mass}}$$

Q. A comp. made up of nitrogen and oxygen atoms in 7:16 mass ratio.

Find empirical formula of comp.

If molecular mass of comp. is 92 u then find molecular formula of comp.

Solⁿ →

N

O

7x gm

16x gm

mole → $\frac{7x}{14}$

$\frac{16x}{16}$

Atoms → $\frac{7x}{14} \times N_A$

$\frac{16x}{16} \times N_A$

$$\text{Ratio} = \frac{1}{2} : 1 \Rightarrow 1 : 2$$

Empirical formula = NO_2

$$n = \frac{92}{14+32} = 2$$

molecular formula = $(\text{NO}_2)_2 = \text{N}_2\text{O}_4$

Q. A comp. made up of C and O atoms such that mass percentage of C in the comp. is 50%. find empirical formula.
If molecular mass of comp. is 288 u then find molecular formula.

Solⁿ →

	C	O
	50 gm	50 gm
mole →	$\frac{50}{12}$	$\frac{50}{16}$

Ratio → $\frac{1}{12} : \frac{1}{16}$

$$\frac{4 : 3}{48} \Rightarrow 4 : 3$$

Empirical formula = C_4O_3

$$n = \frac{288}{96} = 3$$

$$\text{molecular formula} = (\text{C}_4\text{O}_3)_3 = \text{C}_{12}\text{O}_9$$

Minimum molecular mass determination \rightarrow

Q. % by mass of sulphur in insulin is $x\%$.
Find min. molecular mass of insulin?

Solⁿ

$$x \text{ gm sulphur} \longrightarrow 100 \text{ gm Insulin}$$

$$32 \text{ gm sulphur} \longrightarrow \frac{100}{x} \times 32 \text{ gm Insulin}$$

$$\text{min. molecular mass} = \frac{100 \times 32}{x} \text{ amu}$$

$$\text{min. molar mass} = \frac{100 \times 32}{x} \text{ gm}$$

20. The sodium salt of an acid dye contains 7% of sodium. What is the minimum molar mass of the dye?

(A) 336.5

(B) 286.5

(C) 300.6

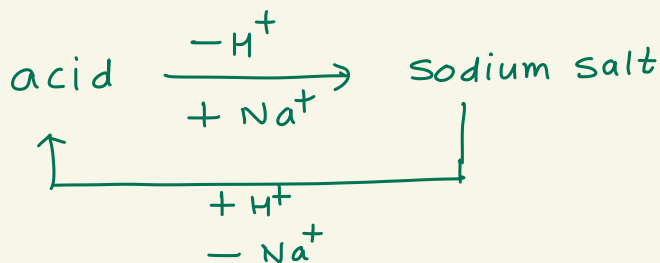
☒ (D) 306.5

(D)

$$7 \text{ gm Na} \longrightarrow 100 \text{ gm Sodium Salt}$$

$$23 \text{ gm Na} \longrightarrow \frac{100}{7} \times 23 \text{ gm Sodium Salt}$$

$$= 328.57 \text{ gm Sodium salt}$$



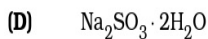
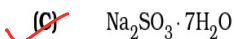
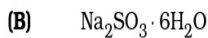
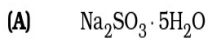
$$\begin{aligned}\text{min. molar mass of acid dye} &= 328.57 + 1 - 23 \\ &= 306.57 \text{ gm}\end{aligned}$$

% by mass of an atom in a comp. \rightarrow

Ex. CH_4 $\% \text{ C} = \frac{12}{16} \times 100 = 75\%$

$$\% \text{ H} = \frac{4}{16} \times 100 = 25\%$$

- 19.** A hydrate of Na_2SO_3 has 50% water in mass. It is :



$$\underline{\text{Sol}^n} \rightarrow \text{Na}_2\text{SO}_3 \cdot x \text{H}_2\text{O}$$

$$\% \text{ H}_2\text{O} = \frac{18x}{126 + 18x} \times 100$$

$$36x = 126 + 18x$$

$$18x = 126$$

$$\Rightarrow x = 7$$

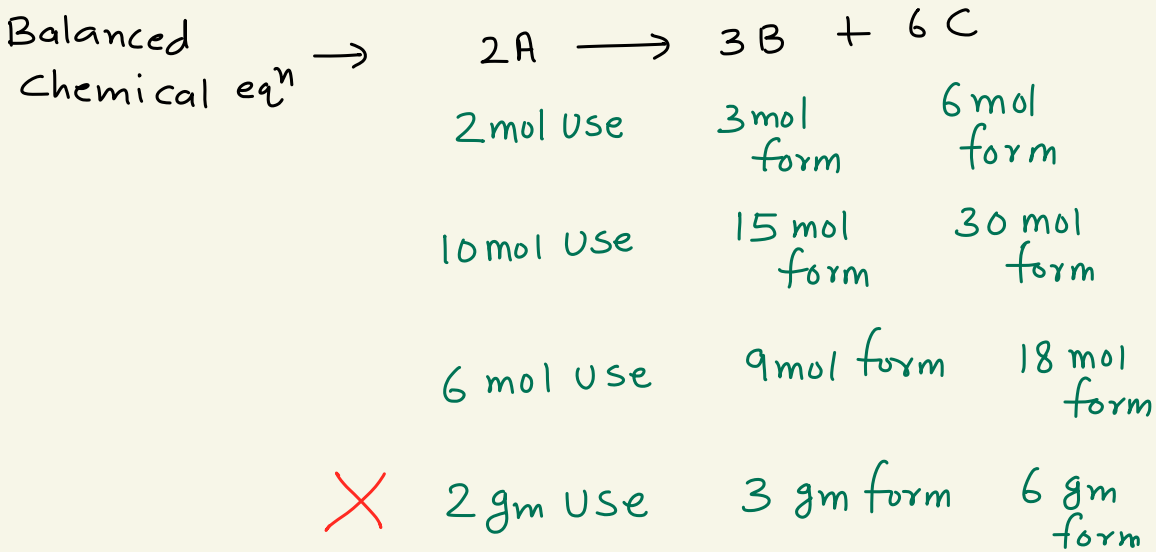
- (iv) The hydrated salt $\text{Na}_2\text{SO}_4 \cdot n\text{H}_2\text{O}$ undergoes 55.9% loss in weight on heating and becomes anhydrous. The value of n will be :



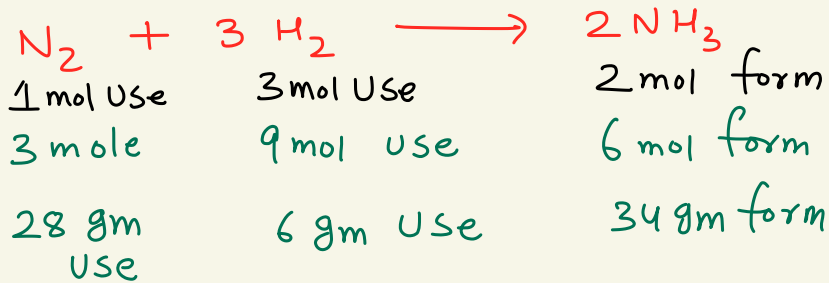
$$\underline{\text{Sol}^n} \rightarrow \% \text{H}_2\text{O} = 55.9 = \frac{18n}{142+18n} \times 100$$

$$n=10$$

Basic reaction stoichiometry →



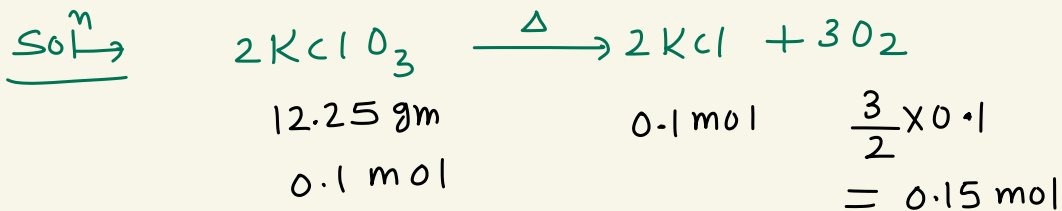
Ex.



What weight of KCl (Potassium Chloride) will be formed on heating 12.25 gm of $KClO_3$?

Also calculate weight of O_2 will be liberated.

$$(K=39, Cl=35.5, O=16)$$



$$W_{KCl} = 0.1 \times 74.5 = 7.45 \text{ gm}$$

$$W_{O_2} = 0.15 \times 32 = 4.8 \text{ gm}$$

Action of Heat on Some Important Compounds :

	Alkali Metals	Alkaline Earth Metals
Carbonates	Stable $Na_2CO_3 \xrightarrow{\Delta} \text{No Reaction}$	Unstable $CaCO_3 \xrightarrow{\Delta} CaO + CO_2$
Bicarbonates	Unstable $2NaHCO_3 \xrightarrow{\Delta} Na_2CO_3 + CO_2 + H_2O$	Unstable $Ca(HCO_3)_2 \xrightarrow{\Delta} CaO + H_2O + 2CO_2$
Sulphates	Stable $Na_2SO_4 \xrightarrow{\Delta} \text{No Reaction}$	Stable

Some Basic Chemical Equations :

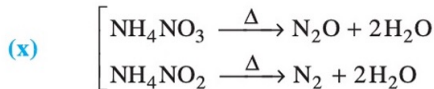
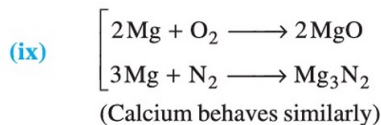
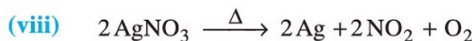
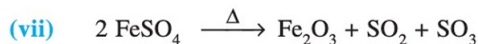
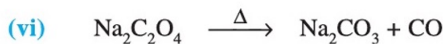
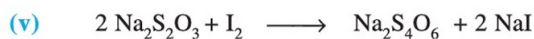
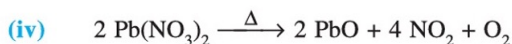
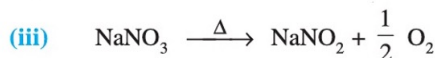
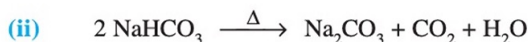
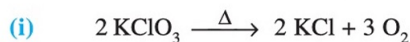
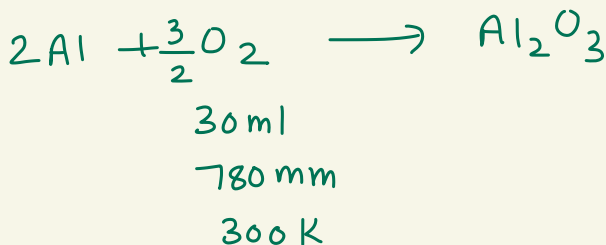


Illustration - 7 A flash bulb used for taking photograph in poor light contains 30 mL of O_2 at 780 mm pressure at $27^\circ C$. Suppose that metal wire flashed in the bulb is pure Aluminium (Al) and it is oxidised to Al_2O_3 in the process of flashing, calculate the minimum weight of Al-wire that is to be used for maximum efficiency.

Solⁿ→



$$n_{O_2} = \frac{PV}{RT} = \frac{780}{760} \times \frac{30}{1000}$$

$$= \frac{0.0821 \times 300}{1.25 \times 10^{-3} \text{ mol}}$$

$$n_{Al} = \left(\frac{2}{3} \times 2 \right) \times 1.25 \times 10^{-3} \text{ mol}$$

$$= 1.67 \times 10^{-3} \text{ mol}$$

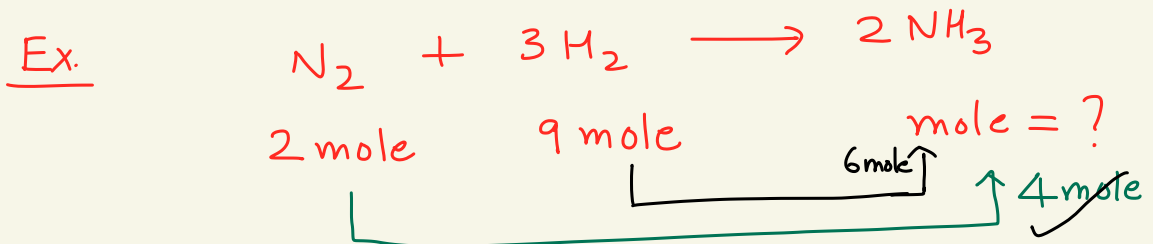
$$w_{Al} = 1.67 \times 10^{-3} \times 27 = 0.045 \text{ gm}$$

Limiting reagent and excess reagent →

Limiting reagent is the reactant which gets consumed first during the Rxⁿ.

Limiting reagent is the reactant which limits the formation of Product.

Excess reagent is the reactant which is left unreacted during the reaction.



$N_2 \rightarrow$ Limiting reagent.

$H_2 \rightarrow$ Excess reagent

3 mol H_2 Use \rightarrow 2 mol NH_3 form

6 mol H_2 Use \rightarrow 4 mol NH_3 form

$$H_2 \text{ left} = 9 - 6 = 3 \text{ mol}$$

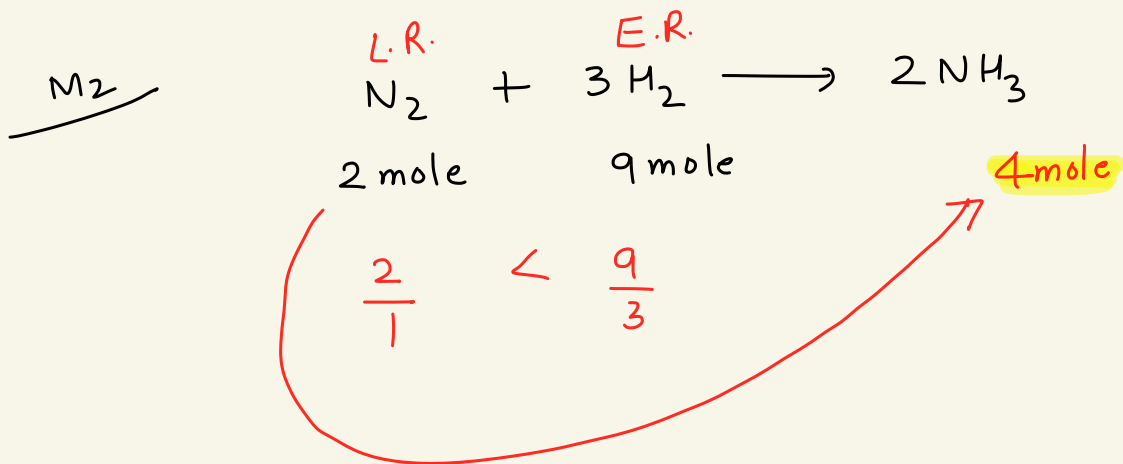


Illustration - 12 Consider the reaction : $2A + 3B \longrightarrow 4C + 5D$

In the above reaction A and B are reactants and C and D are products. If one mole each of A and B are reacted. Then:

I. 2.25 mole of D is formed

II. 1.6 mole of D is formed

III. 0.33 mole of A are left after complete reaction

IV. 1.33 mole of C is formed

The correct choice is :

(A) I, II

☒ (B)

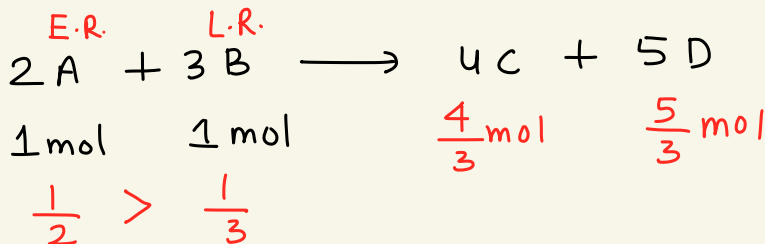
II, III, IV

(C)

I, III, IV

(D)

I, II, IV



2 mol A Use \longrightarrow 3 mol B Use

$\frac{2}{3}$ mol A Use \longrightarrow 1 mol B Use

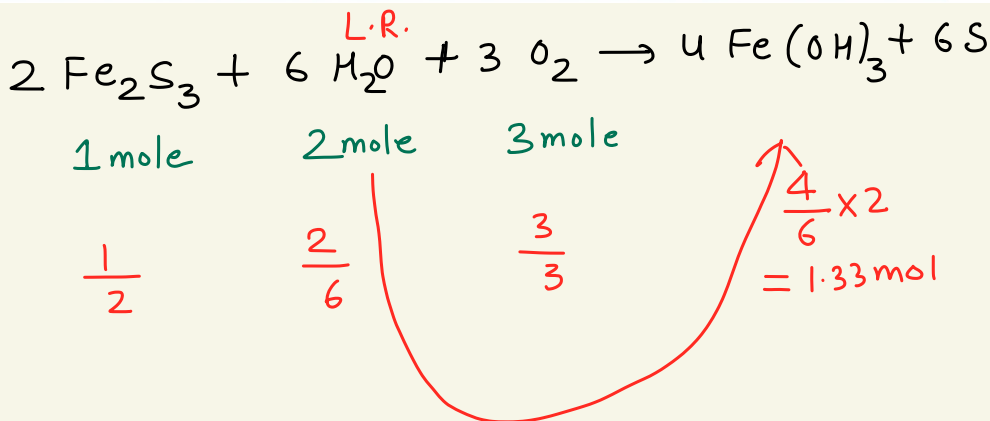
$$A \text{ left} = 1 - \frac{2}{3} = \frac{1}{3} \text{ mol}$$

Illustration - 14

What is the number of moles of $\text{Fe}(\text{OH})_3(\text{s})$ that can be produced by allowing 1 mole of Fe_2S_3 ,

2 moles of H_2O and 3 moles of O_2 to react as : $2\text{Fe}_2\text{S}_3 + 6\text{H}_2\text{O} + 3\text{O}_2 \longrightarrow 4\text{Fe}(\text{OH})_3 + 6\text{S}$?

- (A) 1 mol (B) 1.84 mol ~~(C)~~ 1.34 mol (D) 1.29 mol



32. 100 mL of 20.8% BaCl_2 solution and 50 mL of 9.8% H_2SO_4 solution will form BaSO_4 (Ba = 137, Cl = 35.5, S = 32, H = 1, O = 16) Calculate the weight of BaSO_4 formed. (D)

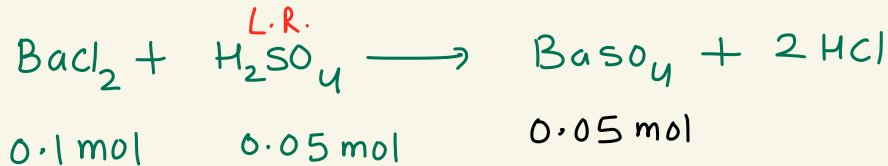


- (A) 23.3 g ~~(B)~~ 11.65 g (C) 30.6 g (D) None of these

Solⁿ \rightarrow

$$W_{\text{BaCl}_2} = \frac{20.8}{100} \times 100 = 20.8 \text{ gm}$$

$$W_{\text{H}_2\text{SO}_4} = 50 \times \frac{9.8}{100} = 4.9 \text{ gm}$$



$$W_{\text{BaSO}_4} = 0.05 \times 233$$

$$= 11.65 \text{ gm}$$

Problems based on % yield of product \rightarrow

$$\% \text{ yield} = \frac{\text{actual yield}}{\text{theoretical yield}} \times 100$$

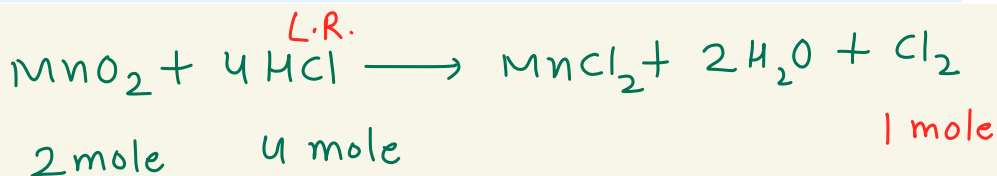
Illustration - 13 In the following reaction : $\text{MnO}_2 + 4\text{HCl} \longrightarrow \text{MnCl}_2 + 2\text{H}_2\text{O} + \text{Cl}_2$. When 2 moles of MnO_2 reacted with 4 moles of HCl , 11.2 L Cl_2 was collected at STP. Find the percent yield of Cl_2 .

(A) 25%

(B) 50%

(C) 100%

(D) 75%



$$\text{Actual moles of } \text{Cl}_2 = \frac{11.2}{22.4} = 0.5 \text{ mole}$$

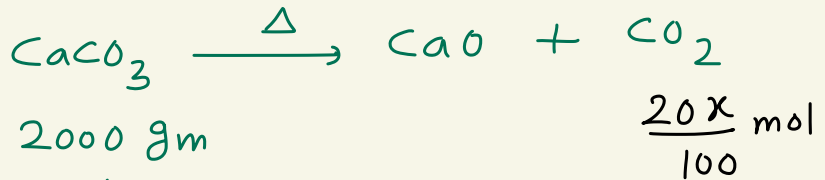
$$\% \text{ yield of } \text{Cl}_2 = \frac{0.5}{1} \times 100$$

$$= 50\%$$

Problems based on % Purity →

Q. 2kg limestone on heating produce 0.44 kg CO_2 . find % purity of CaCO_3 sample.

Solⁿ→



2000 gm

x% Pure

⇓

$2000 \times \frac{x}{100}$ gm

⇓

$\frac{20x}{100}$ mol

$$\frac{20x}{100} \times 44 = 0.44 \times 1000$$

$$x = 50$$

⇒ 50% Pure

Homework

Workbook DTS-1 to 11

Q.19-22,25,28,32-34,36-39,48-52,54-56,61,64,66,67,70,
71,75,78,80,82,84,85,87,88,92,95,96,100,113,129,131