

STUDY MATERIAL

Subject: Physical Science

Chapter: Chemical Calculations

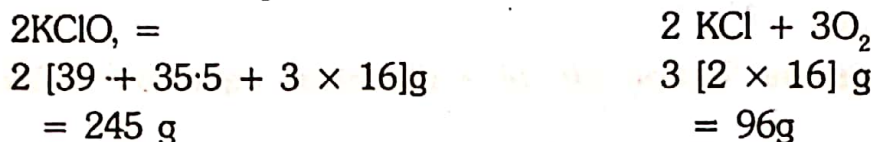
Class: 10

Date: 21th April 2020

Problems related to mass-mass relationship

- **Example 1:** How many grams of oxygen evolve when 122.5 g potassium chlorate is heated? (Given, K = 39, Cl = 35.5, O = 16)

Ans. The balanced equation is :

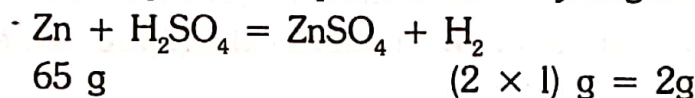


By heating 245g KClO_3 96g O_2 is obtained

$$\therefore \text{By heating } 122.5 \text{ g } \text{KClO}_3 \frac{96 \times 122.5}{245} \text{ g} = 48 \text{ g } \text{O}_2 \text{ is obtained}$$

- **Example 2:** 2.6 g zinc is treated with excess dil H_2SO_4 ; how many gram oxygen combines with the evolved hydrogen?

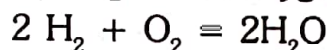
Ans. The balanced equation for production of hydrogen is :



So, 65g zinc produces 2g hydrogen

$$\therefore 2.6 \text{ zinc produces } \frac{2 \times 2.6}{65} \text{ g} = 0.089 \text{ g hydrogen}$$

Now, the reaction where hydrogen and oxygen combine is :

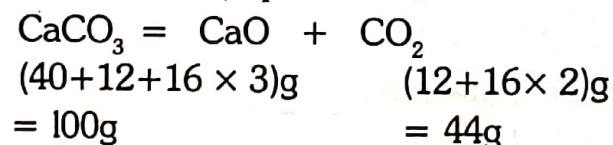


So, 4g hydrogen combine with 32 g oxygen

$$0.089 \text{ g hydrogen combine with } \frac{32 \times 0.089}{4} \text{ g} = 0.64 \text{ g oxygen}$$

- **Example 3:** What is the observed loss in weight of 5g calcium carbonate when it undergoes thermal decomposition?

Ans. The balanced equation is :



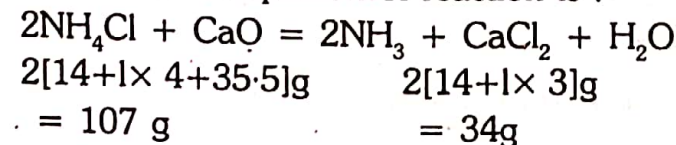
Loss in weight in the weight of CO_2 that escapes

100g CaCO_3 produces 44g CO_2

$$\therefore 5 \text{ g } \text{CaCO}_3 \text{ produces } \frac{44 \times 5}{100} \text{ g} = 2.2 \text{ g } \text{CO}_2$$

- **Example 4:** What is the percentage of ammonia in that quantity of ammonium chloride that can produce 5 g ammonia?

Ans. The balanced equation of reaction is :

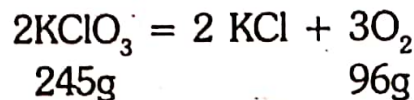


So, 34g ammonia is obtained from 107g NH_4Cl

- **Example 5:** What weight of potassium chlorate of 96% purity will yield 4.8 g oxygen on complete thermal decomposition?

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

Ans. The balanced equation is :



\therefore 96g oxygen is obtained from 245g KClO_3 of 100% purity

\therefore 4.8 g oxygen is obtained from $\frac{245 \times 4.8}{96}$ g
 $= 12.25$ g KClO_3 of 100% purity.

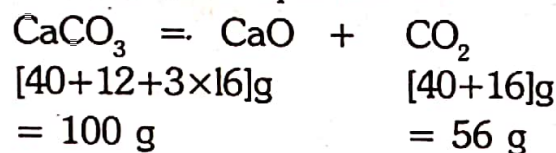
Let x gram of 96% purity contains 12.25g KClO_3 of 100% purity

$$\therefore \frac{96}{100} \cdot x = 12.56 \qquad \text{or, } x = \frac{12.25 \times 100}{96} = 12.76 \text{ (approx)}$$

So, the required quantity of $\text{KClO}_3 = 12.76$ g

● **Example 6:** On strong heating limestone decomposes into quicklime and carbon dioxide. How much quantity of limestone will produced on complete decomposition, 30 g of quicklime by the above reaction?

Ans. The balanced equation is :



So, 56g CaO is obtained by the complete decomposition of 100g CaCO_3

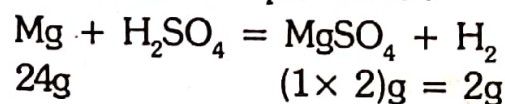
\therefore 30 g CaO is obtained by the complete decomposition of

$$\frac{100 \times 30}{56} \text{ g CaCO}_3 = 53.6 \text{ g CaCO}_3$$

Thus 53.6 g limestone will have to be decomposed.

● **Example 7:** How many grams of magnesium metal will give 1.2 g hydrogen on complete reaction with dilute H_2SO_4 ($\text{Mg} = 24$, $\text{H} = 1$)

Ans. The balanced equation is :



So, 2g H_2 is obtained from 24g Mg

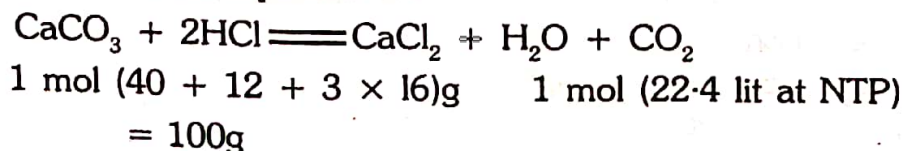
\therefore 1.2 g H_2 is obtained from $\frac{24 \times 1.2}{2}$ g Mg = 14.4 g Mg

So, 14.4 g Mg will be required.

Problems based on mass-volume relationship

● **Example 8:** What volume of carbon dioxide measured at 300 K and 720mm pressure be obtained on treatment of 1g CaCO_3 with dilute HCl ?

Ans. The balanced equation is :



So, 100g CaCO₃ gives 22.4 lit CO₂ at NTP

1g CaCO₃ gives 0.224 lit CO₂ at NTP

Reducing the volume to the given condition applying gas equation,

$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$$

Or, $V_2 = \frac{P_1 V_1 \times T_2}{T_1 \times P_2}$

$$= \frac{760 \times 0.224 \times 300}{273 \times 720}$$

$$= 0.2598 \text{ lit} = 259.8 \text{ ml}$$

Hence, 259.8 ml CO₂ will be obtained at 300K and 720mm pressure on treatment of 1g CaCO₃ with HCl.

$P_1 = 760 \text{ mm}$
$V_1 = 0.224 \text{ lit}$
$T_2 = 273 \text{ K}$
$P_2 = 720 \text{ mm}$
$V_1 = ?$
$T_2 = 300 \text{ K}$

● **Example 9:** How much potassium nitrate should be heated to get enough oxygen required to completely burn 56 lit of hydrogen at NTP ?

Ans. The balanced equation is :



2 moles 1 mol

$$= 2 \times 2\text{g} = 4\text{g} \quad = 32\text{g} = 22.4 \text{ lit (at NTP)}$$

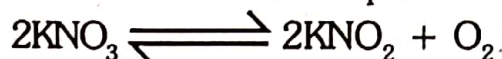
$$= 2 \times 22.4 \text{ lit}$$

$$= 44.8 \text{ lit (at NTP)}$$

So, 44.8 lit H₂ requires 22.4 lit O₂ at NTP

$$56 \text{ lit H}_2 \text{ requires } \frac{2.24 \times 56}{44.8} \text{ lit O}_2 \text{ at NTP}$$
$$= 28 \text{ lit O}_2 \text{ at NTP}$$

The other balanced equation is :



2 moles (2 × 101)g 22.4 lit (at NTP)

$$= 202\text{g}$$

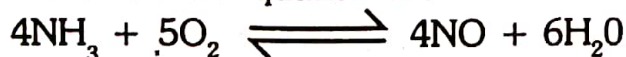
Now, 22.4 lit O₂ at NTP are obtained by heating 202 g KNO₃

$$\therefore 28 \text{ lit O}_2 \text{ at NTP are obtained by heating } \frac{202}{22.4} \times 28\text{g KNO}_3$$
$$= 252.5 \text{ g KNO}_3$$

Problems based on volume-volume relationship

● **Example 10:** In the Ostwald process for the manufacture of nitric acid, ammonia gas is burnt in oxygen in the presence of a pt-catalyst. What volume of O₂ is required and what volume of NO is formed in the combustion of 500 lit of NH₃.

Ans. The balanced equation is :



4 vol 5 vol 4 vol

4 lit 5 lit 4 lit

(i) 4 lit of NH_3 requires 5 lit of O_2 for combustion

500 lit of NH_3 requires $\frac{5 \times 500}{4}$ lit = 625 lit O_2

(ii) 4 lit of NH_3 produces 4 lit NO

\therefore 500 lit of NH_3 produces $\frac{4}{4} \times 500$ lit NO = 500 lit NO

● **Example 11:** Calculate the volume of oxygen necessary to burn completely 5 lit butane gas. What is the volume of carbon dioxide formed?

Ans. The balanced equation is :



2 vol 13 vol 8 vol

2 lit 13 lit 8 lit

So, 2 lit of butane at NTP requires 13 lit O_2 at NTP

\therefore 5 lit of butane at NTP requires $\frac{13 \times 5}{2}$ lit = 32.5 lit of O_2 at NTP.

Also 2 lit of butane at NTP produce 8 lit CO_2 at NTP

\therefore 5 lit of butane of NTP produce

$$= \frac{8}{2} \times 5 \text{ lit} = 20 \text{ lit } \text{CO}_2 \text{ at NTP}$$