

Question 9

(a) 1.5 g of a metal oxide, MO_2 reacts with excess hydrochloric acid, HCl to produce 386 mL chlorine gas at STP. The reaction is given by the following equation:



i) Balance the above equation.



ii) Determine the relative molecular mass of MO_2 and the relative atomic mass of M.

Ar of M is unknown. We cannot determine the number of mole of MO_2



Luckily, the volume of Cl_2 produced at STP is given

All products are formed depend on LR @ MO_2 . Thus, by using backward calculation, we can determine mole of LR

Answer: At STP (0°C and 1 atm),

1 mol of gas occupies 22.4L

$$22.4 \text{ L} = 1 \text{ mol of } \text{Cl}_2$$

$$\text{_____ L} = \text{_____ mol } \text{Cl}_2$$

From the balanced equation,

$$1 \text{ mol } \text{Cl}_2 = 1 \text{ mol } \text{MO}_2$$

$$\text{_____ mol } \text{Cl}_2 = \text{_____ mol } \text{MO}_2$$

$$\text{Molecular mass of } \text{MO}_2 = \frac{\text{mass } \text{MO}_2}{\text{Mole } \text{MO}_2}$$

$$\text{Mole } x = \frac{\text{mass } X}{\text{Molar mass } X}$$

Ar of O = 16

Molecular mass of $\text{MO}_2 = \underline{\hspace{2cm}}$

$= \underline{\hspace{2cm}} \text{ g/mol}$

$87.04 \text{ g/mol} = M + \underline{\hspace{2cm}}$

$M = \underline{\hspace{2cm}} \text{ g/mol}$

Thus, Relative molecular mass of $\text{MO}_2 = \underline{\hspace{2cm}}$

Relative atomic mass of $M = \underline{\hspace{2cm}}$

(b) In a separate experiment, 0.20 g of MO_2 was added to 25 mL of 0.10 M HCl solution.

i. Determine the limiting reactant.



You have calculated the Ar of M. Use it to determine the number of mole of MO_2

There are **3 methods** to determine the LR:

- 1) Compare mole ratios of the reactants
- 2) Compare the amount of products based on different reactants**
- 3) Compare the mole needed vs mole required

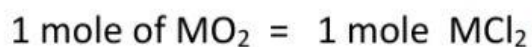
Lets say, we use 2nd method to determine the LR!!



$$\begin{aligned} \text{Mole MO}_2 &= \frac{\text{mass MO}_2}{\text{Molar mass MO}_2} \\ &= \underline{\hspace{2cm}} \text{ mole} \end{aligned}$$

$$\begin{aligned} \text{Mole HCl} &= \frac{MV}{1000} \\ &= \underline{\hspace{2cm}} \text{ mole} \end{aligned}$$

From the balance equation



_____ mole of MO_2 = _____ mole MCl_2 produced



_____ mole HCl = _____ mole MCl_2 produced

_____ produces less amount of product MCl_2

Limiting reactant is _____

Any products can be used for comparison. Better choose MCl_2 because question (ii) ask about the mass of MCl_2

ii) Calculate the mass of MCl_2 produced in the reaction.

Ar of M = 55

Ar of Cl = 35.5

Mole of $\text{MCl}_2 = 6.25 \times 10^{-4}$ mole

Mass of MCl_2 = _____ g

From part (i), you have calculated the mole of MCl_2 produced based on LR. Just use the value

iii) Calculate the percentage yield if the actual mass of MCl_2 produced is 0.072 g.

$$\begin{aligned} \% \text{ yield} &= \frac{\text{actual mass}}{\text{Theoretical mass}} \times 100 \\ &= \text{_____} \% \end{aligned}$$