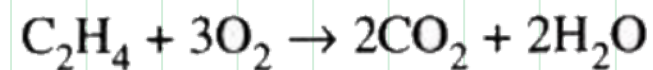


9. What volume of oxygen at STP is required to affect the combustion of 11 litres of ethylene  $[C_2H_4]$  at  $273^\circ C$  and 380 mm of Hg pressure?



(1v) (3v) (2v)

11 l of  $C_2H_4$  as per stoichiometric coeff. requires  $3 \times 11 = \underline{33}$  l of  $O_2$  at  $273^\circ C$  & 380 mm Hg.

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

Given

$$P_1 = 380 \text{ mm Hg}$$

$$V_1 = 33 \text{ l}$$

$$T_1 = 273^\circ C$$

$$= 546 K$$

STP

$$P_2 = 760 \text{ mm Hg}$$

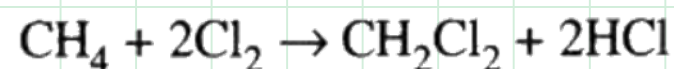
$$V_2 = ?$$

$$T_2 = 273 K$$

$$\frac{380 \times 33}{546} = \frac{760 \times V_2}{273} \Rightarrow V_2 = \frac{33}{4} = 8.25 \text{ l}$$

At STP, vol. of  $O_2$  required = 8.25 l

10. Calculate the volume of HCl gas formed and chlorine gas required when 40 mL of methane reacts completely with chlorine at STP.



1v (2v) (1v) (2v)

40ml  $\rightarrow$

As per stoichiometric coefficients  
40ml  $CH_4$  requires 80 ml  $Cl_2$   
produces 80ml HCl

## • Concept of a mole

Let us take  ${}_6C^{12}$  as an example.

We know the Atomic mass of

1 atom of  ${}_6C^{12}$  is  $12 \times 1.6 \times 10^{-24} \text{ g}$  or  $12 \text{ a.m.u.}$

The question is, how many atoms of  ${}_6C^{12}$  are needed to get the same mass in grams instead of in a.m.u.

Let there be  $x$  atoms

$$\frac{12 \times 1.6 \times 10^{-24} \text{ g}}{12 \text{ g}} = \frac{1 \text{ atom}}{12 \times 1.6 \times 10^{-24}} \times x$$

$$= \frac{1}{1.66 \times 10^{-24}} = 6.02 \times 10^{23} \text{ atoms}$$

$$\text{Also } \frac{1}{6.02 \times 10^{23}} = 1.66 \times 10^{-24}$$

$\therefore$  The number of atoms required to be able to express the extremely tiny mass of a single atom into a meaningful mass in grams which can be measured out to conduct an experiment is  $6.02 \times 10^{23}$  atoms

$\downarrow$   
Avogadro's number.

This number is called a mole

|                 |               |                                 |
|-----------------|---------------|---------------------------------|
| A mole of atoms | $\rightarrow$ | $6.02 \times 10^{23}$ atoms     |
| " " molecules   | $\rightarrow$ | $6.02 \times 10^{23}$ molecules |
| " " ions        | $\rightarrow$ | $6.02 \times 10^{23}$ ions      |
| " " apples      | $\rightarrow$ | $6.02 \times 10^{23}$ apples    |

**Definition:** A mole is the amount of a pure substance, containing the same number of chemical units as there are atoms in exactly 12g of  $C-12$

**NOTE:** The chemical units can be

- atoms
- molecules
- ions

If not specified, mole refers to molecules.

**Avogadro's Number:** Is defined as the number of atoms present in 12g of  $C-12$  isotope i.e.  $6.022 \times 10^{23}$  atoms

(or)

It is the number of elementary units (atoms, molecules or ions) present in 1 mole of a substance.

It is denoted by  $N_A$

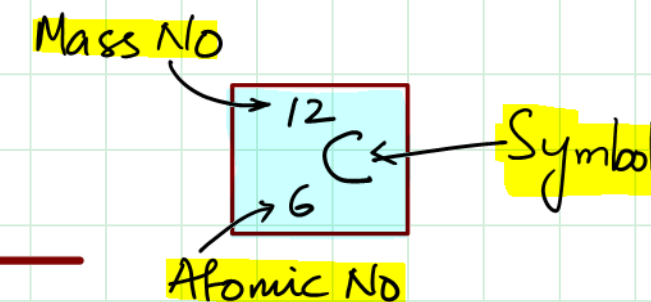
**Molar Volume:**

- The molar volume of any gas is the volume occupied by one mole of the gas at S.T.P. ( $0^\circ\text{C}$  and  $760\text{mm Hg}$ )
- It is  $22.4\text{ l (dm}^3\text{)}$  or  $22400\text{ cm}^3$

1 mole of a substance represents its Gram Molecular Mass

## First 20 elements of the Periodic Table

| Name         | Symbol                  | Atomic No. | Mass No. | e  | p  | n  |
|--------------|-------------------------|------------|----------|----|----|----|
| 1. Hydrogen  | ${}^1_1\text{H}$        | 1          | 1        | 1  | 1  | 0  |
| 2. Helium    | ${}^4_2\text{He}$       | 2          | 4        | 2  | 2  | 2  |
| 3. Lithium   | ${}^7_3\text{Li}$       | 3          | 7        | 3  | 3  | 4  |
| 4. Beryllium | ${}^9_4\text{Be}$       | 4          | 9        | 4  | 4  | 5  |
| 5. Boron     | ${}^{11}_5\text{B}$     | 5          | 11       | 5  | 5  | 6  |
| 6. Carbon    | ${}^{12}_6\text{C}$     | 6          | 12       | 6  | 6  | 6  |
| 7. Nitrogen  | ${}^{14}_7\text{N}$     | 7          | 14       | 7  | 7  | 7  |
| 8. Oxygen    | ${}^{16}_8\text{O}$     | 8          | 16       | 8  | 8  | 8  |
| 9. Fluorine  | ${}^{19}_9\text{F}$     | 9          | 19       | 9  | 9  | 10 |
| 10. Neon     | ${}^{20}_{10}\text{Ne}$ | 10         | 20       | 10 | 10 | 10 |



$$\text{At. No.} = p$$

(Z)

$$\text{Mass No.} = n + p$$

(A)

**Example 1 :** Calculate the percentage composition of various elements in :

Sodium carbonate,  $\text{Na}_2\text{CO}_3$

Given that the relative atomic masses of  $\text{O} = 16$ ,  $\text{Na} = 23$  and  $\text{C} = 12$ .

$$\text{RMM of } \text{Na}_2\text{CO}_3 = 2(23) + 12 + 3(16) = 106$$

$$\% \text{ Na} = \frac{46}{106} \times 100 = 43.4\%$$

$$\% \text{ O} = \frac{48}{106} \times 100 = 45.3\%$$

$$\% \text{ C} = \frac{12}{106} \times 100 = 11.3\%$$

**Example 4 :** The molecular formula of an organic acid is  $\text{CH}_3\text{COOH}$ . What is its empirical formula?

Molecular formula :  $\text{C}_2\text{H}_4\text{O}_2$

Empirical formula :  $\text{CH}_2\text{O}$

**Example 7 :** Calculate the empirical formula of a compound whose molecular formula is  $\text{C}_8\text{H}_6\text{O}_4$  and empirical formula weight is 83.

Molecular formula =  $\text{C}_8\text{H}_6\text{O}_4$

$$\begin{aligned} \text{Molecular wt} &= 8(12) + 6(1) + 4(16) \\ &= 96 + 6 + 64 \\ &= 166 \end{aligned}$$

$$\text{Empirical wt} = 83$$

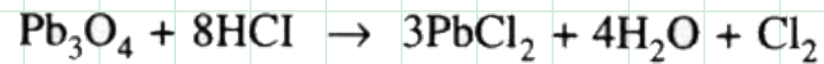
$$\text{Molecular wt} = n (\text{Emp. wt.})$$

$$n = \frac{166}{83} = 2 \Rightarrow n = 2$$

Also Molecular formula =  $n$  (Empirical formula)

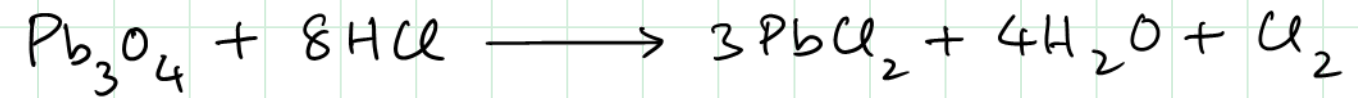
$$\text{Empirical formula} = \frac{1}{2} (\text{C}_8\text{H}_6\text{O}_4) \Rightarrow \text{C}_4\text{H}_3\text{O}_2$$

4. The reaction between red lead and hydrochloric acid is given below :



Calculate : (a) the mass of lead chloride formed by the action of 6.85 g of red lead, (b) the mass of chlorine and (c) the volume of chlorine evolved at STP.

$$[\text{Pb} = 207]$$



$$6.85\text{g}$$

$$\text{GMM of Pb}_3\text{O}_4 = 3(207) + 4(16) = 685\text{g}$$

$$\text{GMM of PbCl}_2 = 207 + 2(35.5) = 278\text{g}$$

a) 685 g of  $\text{Pb}_3\text{O}_4$  gives 3(278) g of  $\text{PbCl}_2$

$$6.85\text{g} \quad " \quad " \quad \frac{3 \times 278}{685} \times 6.85 = 8.34\text{g of lead chloride}$$

b) 685 g of  $\text{Pb}_3\text{O}_4$  gives 71 g of  $\text{Cl}_2$

$$6.85\text{g} \quad \frac{71}{685} \times 6.85 = 0.71\text{g of Cl}_2$$

c)  $\overset{1 \text{ mole}}{71\text{g of Cl}_2}$  occupies a volume of 22.4 l

$$0.71\text{g} \quad " \quad \frac{22.4}{71} \times 0.71 = 0.224\text{l}$$

$$\frac{278}{3}^2$$

$$\begin{array}{r} 49 \\ 14 \\ \hline 63 \end{array} \quad \begin{array}{r} 37 \\ 48 \\ \hline 85 \end{array}$$