Class – 10

Sub. – Chemistry

Chapter – 5

Mole concept and stoichiometry

1. Avogadro’s Law and Gay Lussacs Law

Avogadro's law:
Amedo Avogadro proposed this law in the year 1811. Avogadro's Law states that the volume occupied by an ideal gas is directly proportional to the number of molecules of the gas present in the container.

Gay Lussac's law:
Gay-Lussac's Law was found by Joseph Louis Gay-Lussac in 1809. It states that, for a given mass and constant volume of an ideal gas, the pressure exerted on the sides of its container is directly proportional to its absolute temperature.

2. Mole Concept

The mole is the unit of measurement in the International System of Units (SI) for an amount of substance. The number of molecules per mole is known as Avogadro's constant and is defined such that the mass of one mole of a substance, expressed in grams, is equal to the mean relative molecular mass of the substance.

Example:

1 mole of hydrogen atoms represents 6.022 × 10^{23} hydrogen atoms.
1 mole of hydrogen molecules represents 6.022 × 10^{23} hydrogen molecules.
1 mole of water molecules represents 6.022 × 10^{23} water molecules.

Mole

Mole is the amount of substance, which contains as many elementary entities as there are in 12 gram of carbon. Elementary entities may be atoms, molecules, ions, electrons or protons.
1mole of a substance always contains the same number of entities irrespective of the identity and kind of the substance.
One mole = molecular mass in grams (molar mass)
= 6.022×10^{23} particles = 22.4 litres

Atomicity

Atomicity is the total number of atoms present in one molecule of an element or a substance.

Example:

There are 2 atoms of hydrogen present in H2 molecule. So its atomicity is 2.
The gases can be

- Monatomic, example: Helium (He)
- Diatomic, example: hydrogen (H_2), chlorine (Cl_2), oxygen (O_2), nitrogen (N_2)
- Triatomic, example: ozone (O_3)
- Polyatomic, example: Sulphur (S_8).

Molecules may be homoatomic (atoms of same element) or heteroatomic (atoms from different elements e.g. CO_2,NH_3)

Gram atomic mass

Gram atomic mass is the mass, in grams, of one mole of atoms in a monatomic chemical element. It is numerically equal to the relative atomic mass in grams. The atomic mass of an element expressed in grams is called gram atomic mass.

Example:

oxygen is 16 grams.

1 gram atom of sodium is equal to 23g of sodium.

Gram molecular mass

The molecular mass expressed in grams is called molecular mass or MOLE

3. Percentage composition, Empirical and Molecular formulae

worked example

1. **Calculate the number of moles in 25.6g of Sulphur (S = 32)**

Number of moles = Mass of Sulphur in grams/gram atomic mass of Sulphur

$$= 25.632632 = 0.8 \text{moles}$$

2. **Calculate the mass of 0.4 moles of potassium (K = 39)**

Mass of potassium in grams = gram atomic mass of potassium x number of moles

$$= 39 \times\times 0.4 = 15.6\text{g}$$

Determination of empirical and molecular formula

An organic compound contains 40% Oxygen and 6.67% hydrogen. The rest is made of carbon. Its molecular mass is 180. Determine its empirical and molecular formulae.

Solution:

Element C

%	53.33
Atomic mass	16

Relative number of atoms	53.33/16 = 3.33
Simplest atomic ratio	3.33/3.33 = 1
Whole number ratio	1

Element O

%	40
Atomic mass	12
Relative number of atoms	40/12 = 3.33

Simplest atomic ratio	3.33/3.33 = 1
Whole number ratio	1

Element H

%	6.67
Atomic mass	1
Relative number of atoms	6.67/1 = 6.67
Simplest atomic ratio	6.67/3.33 = 2

Whole number ratio	2

Therefore, empirical formula of the compound = CH_2O
Calculation of molecular formula:

Empirical formula mass = (1 × 12 amu + 2 ×1 amu + 1 × 16 amu) = 30 amu
Molecular mass = 180 amu

Molecular mass = n × empirical formula mass
n = Molecular mass/ empirical formula mass

n = 180/30 = 6

Therefore, Molecular formulae of a compound
= $6 \times CH_2O = C_6H_{12}O_6$

Vapour Density

Vapour density is the ratio of the mass of a volume of a gas, to the mass of an equal volume of hydrogen, measured under the same conditions of temperature and pressure.

Molecular mass = V.D ×× 2