

Atoms and Molecules

Introduction

Everything around us is made up of tiny particles called **atoms** and **molecules**. Atoms are the smallest units of an element, while molecules are formed when two or more atoms combine chemically. This chapter explains the laws of chemical combination, atomic and molecular masses, and the concept of the mole.

Laws of Chemical Combination

Law of Conservation of Mass

This law was given by **Antoine Lavoisier**. It states that **mass can neither be created nor destroyed during a chemical reaction**. The total mass of the reactants is always equal to the total mass of the products.

Law of Constant Proportions

This law was proposed by **Joseph Proust**. It states that **a chemical compound always contains the same elements combined in the same fixed proportion by mass**, regardless of its source.

What are Atoms?

Definition

An **atom** is the smallest particle of an element that retains its chemical properties.

Atoms are extremely small and cannot be seen with the naked eye. They usually do not exist independently and combine with other atoms to form molecules.

Examples: Hydrogen (H), Oxygen (O), Carbon (C), Sodium (Na).

What are Molecules?

Definition

A **molecule** is formed when two or more atoms combine chemically. It is the smallest particle of a substance that can exist independently and shows all the properties of that substance.

Examples:

- Oxygen – O_2
- Water – H_2O

- Carbon dioxide – CO_2
- Nitrogen – N_2

Atomicity

Meaning

Atomicity is the **number of atoms present in one molecule** of an element.

Examples:

- Monoatomic – He
- Diatomic – H_2 , O_2
- Triatomic – O_3
- Polyatomic – P_4 , S_8

Ions

Charged Particles

An **ion** is an atom or group of atoms carrying a positive or negative charge.

- **Cation:** Positively charged ion (Na^+ , Ca^{2+})
- **Anion:** Negatively charged ion (Cl^- , SO_4^{2-})

Ions combine to form ionic compounds.

Chemical Formulae

Writing Chemical Formulae

A chemical formula shows the types and number of atoms present in a compound.

Examples:

- Water – H_2O
- Sodium Chloride – NaCl
- Calcium Carbonate – CaCO_3
- Ammonia – NH_3

Chemical formulae are written using the symbols and valencies of elements.

Molecular Mass and Formula Unit Mass

Definition

- **Molecular Mass** is the sum of the atomic masses of all atoms present in a molecule.
- **Formula Unit Mass** is the sum of the atomic masses of all atoms in the formula unit of an ionic compound.

Mole Concept

What is a Mole?

A **mole** is the amount of substance containing **6.022×10^{23} particles** (Avogadro's Number).

The mole concept helps in measuring very large numbers of atoms and molecules conveniently.

Key Points

- Matter is made up of atoms and molecules.
- Atoms are the smallest units of elements.
- Molecules are formed by the chemical combination of atoms.
- Mass is conserved during a chemical reaction.
- Compounds always contain elements in a fixed proportion by mass.
- Chemical formulae represent the composition of compounds.
- One mole contains **6.022×10^{23} particles**.

Chapter Summary

This chapter explains the basic building blocks of matter—atoms and molecules. It introduces the laws of chemical combination, the concept of ions, chemical formulae, molecular mass, and the mole concept. These concepts form the foundation of chemistry and help us understand how substances are formed and how chemical reactions take place.