

Atoms and Molecules

- **Atoms**

- **According to Dalton's atomic theory**

- Matter is made up of very tiny particles and these particles are called atoms.
- Atoms cannot be divided further i.e., atoms are indivisible
- An atom can be defined as the smallest particle of matter that can neither be created nor destroyed by chemical means.

- **Laws of Chemical Combination**

- **Law of conservation of mass**

- Mass can neither be created nor destroyed in a chemical reaction. It means that the sum of the masses of the reactants and the products remains the same during a reaction.

- **Laws of Chemical Combination**

- **Law of constant proportion**

- A chemical substance always contains the same elements in a fixed proportion by mass, irrespective of the source of compound.

- The size of an atom is indicated by the radius of the atom called the **atomic radius**. It is often expressed in **nanometers**.

- **Representation of atoms**

- The symbol of the element is made from one or two letters of the English or the Latin name of the element.
- Symbols are significant as they represent a particular element and they represent one atom of that element.

- **Atomic Mass**

- The mass of an atom is known as the atomic mass.
- The atomic mass of an atom of an element is also known as its relative atomic mass, since it is determined relative to the mass of C-12 isotope.

- **Gram molecular mass:** The mass of one mole of atoms is known as the **molar mass of atoms, gram atomic mass, or gram atoms**. For example, the atomic mass of nitrogen is 14 u and the gram atomic mass of nitrogen is 14 g. The mass of one mole molecules of any



substance is equal to the **gram molecular mass** of that substance.

- **Relative atomic mass or atomic weight:** It is the ratio of mass of one atom of an element to the mass of an atom of hydrogen taken as unity.
- **Gram molecular volume:** The volume occupied by 1 gram molecule of a dry gas at S.T.P is called gram molecular volume. The experimental value of 1 gram molecular volume of a gas is 22.4 L at S.T.P.
- **Molecule**
 - A molecule is formed when two or more atoms of the same element or different elements get combined chemically.
 - The number of atoms that combine to form a molecule is called the atomicity of the molecule.
- **Ion**
 - An ion is a charged species in which an atom or a group of atoms possess a net electric charge (positive or negative).
 - Positively charged ions are called cations (basic radical) and negatively charged ions (acidic radical) are called anions.
 - Compounds in which molecules are formed by the combination of cations (positively charged ions) and anions (negatively charged ions) are known as ionic compounds.
- **Chemical formula**
 - A chemical formula is the representation of the composition of a molecule in terms of the symbols of elements present in that molecule.
- **Molecular formula** is a **chemical formula** that indicates the kinds of atoms and the numbers of each kind of atom in a molecule of a compound.
- To write the chemical formula of a compound, one should have prior knowledge of two things.
 - **The symbols of the constituent elements.**
 - **The combining capacity of the atom of each element constituting the compound.**
- **Molecular Mass**
 - The molecular mass of a substance is the sum of the atomic masses of all the atoms present in a molecule of that substance.
- **Formula unit mass**



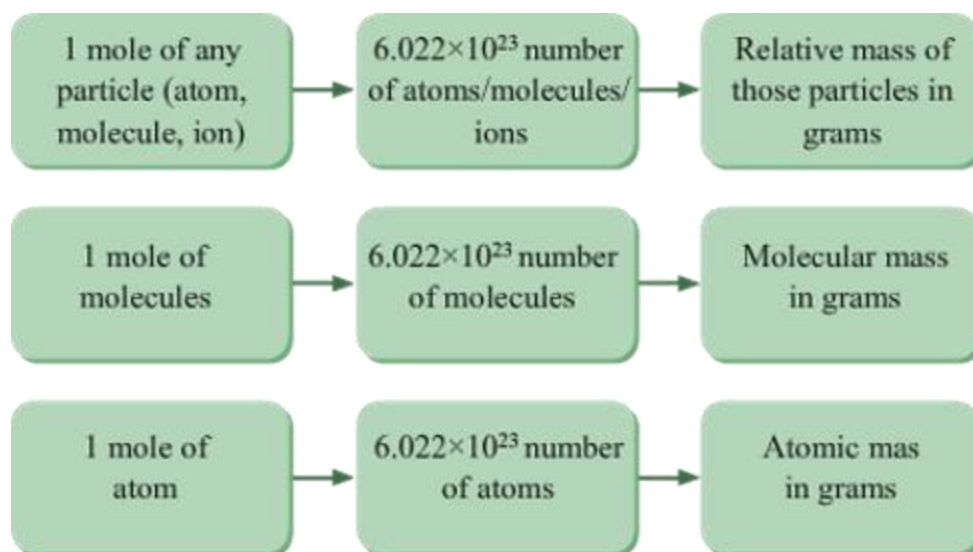
- The formula unit mass of a substance is the sum of the atomic masses of all the atoms present in a formula unit of that substance.

- **Mole Concept**

- One mole of a substance is the quantity of the substance containing 6.022×10^{23} numbers of particles (atoms, molecules, or ions). The number i.e., 6.022×10^{23} is known as the Avogadro number. It means that one mole of any substance (element or compound) contains 6.022×10^{23} particles (atoms or molecules).
- The mass of 1 mole of a substance is known as its molar mass.

$$\text{Molar mass} = \frac{\text{Mass of substance}}{\text{Number of moles}}$$

- Avogadro's Law: Under the same conditions of temperature and pressure, equal volumes of all gases contain the equal number of moles.



- Gay-Lussac's Law: At constant volume, the pressure of a fixed amount of a gas is directly proportional to the temperature.

$$\frac{p_1}{T_1} = \frac{p_2}{T_2}$$