

## CHAPTER 1

### SOME BASIC CONCEPTS OF CHEMISTRY

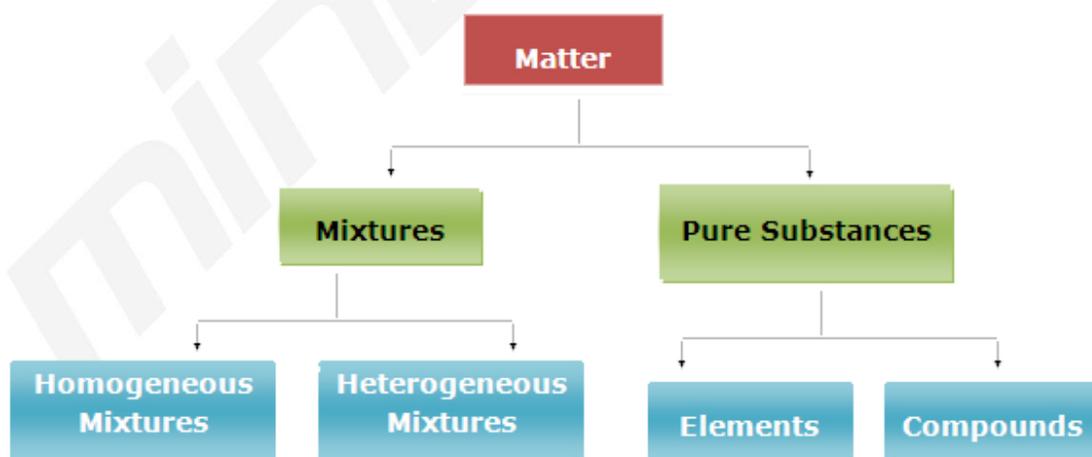
#### SYNOPSIS :

- **Chemistry** deals with the composition, structure and properties of atoms and molecules.
- Chemistry plays an **important role** in meeting human needs for food, health care products and other materials aimed at improving the quality of life.
- **Life saving drugs:** Such as cisplatin and taxol, are effective in **cancer therapy** and AZT used for helping AIDS victims, have been isolated from plant and animal sources or prepared by synthetic methods.
- **Nature of Matter :** Anything which has mass and occupies space is called 'matter'.



- **Matter** can exist in three physical states viz. solid, liquid and gas.
- **solids** particles are held very close to each other in an orderly fashion and there is not much freedom of movement, they have definite volume and shape.
- **Liquids** particles are close to each other but they can move around, they have definite volume but not the definite shape. They take the shape of the container in which they are placed.
- **Gases** particles are far apart as compared to those present in solid or liquid states and their movement is easy and fast, they have neither definite volume nor definite shape. They completely occupy the container in which they are placed.

● **Classification of Matter:**



- A **mixture** may be homogeneous or heterogeneous.
- In a **homogeneous mixture**, the components completely mix with each other and its composition is uniform throughout.
- In **heterogeneous mixtures**, the composition is not uniform throughout and sometimes the different components can be observed.
- **Pure substances** have fixed composition, whereas **mixtures** may contain the components in any ratio and their composition is variable. Copper, silver, gold, water, glucose are some examples of pure substances.
- Pure substances can be further classified into **elements** and **compounds**.
- Element consists of only one type of particles. These particles may be **atoms** or **molecules**.
- Two or more atoms combine to give **molecules of the element**. When two or more atoms of different elements combine, the molecule of a compound is obtained.

- **Physical properties of matter** are those properties which can be measured or observed without changing the identity or the composition of the substance. Examples : colour, odour, melting point, boiling point, density etc.
- **Chemical properties** require a chemical change to occur. Examples: acidity or basicity, combustibility etc.
- Two different **systems of measurement**: The English System and the Metric system.
- **Mass of a substance** : The amount of matter present in it weight is the force exerted by gravity on an object.
- **Volume** : Often denoted in  $\text{cm}^3$  or  $\text{cm}^3$  units.
- **Litre (L)** : Not an SI unit, is used for measurement of volume of liquids.  $1 \text{ L} = 1000\text{mL}$ ,  $1000 \text{ cm}^3 = 1 \text{ dm}^3$
- **Density of a substance** is its amount of mass per unit volume.

• **SI unit of density** =  $\frac{\text{SI unit of mass}}{\text{SI unit of volume}}$

$$= \frac{\text{kg}}{\text{m}^3} \text{ or } \text{kg m}^{-3}$$

- **Three common scales to measure temperature** — °C (degree celsius), °F (degree fahrenheit) and K (kelvin).
- **Precision** refers to the closeness of various measurements for the same quantity.
- **Accuracy** is the agreement of a particular value to the true value of the result.
- **Significant figures** are meaningful digits which are known with certainty.
- To convert units from one system to other, the method used to accomplish is **factor label method** or **unit factor method** or **dimensional analysis**.
- **Law of Conservation of Mass** : It states that matter can neither be created nor destroyed. This law was put forth by Antoine Lavoisier in 1789.

- **Law of Definite Proportions** : This law was given by, a French chemist, Joseph Proust. He stated that a given compound always contains exactly the same proportion of elements by weight. It is sometimes also referred to as **Law of definite composition**.
- **Law of Multiple Proportions** : This law was proposed by Dalton in 1803. According to this law, if two elements can combine to form more than one compound, the masses of one element that combine with a fixed mass of the other element, are in the ratio of small whole numbers.
- **Gay Lussac's Law of Gaseous Volumes** : This law was given by Gay Lussac in 1808. He observed that when gases combine or are produced in a chemical reaction they do so in a simple ratio by volume provided all gases are at same temperature and pressure.
- **Avogadro Law** : In 1811, Avogadro proposed that equal volumes of gases at the same temperature and pressure should contain equal number of molecules.

● **Dalton's Atomic Theory** : In 1808, Dalton published 'A New System of Chemical Philosophy' in which he proposed: Matter consists of indivisible atoms. All the atoms of a given element have identical properties including identical mass. Atoms of different elements differ in mass. Compounds are formed when atoms of different elements combine in a fixed ratio. Chemical reactions involve reorganization of atoms. These are neither created nor destroyed in a chemical reaction. Dalton's theory could explain the **laws of chemical combination.**

● **One atomic mass unit** : A mass exactly equal to onetwelfth the mass of one carbon - 12 atom.

$$\text{And } 1 \text{ amu} = 1.66056 \times 10^{-24} \text{g}$$

$$\text{Mass of an atom of hydrogen} = 1.6736 \times 10^{-24} \text{g}$$

$$\begin{aligned} \text{Thus, in items of amu, the mass of hydrogen atom} &= \frac{1.6736 \times 10^{-24} \text{g}}{1.66056 \times 10^{-24} \text{g}} \\ &= 1.0078 \text{ amu} \\ &= 1.0080 \text{ amu} \end{aligned}$$

Similarly, the mass of oxygen - 16 ( $^{16}\text{O}$ ) atom would be 15.995 amu. Today, 'amu' has been replaced by 'u' which is known as unified mass.

- **Molecular mass** is the sum of atomic masses of the elements present in a Molecule, is obtained by multiplying the atomic mass of each element by the number of its atoms and adding them together. For example, molecular mass of methane which contains one carbon atom and four hydrogen atoms can be obtained as follows :  
**Molecular mass of methane:**  $(\text{CH}_4) = (12.011 \text{ u}) + 4 (1.008 \text{ u})$   
 $= 16.043 \text{ u}$
- One **mole** is the amount of a substance that contains as many particles or entities as there are atoms in exactly 12 g (or 0.012 kg) of the  $^{12}\text{C}$  isotope.
- **Number of entities in 1 mol** is so important that it is given a separate name and symbol. It is known as '**Avogadro constant**', denoted by  $N_A$  in honour of Amedeo Avogadro.
- An **empirical formula** represents the simplest whole number ratio of various atoms present in a compound.
- The **molecular formula** shows the exact number of different types of atoms present in a molecule of a compound.

- The word '**stoichiometry**' is derived from two Greek words – stoicheion (meaning element) and metron (meaning measure), deals with the calculation of masses (sometimes volumes also) of the reactants and the products involved in a chemical reaction.
- The reactant which gets consumed, limits the amount of product formed is called **the limiting reagent**.

- **Mass per cent** = 
$$\frac{\text{Mass of solute}}{\text{Mass of solution}} \times 100$$

- **Mole Fraction** : The ratio of number of moles of a particular component to the total number of moles of the solution.

- **Molarity (M)** = 
$$\frac{\text{No. of moles of solute}}{\text{Volume of solution in litres}}$$

- **Molality (m)** = 
$$\frac{\text{No. of moles of solute}}{\text{Mass of solvent in kg}}$$