Notes: Chapter 3 - Atoms and Molecules

● Introduction to Atoms

- **Atom**: The smallest particle of an element that can participate in a chemical reaction.
  - **Example**: Hydrogen atom, Oxygen atom.
- Atoms are indivisible and retain the chemical properties of the element.

Practice Questions:

1. Define an atom. Give an example.
2. How do atoms participate in chemical reactions?
3. Why are atoms considered the building blocks of matter?

Revision Points:

- Atoms are the smallest unit of matter and retain the properties of elements.
- They participate in chemical reactions to form new substances.

● Laws of Chemical Combination

○ Law of Conservation of Mass

- **Definition**: Mass can neither be created nor destroyed in a chemical reaction.
  - **Example**: The total mass of reactants is equal to the total mass of products in any chemical reaction.

○ Law of Constant Proportion

- **Definition**: In a chemical compound, the elements are always present in definite proportions by mass.
  - **Example**: Water (H_2O) always contains hydrogen and oxygen in a mass ratio of 1:8.

Practice Questions:

1. State the law of conservation of mass with an example.
2. What does the law of constant proportion state? Explain with an example.

3. Why is the total mass of reactants always equal to the total mass of products?

Revision Points:

- The law of conservation of mass states that mass is conserved in all chemical reactions.
- The law of constant proportion implies that compounds always have fixed compositions by mass.

● Dalton's Atomic Theory

- **John Dalton** proposed the first modern atomic theory. The key postulates are:
  - **Atoms** are indivisible particles.
  - Atoms of the same element are identical in mass and properties.
  - Atoms of different elements have different masses and properties.
  - Compounds are formed when atoms of different elements combine in a fixed ratio.
  - Chemical reactions involve the rearrangement of atoms, not their destruction or creation.

Practice Questions:

1. Write any three postulates of Dalton's atomic theory.
2. How does Dalton's atomic theory explain the formation of compounds?
3. According to Dalton's theory, why are atoms of different elements different?

Revision Points:

- Dalton's atomic theory explains that atoms are indivisible and combine in fixed ratios to form compounds.
- Atoms of the same element are identical, while atoms of different elements vary in mass and properties.

● Atoms, Molecules, and Ions

○ Atoms

- The basic unit of an element.
  - **Example**: Hydrogen (H), Carbon (C).

○ Molecules

- A group of two or more atoms chemically bonded together.
  - **Example**: Oxygen (O_2), Water (H_2O).
- **Molecules of Elements**: When two or more atoms of the same element bond together.
  - **Example**: O_2, N_2.
- **Molecules of Compounds**: When atoms of different elements bond together.
  - **Example**: H_2O, CO_2.

○ **Ions**

- Atoms or groups of atoms with a net electrical charge.
  - **Cations**: Positively charged ions (e.g., Na^+, Ca^{2+}).
  - **Anions**: Negatively charged ions (e.g., Cl^-, O^{2-}).

Practice Questions:

1. What is a molecule? How does it differ from an atom?
2. Define cations and anions with examples.
3. What is the difference between a molecule of an element and a molecule of a compound?

Revision Points:

- Atoms are the basic units of matter.
- Molecules consist of two or more atoms chemically bonded, while ions carry a net charge.

● **Writing Chemical Formulae**

○ **Valency**

- **Valency**: The combining capacity of an element. It determines how many atoms of an element can bond with other atoms.
  - **Examples**:
    - Hydrogen has a valency of 1.
    - Oxygen has a valency of 2.

○ **Writing the Chemical Formula**

- The chemical formula of a compound shows the kinds of atoms and their proportions.
  - **Steps to write a chemical formula**:
    1. Write the symbols of the elements.

2. Write their valencies.
3. Cross-multiply the valencies.

- **Example**: The formula of water (H_2O) is derived from the valency of Hydrogen (1) and Oxygen (2).

Practice Questions:

1. What is valency? How is it used to write the chemical formula of a compound?
2. Write the chemical formula for the following compounds:
   - (a) Magnesium chloride (Mg, Cl).
   - (b) Aluminum oxide (Al, O).
3. Explain the significance of a chemical formula.

Revision Points:

- Valency represents the combining power of an element.
- Chemical formulae represent the proportions of elements in compounds, derived from their valencies.

● Molecular Mass and Mole Concept

○ Molecular Mass

- The sum of the atomic masses of all the atoms in a molecule.
  - **Example**: The molecular mass of water (H_2O) is 18 u (2 × 1 for H + 16 for O).

○ Mole Concept

- **Mole**: A unit used to express the amount of a substance. One mole contains 6.022×10^{23} particles (Avogadro's number).
  - **Example**: One mole of water contains 6.022×10^{23} molecules of water.

Practice Questions:

1. How do you calculate the molecular mass of a compound? Give an example.
2. What is a mole? Why is it important in chemistry?
3. Calculate the number of molecules in 2 moles of carbon dioxide (CO_2).

Revision Points:

- Molecular mass is the total atomic mass of a molecule.
- One mole contains Avogadro’s number of particles, and it is a standard unit for counting atoms and molecules.

● Revision Points Summary

- Atoms are indivisible particles that form the basis of all matter.
- Dalton's atomic theory explains the nature and behavior of atoms.
- Molecules are formed by the bonding of atoms, and ions carry a charge.
- Chemical formulae are derived using valency, and molecular mass is the sum of atomic masses.
- The mole concept is crucial for quantifying the amount of substance.
- Chemical equations must be balanced to satisfy the law of conservation of mass.