CBSE Class 9 Science (Chemistry)

Chapter 9: Atomic Foundations of Matter

Board: CBSE (2026–2027) **Book:** Science – Exploration **Type:** Topper's Notebook Notes

1. Introduction

Welcome to the microscopic world! Everything around us—water, air, books, and even our own bodies—is made up of matter. But what is matter built of at the fundamental level? This chapter explores how ancient philosophers and modern scientists discovered that matter is made of tiny, indivisible building blocks called **atoms** and **molecules**, governed by precise chemical laws.

2. Learning Objectives

- Understand the historical evolution of atomic theory.
- State and apply the **Laws of Chemical Combination**.
- Differentiate between **atoms** and **molecules**.
- Master writing **chemical formulae** using valencies.
- Calculate **molecular mass** and **formula unit mass** accurately.

3. Complete Theory & Core Concepts

Classification of Matter (Flowchart)

```
Matter
 ├── Pure Substances
 │    ├── Elements (e.g., Fe, O₂)
 │    └── Compounds (e.g., H₂O, CO₂)
 └── Mixtures
      ├── Homogeneous (e.g., Saltwater)
      └── Heterogeneous (e.g., Oil in water)
```

4. Important Laws of Chemical Combination

A. Law of Conservation of Mass

> **Definition:** Mass can neither be created nor destroyed in a chemical reaction.
>
> $$\textit{Total Mass of Reactants} = \textit{Total Mass of Products}$$

- **Example:** Burning carbon to form carbon dioxide: $C + O_2 \rightarrow CO_2$ ($12\ g + 32\ g = 44\ g$).
- **Real-life Application:** Balancing chemical plants and industrial reactors to prevent waste.
- **Memory Trick:** *Reactants go in, Products come out—Mass stays stout!*
- **Common Mistake:** Forgetting that gases released into the atmosphere also have mass.

B. Law of Constant Proportions (Law of Definite Proportions)

> **Definition:** In a chemical substance, the elements are always present in fixed proportions by mass, regardless of the source or method of preparation.

- **Example:** Pure water (H_2O) from a tap, river, or rain always has hydrogen and oxygen in a fixed mass ratio of $1:8$.
- **Real-life Application:** Synthetic manufacturing of vitamins and medicines ensures uniform composition.

C. Dalton's Atomic Theory

1. All matter is made of tiny, indivisible particles called **atoms**.
2. Atoms of a given element are identical in mass and properties.
3. Compounds are formed by the combination of atoms of different elements in a fixed ratio.
4. Chemical reactions involve reorganization of atoms.

Limitations: It could not explain isotopes and why atoms combine.

5. Atoms & Molecules

Atoms

- **Definition:** The smallest particle of an element that takes part in a chemical reaction.
- **Properties:** Extremely small, mostly empty space, electrically neutral.

Molecules

- **Definition:** A group of two or more atoms chemically bonded together.
- **Atomicity:** The number of atoms constituting a molecule (e.g., O_2 is diatomic, atomicity = 2).

6. Chemical Formulae & Valency

Steps for Writing Chemical Formulae (Criss-Cross Method)

1. Write symbols of the constituent elements side-by-side.
2. Write their respective **valency** (combining capacity) underneath.
3. Criss-cross the valencies to obtain the subscript.
4. Simplify the ratio if necessary.

Example: Aluminium Oxide (Al_2O_3)

- Symbols: Al O
- Valency: 3 2
- Formula: Al_2O_3

7. Molecular Mass & Formula Unit Mass

- **Molecular Mass:** Sum of atomic masses of all atoms in a molecule (Unit: u).
  Example: $H_2O = (2 \times 1) + 16 = 18\ u$.
- **Formula Unit Mass:** Used for ionic compounds (e.g., $NaCl = 23 + 35.5 = 58.5\ u$).

8. Essential Reference Tables

Element	Symbol	Valency	Atomic Mass (u)
Hydrogen	H	1	1
Carbon	C	4	12
Nitrogen	N	$3, 5$	14
Oxygen	O	2	16
Sodium	Na	1	23

9. Numerical Problems Solved Step-by-Step

> **Problem 1:** Calculate the molecular mass of nitric acid (HNO_3).
> **Given:** Atomic masses: $H = 1\ u$, $N = 14\ u$, $O = 16\ u$.
> **Solution:**
> $Molecular\ mass\ of\ HNO_3 = (1 \times 1) + (1 \times 14) + (3 \times 16)$
> $= 1 + 14 + 48 = 63\ u$.

10. Key Activities from Textbook

- **Activity 9.1:** Verification of Law of Conservation of Mass using Barium Chloride and Sodium Sulphate solutions in an H-tube.
  Observation: No change in total mass before and after mixing (precipitation reaction).

11. One-Page Formula & Definition Sheet

- **Law of Conservation of Mass:** $Mass(Reactants) = Mass(Products)$
- **Molecular Mass:** $\sum (Atomic\ Mass \times Number\ of\ Atoms)$
- **Atomicity:** Total count of atoms in a single molecule.

12. Important Questions (CBSE 2026–27 Pattern)

Multiple Choice Questions (MCQs)

Q1. What is the atomicity of ozone (O_3)?
(a) 1 (b) 2 (c) 3 (d) 4

Answer: (c) 3
Explanation: An ozone molecule consists of three oxygen atoms bonded together.

Short Answer Question

Q: State the Law of Constant Proportions with an example.
A: In a chemical substance, elements are present in a fixed ratio by mass. For example, water (H_2O) always has hydrogen and oxygen in a $1:8$ mass ratio.

13. One-Day Revision Sheet

- **Atoms:** Indivisible building blocks of elements (Dalton).
- **Molecules:** Stable groupings of atoms.

- **Valency:** Combining power used for formula writing.
- **Mass Units:** Expressed in atomic mass units (u).