Chemistry

Awais Hamza

Doctors institue of Medical and Emerging Sciences

Composition of Substance

- **Matter**
- Anything that has **mass** and **occupies space**.
- Exists in **three states**: solid, liquid, gas.
- Examples: water, air, iron.

Substance

- A form of matter that has a **definite composition** and **distinct properties**.
- Types:
  - **Elements** → cannot be broken down (e.g., O_2, Fe).
  - **Compounds** → formed by chemical combination of elements (e.g., H_2O, NaCl).

Atom

- The **smallest particle** of an element that can take part in a chemical reaction.
- Retains the **identity** of the element.

Modern Definition of Atom

- "An atom is the **smallest particle** of an element that may or may not have an **independent existence**, but always takes part in a **chemical reaction**."

Subatomic Particles

- **Electron (e^-)**: discovered by **J.J. Thomson** (1897), negative charge (−1), negligible mass.
- **Proton (p^+)**: discovered by **Goldstein** (1886), positive charge (+1), mass ≈ 1 amu.
- **Neutron (n^0)**: discovered by **James Chadwick** (1932), neutral charge, mass ≈ 1 amu.

Ordinary Microscope

- Atoms are **too small** to be seen by ordinary (light) microscopes.
- Wavelength of visible light (≈ 400–700 nm) is **much larger** than atomic size (≈ 0.1 nm).
- ✗ Therefore, **atoms cannot be observed** directly with ordinary microscopes.
- Only **indirect evidence** like **Brownian motion** (random motion of pollen grains in water due to invisible atoms/molecules) supported their existence.

Electron Microscope

- Developed in the **20th century**.
- Uses a **beam of electrons** with very short wavelength (≈ 0.01–0.001 nm).
- ✓ Much higher **resolving power** than light microscopes.
- **Direct evidence of atoms** was obtained — individual atoms on surfaces of metals and crystals could be seen.

.

Ordinary and Electron Microscope

- **Ordinary microscope** → cannot see atoms (size too small).
- **Electron microscope** → atoms can be seen and studied directly.

Size and Mass of Atoms

- **Size**: radius of an atom ≈ **10^{-10} m (1 Å)**.
- **Mass**: expressed in **atomic mass unit (amu)**.
- 1 amu = 1/12 mass of a carbon-12 atom.
- Mass of hydrogen atom ≈ **1 amu**.