CBSE CLASS 9 SCIENCE (EXPLORATION)

CHAPTER 8: JOURNEY INSIDE THE ATOM • PREMIUM TOPPER NOTES (2026–27)

1. Chapter Overview

This chapter explores the building blocks of matter, revealing how atoms are composed of subatomic particles (electrons, protons, and neutrons). It traces the historical evolution of atomic models—from Dalton's indivisible sphere to the modern quantum-based Bohr model—and explains how electrons are distributed in shells, leading to concepts like valency, isotopes, and isobars.

2. Learning Outcomes

- Understand the subatomic nature of matter.
- Compare and contrast various historical atomic models and their limitations.
- Calculate atomic number, mass number, number of protons, neutrons, and electrons.
- Write electronic configurations and determine valency for the first 20 elements.
- Distinguish clearly between **isotopes** and **isobars** with applications.

3. All Important Definitions

- **Atom:** The basic unit of a chemical element, historically thought to be indivisible, but now known to consist of subatomic particles.
- **Subatomic Particles:** The particles inside an atom—**electrons**, **protons**, and **neutrons**.
- **Channel Rays (Anode Rays):** Positively charged radiations discovered by **E. Goldstein**, consisting of positively charged particles called protons.
- **Atomic Number (Z):** The total number of **protons** present in the nucleus of an atom.
- **Mass Number (A):** The sum of the total number of **protons** and **neutrons** in the nucleus of an atom.
- **Valency:** The combining capacity of an atom, representing the number of electrons gained, lost, or shared to achieve a stable octet.
- **Isotopes:** Atoms of the **same element** having the **same atomic number** but **different mass numbers**.
- **Isobars:** Atoms of **different elements** having the **same mass number** but **different atomic numbers**.

4. Discovery of Subatomic Particles

- **Electron:** Discovered by **J.J. Thomson** (1897) using a cathode-ray discharge tube. Electrons carry a negative charge ($1.6 imes 10^{-19} ext{ C}$) and have negligible mass ($1/1836$th the mass of a hydrogen atom).
- **Proton:** Discovered by **E. Goldstein** (1886) and named by **Ernest Rutherford**. Protons carry a positive charge equal in magnitude to the electron.

- **Neutron:** Discovered by **James Chadwick** (1932). It is a neutral particle with mass nearly equal to that of a proton.

5. Important Discoveries and Scientists

Scientist	Discovery / Contribution	Year
J.J. Thomson	Discovery of **Electron** & Plum Pudding Model	1897
E. Goldstein	Discovery of **Proton** (Channel Rays)	1886
Ernest Rutherford	α-Ray Scattering Experiment & Nucleus	1911
Niels Bohr	Bohr's Model of Atom (Discrete Shells)	1913
James Chadwick	Discovery of **Neutron**	1932

6. Atomic Models in Chronological Order

1. Ancient Ideas (Maharishi Kanad & Democritus)

Proposed that matter can be broken down continuously until particles cannot be divided further, termed **"Parmanu"** or **"Atomos"** (indivisible).

2. Dalton's Atomic Theory (1808)

Matter consists of indivisible atoms. Atoms of a given element are identical in mass and properties, but this failed when subatomic particles were discovered.

3. J.J. Thomson's Model (Watermelon / Plum Pudding Model)

An atom is a positively charged sphere with **electrons** embedded like seeds in a watermelon or plums in a pudding. The total positive and negative charges balance out.
Limitation: Could not explain the results of Rutherford's scattering experiment.

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+------------------------+
|   +    -     +    -    |
| -    +    -    +    -  |
|   +    -     +    -    |
+------------------------+
 (Thomson's Plum Pudding)
```

4. Rutherford's Nuclear Model (α-Particle Scattering Experiment)

Experiment: Fast-moving alpha (α) particles (doubly-charged helium ions) were made to fall on a thin gold foil.
Observations: Most passed straight through; some deflected by small angles; very few (1 in 12,000) bounced back.
Conclusions: Most space inside the atom is empty; positive charge is concentrated in a tiny central **nucleus**.

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Alpha Particles --->  o   o   o  -----> [ Gold Foil / Nucleus ]
                                           \ (Deflected)
                                         <-- (Bounced Back)
```

5. Bohr's Model of Atom (1913)

To overcome Rutherford's flaw, **Niels Bohr** proposed that electrons revolve in certain stable orbits called **discrete orbits or energy levels** ($K, L, M, N \dots$) without radiating energy.

7. Structure of Atom & Subatomic Comparison Table

Property	Electron (e^-)	Proton (p^+)	Neutron (n^0)
Location	Outside nucleus (Shells)	Inside Nucleus	Inside Nucleus
Relative Charge	-1	+1	0 (Neutral)
Absolute Mass	$9.1 imes 10^{-31} ext{ kg}$	$1.673 imes 10^{-27} ext{ kg}$	$1.675 imes 10^{-27} ext{ kg}$

8. Atomic Number & Mass Number Formulae

- **Atomic Number (Z)** = Number of Protons (p) = Number of Electrons (e^-) [in a neutral atom]
- **Mass Number (A)** = Number of Protons (p) + Number of Neutrons (n)
- **Number of Neutrons (n)** = $A - Z$

Memory Trick: PEN stands for **P**rotons = **E**lectrons = Atomic Number (Z) in neutral atoms!

$$\sqrt{}\ \textit{Max Electrons in Shell} = 2n^2 \quad | \quad \textit{Mass Number } (A) = p + n$$

9. Electronic Configuration & Valency

- Maximum number of electrons in a shell is given by the formula **$2n^2$** ($K=2, L=8, M=18, N=32$).
- **Octet Rule:** Atoms tend to have a maximum of **8 electrons** in their outermost shell for stability.
- **Valency Calculation:** If outer electrons ≤ 4, valency = outer electrons. If > 4, valency = $8 - (ext{outer electrons})$.

10. Isotopes and Isobars

Feature	Isotopes	Isobars
Definition	Same atomic no., different mass no.	Different atomic no., same mass no.
Protons	Same	Different
Neutrons	Different	Same total nucleons
Examples	Hydrogen (${}^{1}_{1}\text{H}, {}^{2}_{1}\text{H}, {}^{3}_{1}\text{H}$)	Calcium (${}^{40}_{20}\text{Ca}$) & Argon (${}^{40}_{18}\text{Ar}$)

Applications of Isotopes: ${}^{235}\text{U}$ in nuclear reactors, ${}^{60}\text{Co}$ in cancer therapy, ${}^{131}\text{I}$ in goitre treatment.

11. Common Mistakes & Quick Revision Tips

- **Mistake:** Confusing Atomic Number (Z) with Mass Number (A).
  Correction: Atomic number = protons only; Mass number = protons + neutrons.
- **Exam Tip:** Always practice electronic configuration for the first 20 elements and draw neat labeled diagrams for atomic models.