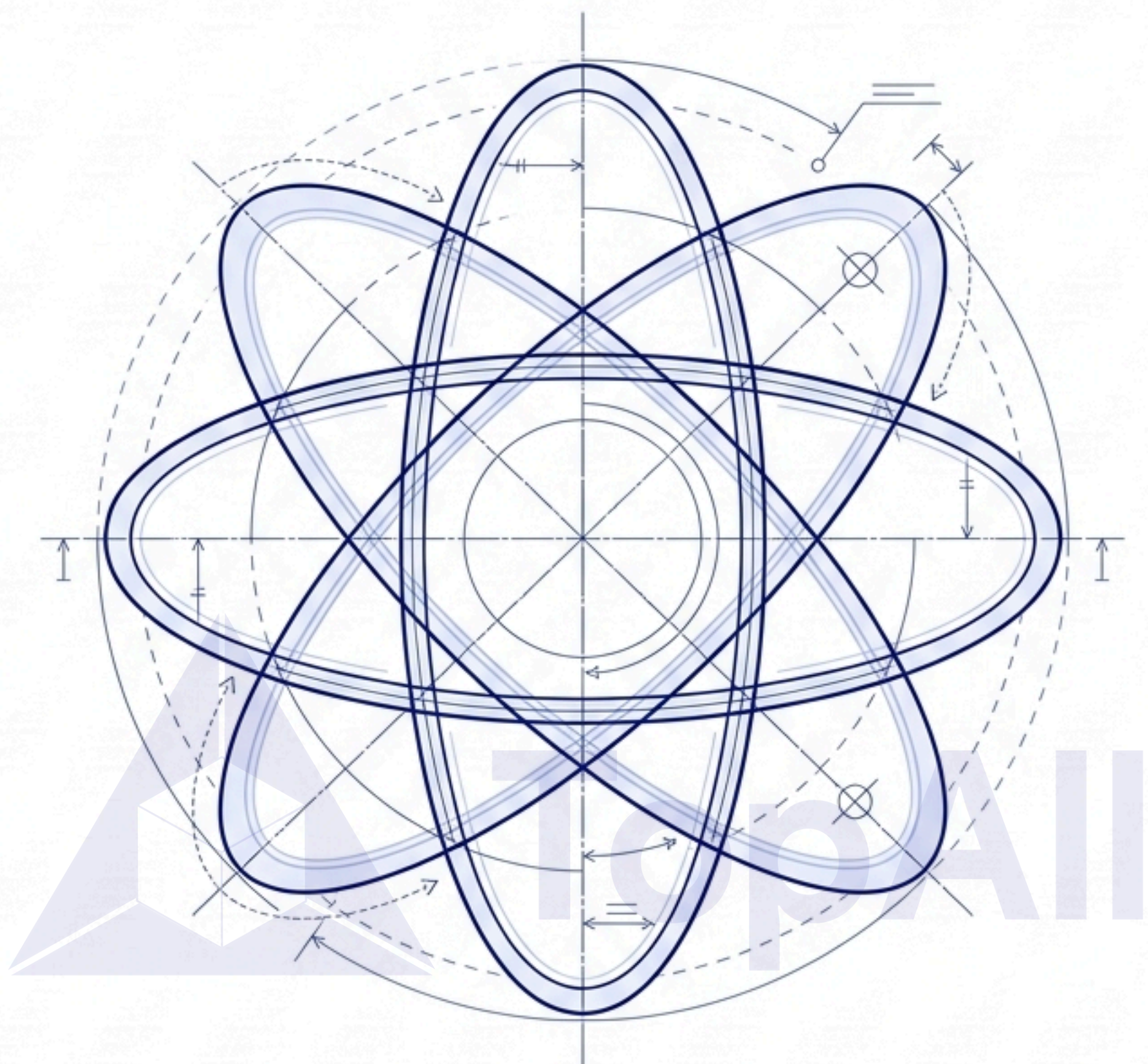




Isotopes vs Isobars

Decoding Atomic and Mass Numbers

JEE CLASS 11 CHEMISTRY // ATOMIC STRUCTURE

Mass Number (A)

$A = \text{protons} + \text{neutrons}$

Representing the total number of nucleons.



A

X

Atomic Number (Z)

$Z = \text{protons}$

Defines the element. (In a neutral atom, $Z = \text{electrons}$).



Z



Element Symbol (X)

The chemical identity dictated by Z.

$$n = A - Z \text{ (Number of neutrons = Mass Number - Atomic Number)}$$

Isotopes: Same Z, Different A

Atoms with identical atomic number (Z) but different mass numbers (A). The difference is purely driven by the neutron count.



Protium (~99.98%)

Subatomic Ledger

$$Z = 1, A = 1$$

$$p^+ = 1, n^0 = 0$$



Deuterium (0.015%)

Subatomic Ledger

$$Z = 1, A = 2$$

$$p^+ = 1, n^0 = 1$$



Tritium (Trace amounts)

Subatomic Ledger

$$Z = 1, A = 3$$

$$p^+ = 1, n^0 = 2$$

Other common examples: Carbon (C-12, C-13, C-14) and Chlorine (Cl-35, Cl-37).

Isobars: Same A, Different Z

Atoms with the same mass number (A) but different atomic numbers (Z). They are entirely different elements that happen to have the same total nucleon count.

Carbon-14



Subatomic Ledger

$$Z = 6, A = 14$$

$$p^+ = 6, n^0 = 8$$

Nitrogen-14



Subatomic Ledger

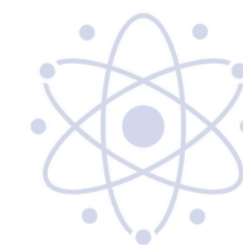
$$Z = 7, A = 14$$

$$p^+ = 7, n^0 = 7$$



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The Synthesis Matrix

	Isotopes	Isobars
Atomic Number (Z)	Same	Different
Mass Number (A)	Different	Same
Protons (p ⁺)	Same	Different
Neutrons (n ⁰)	Different	Different
Element Identity	Same Element	Different Elements

CAUTION: The Property Trap

TRAP: "Because isotopes have different masses, they exhibit different chemical properties." -> FALSE.

Step 1: Chemical properties are strictly controlled by the number of electrons.



Step 2: Electron count is determined by the number of protons (Z).



Step 3: Neutrons in the nucleus have virtually zero effect on chemical behavior.

Isotopes = Same chemical properties (same Z).
Isobars = Different chemical properties (different Z).

Key Takeaways

ISOTOPES = Same atomic number (Z), different mass number (A). They are the same element with varying weights.

ISOBARS = Same mass number (A), different atomic number (Z). They are different elements sharing the same nucleon total.

THE NEUTRON ENGINE :

Neutrons (n^0) are the sole subatomic particle responsible for the mass difference between isotopes of a given element.



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