CCo2 — Structure of Atom

📖 CCO2 · CDS General Science — Chemistry ★ High Priority

Atomic structure explains the behaviour of every element. CDS tests this chapter through questions on subatomic particles, atomic models (especially Bohr), atomic number vs mass number, isotopes, and electronic configuration rules.

📌 **CDS Focus:** Atomic number = protons; Mass number = protons + neutrons; electrons = protons (neutral atom). Isotopes (same Z, different A), isobars (different Z, same A), isotones (same neutrons). Bohr model for hydrogen. Electronic configuration using $2n^2$ rule.

1. Subatomic Particles

FIG. 1 — THREE SUBATOMIC PARTICLES: DISCOVERY, CHARGE, MASS AND LOCATION

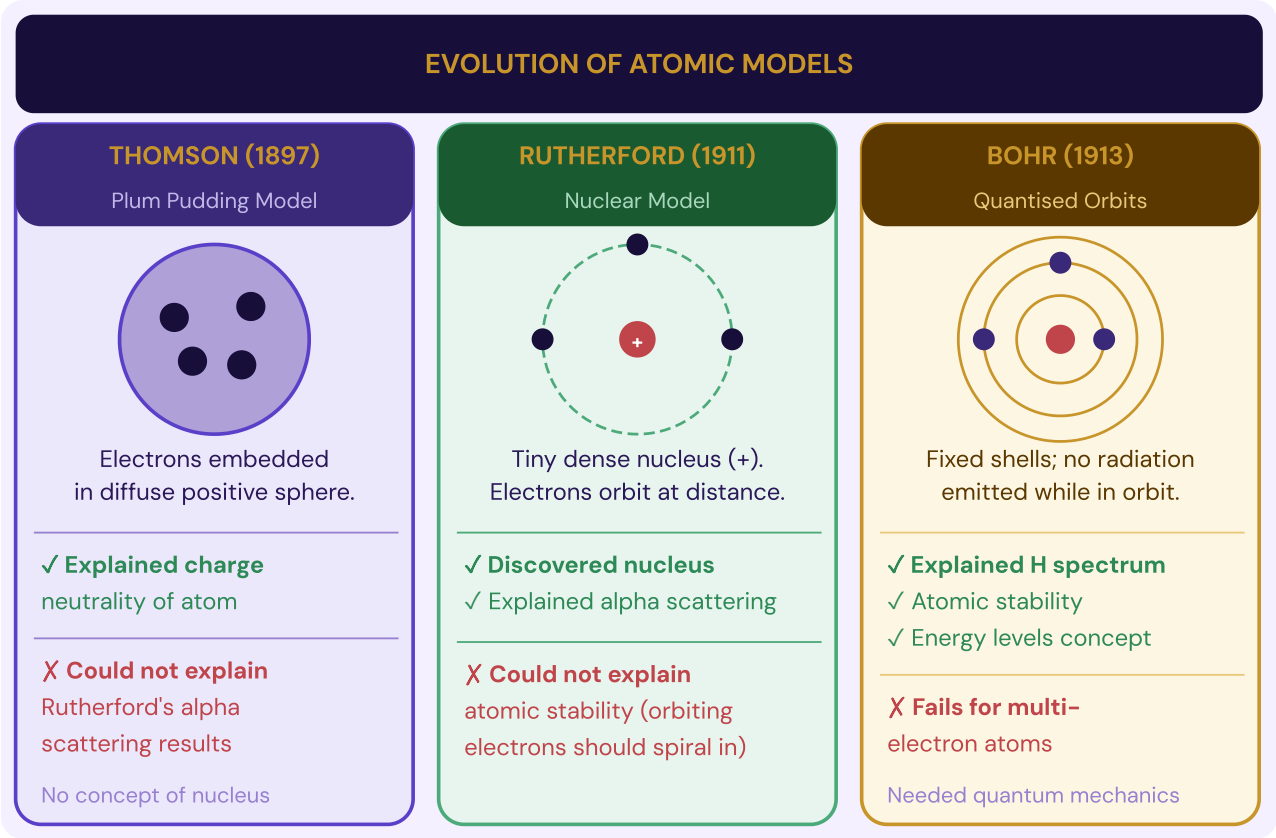
THREE SUBATOMIC PARTICLES — Discovery, Charge, Mass, Location

Particle	Discoverer	Charge	Relative Mass	Location
Electron e^-	J.J. Thomson 1897	−1	1/1836 of proton ≈ 0	Orbitals outside the nucleus
Proton p^+	Goldstein 1886	+1	1 amu	Inside nucleus
Neutron n°	Chadwick 1932	0	≈ 1 amu	Inside nucleus

Atomic Number Z = Protons = Electrons (neutral atom) | Mass Number A = Protons + Neutrons

2. Atomic Models

FIG. 2 — EVOLUTION OF ATOMIC MODELS: THOMSON → RUTHERFORD → BOHR



3. Isotopes, Isobars and Isotones

FIG. 3 — ISOTOPES, ISOBARS, ISOTONES: WHAT THEY SHARE AND WHAT THEY DON'T

ISOTOPES vs ISOBARS vs ISOTONES			
Term	**Same**	**Different**	**Example**
ISOTOPES Same element; different neutrons	**Atomic Number (Z)** Same protons & electrons	**Mass Number (A)** Different number of neutrons	^{1}H, ^{2}H (D), ^{3}H (T) All have Z = 1 ^{12}C, ^{13}C, ^{14}C (Z=6)
ISOBARS Different elements; same nucleon count	**Mass Number (A)** Same total nucleons	**Atomic Number (Z)** Different elements entirely	^{60}Co and ^{60}Ni ^{40}Ca and ^{40}Ar A = 40, Z differs
ISOTONES Different elements; same neutron count	**Neutron Number** n = A − Z is the same	**Z and A both differ** Different elements, different mass	^{14}C and ^{15}N Both have 8 neutrons C: 14−6=8; N: 15−7=8

4. Electronic Configuration

Rules for Electronic Configuration:

- **Aufbau Principle:** Fill orbitals in order of increasing energy: 1s, 2s, 2p, 3s, 3p, 4s, 3d...
- **Pauli Exclusion Principle:** Each orbital can hold maximum 2 electrons with opposite spins.
- **Hund's Rule:** Fill each orbital in a subshell singly before pairing.
- **$2n^2$ rule:** Maximum electrons in shell n = $2n^2$. Shell 1 = 2; Shell 2 = 8; Shell 3 = 18; Shell 4 = 32.

Examples: Na (Z=11) = 2,8,1 | Cl (Z=17) = 2,8,7 | Ca (Z=20) = 2,8,8,2

📝 CDS PYQs — Structure of Atom

Q1. Which atomic model was the first to introduce the concept of a nucleus?

CDS PYQ

(a) Thomson's model (b) Rutherford's model (c) Bohr's model

(d) Dalton's model

✓ Answer: (b) Rutherford's model

Rutherford's gold foil experiment (1911) showed that most of the atom is empty space with a tiny, dense, positively charged nucleus at the centre. He discovered the nucleus — a concept absent from Thomson's plum pudding model. This is the most tested atomic model question in CDS.

Q2. Isotopes of an element have the same: CDS PYQ

(a) Mass number (b) Atomic number (c) Number of neutrons (d) Atomic mass

✓ Answer: (b) Atomic number

Isotopes are atoms of the same element with the **same atomic number (Z)** but different mass numbers (A). They have the same number of protons and electrons but different neutrons. Examples: Hydrogen isotopes (^{1}H, ^{2}H, ^{3}H) all have Z=1. Carbon isotopes ^{12}C, ^{13}C, ^{14}C all have Z=6. Isotopes have identical chemical properties but different physical properties.

Q3. The number of neutrons in an atom of ^{28}Al (Aluminium, Z=13) is: CDS PYQ

(a) 13 (b) 14 (c) 27 (d) 15

✓ Answer: (b) 14

Neutrons = Mass number − Atomic number = 27 − 13 = **14**. Al has Z=13 (13 protons, 13 electrons) and A=27. This formula (neutrons = A − Z) is the most directly tested calculation in atomic structure questions for CDS.

Q4. Bohr's atomic model successfully explained: CDS PYQ

(a) Multi-electron atoms (b) Hydrogen spectrum (c) Nuclear structure

(d) Radioactivity

✓ Answer: (b) Hydrogen spectrum

Bohr's model (1913) successfully explained the **line emission spectrum of hydrogen** — specifically, why hydrogen emits light at only certain discrete wavelengths (Balmer series in visible range). When electrons jump between fixed energy levels, they emit photons of specific energy. Bohr's model fails for multi-electron atoms — that required quantum mechanics.

🧠 Quick Memory Chart — CCo2

⚛ Particles

- e^-: Thomson (1897), charge -1
- p^+: Goldstein (1886), charge +1
- n°: Chadwick (1932), neutral
- Z = protons = electrons
- A = protons + neutrons

⚖ Models

- Thomson: plum pudding
- Rutherford: nuclear (discovered nucleus)
- Bohr: fixed orbits; explained H spectrum
- Quantum: electron cloud (modern)
- Bohr fails for multi-e^- atoms

⊙ Iso- Types

- Isotopes: same Z, different A
- Isobars: same A, different Z
- Isotones: same neutrons
- Isomers: same formula, different structure
- Isoelectronic: same electrons

📝 Practice Exercise

E1. An atom has Z=17, A=35. The number of neutrons is:

(a) 17 (b) 18 (c) 35 (d) 52

E2. ^{12}C and ^{14}C are:

(a) Isobars (b) Isotopes (c) Isotones (d) Isomers

E3. Maximum electrons in the third shell (n=3) of an atom:

(a) 8 (b) 16 (c) 18 (d) 32

Answers: E1 → (b) 18 [35-17=18] | E2 → (b) Isotopes [same Z=6, different A] | E3 → (c) 18 [$2n^2 = 2(3)^2 = 18$]