

P4 Atomic structure

Physics Paper 1 | AQA Combined Science Trilogy | Start with the nucleus and charges

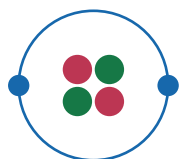
Proton +1

Neutron 0

Electron -1

Neutrons = mass – atomic number

1 Atoms, numbers and isotopes



Nucleus: protons + neutrons

Electrons outside

Almost all mass in nucleus

Atomic number: protons.

Mass number: protons + neutrons.

Neutral atom: protons = electrons.

Isotopes: same protons, different neutrons.

Carbon-14: 6 protons, **8 neutrons**.

Lose an electron → **positive ion**.

Atom radius $\approx 10^{-10}$ m; nucleus radius less than 1/10,000 of atom radius.

2 Evidence changes the model

Solid sphere → plum pudding: discovery of negative electrons changed the model. Plum pudding had spread-out positive charge.

Alpha scattering:

- Most pass through → mostly empty space.
- Very few turn sharply → tiny, dense, positive nucleus. Like charges repel.

Bohr: specific electron energy levels.

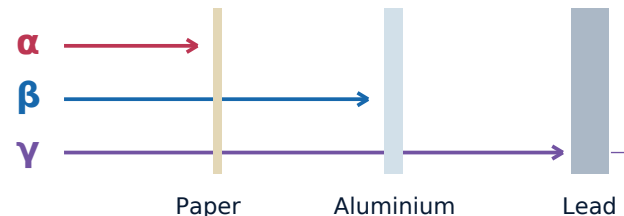
Chadwick: evidence for neutrons.

Electron absorbs energy → higher level.

Returns to lower level → emits

electromagnetic radiation.

3 Alpha, beta and gamma



Alpha: 2 protons + 2 neutrons. Most ionising; few cm in air; stopped by paper.

Beta: fast electron from nucleus. Medium ionisation; stopped by thin aluminium.

Gamma: EM wave. Least ionising; most penetrating. Thick lead/concrete **reduces** it.

4 Decay and nuclear equations

Unstable nuclei decay randomly.

Activity in **Bq** = decays per second.

A GM tube detects radiation. Count rate is not necessarily the source activity.

Alpha: mass –4, atomic number –2.



Beta-minus: neutron → proton + electron.

Mass unchanged; atomic number +1.

Gamma: neither number changes.

Check both rows: mass numbers balance; atomic numbers balance.

5 Half-life: halve, then halve again

Half-life: time for source activity to halve.

Also applies to undecayed nuclei.

Use counts with background subtracted.

160 → 80 → 40 → 20

0 min 2 min 4 min 6 min

Example: corrected counts/min above.

Half-life = 2 minutes.

HIGHER TIER ONLY

After 3 half-lives: **1/8 remains**.

Decayed : initial = **7 : 8**.

6 Exposure, uses and precautions

Irradiation: radiation reaches an object.

Contamination: radioactive material gets on/in it; this material keeps emitting.

Irradiation alone does not make it radioactive in these GCSE situations.

Hazard: ionisation can damage cells/DNA. An internal alpha source is strongly ionising close to tissue.

Reduce exposure: less time, more distance, appropriate shielding.

Uses: beta for paper thickness; gamma for sterilising through packaging.

Peer review: scientists check evidence.