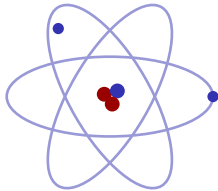


Nuclear Physics

IGCSE Physics ■ Topic 5

IGCSE Physics

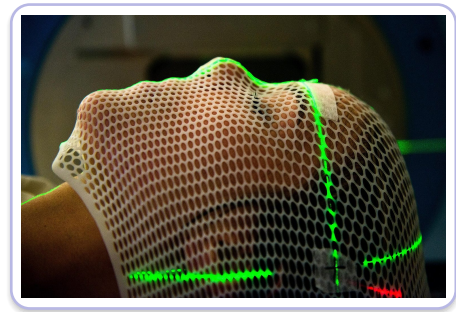
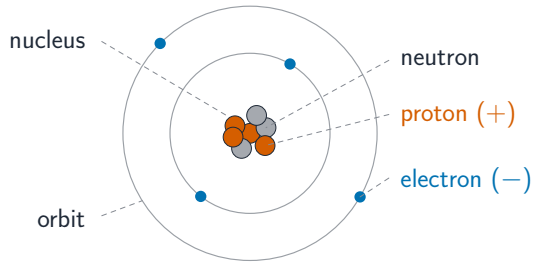


What we will cover

- 1 The nuclear atom
- 2 Nucleus, isotopes, fission & fusion
- 3 Radioactivity
- 4 Three types of radiation
- 5 Decay & half-life
- 6 Recap

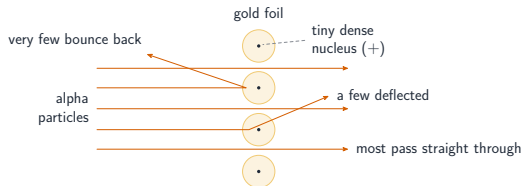


The nuclear atom



Radiotherapy

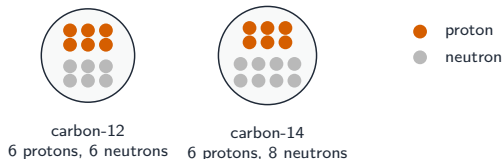
Alpha-scattering evidence



Alpha particles α 粒子 on gold foil:

- most pass straight $\rightarrow$ mostly empty
- a few deflect $\rightarrow$ positive nucleus
- a very few bounce back $\rightarrow$ tiny, heavy nucleus

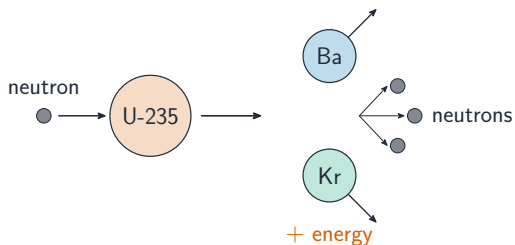
Inside the nucleus



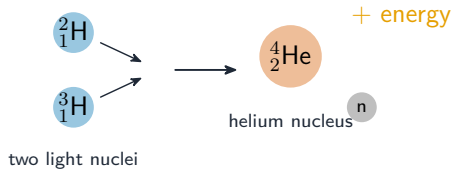
Nucleons 核子: **protons** 质子 (+1) and **neutrons** 中子 (0). Notation A_ZX .

- Z = proton number; A = nucleon number; neutrons = $A - Z$
- **isotopes** 同位素: same Z , different A

Fission and fusion



fission 核裂变: a heavy nucleus splits



fusion 核聚变: light nuclei join (the Sun)

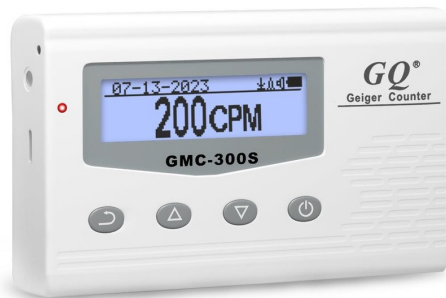
Both lose a little mass, turned into energy; the A and Z numbers balance on each side.

Radioactivity

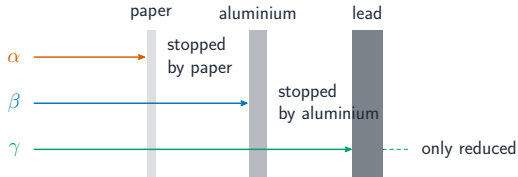
An **unstable** 不稳定 nucleus **decays** 衰变, giving out radiation. Decay is **spontaneous** and **random**. **Background radiation** 背景辐射 (radon, rocks, cosmic rays) is always present – subtract it:

250 next to source, 30 background

corrected = 220 counts/min

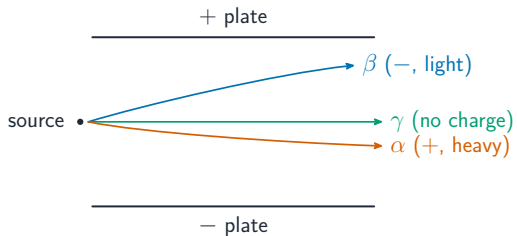


Three types of radiation



- α – He nucleus (+2): most **ionising** 电离, stopped by paper
- β – fast electron (−1): aluminium
- γ – EM wave (0): least ionising, only reduced by lead

Deflection in fields



Charged α and β bend **opposite** ways; the lighter β bends more. Uncharged γ is **not** deflected.

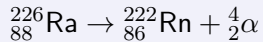
Decay equations

$$\alpha : {}^A_Z\text{X} \rightarrow {}^{A-4}_{Z-2}\text{Y} + {}^4_2\alpha$$

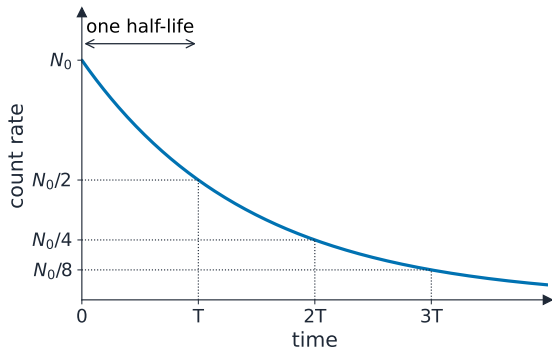
$$\beta : {}^A_Z\text{X} \rightarrow {}^A_{Z+1}\text{Y} + {}^0_{-1}\beta$$

γ emission: only energy leaves, A and Z unchanged.

${}^{226}_{88}\text{Ra}$ emits α



Half-life



Half-life 半衰期: the time for half the unstable nuclei (or the count rate) to halve.

800 $\rightarrow$ 100 **counts/min**, $T = 5$
days

three halvings $\Rightarrow$ 15 days

Uses and safety

Match the source to the job:

- smoke alarms – α
- **sterilising** 消毒 – penetrating γ
- thickness gauge – β

Lower the **dose** 剂量: less **time**,
more **distance**, **shielding** 屏蔽
(lead).

Handle with tongs; store in a lead box.

Topic 5 – key takeaways

1 Nucleus

${}^A_Z\text{X}$; isotopes share Z

2 Radiation

α (paper), β (Al), γ (lead)

3 Decay

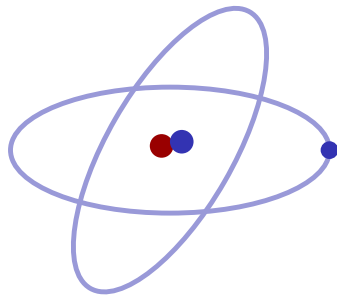
A & Z balance; α , β , γ

4 Half-life

count rate halves each half-life

Check yourself

- 1 How many neutrons in $^{197}_{79}\text{Au}$?
- 2 Which radiation is stopped by paper?
- 3 $^{24}_{11}\text{Na}$ emits β – the new proton number?
- 4 After 2 half-lives, what fraction is left?



Answers 1. $197 - 79 = 118$ 2. alpha 3. 12 4. one quarter