Exercise walk-through

4.3 Radioactive decay and nuclear radiation (4.4.2.1)

AQA · GCSE · Physics

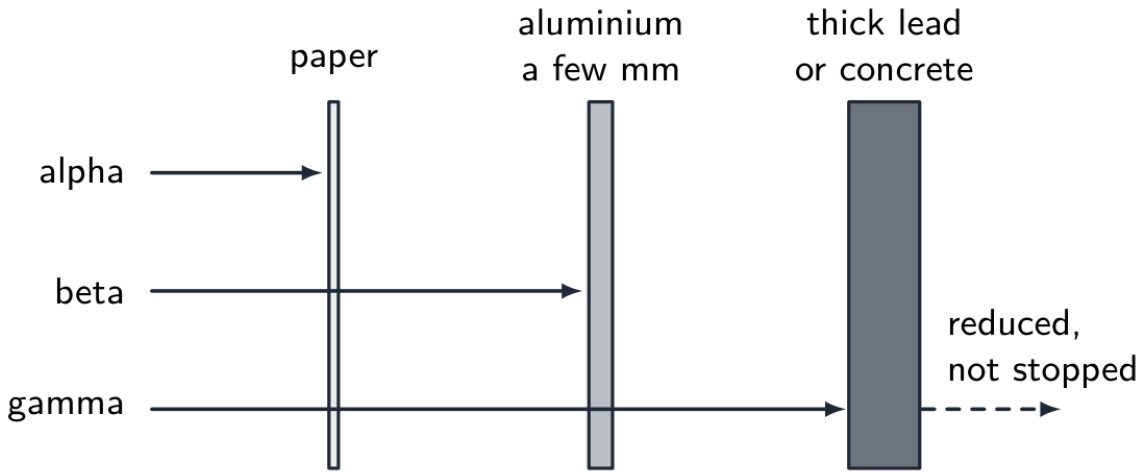
Radioactive decay and nuclear radiation

- The **activity** of a source is the rate at which its nuclei decay, measured in **becquerel** (Bq). 1 Bq is one decay per second.
- **Count-rate** is the number of decays recorded each second by a detector, such as a Geiger–Müller tube.
- Smoke alarms use alpha: it ionises the air strongly and is stopped by smoke.

Radioactive decay and nuclear radiation (2)

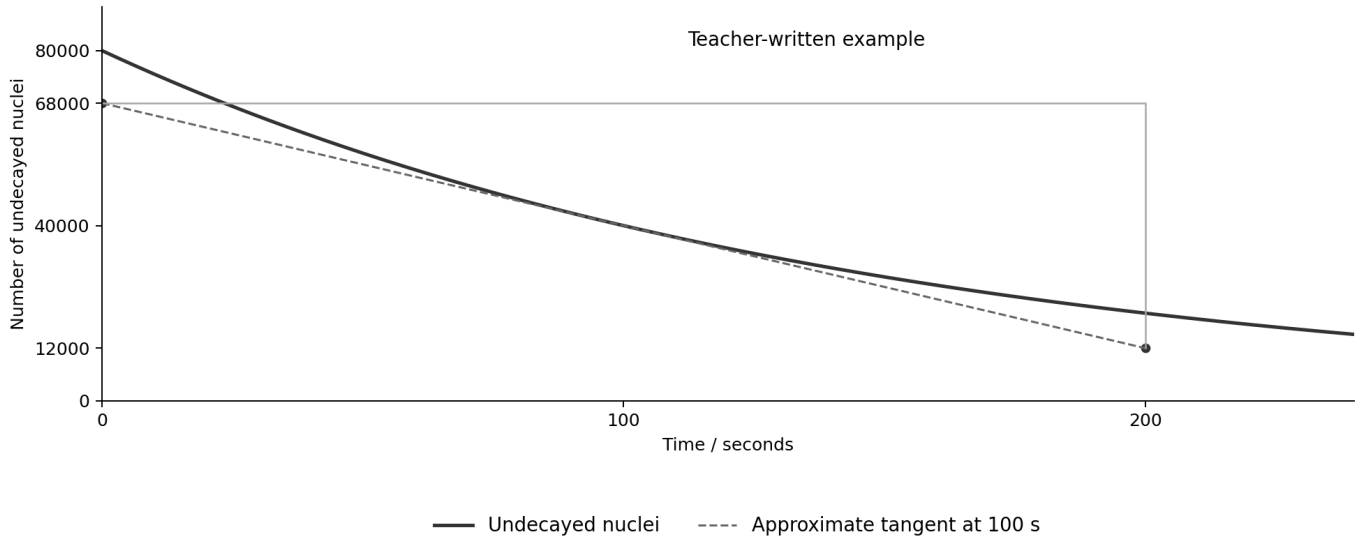
- Paper thickness gauges use beta: some passes through paper, and the amount depends on the thickness.
- Medical tracers use gamma: it passes out of the body to a detector.

Figure: Radioactive decay and nuclear radiation



- Penetration: alpha stopped by paper, beta by aluminium, gamma reduced by thick lead.
- Match each part of the diagram to the text.

Figure: Radioactive decay and nuclear radiation (2)



- Number of undecayed nuclei against time, with a tangent drawn at 100 s to find the **activity**.
- Read the axes and units first.

Exercises 2.1·2.2

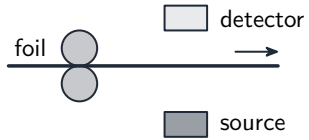
2.1 State the composition of an alpha particle. [1]

alpha particle

2.2 Which radiation is the most ionising, and which has the longest range in air? [2]

alpha beta gamma

2.3 A factory checks the thickness of aluminium foil with radiation. State the best radiation and why not the others. [3]



Exercises 2.1·2.2

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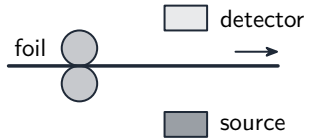
alpha particle

2.1 Two protons and two neutrons – the same as a helium nucleus.

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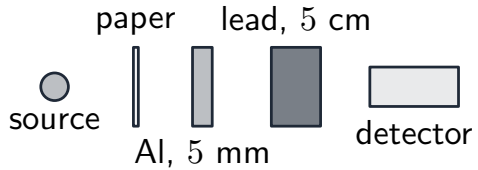
2.2 Most ionising: alpha. Longest range in air: gamma.

2.3 Beta: alpha would not pass through any metal foil; gamma is too penetrating to give a useful change for this thin foil; beta is partly absorbed by thin metal, so count-rate follows thickness.

Exercise 3.1

3.1 A teacher keeps the source and detector positions fixed and subtracts background. The net count rate is 100 counts/s without an absorber, 100 counts/s with paper, 40 counts/s with 5 mm of aluminium, and 20 counts/s when 5 cm of lead is also added. Assume only alpha, beta and gamma emissions are possible, and that paper and aluminium have negligible effects on the gamma component in this test.

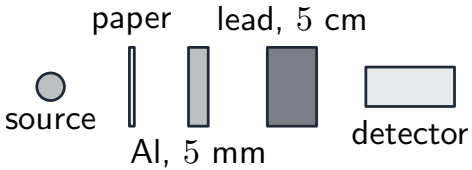
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Identify the radiation components detected, using each absorber result. [3]



3.1 No detected alpha component: paper does not reduce the net count rate. Beta is present: aluminium stops the beta component, reducing the rate. Gamma is present: radiation remains after aluminium and is further reduced by lead. The evidence supports a beta–gamma mixture, not gamma alone.

Exercise 3.2

3.2 A source emits beta particles. Explain what happens in the nucleus when a beta particle is emitted, and the effect on the atomic number. [2]

beta emission

3.3 A hospital needs a source to sterilise sealed pre-packed syringes in their boxes.



(a) State the most suitable radiation and justify your choice with two properties. [3]

(b) Give one reason the source should have a long half-life. [1]

(c) Workers stand behind a shield while the source is exposed. Explain why the syringes are not radioactive afterwards. [2]

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3.3 (a) Gamma: it passes through the boxes; its ionisation damages or kills the microor-

Full solution on next slide

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Full solution 3.2

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3.3 (a) Gamma: it passes through the boxes; its ionisation damages or kills the microorganisms inside. (b) So the source does not need frequent replacement (activity stays high for years). (c) The syringes were irradiated, not contaminated: irradiation exposes them to radiation but does not transfer radioactive material, so nothing radioactive remains on them.