Radiation penetration: a paper simulation

Student activity • observation and reasoning

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The question

How can changes in transmitted signal distinguish radiation types?

Run an original paper simulation of three idealised radiation types and compare the model with real limitations.

Equipment

- Booklet, simulation data, ruler and calculator

Paper simulation only. Do not obtain radioactive sources, dismantle smoke alarms, handle lead sheets or test shielding on people. No radiation exposure or dose measurement is performed.

Course coverage: Shared Physics / Double Award: 7.5–7.6. Radiation nature, ionisation and penetration investigated using a simulation.

Plan, model or apparatus sketch

Draw a labelled particle, nuclear-symbol or detector model appropriate to the task.

Method and reasoning

Read the whole sequence before starting

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1. Draw a source, absorber position and detector at fixed spacing. Label this as a paper simulation; no physical source or absorber is required.

2. Use these model raw counts for equal 60 s intervals: background 10; no absorber 210 for each type; paper alpha 10, beta 190, gamma 205; aluminium alpha 10, beta 10, gamma 180; thick dense shielding gamma 70. All values are invented.

3. Subtract the background 10 from each raw count. Calculate the fraction transmitted relative to each type's no-absorber corrected count.

4. Compare alpha's short penetration, beta's intermediate penetration and gamma's greater penetration. Explain why a nonzero raw count behind an absorber does not necessarily mean the source signal is transmitted.

5. Discuss why dense shielding reduces gamma intensity rather than providing a universal complete stop. State that actual behaviour depends on particle/photon energy, absorber material and thickness.

6. Compare penetration with ionising ability. Explain why strongly ionising alpha can be a serious internal hazard despite low penetration. State that the model cannot select real shielding or measure dose.

Cleanup

- Retain corrected counts and return calculators.

Record your evidence

Blank spaces are for your own work

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Reference and task data

The simulation deliberately uses simple deterministic values, so it omits random counts and detector efficiency. Corrected no-absorber count is 200. Paper fractions are alpha 0, beta 0.90, gamma 0.975; aluminium gamma 0.85; dense shielding gamma 0.30.

Case	Raw count	Corrected count	Fraction
Alpha / paper	10		
Beta / paper	190		
Gamma / paper	205		
Beta / aluminium	10		
Gamma / aluminium	180		
Gamma / dense shield	70		

Show your calculations, labelled model or correction here.

Explain and evaluate

Use evidence and show calculation steps where relevant

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1. Why subtract background?

2. Find beta’s corrected paper count.

3. Find beta’s paper transmitted fraction.

4. Does gamma stop completely in the stated dense shield model?

5. Which has strongest typical ionisation per short track?

6. Name two limits of this simulation.