Radioactivity in industry: choosing a method

Student activity • observation and reasoning

YEAR 11 / LESSON 98 / PHYSICS + SCIENCE (DOUBLE AWARD)

The question

How does a useful industrial application depend on penetration and detection?

Compare thickness monitoring, tracing and sterilisation using original paper models.

Equipment

- Booklet, original application diagrams and calculator

Paper models only. No industrial source, radioactive tracer, smoke alarm, steriliser or shielding material is handled or dismantled.

Course coverage: Shared Physics / Double Award: 7.14. Industrial uses of radioactivity.

Plan, model or apparatus sketch

Draw a labelled graph, nuclear diagram or application model appropriate to the question.

Method and reasoning

Read the whole sequence before starting

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1. Draw a source and detector on opposite sides of a paper sheet. Explain how a suitably chosen beta source can monitor thickness when some radiation is absorbed and some reaches the detector.

2. Use the invented calibration pairs thickness 1, 2 and 3 arbitrary units with background-corrected rates 180, 120 and 80 counts per second. Predict whether a rate of 150 suggests thicker or thinner paper than the two-unit reference; do not assume a linear calibration.

3. Draw a pipe tracer scenario and explain why the radiation must escape sufficiently to reach an external detector and why the tracer's half-life must suit the measurement duration.

4. Explain gamma irradiation as one method for sterilising packaged equipment. Distinguish radiation exposure from adding radioactive material to the equipment.

5. Compare an industrial application's useful signal with the need for shielding, containment, interlocks and trained operators. These are system features, not a classroom construction plan.

6. Choose an application and justify radiation type and half-life qualitatively. Identify what cannot be decided without real calibration, material and operating information.

Cleanup

- Keep the application comparison and return calculators.

Record your evidence

Blank spaces are for your own work

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Reference and task data

The thickness data are invented and corrected for background. A higher rate indicates thinner paper for the stated geometry and calibration. No real product, source or tracer is tested.

Application	Required radiation property	Half-life / control reasoning
Thickness monitoring		
Pipe tracer		
Sterilisation		

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 is beta useful in the paper model?

2. What does a higher transmitted count suggest?

3. Is 150 counts s^{-1} thicker than the two-unit reference?

4. Why must tracer radiation reach a detector?

5. Why is a suitable half-life a compromise?

6. Does ordinary gamma sterilisation require radioactive material to be added to the product?