Half-life: correcting and interpreting data

Student activity • observation and reasoning

YEAR 11 / LESSON 96 / PHYSICS + SCIENCE (DOUBLE AWARD)

The question

Why must background be removed before estimating half-life from counts?

Analyse original model counts with a fixed background and distinguish an ideal trend from random measurements.

Equipment

• Booklet, graph paper, ruler and calculator

Paper-based data analysis only. No radioactive source, detector or exposure activity is used.

Course coverage: Shared Physics / Double Award: 7.12–7.13. Half-life definition, calculations and graphical estimates.

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

YEAR 11 / LESSON 96 / PHYSICS + SCIENCE (DOUBLE AWARD)

1. Use the labelled practice table: time 0, 2, 4, 6, 8 and 10 minutes; raw count rates 330, 170, 90, 50, 30 and 20 counts per minute. The constant model background is 10 counts per minute.

2. Subtract background from every rate and plot corrected count rate against time, with units and a suitable scale. Mark the points as invented ideal data.

3. Estimate the time for corrected rate to fall from 320 to 160, from 160 to 80 and from 80 to 40. Compare these intervals and state the model half-life.

4. Use the half-life to predict the corrected rate at 12 minutes and the corresponding raw rate with background included. Explain why the raw curve does not tend to zero in this model.

5. Define half-life in terms of the expected halving of undecayed nuclei or activity in a large sample. Explain why it does not predict an individual nucleus's decay time.

6. Discuss what would change with real data: statistical scatter, uncertainty and limits near background. Do not force a measured graph through a perfectly smooth sequence.

Cleanup

- Retain the graph and calculation checks.

Record your evidence

Blank spaces are for your own work

YEAR 11 / LESSON 96 / PHYSICS + SCIENCE (DOUBLE AWARD)

Reference and task data

Corrected rates are 320, 160, 80, 40, 20 and 10 counts min^{-1}. The ideal half-life is 2 minutes. At 12 minutes the corrected rate is 5 and the raw rate 15 counts min^{-1}. All values are practice data, not source measurements.

Time / min	Raw / counts min^{-1}	Corrected / counts min^{-1}
0	330	
2	170	
4	90	
6	50	
8	30	
10	20	

Show your calculations, labelled model or correction here.

Explain and evaluate

Use evidence and show calculation steps where relevant

YEAR 11 / LESSON 96 / PHYSICS + SCIENCE (DOUBLE AWARD)

1. Why subtract 10?

2. Find the corrected initial rate.

3. Find the half-life.

4. Find the corrected rate at 6 minutes.

5. Find the raw rate at 12 minutes.

6. Will every nucleus decay at one half-life?