

22.1 Nuclear changes and radiation evidence

Name: _____ Class: _____ Date: _____

Total: 10 marks

KEY WORDS half-life • background radiation

Objective

Nuclear changes and radiation evidence. Original classroom practice for IB HL; not an official IB paper.

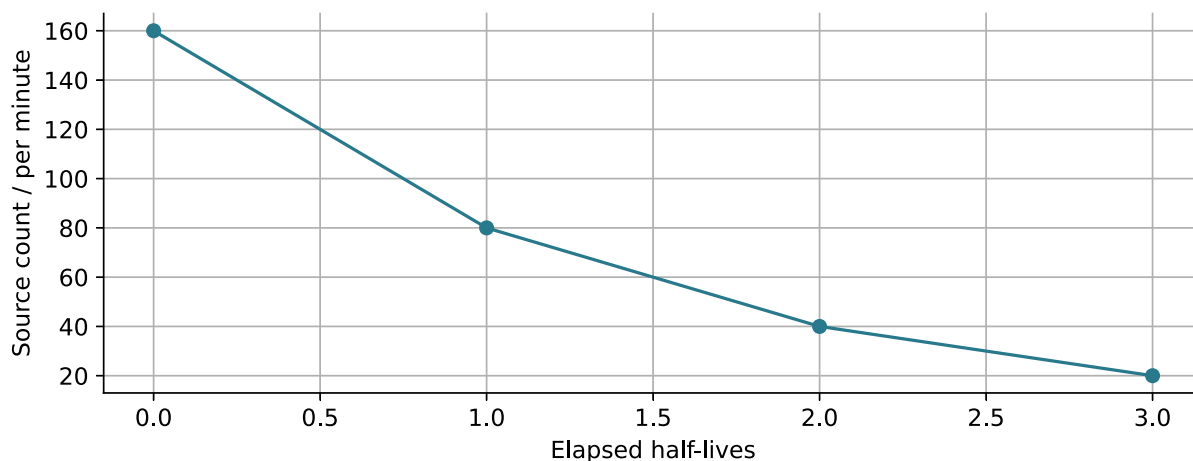
1 Key knowledge and worked examples

■ What would explain this observation?

- A detector records counts even when the classroom source is removed. Background must be considered before attributing every count to the source.

■ Build the model

- Radioactive decay is spontaneous and random for an individual nucleus.
- **Half-life** describes the time for half the undecayed nuclei in a large population to decay, or for background-corrected activity to halve.
- half-life: Time for activity or undecayed population to halve.
- **background radiation** : Radiation measured apart from the investigated source.



■ **Choose evidence that can test it**

- Subtract background counts measured over the same time interval.
- Distinguish irradiation from contamination.
- Shielding, distance and reduced exposure time can reduce risk under a school-controlled procedure.

In the lab: Use teacher-managed sources and the school radiation rules. Record count duration and repeat background measurements. Do not extrapolate a half-life from one nucleus or from uncorrected readings.

■ **Work from known quantities**

- Known: measured count rate falls from 100 to 55 counts per minute; background is 10.
- Source rates are 90 and 45, so one half-life has elapsed.
- Without subtraction, 55/100 would obscure the exact half in this example.

Your turn: An initial source count is 160 per minute. Find it after three half-lives.

■ **Check the conclusion and its limits**

- An irradiated object is not automatically radioactive.
- A half-life does not predict the exact decay time of one nucleus.

Not true: Half-life predicts the exact decay time of an individual nucleus. Radioactive decay is random at the level of single nuclei. Half-life is a statistical quantity: it predicts the fraction of a LARGE number of nuclei decaying in a given time, never the moment one nucleus will decay.

Key:

- Radioactive decay is spontaneous and random for an individual nucleus.
- Subtract background counts measured over the same time interval.
- Watch for: an irradiated object is not automatically radioactive.

■ **Write from 80 counts per minute**

- An initial source count is 320 per minute.
- Find the count after two half-lives. Half-life does not time one nucleus.

2 Practice

2.1 Which count should be used for source activity? Choose one answer.

- **A** Raw source-plus-background only
- **B** Measured count minus background over equal times
- **C** The largest repeated count only

[1]

2.2 An initial source count is 160 per minute. Find it after three half-lives. Show the relation, substitution and units.

[2]

2.3 Decide whether this claim is true and justify: Radioactive decay is random at the level of single nuclei.

[2]

2.4 Time for activity or undecayed population to halve: write the technical term.

[1]

3 Exam-style questions

3.1 A fictional counter reads 90 counts/min, then 50 after one half-life. Background is constant. Infer background and initial source rate. [4]
