Background radiation and count rate

Student activity • demonstration and reasoning

YEAR 11 / LESSON 95 / PHYSICS + SCIENCE (DOUBLE AWARD)

The question

Why is detector count rate not automatically the activity of a source?

Observe background counts with a closed educational detector or analyse the clearly labelled practice alternative.

Equipment

- Optional staff enclosed GM detector/counter and timer
- Booklet, practice-data sheet and calculator

No radioactive source is brought in or handled. Staff operate the intact detector; do not open it, touch a fragile window or access its internal high-voltage circuit. Do not use counts to screen people or make a personal health or dose judgement.

Course coverage: Shared Physics / Double Award: 7.1, 7.9–7.11. Detection, background sources, activity and becquerels.

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. Staff position an intact educational Geiger–Müller detector and counter at a fixed classroom location, with no added radioactive source. Follow its normal enclosed operating instructions.

2. Record background counts for five separate 60 s intervals without moving the detector. Record each actual count and calculate count rate by dividing by 60 s.

3. Calculate the total count over 300 s and the mean count rate. Explain why equal intervals can have different counts.

4. If the detector is unavailable, use the labelled practice counts 18, 22, 20, 17 and 23 for five 60 s intervals. Mark every result as practice, not measured.

5. Identify natural background contributions from space, rocks and radioactive materials within living things. Explain that detector position, shielding and response affect count rate.

6. Define one becquerel as one nuclear decay per second. Explain why a detector records only a fraction of emissions and cannot directly provide source activity or personal dose without calibration and geometry information.

Cleanup

- Switch off and store the detector; retain the counts and timing.

Record your evidence

Blank spaces are for your own work

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Reference and task data

Practice totals are 100 counts in 300 s, giving 0.333 counts s^{-1}, or 20 counts min^{-1}. No added source is present. A GM detector responds to ionisation; photographic film can also register ionising radiation but is not used here.

Interval	Duration / s	Actual count	Rate / s^{-1}
1	60		
2	60		
3	60		
4	60		
5	60		

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 are equal-interval counts different?

2. Find the practice total.

3. Find its mean rate in counts per second.

4. Name two natural background sources.

5. Define 1 Bq.

6. Why is 0.333 counts s^{-1} not necessarily 0.333 Bq?