FREE REVISION PACK

Radioactive Decay & Half-Life

AQA A-level Physics · 7408 · Specification 3.8.1.3

Easy Medium Hard Multiple choice · past-paper questions

7	7	≈ 10 min
QUESTIONS	TOTAL MARKS	SUGGESTED TIME*

Contents

Q	LEVEL	FOCUS	SOURCE	MARKS
1	Easy	What randomness means for decay	AQA June 2023 · A-level Paper 2 · Q28	1 mark
2	Easy	Decay constant from the half-life	AQA June 2017 · A-level Paper 2 · Q28	1 mark
3	Easy	Order of magnitude of λ	AQA June 2022 · A-level Paper 2 · Q28	1 mark
4	Medium	What the rate of decay is proportional to	AQA November 2020 · A-level Paper 2 · Q29	1 mark
5	Medium	Initial number of nuclei from an activity graph	AQA June 2023 · A-level Paper 2 · Q32	1 mark
6	Medium	Two samples with equal nuclei after 18 minutes	AQA November 2021 · A-level Paper 2 · Q28	1 mark
7	Hard	Age of a rock from its lead-to-uranium ratio	AQA June 2024 · A-level Paper 2 · Q32	1 mark

Key ideas to have ready

- Decay is random: you can't predict when a particular nucleus will decay, but a large sample decays predictably.
- Activity $A = \lambda N$ (Bq). $N = N_0 e^{-\lambda t}$ and $A = A_0 e^{-\lambda t}$.
- Half-life $T_{½} = \ln 2 / \lambda = 0.693 / \lambda$. After n half-lives the number left is $N_0 / 2^n$.
- If a stable product builds up, parent + product = N_0, so the ratio of the two gives the age of a sample.

How to use this pack

1. The questions are grouped into levels (Easy, Medium and Hard). Work through them in order, and check your answers at the end of each level before moving on.
2. Every question is multiple choice with one correct answer. Write down your working anyway; that is how you find mistakes.
3. The separate mark scheme uses the same numbers and explains every answer.

Levels are based on how students did in AQA's examiner reports where that information exists, plus our own difficulty rating. *About 1.5 minutes per question.

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Easy

Definitions and one-step ideas. Most students get these right.

Questions 1–3

Only **one** answer per question is allowed. For each question, completely fill in the circle alongside the appropriate answer.

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1 The random nature of radioactive decay means that it is never possible to predict

[1 mark]

A when a particular nucleus will decay. ○

B whether a β^- particle or a β^+ particle is emitted. ○

C the approximate time taken for the activity to decrease to a specified value. ○

D the approximate thickness of an absorber needed to reduce the count rate to a specified value. ○

AQA June 2017 · A-level Paper 2 · Q28

2 Nobelium-259 has a half-life of 3500 s.

What is the decay constant of nobelium-259?

[1 mark]

A $8.7 \times 10^{-5}\ s^{-1}$ ○

B $2.0 \times 10^{-4}\ s^{-1}$ ○

C $1.7 \times 10^{-2}\ s^{-1}$ ○

D $1.2 \times 10^{-2}\ s^{-1}$ ○

AQA June 2022 · A-level Paper 2 · Q28

3 A nuclide has a half-life of 10 ms.

The decay constant for this nuclide lies between

[1 mark]

A $1\ s^{-1}$ and $10\ s^{-1}$. ○

B $10\ s^{-1}$ and $10^2\ s^{-1}$. ○

C $10^2\ s^{-1}$ and $10^3\ s^{-1}$. ○

D $10^3\ s^{-1}$ and $10^6\ s^{-1}$. ○

Medium

Two or three steps. Roughly a third to a half of students get these right.

Questions 4–6

AQA November 2020 · A-level Paper 2 · Q29

4 The number of parent nuclei in a sample of a radioactive element is N at time t.
The radioactive element has a half-life $t_{\frac{1}{2}}$

The rate of decay is proportional to

[1 mark]

A N ⬭

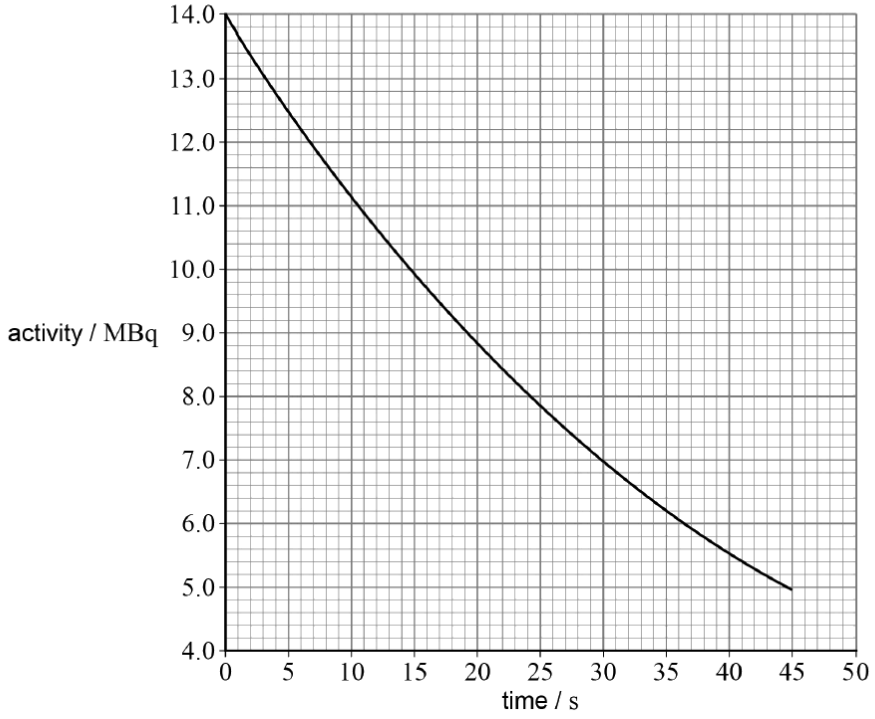
B t ⬭

C $\frac{1}{t}$ ⬭

D $t_{\frac{1}{2}}$ ⬭

AQA June 2023 · A-level Paper 2 · Q32

5 The graph shows the variation of activity with time for a sample of a nuclide **X**.



What was the initial number of nuclei of **X** in the sample?

[1 mark]

A 4.67×10^5 ⬭

B 3.0×10^8 ⬭

C 4.2×10^8 ⬭

D 6.1×10^8 ⬭

AQA November 2021 · A-level Paper 2 · Q28

6 **X** and **Y** are two radioactive nuclides. **X** has a half-life of 3.0 minutes and **Y** has a half-life of 9.0 minutes.

Two freshly prepared samples of **X** and **Y** start decaying at the same time.
After 18 minutes the number of radioactive nuclei in both samples is the same.
The sample of **Y** initially contained N radioactive nuclei.

What was the initial number of radioactive nuclei in the sample of **X**?

[1 mark]

A $4N$ ⬭

B $16N$ ⬭

C $32N$ ⬭

D $64N$ ⬭

Hard Several steps, often with a trap built in. Fewer than 3 in 10 students get these right. **Question 7**

AQA June 2024 · A-level Paper 2 · Q32

7 A rock sample is found to contain the stable isotope lead-207. When it was formed, the rock contained uranium-235 but did not contain any lead-207.

Uranium-235 decays by a series of steps into lead-207. The half-life of uranium-235 is 0.71 billion years. The half-lives of the nuclides in the intermediate steps are negligible.

The sample of rock now contains one atom of lead-207 for every four atoms of uranium-235.

How long ago was the rock formed?

[1 mark]

A 0.23 billion years ⬭

B 0.31 billion years ⬭

C 1.4 billion years ⬭

D 2.0 billion years ⬭

End of questions. Check your answers with the matching mark scheme. More free packs and 1-to-1 tuition: **www.getbetteratphysics.co.uk**