

GCSE Physics

Worksheet: Different half-lives of radioactive isotopes

TIME 25 min	TOTAL 25 marks	CALCULATOR Allowed	DIFFICULTY Easy, Medium
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Topics: Different half-lives of radioactive isotopes

NAME	CLASS	DATE
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- Use black ink or black ball-point pen. Pencil should only be used for drawing.
- Answer all questions in the spaces provided.
- In all calculations, show clearly how you work out your answer.
- The marks for questions are shown in brackets.

01

Isotope P has a half-life of 2 hours. Isotope Q has a half-life of 20 years.

01.1

Which isotope’s activity falls to a very low level more quickly?

[1 mark]

01.2

Which isotope would need to be stored safely for longer?

[1 mark]

0 2

Table 1 shows the half-lives of four radioactive isotopes.

Table 1

Isotope	Half-life
iodine-131	8 days
caesium-137	30 years
plutonium-239	24 000 years
radon-222	3.8 days

0 2 . 1

Complete the sentence.
Radioactive isotopes have a very wide range of values.

.....

[1 mark]

0 2 . 2

Which isotope in Table 1 has the longest half-life?
Tick (✓) **one** box.

iodine-131

☐

caesium-137

☐

plutonium-239

☐

radon-222

☐

[1 mark]

0 2 . 3

The activity of which isotope in Table 1 would fall to a very low level most quickly?

.....

.....

.....

.....

[1 mark]

0 2 . 4

Suggest why waste containing plutonium-239 must be stored safely for thousands of years.

.....

.....

[1 mark]

0 3

A hospital collects waste containing technetium-99m, which has a half-life of 6 hours. The waste is stored for 60 hours before it is disposed of.

0 3 . 1

Calculate the fraction of the technetium-99m that remains after 60 hours.

.....

.....

.....

.....

Fraction =

[2 marks]

0 3 . 2

Explain why storing the waste for 60 hours makes it safe to dispose of.

.....

.....

[1 mark]

0 3 . 3

Suggest why this method would not be suitable for waste containing caesium-137, which has a half-life of 30 years.

.....

.....

.....

.....

[2 marks]

0 4

0 4 . 1

Explain why a medical tracer used for a short diagnostic scan should have a short half-life, while a source used in an industrial thickness gauge that operates continuously for years should have a long half-life.

.....

.....

.....

.....

[2 marks]

0 5

Two samples, A and B, contain the same number of radioactive nuclei.

The isotope in sample A has a half-life of 2 hours.

The isotope in sample B has a half-life of 5000 years.

0 5 . 1

Which sample has the higher activity at the start? Give a reason for your answer.

.....

.....

.....

.....

[2 marks]

0 5 . 2

Explain why sample A is less hazardous than sample B one week later.

.....

.....

.....

.....

[2 marks]

0 5 . 3

Explain why the hazard from a radioactive material depends on the half-life of the isotope it contains.

.....

.....

.....

.....

[2 marks]

0 6

Table 2 shows the half-lives of four radioactive isotopes used in medicine. A hospital needs a tracer for a scan that will be carried out a few hours after the tracer is made. After the scan, the activity of the tracer in the patient’s body should fall quickly.

Table 2

Isotope	Half-life
Krypton-81m	13 seconds
Technetium-99m	6 hours
Iodine-131	8 days
Cobalt-60	5.3 years

0 6 . 1

Use Table 2 to identify the most suitable isotope for this scan. Explain your choice.

.....

.....

.....

.....

.....

.....

[3 marks]

0 7

A sample of fluorine-18, used in medical PET scans, has a half-life of 110 minutes and an initial activity of 480 MBq.

0 7 . 1

Calculate the activity remaining after 5.5 hours.

.....

.....

.....

.....

.....

Activity = MBq

[3 marks]

END OF QUESTIONS

Original practice questions written to match the specification. Not produced by, affiliated with or endorsed by AQA.

Mark scheme

GCSE Physics · Worksheet: Different half-lives of radioactive isotopes · 25 marks

Question 1 (2 marks)

01.1 [1 mark]

Answer: P

- P (1)
-

01.2 [1 mark]

Answer: Q

- Q (it stays radioactive for much longer) (1)
-

Question 2 (4 marks)

02.1 [1 mark]

Answer: half-life

- half-life (1)
-

02.2 [1 mark]

Correct: plutonium-239

02.3 [1 mark]

Answer: Radon-222

- radon-222 (1)
-

02.4 [1 mark]

Answer: Its half-life is 24 000 years, so it remains radioactive for a very long time.

- it has a very long half-life, so it stays radioactive (hazardous) for thousands of years (1)
-

Question 3 (5 marks)

03.1 [2 marks]

Answer: $1/1024$ (about 0.001)

- $60 \div 6 = 10$ half-lives (1)
 - $(\frac{1}{2})^{10} = 1/1024$ (≈ 0.001) (1)
-

03.2 [1 mark]

Answer: The activity has fallen to about a thousandth of its original value.

- its activity has fallen to about 0.1% of the original / to a very low (negligible) level (1)
-

03.3 [2 marks]

Answer: Ten half-lives of caesium-137 is 300 years, so it would stay hazardous for centuries.

- storing it for 10 half-lives would take 300 years (1)
 - so the waste stays hazardous for centuries and must be stored securely / shielded for a very long time (1)
-

Question 4 (2 marks)

04.1 [2 marks]

Answer: The tracer's short half-life lets the patient's dose fall away quickly; the gauge's long half-life keeps its activity steady over years of use.

- a short half-life for the tracer means its activity (and the patient's radiation dose) falls away quickly once the scan is finished (1)
 - a long half-life for the gauge source means its activity stays roughly constant throughout years of continuous use, so it does not need to be replaced or recalibrated frequently (1)
-

Question 5 (6 marks)

05.1 [2 marks]

Answer: A: its nuclei decay much more quickly, so there are more decays per second.

- A (1)
- with a shorter half-life, a larger proportion of its nuclei decay each second (1)

Notes: The reason mark depends on choosing A.

05.2 [2 marks]

Answer: After 84 half-lives A has almost completely decayed, but B's activity is practically unchanged.

- one week is 84 half-lives of A, so almost all of A has decayed / its activity is negligible (1)
 - the activity of B has hardly changed (because its half-life is so long), so it is still hazardous (1)
-

05.3 [2 marks]

Answer: Short half-life: intense but short-lived hazard. Long half-life: weaker but very long-lasting hazard.

- a short half-life gives a high activity, but only for a short time (1)
 - a long half-life means the material stays radioactive (hazardous) for a very long time, although its activity is lower (1)
-

Question 6 (3 marks)

06.1 [3 marks]

Answer: Technetium-99m: long enough to survive the few hours before the scan (unlike krypton-81m), but short enough for the activity to fall quickly afterwards (unlike iodine-131 or cobalt-60).

- technetium-99m (1)
 - its half-life is long enough for plenty of it to remain when the scan is done a few hours after it is made (krypton-81m would have decayed to almost nothing within minutes) (1)
 - but short enough for the activity in the patient to fall quickly after the scan (iodine-131 and cobalt-60 would stay active for far too long) (1)
-

Question 7 (3 marks)

07.1 [3 marks]

Answer: 60 MBq

- 5.5 hours = 330 minutes = $330 \div 110 = 3$ half-lives (1)
 - $480 \div 2^3$ (1)
 - 60 (MBq) (1)
-