AQA GCSE Combined Science - Trilogy | 8464

SPECIFICATION POINT 6.4.2.2

Nuclear equations

Past-paper questions

Tier	**Higher**
Question groups	**4**
Available paper years	**2019–2025**

Using this booklet

1. Answer the questions in order and show your working.
2. Original question numbers and marks are retained.
3. Print at actual size (100%) for measuring questions.
4. Use the companion answer booklet to check your work.

Name: _____ **Date:** _____

Whole questions are retained for context, so some parts assess other specification points. Current and legacy sources are labelled. Continue on extra paper if needed.

6.4.2.2 Nuclear equations

Question 01

June 2019 | 8464/P/1H | Original Q6

0 6 Lanthanum-140 is a radioactive isotope.

0 6 . 1 A nucleus of lanthanum-140 emits gamma radiation.

What happens to the mass number and the charge of the nucleus when gamma radiation is emitted?

[1 mark]

Tick (✓) **one** box.

Mass number	Charge	
Decreases	Decreases	☐
Decreases	Stays the same	☐
Stays the same	Decreases	☐
Stays the same	Stays the same	☐

0 6 . 2 Why is it difficult to detect gamma radiation?

[1 mark]

Question 6 continues on the next page

6.4.2.2 Nuclear equations

Question 01 · continued

0 6 . 3 Activity is the rate at which a radioactive source decays.

A teacher measured the count-rate from a sample of lanthanum-140 using a Geiger-Muller (G-M) tube.

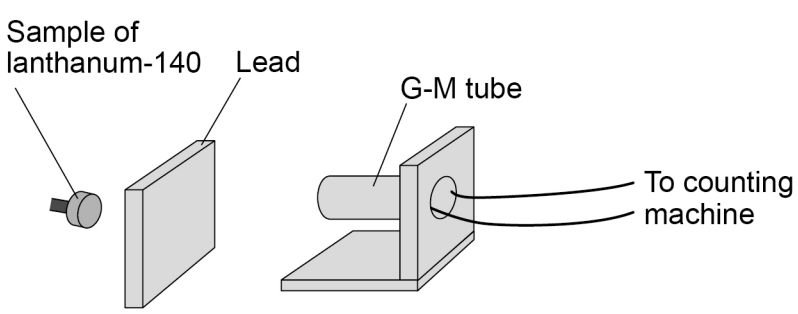
Explain why the count rate was less than the activity of the sample of lanthanum-140

[2 marks]

The teacher investigated how the thickness of lead affected the amount of gamma radiation that could pass through it.

Figure 6 shows the apparatus.

Figure 6



0 6 . 4 Explain why the teacher stood as far away from the apparatus as possible.

[2 marks]

6.4.2.2 Nuclear equations

Question 01 · continued

Table 1 shows the results.

Table 1

Thickness of lead in cm	Count rate in counts per second
0.5	110
1.0	60
1.5	33
2.0	18
2.5	10

0 6 . 5 The teacher concluded that the count rate was **not** inversely proportional to the thickness of lead.

Explain why the teacher was correct.

Use the data in **Table 1**.

[3 marks]

0 6 . 6 Lanthanum-140 can also emit beta radiation and change into cerium.

Complete the equation showing the decay of lanthanum (La) 140 into cerium (Ce).

[2 marks]

$$^{140}_{57}La \longrightarrow {}^{\quad}_{\quad}e + {}^{\quad}_{\quad}Ce$$

6.4.2.2 Nuclear equations

Question 01 · continued

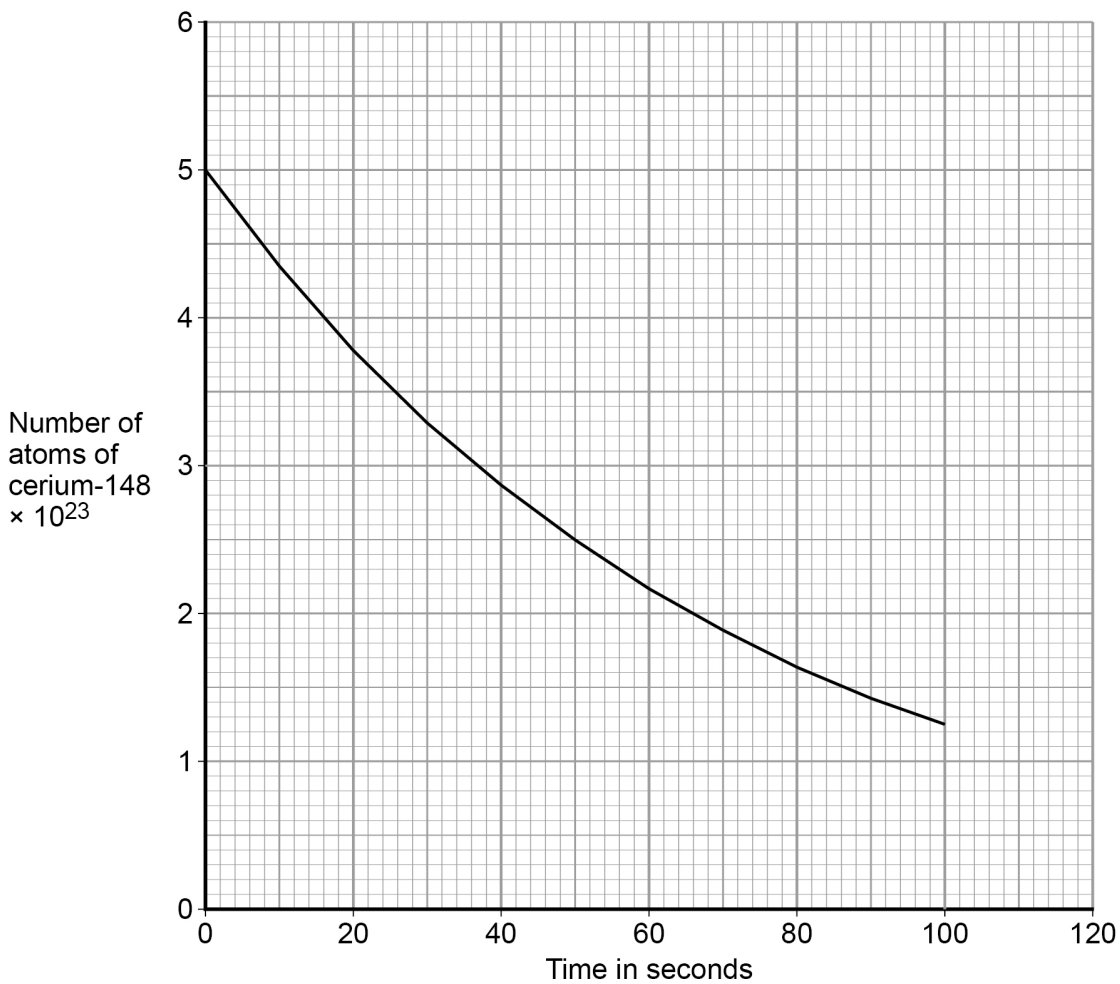
There are other isotopes of cerium which are radioactive.

Different isotopes of cerium have different half-lives.

The half-life of an isotope can be found by studying how the number of atoms changes over time.

Figure 7 shows how the number of atoms of cerium-148 in a 120 g sample changes over time.

Figure 7



6.4.2.2 Nuclear equations

Question 01 · continued

0 6 . 7 Determine the ratio of the number of cerium atoms in the sample when it was 100 seconds old compared with when the sample was 350 seconds old.

Use data from **Figure 7**.

[4 marks]

Ratio = _____

0 6 . 8 Determine the activity of the sample of cerium when the sample was 20 seconds old.

Use **Figure 7**.

[3 marks]

Activity = _____ Bq

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6.4.2.2 Nuclear equations

Question 02

November 2020 | 8464/P/1H | Original Q2

0 2 Different radioactive isotopes emit different types of nuclear radiation.

A polonium-210 (Po) nucleus emits an alpha particle (α) and turns into a lead (Pb) nucleus.

This can be represented by the equation:

$$^{210}_{84}Po \longrightarrow {}^{A}_{Z}Pb + \alpha$$

0 2 . 1 What is the value of A in the equation?

[1 mark]

Tick (✓) **one** box.

A = 206 ☐ A = 208 ☐ A = 210 ☐ A = 211 ☐

0 2 . 2 What is the value of Z in the equation?

[1 mark]

Tick (✓) **one** box.

Z = 80 ☐ Z = 82 ☐ Z = 85 ☐ Z = 86 ☐

Question 2 continues on the next page

Question 02 · continued

0 2 . 3 A strontium-89 nucleus (Sr) emits a beta particle (β) and turns into an yttrium nucleus (Y).

This can be represented by the equation:

$$^{89}_{38}\text{Sr} \longrightarrow {}^{A}_{Z}\text{Y} + \beta$$

What are the values of A and Z in the equation?

[2 marks]

A = _____

Z = _____

0 2 . 4 Gamma radiation is another type of nuclear radiation.

What does gamma radiation consist of?

[1 mark]

Tick (✓) **one** box.

- High energy neutrons ☐
- Electromagnetic waves ☐
- Particles with no charge ☐
- Positively charged ions ☐

6.4.2.2 Nuclear equations

Question 02 · continued

0 2 . 5 Explain the differences between the properties of alpha, beta and gamma radiations.

[6 marks]

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6.4.2.2 Nuclear equations

Question 03

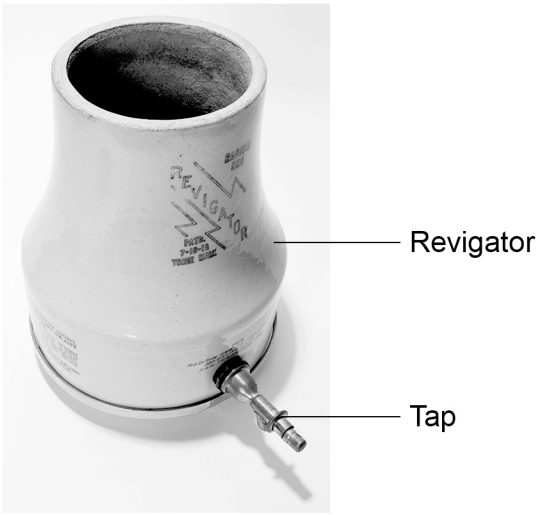
0 5 Some people used to think that radioactive substances had health benefits.

In the 1920s, a water container called a revigator was sold.

The walls of a revigator contain radioactive isotopes.

Figure 6 shows a revigator.

Figure 6



The revigator was filled with water and left overnight.

People then drank the water from the revigator.

6.4.2.2 Nuclear equations

Question 03 · continued

0 5 . 1 The water was irradiated and contaminated by the radioactive isotopes in the walls of the revigator.

Explain how irradiating and contaminating the water affected the hazard caused by drinking the water.

[4 marks]

Irradiating _____

_____

_____

_____

Contaminating _____

_____

_____

_____

Question 5 continues on the next page

6.4.2.2 Nuclear equations

Question 03 · continued

A scientist tested some water that had been left in a revigator.

The water contained radon-222 and vanadium-52.

0 5 . 2 Vanadium-52 (V) decays by emitting beta particles.

What is the correct nuclear equation for this process?

[1 mark]

Tick (✓) **one** box.

$^{52}_{23}V - {}^{0}_{-1}\beta \rightarrow {}^{52}_{22}Ti$ ☐

$^{52}_{23}V - {}^{0}_{-1}\beta \rightarrow {}^{52}_{24}Cr$ ☐

$^{52}_{23}V \rightarrow {}^{52}_{22}Ti + {}^{0}_{-1}\beta$ ☐

$^{52}_{23}V \rightarrow {}^{52}_{24}Cr + {}^{0}_{-1}\beta$ ☐

6.4.2.2 Nuclear equations

Question 03 · continued

0 5 . 3 **Table 2** shows the half-lives of radon-222 and vanadium-52.

Table 2

Isotope	Half-life
Radon-222	3.8 days
Vanadium-52	3.7 minutes

The scientist measured the radiation emitted by a sample of radon-222 and the radiation emitted by a sample of vanadium-52.

The scientist repeated the measurements 7.4 minutes later.

Explain how the activity of the radon-222 and vanadium-52 had changed after 7.4 minutes.

[4 marks]

Radon-222 _____

_____

_____

_____

Vanadium-52 _____

_____

_____

_____

0 5 . 4 Scientists monitored the effects of drinking the water from a revigator.

Their methods and results were checked by other scientists.

What name is given to the process of other scientists checking work before it is published?

[1 mark]

_____

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6.4.2.2 Nuclear equations

Question 04

June 2025 | 8464/P/1H | Original Q4

0 4 Three types of radiation emitted by unstable nuclei are:

- alpha particle
- beta particle
- gamma ray.

0 4 . 1 Describe each type of radiation.

[3 marks]

Alpha particle _____

_____

Beta particle _____

_____

Gamma ray _____

_____

0 4 . 2 The radioactive isotope gold-198 (Au) decays to mercury (Hg) by emitting beta radiation.

Complete the nuclear equation for the decay of gold-198.

[2 marks]

$$^{198}_{79}\text{Au} \rightarrow \,^{\_\_}_{\_\_}\text{Hg} + \,^{\_\_}_{\_\_}\beta$$

Question 4 continues on the next page

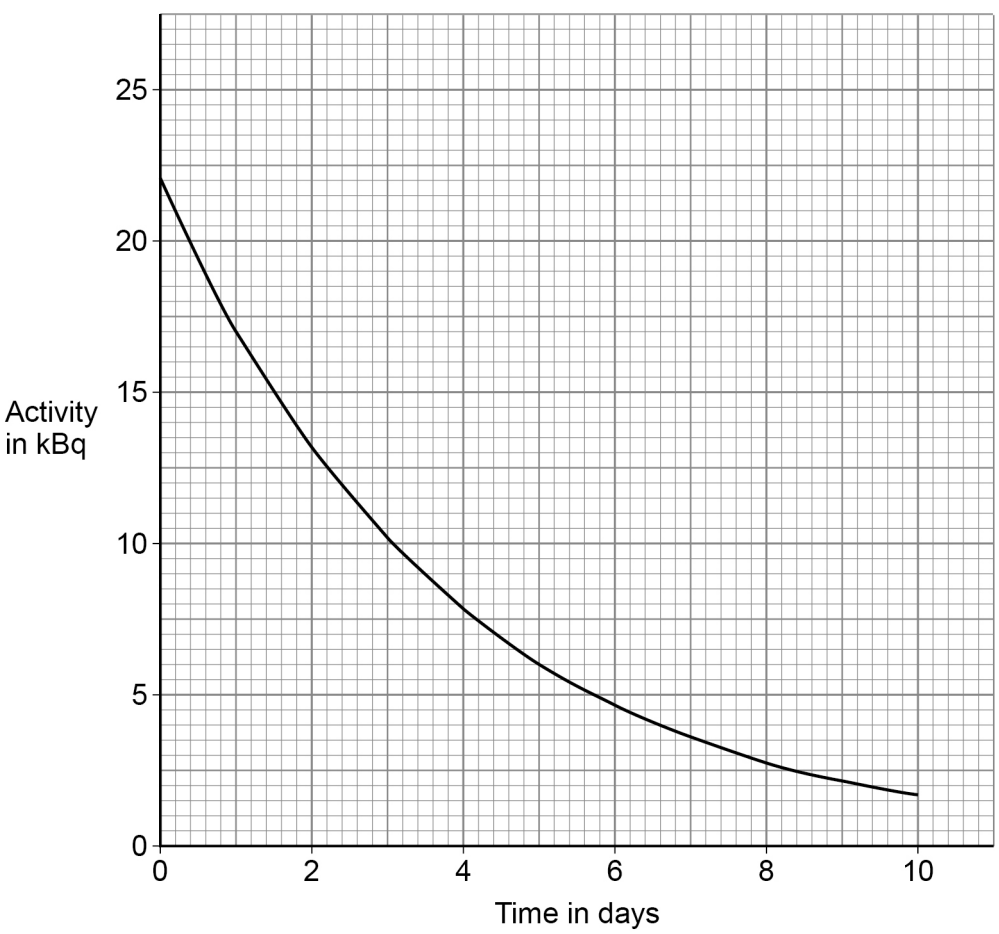
Question 04 · continued

Gold-198 is used in the treatment of cancer.

A small sample containing gold-198 is surgically implanted into a patient, very near to the cancer cells.

Figure 4 shows how the activity of the sample changes after it has been implanted.

Figure 4



0 4 . 3 Determine the half-life of gold-198.

[2 marks]

Half-life = _____ days

6.4.2.2 Nuclear equations

Question 04 · continued

0 4 . 4 Determine the percentage decrease in the activity at 5 days.

Give your answer to 2 significant figures.

[4 marks]

Percentage decrease (2 significant figures) = _____ %

0 4 . 5 The sample containing gold-198 is implanted very near to the cancer cells.

Give **two** reasons why.

[2 marks]

1 _____

2 _____

0 4 . 6 After treatment, the sample containing gold-198 is **not** removed from the patient.

Suggest why the sample is left in the patient and **not** removed.

[1 mark]

_____

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