AQA GCSE Physics | 8463

SPECIFICATION POINT 4.4.3.2

# Different half-lives of radioactive isotopes

## Past-paper questions

| | |
|---|---|
| Tier | **Foundation** |
| Question groups | **34** |
| Available paper years | **2003–2025** |

## 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:** _____

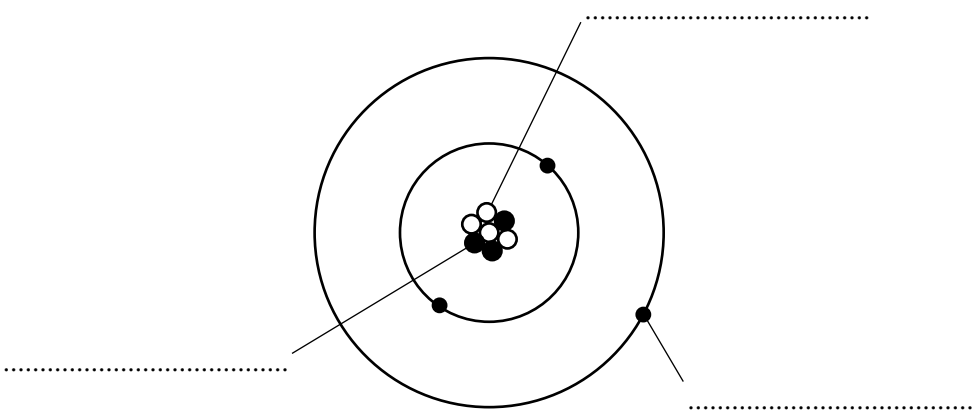
Whole questions are retained for context, so some parts assess other specification points. Current and legacy sources are labelled. Continue on extra paper if needed.

### 4.4.3.2 Different half-lives of radioactive isotopes

**Question 01**

June 2003 | 3451F | Original Q6 | Legacy

**6** (a) The diagram represents an atom of lithium.




(i) Complete the diagram by writing in the spaces the name of each type of particle. Use only words given in the box. Each word may be used once or not at all.

| | | | |
|---|---|---|---|
| **electron** | **neutron** | **nucleus** | **proton** |

*(3 marks)*

(ii) Which type of particle found inside the atom is uncharged?

.....

*(1 mark)*

(iii) What is the mass number of this atom, 3, 4, 7 or 10?

.....

Give a reason for your choice.

.....

.....

*(2 marks)*

**4.4.3.2 Different half-lives of radioactive isotopes**

**Question 01 · continued**





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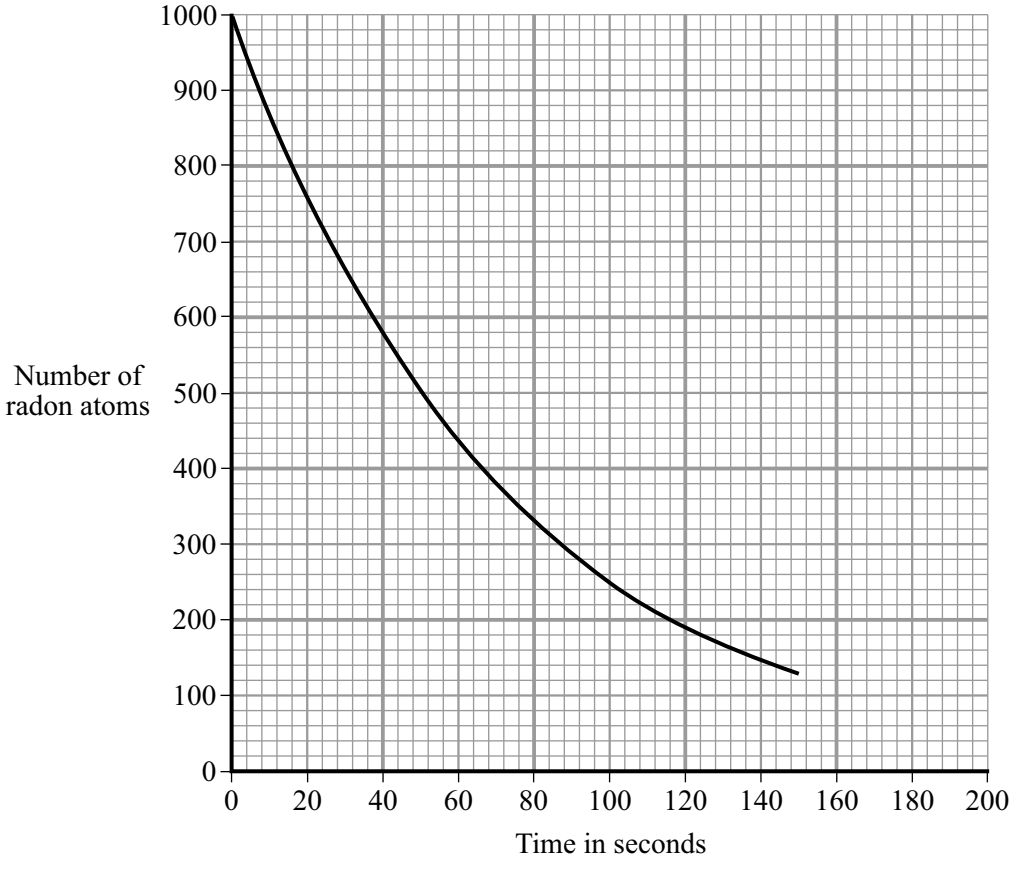
(b) Radon is a radioactive element. The graph shows how the number of radon atoms in a sample of air changes with time.




(i) How long did it take the number of radon atoms in the sample of air to fall from 1000 to 500?

Time = .....seconds
*(1 mark)*

(ii) How long is the half-life of radon?

Half-life = .....seconds
*(1 mark)*

(iii) Complete this sentence by crossing out the **two** lines in the box that are wrong.

As a radioactive material gets older, it emits

| |
|---|
| less |
| a constant level of |
| more |

radiation per second.

*(1 mark)*

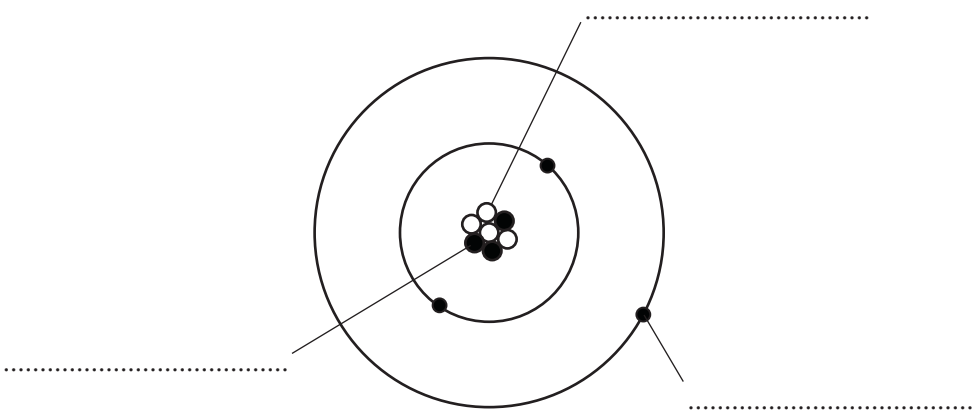
9

**4.4.3.2 Different half-lives of radioactive isotopes**

**Question 02**

June 2003 | 3462F3 | Original Q6 | Legacy

**6** (a) The diagram represents an atom of lithium.




(i) Complete the diagram by writing in the spaces the name of each type of particle. Use only words given in the box. Each word may be used once or not at all.

| | | | |
|---|---|---|---|
| **electron** | **neutron** | **nucleus** | **proton** |

*(3 marks)*

(ii) Which type of particle found inside the atom is uncharged?

.....

*(1 mark)*

(iii) What is the mass number of this atom, 3, 4, 7 or 10?

.....

Give a reason for your choice.

.....

.....

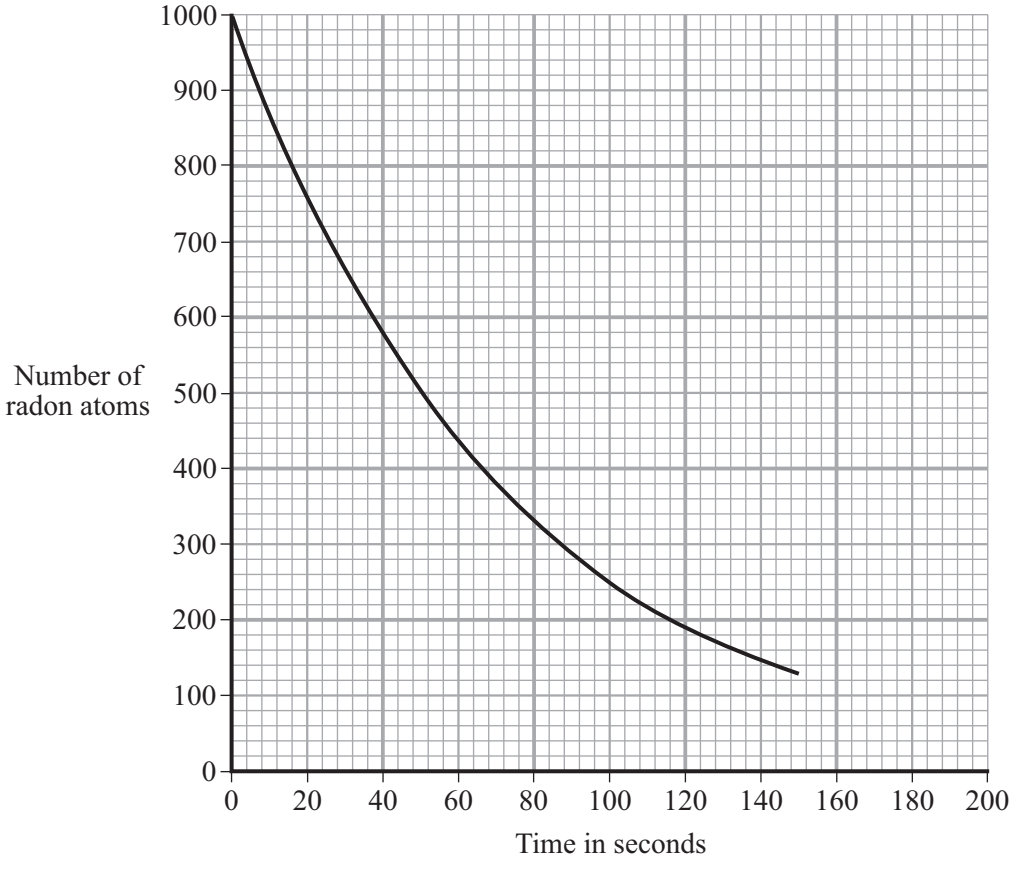
*(2 marks)*

**4.4.3.2 Different half-lives of radioactive isotopes**

**Question 02 · continued**



(b) Radon is a radioactive element. The graph shows how the number of radon atoms in a sample of air changes with time.




(i) How long did it take the number of radon atoms in the sample of air to fall from 1000 to 500?

Time = .....seconds

*(1 mark)*

(ii) How long is the half-life of radon?

Half-life = .....seconds

*(1 mark)*

(iii) Complete this sentence by crossing out the **two** lines in the box that are wrong.

As a radioactive material gets older, it emits

| |
|---|
| less |
| a constant level of |
| more |

radiation per second.

*(1 mark)*

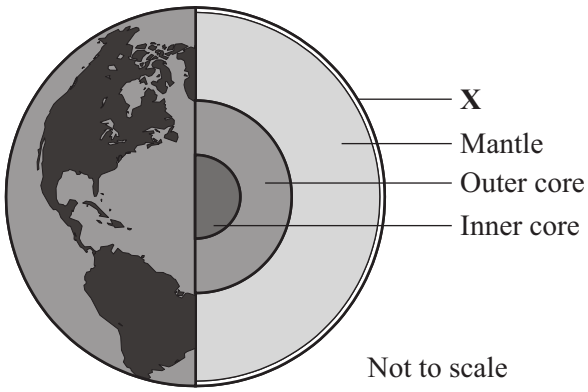
9

### 4.4.3.2 Different half-lives of radioactive isotopes

**Question 03**

June 2004 | 3451F | Original Q5 | Legacy

**5** (a) The diagram gives information about some of the layers that make up the Earth.




(i) What name is given to the outer layer of the Earth labelled **X**?

.....

*(1 mark)*

(ii) What is the difference between the inner core and the outer core?

.....

.....

*(2 marks)*

(b) Which of the following is used to detect the waves produced by an earthquake?

Draw a ring around your answer.

**barograph** **seismograph** **tachograph**

*(1 mark)*

**4.4.3.2 Different half-lives of radioactive isotopes**

**Question 03 · continued**





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(c) Most earthquakes happen where tectonic plates meet. Tectonic plates are large pieces of the Earth's outer layer that move very slowly. Sometimes the plates slide against each other. Earthquakes happen when the force built up in the rock below the Earth's surface is large enough to make the plates move suddenly.

Suggest why it is difficult to accurately predict when an earthquake will happen.

.....

.....

.....

.....

*(2 marks)*

(d) In some parts of the world heat from the rock in the Earth's outer layer produces high pressure steam. The steam is used to generate electricity.

Which **one** of the following words is used to describe this type of energy resource?

Draw a ring around your answer.

**geometric** **geostationary** **geothermal**

*(1 mark)*

(e) A rock sample contains 10 000 atoms of a radioactive uranium isotope. The half-life of this isotope is 4500 million years.

(i) How many atoms of the uranium isotope will be in the rock sample after 4500 million years?

.....

*(1 mark)*

(ii) How many atoms of the uranium isotope will be in the rock sample after 9000 million years?

.....

*(1 mark)*

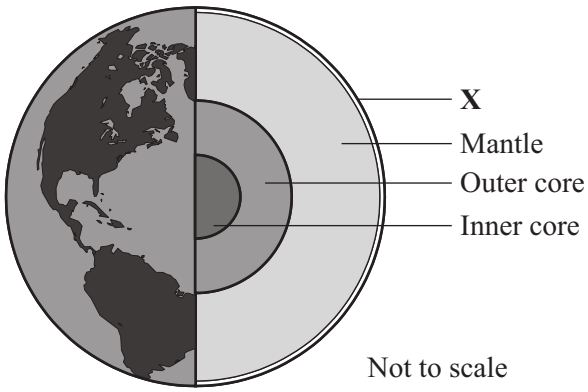
9

### 4.4.3.2 Different half-lives of radioactive isotopes

**Question 04**

June 2004 | 3462F3 | Original Q5 | Legacy

**5** (a) The diagram gives information about some of the layers that make up the Earth.




(i) What name is given to the outer layer of the Earth labelled **X**?

.....

*(1 mark)*

(ii) What is the difference between the inner core and the outer core?

.....

.....

*(2 marks)*

(b) Which of the following is used to detect the waves produced by an earthquake?

Draw a ring around your answer.

**barograph** **seismograph** **tachograph**

*(1 mark)*

**4.4.3.2 Different half-lives of radioactive isotopes**

**Question 04 · continued**





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(c) Most earthquakes happen where tectonic plates meet. Tectonic plates are large pieces of the Earth's outer layer that move very slowly. Sometimes the plates slide against each other. Earthquakes happen when the force built up in the rock below the Earth's surface is large enough to make the plates move suddenly.

Suggest why it is difficult to accurately predict when an earthquake will happen.

.....

.....

.....

.....

*(2 marks)*

(d) In some parts of the world heat from the rock in the Earth's outer layer produces high pressure steam. The steam is used to generate electricity.

Which **one** of the following words is used to describe this type of energy resource?

Draw a ring around your answer.

**geometric** **geostationary** **geothermal**

*(1 mark)*

(e) A rock sample contains 10 000 atoms of a radioactive uranium isotope. The half-life of this isotope is 4500 million years.

(i) How many atoms of the uranium isotope will be in the rock sample after 4500 million years?

.....

*(1 mark)*

(ii) How many atoms of the uranium isotope will be in the rock sample after 9000 million years?

.....

*(1 mark)*

9

### 4.4.3.2 Different half-lives of radioactive isotopes

**Question 05**

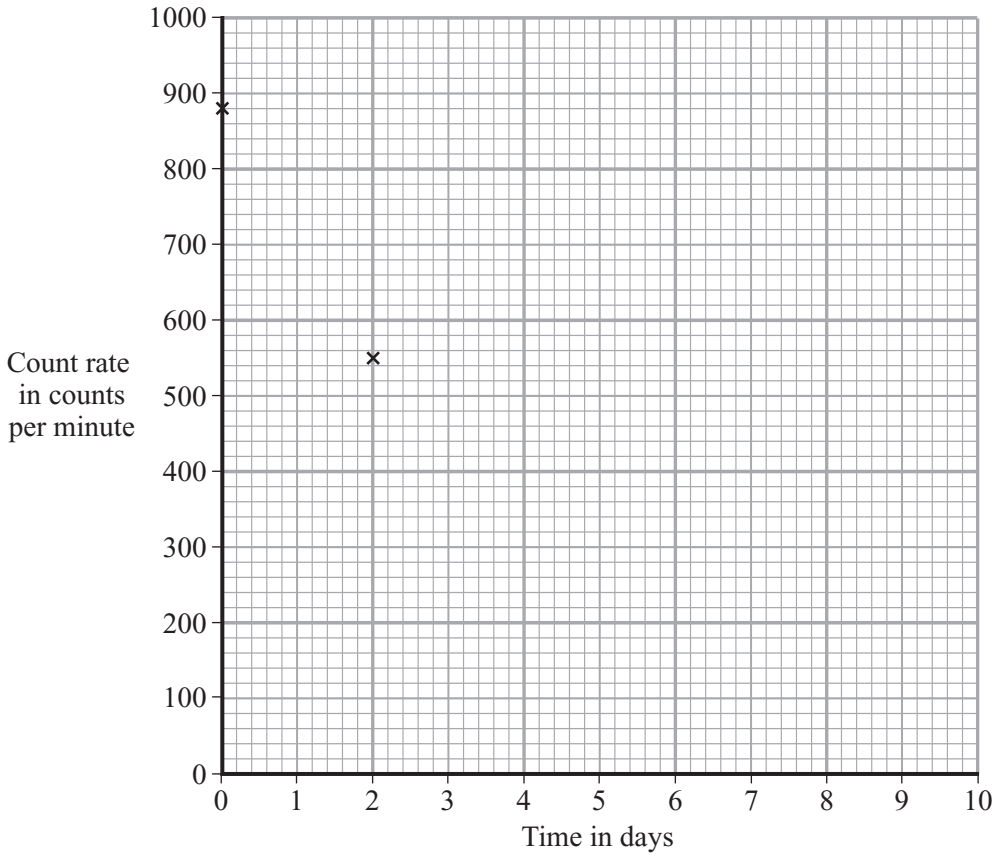
June 2005 | 3451 | Original Q7 | Legacy

**7** The table shows how the count rate from a radioactive substance changes in 10 days.

| Time in days | 0 | 2 | 4 | 6 | 8 | 10 |
|---|---|---|---|---|---|---|
| Count rate in counts per minute | 880 | 555 | 350 | 220 | 140 | 90 |

(a) Draw a graph of count rate against time.

The first two points have been plotted for you.




*(3 marks)*

(b) (i) Use your graph to find out how long it takes for the count rate to fall from 880 counts per minute to 440 counts per minute.

Time = ..... days
*(1 mark)*

(ii) What is the half-life of this substance?

Half-life = ..... days
*(1 mark)*

**4.4.3.2 Different half-lives of radioactive isotopes**

**Question 05 · continued**





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(c) The table gives the half-life and type of radiation given out by four different radioactive isotopes.

| Radioactive isotope | Half-life in days | Radiation given out |
|---|---|---|
| bismuth-210 | 5.0 | beta |
| polonium-210 | 138.0 | alpha and gamma |
| radon-222 | 3.8 | alpha |
| thorium-234 | 24.1 | beta and gamma |

Some samples of each isotope have the same count rate today. Which sample will have the lowest count rate one month from today?

.....

Give a reason for your answer.

.....

*(2 marks)*

7

**TURN OVER FOR THE NEXT QUESTION**

### 4.4.3.2 Different half-lives of radioactive isotopes

**Question 06**

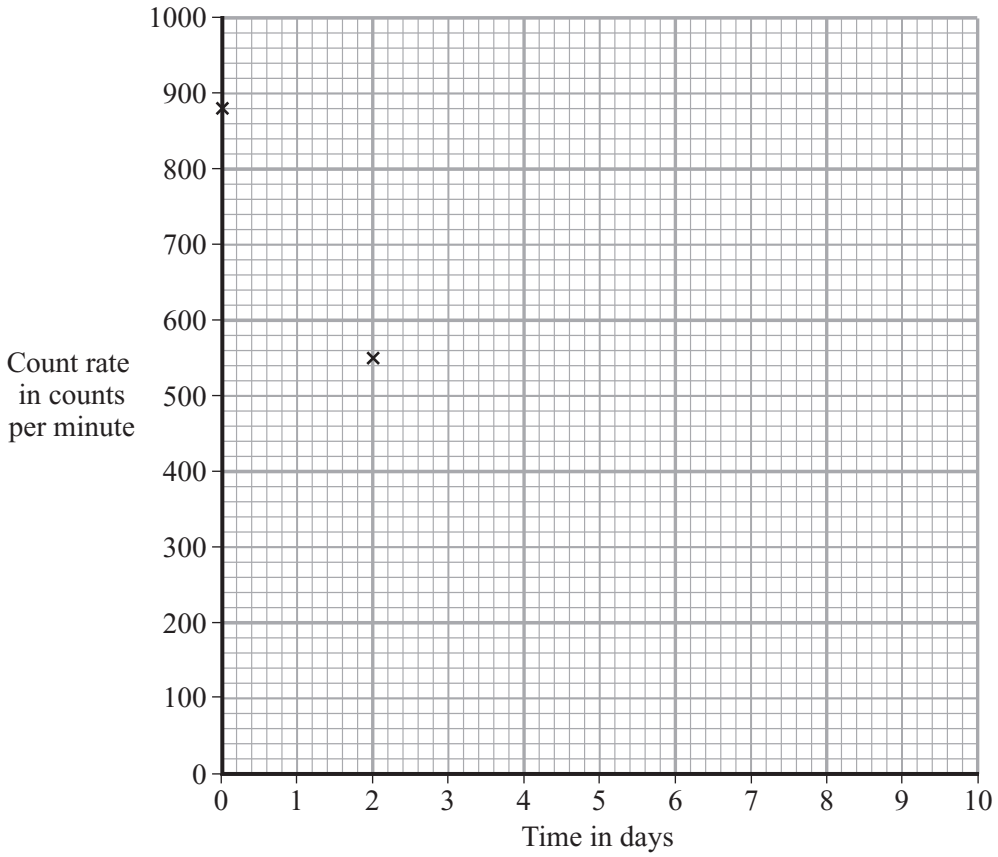
June 2005 | 3462 | Original Q7 | Legacy

**7** The table shows how the count rate from a radioactive substance changes in 10 days.

| Time in days | 0 | 2 | 4 | 6 | 8 | 10 |
|---|---|---|---|---|---|---|
| Count rate in counts per minute | 880 | 555 | 350 | 220 | 140 | 90 |

(a) Draw a graph of count rate against time.

The first two points have been plotted for you.




*(3 marks)*

(b) (i) Use your graph to find out how long it takes for the count rate to fall from 880 counts per minute to 440 counts per minute.

Time = ..... days
*(1 mark)*

(ii) What is the half-life of this substance?

Half-life = ..... days
*(1 mark)*

**4.4.3.2 Different half-lives of radioactive isotopes**

**Question 06 · continued**





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(c) The table gives the half-life and type of radiation given out by four different radioactive isotopes.

| Radioactive isotope | Half-life in days | Radiation given out |
|---|---|---|
| bismuth-210 | 5.0 | beta |
| polonium-210 | 138.0 | alpha and gamma |
| radon-222 | 3.8 | alpha |
| thorium-234 | 24.1 | beta and gamma |

Some samples of each isotope have the same count rate today. Which sample will have the lowest count rate one month from today?

.....

Give a reason for your answer.

.....

*(2 marks)*

7

**TURN OVER FOR THE NEXT QUESTION**

**4.4.3.2 Different half-lives of radioactive isotopes**

**Question 07**



**2** (a) The names of three types of radiation are given in **List A**. Various properties of these three types of radiation are given in **List B**.

Draw a line to link each type of radiation in **List A** to its correct property in **List B**. Draw only **three** lines.

| **List A**<br>**Type of radiation** | **List B**<br>**Property of radiation** |
|---|---|
| | not dangerous |
| alpha (α) | |
| | stopped by paper |
| beta (β) | |
| | travels at 300 000 000 m/s |
| gamma (γ) | |
| | travels up to 1 metre in air |

*(3 marks)*

(b) This sign warns people that a radioactive source is being used in a laboratory.



Why is it important to warn people that a radioactive source is being used?

.....

.....

*(1 mark)*

**4.4.3.2 Different half-lives of radioactive isotopes**

**Question 07 · continued**



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(c) To study the blood flow in a patient's lungs, a doctor injects some technetium-99 compound into the patient. The gamma radiation given out by the technetium-99 atoms is detected using a gamma camera outside the patient's body.

Which statement gives the reason why gamma radiation is used? Put a tick (✓) in the box next to your choice.

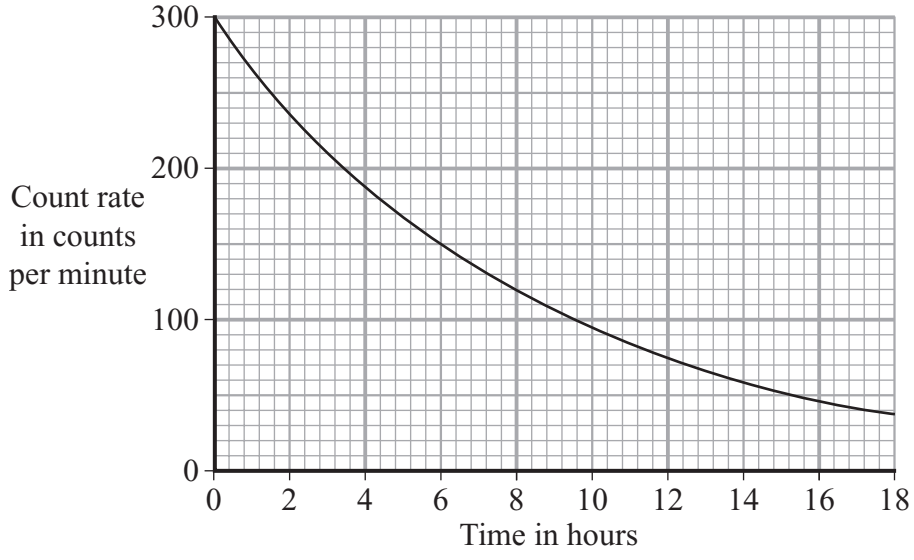
It can travel through a vacuum. ☐

It is not affected by a magnet. ☐

It can pass through the human body. ☐

*(1 mark)*

(d) The graph shows how the count rate from a sample of technetium-99 changes with time.




(i) How many hours does it take for the count rate to fall from 300 counts per minute to 150 counts per minute?

Time = ..... hours
*(1 mark)*

(ii) What is the half-life of technetium-99?

Half-life = ..... hours
*(1 mark)*

7

4.4.3.2 Different half-lives of radioactive isotopes

Question 08

June 2007 | PHY1B | Original Q9 | Legacy

## QUESTION NINE

There was an accident at the Chernobyl nuclear power station in April 1986. This resulted in the release of radioactive materials into the environment. Some of these materials may cause cancer of the thyroid gland in children.

The table shows the number of cases of thyroid cancer in children in two regions near the Chernobyl power station. It also shows the number of cases per 100 000 children in those regions.

| | | Childhood thyroid cancer cases per year, 1986–1998 | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Region \ Year | | 86 | 87 | 88 | 89 | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 |
| Belarus | Number of cases | 3 | 4 | 6 | 5 | 31 | 62 | 62 | 87 | 77 | 82 | 67 | 73 | 48 |
| | Number of cases per 100 000 children | 0.2 | 0.3 | 0.4 | 0.3 | 1.9 | 3.9 | 3.9 | 5.5 | 5.1 | 5.6 | 4.8 | 5.6 | 3.9 |
| Ukraine | Number of cases | 8 | 7 | 8 | 11 | 26 | 22 | 49 | 44 | 44 | 47 | 56 | 36 | 44 |
| | Number of cases per 100 000 children | 0.2 | 0.1 | 0.1 | 0.1 | 0.2 | 0.2 | 0.5 | 0.4 | 0.4 | 0.5 | 0.6 | 0.4 | 0.5 |

**9A** By how many did the number of cases of childhood thyroid cancer per year increase in the Belarus region between the year of the Chernobyl accident and 1995?

**1** 2

**2** 3

**3** 79

**4** 82

**9B** A city in Ukraine has 200 000 children.

How many cases of childhood thyroid cancer would be expected in the city in 1992?

**1** 1

**2** 2

**3** 5

**4** 49

4.4.3.2 Different half-lives of radioactive isotopes

Question 08 · continued



One of the radioactive materials responsible for producing childhood thyroid cancer is iodine-131. Children may take in iodine-131 in contaminated food. The iodine-131 is accumulated by the thyroid gland.

**9C** The half-life of iodine-131 is 8 days. 100 atoms of iodine-131 are taken into the thyroid gland.

How many of these radioactive iodine-131 atoms will there be after 16 days?

**1** 25

**2** 50

**3** 75

**4** 100

**9D** Which type of radiation is most likely to cause damage by ionisation once inside the body?

**1** alpha radiation

**2** beta radiation

**3** gamma radiation

**4** ultraviolet radiation

**END OF TEST**

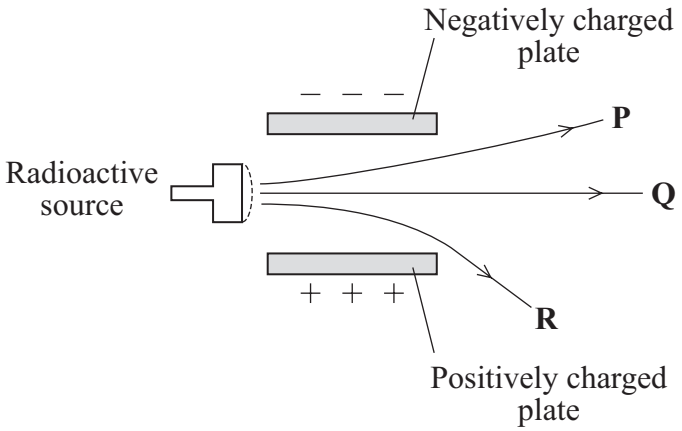
**4.4.3.2 Different half-lives of radioactive isotopes**

**Question 09**

January 2008 | PHY1F | Original Q3 | Legacy

**3** A radioactive source emits alpha (α), beta (β) and gamma (γ) radiation. The diagram shows what happens to the radiation as it passes between two charged metal plates.

**Diagram 1**




(a) Which line **P**, **Q** or **R** shows the path taken by:

(i) alpha radiation .....

*(1 mark)*

(ii) gamma radiation? .....

*(1 mark)*

**4.4.3.2 Different half-lives of radioactive isotopes**

**Question 09 · continued**



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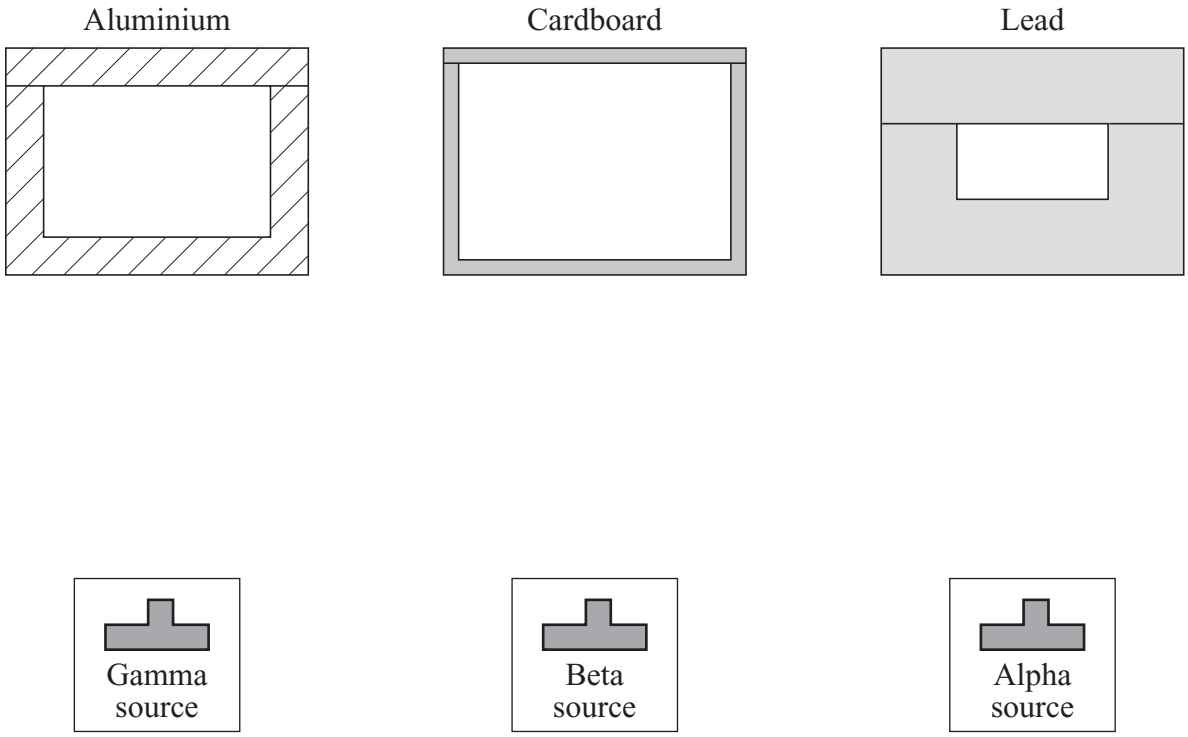
(b) The diagram shows three different boxes and three radioactive sources. Each source emits only one type of radiation and is stored in a different box. The box reduces the amount of radiation getting into the air.




Draw **three** lines to show which source should be stored in which box so that the minimum amount of radiation gets into the air.

*(2 marks)*

**Question 3 continues on the next page**

**4.4.3.2 Different half-lives of radioactive isotopes**

**Question 09 · continued**



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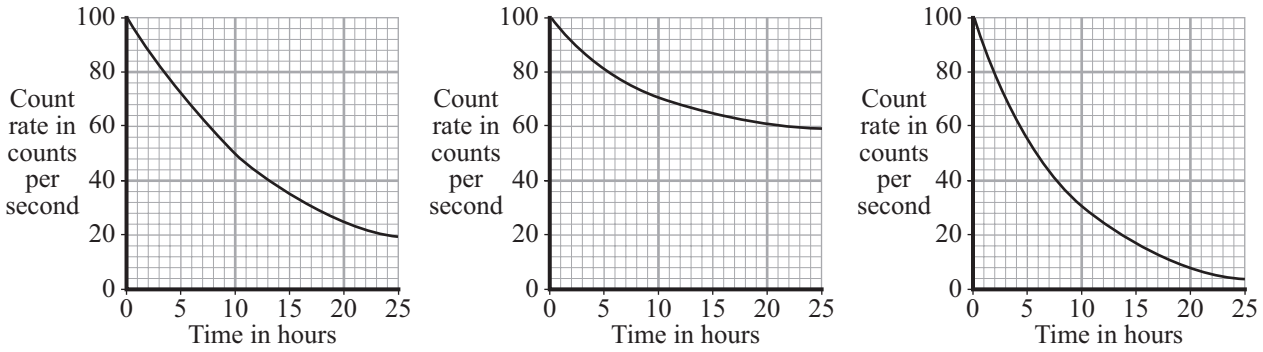
(c) The graphs show how the count rates from three different radioactive sources, **J**, **K**, and **L**, change with time.




**J** **K** **L**

(i) Which source, **J**, **K**, or **L**, has the highest count rate after 24 hours? .....

*(1 mark)*

(ii) For source **L**, what is the count rate after 5 hours?

..... counts per second

*(1 mark)*

(iii) Which source, **J**, **K**, or **L**, has the longest half-life? .....

*(1 mark)*

(iv) A radioactive source has a half-life of 6 hours.

What might this source be used for?

Put a tick (✓) in the box next to your choice.

To monitor the thickness of paper as it is made in a factory ☐

To inject into a person as a medical tracer ☐

To make a smoke alarm work ☐

*(1 mark)*

8

**4.4.3.2 Different half-lives of radioactive isotopes**

**Question 10**

June 2008 | PHY1BP | Original Q7 | Legacy

## QUESTION SEVEN

Radon is a radioactive gas. It emits alpha particles and has a half-life of 4 days. It occurs naturally in certain rocks and can become trapped in houses built on these rocks.

**7A** What is meant by describing radon as a *radioactive* gas?

**1** It is a very reactive chemical.

**2** It emits radio waves when it decays.

**3** It emits radiation when it decays.

**4** It reacts chemically only when exposed to radio waves.

**7B** What is meant by the *half-life* of a radioactive substance?

**1** The time taken for its count rate to fall to half its initial value.

**2** The time taken for all of the atoms to halve in size.

**3** The time taken for half of an atom to decay.

**4** The time taken for half of the atoms to become radioactive.

**7C** Why is it important to remove radon gas that becomes trapped in houses?

**1** Alpha radiation can cause illnesses such as cancer.

**2** Alpha radiation can weaken the rock structure.

**3** Radioactivity will cause television interference.

**4** Radon gas is highly flammable.

**4.4.3.2 Different half-lives of radioactive isotopes**

**Question 10 · continued**



**7D** A sheet of plastic is often built into the foundations of houses built on these rocks to stop . . .

**1** alpha particles rising through the rocks into the houses.

**2** radon gas rising into the houses.

**3** gamma radiation rising into the houses.

**4** all forms of radiation rising into the houses.

**Turn over for the next question**

### 4.4.3.2 Different half-lives of radioactive isotopes

**Question 11**

June 2008 | PHY1BP | Original Q9 | Legacy

## QUESTION NINE

The table gives some information about four radioactive isotopes, **P**, **Q**, **R** and **S**.

| Radioactive isotope | | Type of radiation emitted | Half-life |
|---|---|---|---|
| **P** | americium-237 | alpha | 78 minutes |
| **Q** | americium-241 | alpha | 432 years |
| **R** | technetium-99 | gamma | 6 hours |
| **S** | krypton-78 | beta | 10.7 years |

**9A** Which isotope emits an electron from the nucleus?

**1** **P**

**2** **Q**

**3** **R**

**4** **S**

**9B** Which isotope emits radiation with the longest range in air?

**1** **P**

**2** **Q**

**3** **R**

**4** **S**

**9C** Which isotope would be the most suitable for use in a system for controlling paper thickness in a paper factory?

**1** **P**

**2** **Q**

**3** **R**

**4** **S**

**4.4.3.2 Different half-lives of radioactive isotopes**

**Question 11 · continued**



**9D** Which isotope would be most suitable for monitoring the flow of blood through the heart?

**1** **P**

**2** **Q**

**3** **R**

**4** **S**

**END OF TEST**

**4.4.3.2 Different half-lives of radioactive isotopes**

**Question 12**

November 2008 | PHY1BP | Original Q9 | Legacy

## QUESTION NINE

Many atoms have nuclei that decay and emit alpha particles. Some of these nuclei have very short half-lives, others have very long ones.

**9A** What is an alpha particle?

**1** an electron from outside the nucleus

**2** an electron from inside the nucleus

**3** a helium nucleus

**4** a proton from inside the nucleus

**9B** How can the rate, at which a particular radioactive substance decays, be changed?

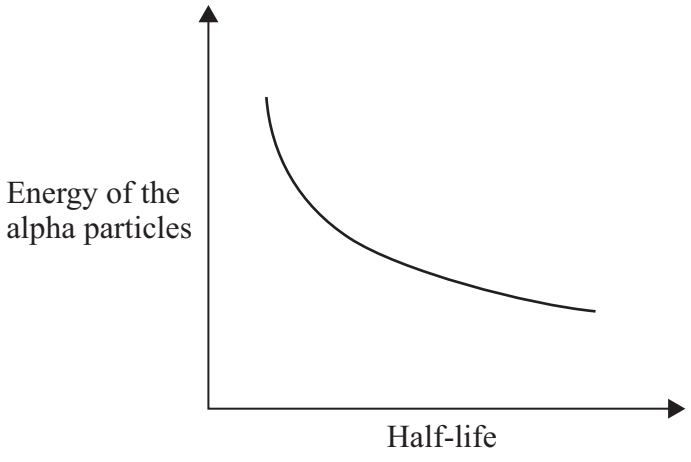
**1** by changing the temperature of the nucleus

**2** by changing the atmospheric pressure

**3** by changing the amount of humidity

**4** The rate cannot be changed.

The graph shows the relationship between the energy of the emitted alpha particles and the half-life of the nuclei from which they came.



**4.4.3.2 Different half-lives of radioactive isotopes**

**Question 12 · continued**



**9C** What relationship does the graph show?

**1** Alpha particles always have the same amount of energy.

**2** The longer the half-life, the less energy the alpha particles have.

**3** The longer the half-life, the more energy the alpha particles have.

**4** There is no relationship between the half-life and the energy of the alpha particles.

**9D** What is the meaning of the term *half-life*?

**1** half of the time taken for all the atoms originally present to decay

**2** the time halfway between when an atom was formed and when it decays

**3** the time taken for half of the atoms originally present to decay

**4** the time taken for one atom to split in half

**END OF TEST**

**4.4.3.2 Different half-lives of radioactive isotopes**

**Question 13**

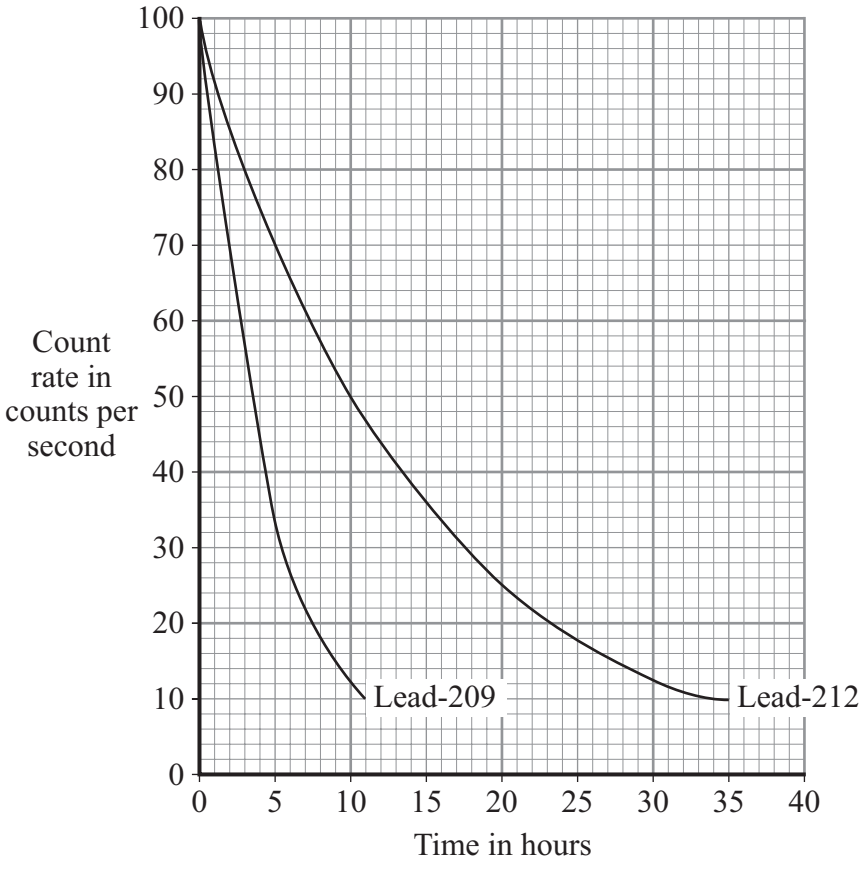
March 2009 | PHY1BP | Original Q5 | Legacy

**QUESTION FIVE**

The graph shows the radioactive decay of two isotopes of lead.

In lead-209, the total number of protons and neutrons is 209.

In lead-212, the total number of protons and neutrons is 212.




Match values, **A**, **B**, **C** and **D**, with the numbers **1–4** in the sentences.

**A** 3

**B** 10

**C** 12

**D** 60

The half-life of lead-212 is . . . **1** . . . hours.

After 10 hours, the count rate of lead-209 is . . . **2** . . . counts per second.

When the count rate of lead-209 has dropped to 20 counts per second, the count rate of lead-212 has dropped to . . . **3** . . . counts per second.

Lead-212 has . . . **4** . . . more neutrons than lead-209.

### 4.4.3.2 Different half-lives of radioactive isotopes

**Question 14**

June 2009 | PHY1BP | Original Q6 | Legacy

## QUESTION SIX

The radioactive isotope phosphorus-32 emits beta particles.

Scientists use phosphorus-32 to help them to understand how plants use phosphorus to grow.

**6A** A material is described as radioactive if it gives out . . .

**1** radio waves all the time.

**2** nuclear radiation all the time.

**3** radio waves when heated.

**4** nuclear radiation when heated.

**6B** Phosphorus-32 is one of the isotopes of phosphorus.

Atoms of the other isotopes of phosphorus have different numbers of . . .

**1** electrons.

**2** neutrons.

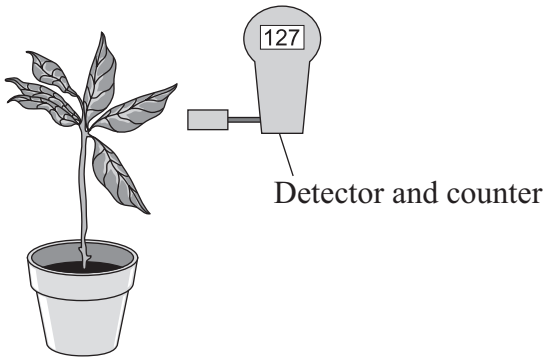
**3** nuclei.

**4** protons.

**4.4.3.2 Different half-lives of radioactive isotopes**

**Question 14 · continued**






**6C** The path of the phosphorus in the plant can be traced because the detector can detect . . .

**1** beta particles.

**2** phosphorus atoms.

**3** phosphorus nuclei.

**4** ultraviolet radiation.

**6D** Phosphorus-32 has a half-life of 14 days.

This means that the number of phosphorus-32 nuclei will . . .

**1** fall to zero in 14 days.

**2** halve in 14 days.

**3** double in 14 days.

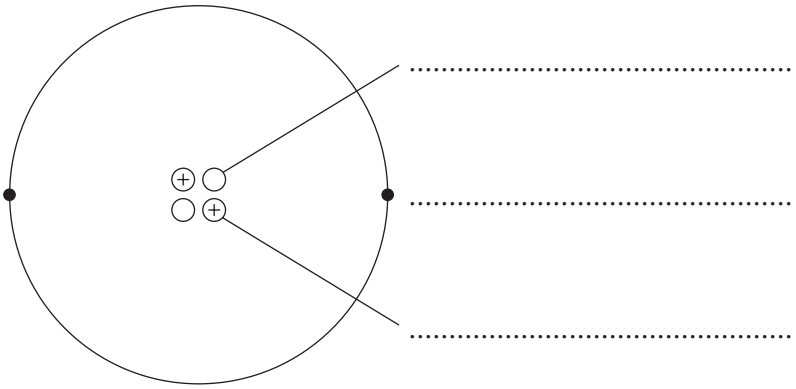
**4** be unchanged in 14 days.

### 4.4.3.2 Different half-lives of radioactive isotopes

**Question 15**



**3** The diagram shows a helium atom.




**3** (a) (i) Use the words in the box to label the diagram.

| | | |
|---|---|---|
| **electron** | **neutron** | **proton** |

*(2 marks)*

**3** (a) (ii) An alpha particle is the same as the nucleus of a helium atom.

How is an alpha particle different from a helium atom?

.....

.....

*(1 mark)*

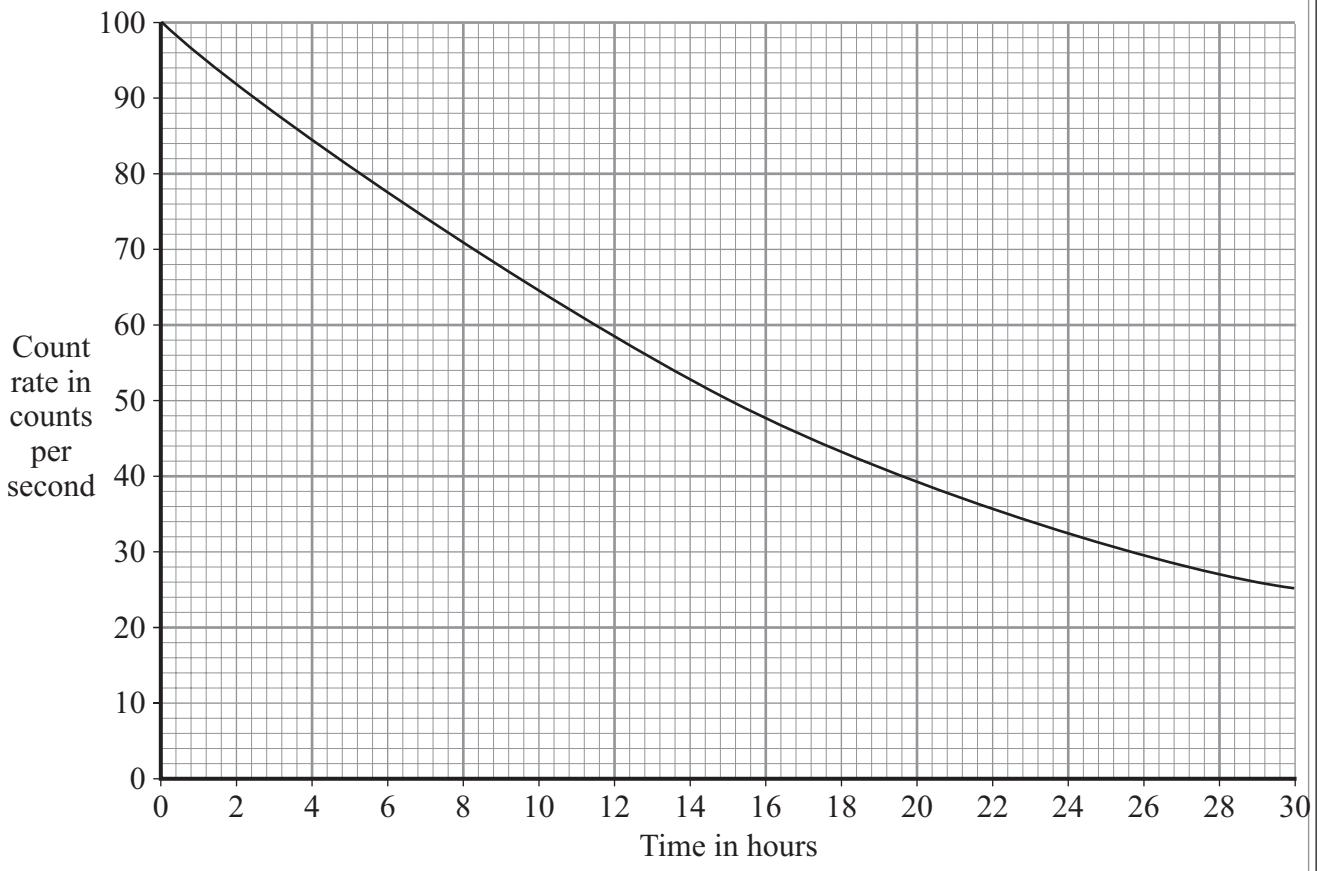
**4.4.3.2 Different half-lives of radioactive isotopes**

**Question 15 · continued**



*for mark*

**3** (b) The graph shows how the count rate from a sample of radioactive sodium-24 changes with time.




**3** (b) (i) How many hours does it take for the count rate to fall from 100 counts per second to 50 counts per second?

Time = ..... hours
*(1 mark)*

**3** (b) (ii) What is the half-life of sodium-24?

Half-life = ..... hours
*(1 mark)*

**Question 3 continues on the next page**

**4.4.3.2 Different half-lives of radioactive isotopes**

**Question 15 · continued**



*for mark*

**3** (c) A smoke detector contains a small amount of americium-241.

Americium-241 is a radioactive substance which emits alpha particles. It has a half-life of 432 years.

**3** (c) (i) Which **one** of the following statements gives a reason why the americium-241 inside the smoke detector will **not** need replacing?

Put a tick (✓) in the box next to your answer.

The alpha particles have a low energy. ☐

People replace smoke detectors every few years. ☐

Americium-241 has a long half-life. ☐

*(1 mark)*

**3** (c) (ii) The diagram shows the label on the back of the smoke detector.




Why do people need to know that the smoke detector contains a radioactive material?

.....

.....

*(1 mark)*

7

### 4.4.3.2 Different half-lives of radioactive isotopes

**Question 16**

November 2009 | PHY1BP | Original Q3 | Legacy

## QUESTION THREE

This question is about a radioactive isotope that emits alpha particles.

Match words, **A**, **B**, **C** and **D**, with the descriptions **1–4** in the table.

**A** count rate

**B** half-life

**C** penetrating power

**D** range

| | **Description** |
|---|---|
| **1** | the number of alpha particles detected per second |
| **2** | the distance the alpha particles travel before being fully absorbed |
| **3** | the time it takes for half of the nuclei of the isotope to decay |
| **4** | the ability of the alpha particles to pass through matter |

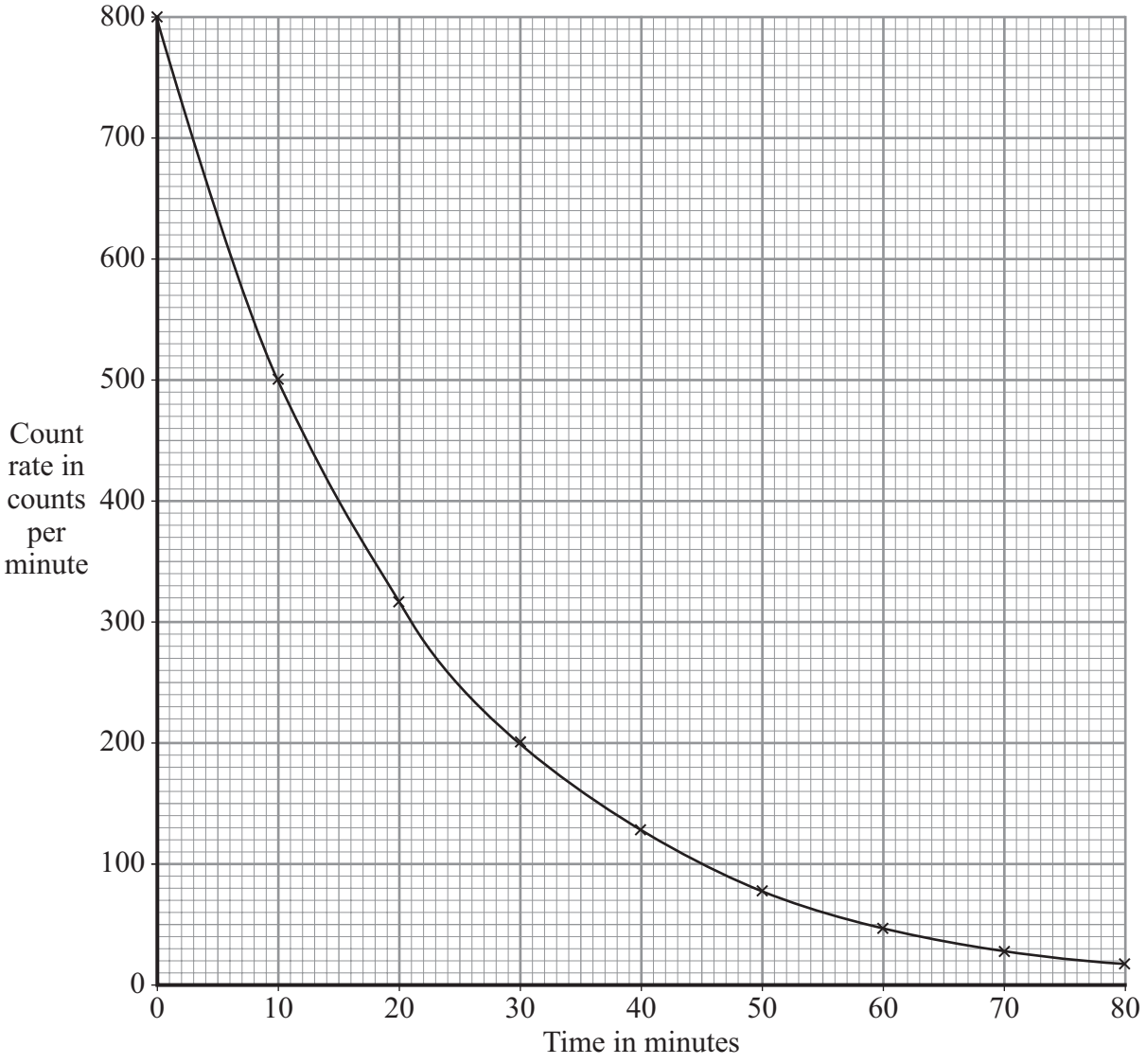
**4.4.3.2 Different half-lives of radioactive isotopes**

**Question 17**

November 2009 | PHY1BP | Original Q9 | Legacy

## QUESTION NINE

The graph shows how the count rate of a radioactive isotope varies with time.




**9A** What is the half-life of the isotope?

**1** 10 minutes

**2** 15 minutes

**3** 20 minutes

**4** 80 minutes

Question 17 · continued



**9B** The person who plotted the graph has drawn a line graph rather than a bar chart.

What is the reason for this?

**1** Both the count rate and time are continuous variables.

**2** Time is a discrete variable and count rate is a continuous variable.

**3** Time is a continuous variable and count rate is a categoric variable.

**4** Both the count rate and time are discrete variables.

**9C** The government recommends that all homes are fitted with smoke alarms. Americium-241 is used in these alarms. Americium-241 emits alpha particles and has a half-life of 460 years.

The americium-241 is safe to use in homes because . . .

**1** it has a long half-life.

**2** alpha particles travel only a few centimetres in air.

**3** smoke alarm batteries are replaced regularly.

**4** its nucleus has 146 neutrons.

**9D** This information is about the isotope technetium-99.

- It emits gamma radiation.
- Its half-life is 6 hours.
- It decays to a stable isotope of rubidium.
- It is used for diagnostic medical studies.
- It is put into the body.

A doctor wants to convince a patient that technetium-99 is safe to use to diagnose a medical problem.

Which of the following should he use to reassure the patient?

**1** Rubidium is a rare metallic element.

**2** Gamma radiation is part of the electromagnetic spectrum.

**3** The half-life of the technetium-99 isotope is relatively short.

**4** There is no risk in using radioactive materials.

**END OF TEST**

**4.4.3.2 Different half-lives of radioactive isotopes**

**Question 18**

January 2019 | PHY1F | Original Q4 | Legacy

**4** Some rocks inside the Earth contain a radioactive element, uranium-238. When an atom of uranium-238 decays, it gives out an alpha particle.

**4** (a) The following statement about alpha particles was written by a student.
The statement is **not** correct.

*Alpha particles can pass through a very thin sheet of lead.*

Change **one** word in the statement to make it correct.

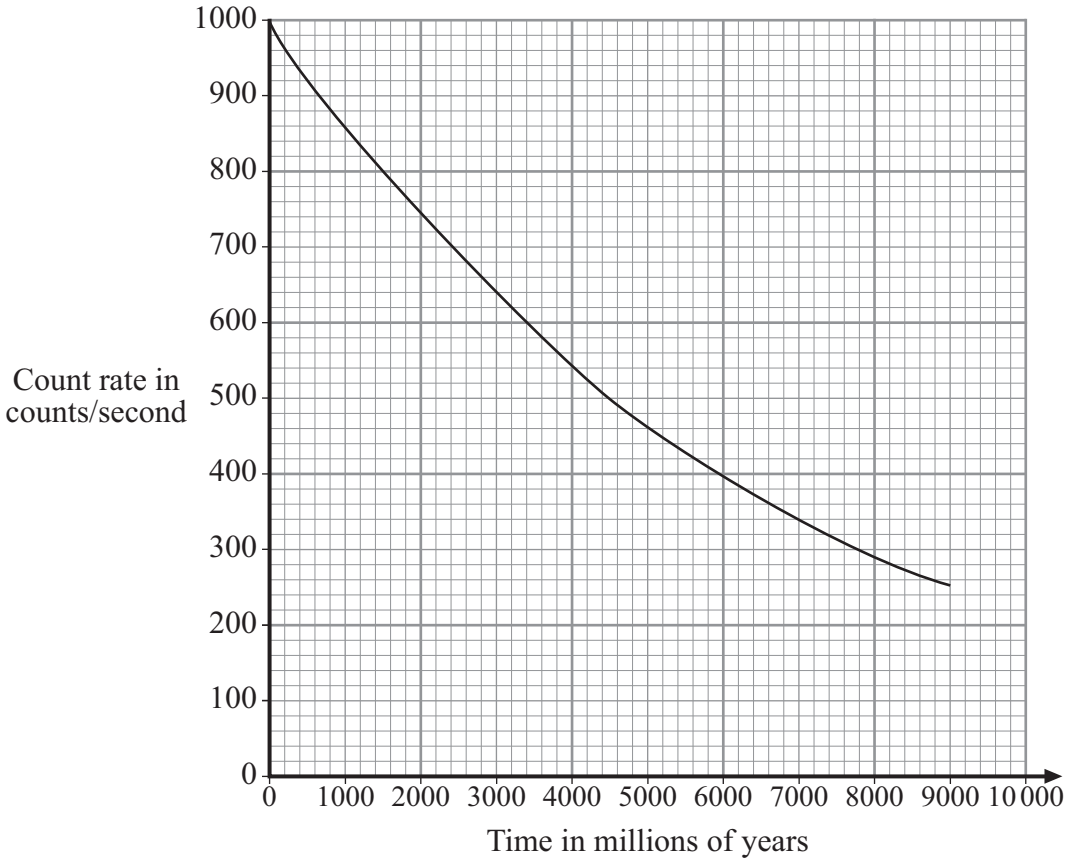
Write down your **new** statement.

.....

.....

*(1 mark)*

**4** (b) The graph shows how the count rate from a sample of uranium-238 changes with time.




The graph can be used to find the half-life of uranium-238. The half-life is 4500 million years.

**4** (b) (i) Draw on the graph to show how it can be used to find the half-life of uranium-238.

*(1 mark)*

**4.4.3.2 Different half-lives of radioactive isotopes**

**Question 18 · continued**



*for mark*

**4** (b) (ii) There is now half as much uranium-238 in the rocks as there was when the Earth was formed.

How old is the Earth?

Draw a ring around your answer.

**2250 million years** **4500 million years** **9000 million years**

*(1 mark)*

**4** (b) (iii) If a sample of uranium-238 were available, it would not be possible to measure the half-life in a school experiment.

Explain why.

.....

.....

.....

.....

*(2 marks)*

5

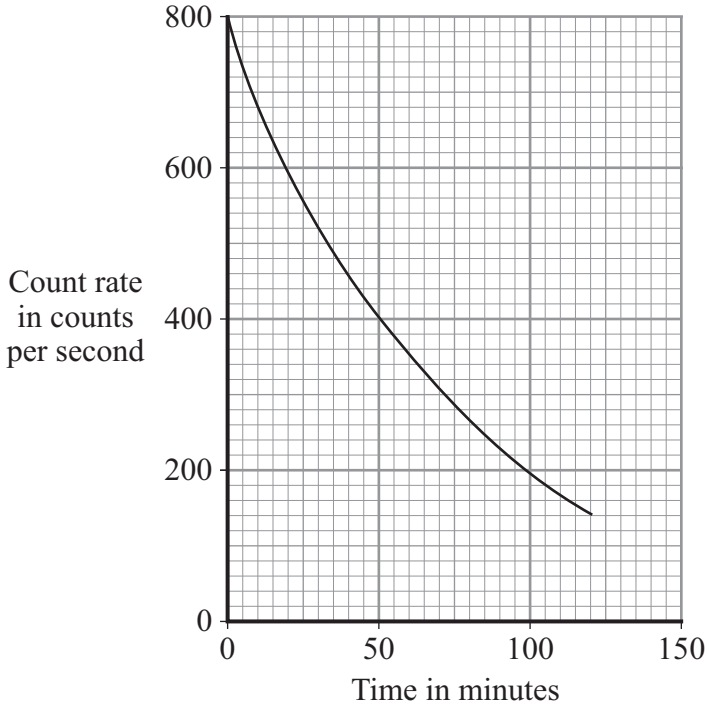
**4.4.3.2 Different half-lives of radioactive isotopes**

**Question 19**

March 2010 | PHY1BP | Original Q5 | Legacy

**QUESTION FIVE**

The graph shows how the count rate of a radioactive substance changes with time.




Match figures, **A**, **B**, **C** and **D**, with the statements **1–4** in the table.

**A** 50

**B** 100

**C** 400

**D** 800

| | |
|---|---|
| **1** | the initial count rate of the substance |
| **2** | the count rate after one half-life |
| **3** | the half-life of the substance in minutes |
| **4** | the count rate after three half-lives |

**4.4.3.2 Different half-lives of radioactive isotopes**

**Question 20**

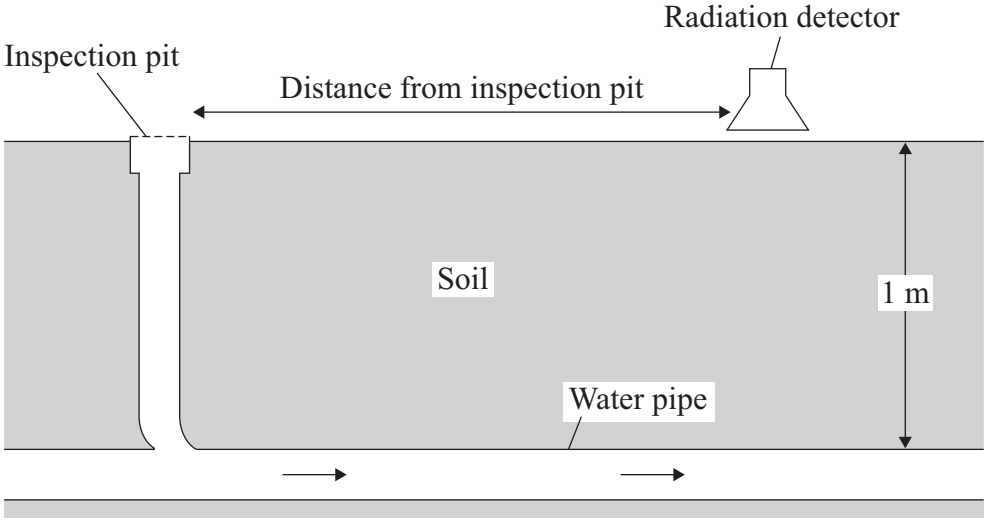
March 2010 | PHY1BP | Original Q8 | Legacy

## QUESTION EIGHT

Some engineers investigated a problem with the flow of water through an underground pipe.
The pipe was 1 metre below the ground.

The engineers put a small amount of radioactive liquid into the pipe through an inspection pit.
The radioactive liquid had a half-life of two days.

A radiation detector was used to measure the count rate at different distances from the inspection pit.




The results are shown below.

| Distance from the inspection pit in metres | Count rate in counts per minute |
|---|---|
| 1 | 23 |
| 2 | 21 |
| 3 | 23 |
| 4 | 28 |
| 5 | 32 |
| 6 | 27 |
| 7 | 20 |
| 8 | 18 |
| 9 | 19 |
| 10 | 20 |

**4.4.3.2 Different half-lives of radioactive isotopes**

**Question 20 · continued** March 2010 | PHY1BP | Original Q8 | Legacy

**8A** The engineers would use a radioactive liquid that emits . . .

**1** alpha radiation.

**2** beta radiation.

**3** gamma radiation.

**4** X-radiation.

**8B** The readings suggest that . . .

**1** the pipe was clear and water was flowing normally.

**2** the pipe was not level.

**3** the pipe had a leak.

**4** the pipe had a blockage.

**8C** To improve the reliability of the data, the engineers should . . .

**1** use a more sensitive counter.

**2** re-calibrate the counter.

**3** repeat their investigation and calculate the means.

**4** decide whether the variables are continuous or discrete.

**8D** To fix the problem, workmen were asked to dig a hole down to the pipe.

The best place for the workmen to dig the hole is . . .

**1** 3 m from the inspection pit.

**2** 5 m from the inspection pit.

**3** 7 m from the inspection pit.

**4** 9 m from the inspection pit.

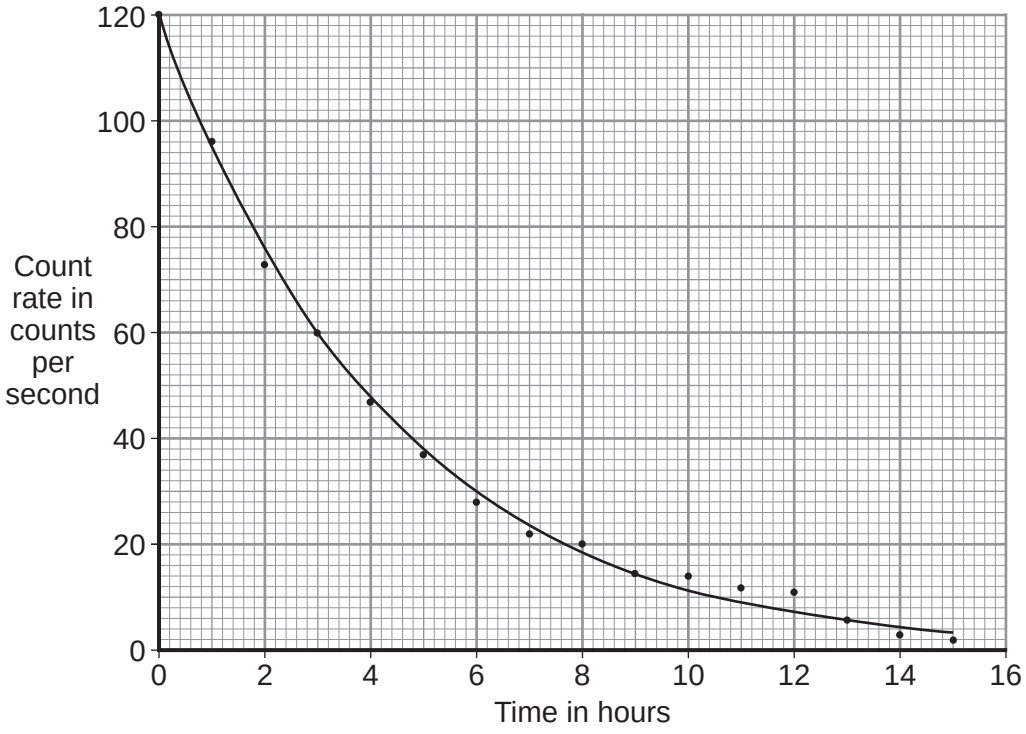
### 4.4.3.2 Different half-lives of radioactive isotopes

**Question 21**

June 2010 | PHY1BP | Original Q9 | Legacy

**QUESTION NINE**

The graph shows the count rate of a radioactive isotope over 15 hours.




**9A** Which row in the table describes correctly the types of variable?

| | Count rate | Time |
|---|---|---|
| **1** | categoric | categoric |
| **2** | categoric | continuous |
| **3** | continuous | categoric |
| **4** | continuous | continuous |

**9B** Not all the points of the graph lie on the drawn curve.

The line drawn is called . . .

**1** a discrete line.

**2** a line of best fit.

**3** a line of least resistance.

**4** an error line.

4.4.3.2 Different half-lives of radioactive isotopes

Question 21 · continued



**9C** The half-life of the radioactive isotope is . . .

**1** 2 hours.

**2** 3 hours.

**3** 5 hours.

**4** 7 hours.

**9D** A different radioactive isotope has a half-life of 10 hours.

What fraction of the original mass of isotope will be left after 30 hours?

**1** $\frac{1}{3}$

**2** $\frac{1}{8}$

**3** $\frac{1}{30}$

**4** $\frac{7}{8}$

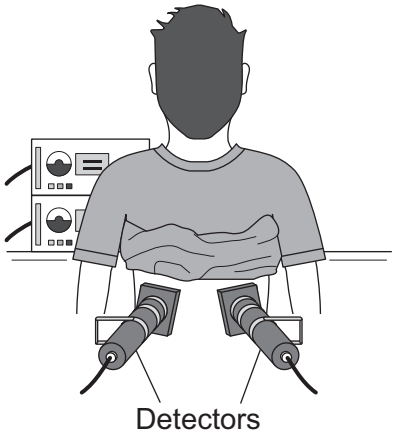
**END OF TEST**

### 4.4.3.2 Different half-lives of radioactive isotopes

**Question 22**

June 2010 | PHY1F | Original Q7 | Legacy

**7 (a)** A doctor uses the radioactive isotope technetium-99 to find out if a patient's kidneys are working correctly.




The doctor injects a small amount of technetium-99 into the patient's bloodstream.

Technetium-99 emits *gamma radiation*.

Give **two** reasons why an isotope that emits gamma radiation is injected into the patient rather than an isotope that emits alpha radiation.

1 .....

.....

2 .....

.....

*(2 marks)*

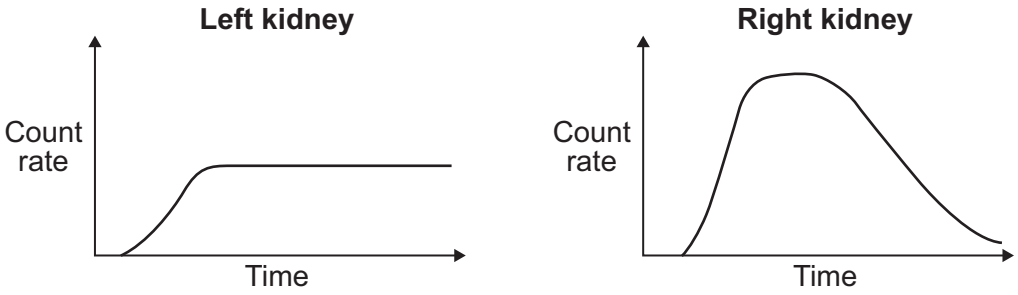
**4.4.3.2 Different half-lives of radioactive isotopes**

**Question 22 · continued** June 2010 | PHY1F | Original Q7 | Legacy

**7 (b)** If the patient's kidneys are working correctly, the technetium-99 will pass from the bloodstream into the kidneys and then into the patient's urine.

Detectors are used to measure the radiation emitted from the kidneys.

The level of radiation emitted from each kidney is recorded on a graph.




**7 (b) (i)** How do the graphs show that technetium-99 is passing from the bloodstream into each kidney?

.....

.....

*(1 mark)*

**7 (b) (ii)** By looking at the graphs, the doctor is able to tell if there is a problem with the patient's kidneys.

Which **one** of the following statements is correct?

Put a tick (✓) in the box next to your answer.

Only the right kidney is working correctly. ☐

Only the left kidney is working correctly. ☐

Both kidneys are working correctly. ☐

Explain the reason for your answer.

.....

.....

.....

.....

*(3 marks)*

**Question 7 continues on the next page**

### 4.4.3.2 Different half-lives of radioactive isotopes

**Question 22 · continued**



**7 (c)** The patient was worried about having a radioactive isotope injected into their body. The doctor explained that the risk to the patient's health was very small as technetium-99 has a short *half-life*.

**7 (c) (i)** What does the term *half-life* mean?

.....

.....

*(1 mark)*

**7 (c) (ii)** Explain why it is important that the doctor uses an isotope with a short half-life rather than an isotope with a long half-life.

.....

.....

.....

.....

*(2 marks)*

9

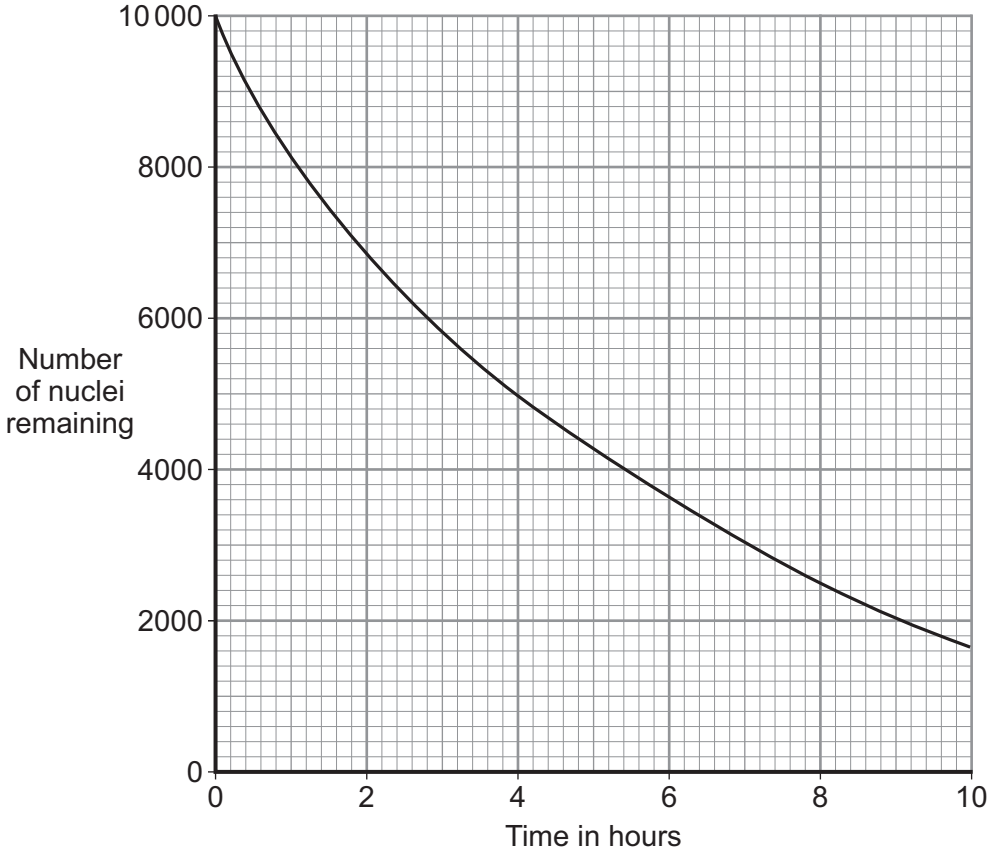
### 4.4.3.2 Different half-lives of radioactive isotopes

**Question 23**

November 2010 | PHY1BP | Original Q9 | Legacy

**QUESTION NINE**

The graph shows the decay of a small sample of radioactive isotope. At the start, the sample contains 10 000 nuclei.




**9A** What is the half-life of the isotope shown in the graph?

**1** 2 hours

**2** 4 hours

**3** 6 hours

**4** 8 hours

**9B** How many of the original nuclei would remain after three half-lives?

**1** 1250

**2** 2500

**3** 3333

**4** none

4.4.3.2 Different half-lives of radioactive isotopes

Question 23 · continued



**9C** This radioactive isotope may be suitable . . .

**1** as a source of radiation in a smoke alarm.

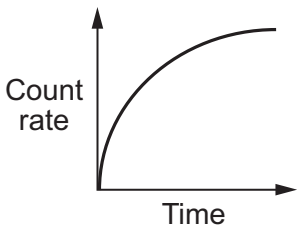
**2** as a source of radiation to monitor the thickness of paper in a paper mill.

**3** as a medical tracer in the human body.

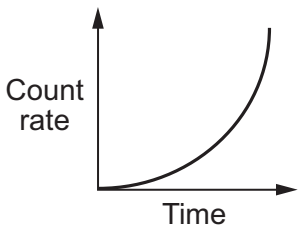
**4** to use in finding the age of an ancient bone.

**9D** Which one of the following graphs would show how the count rate for this isotope changes with time?

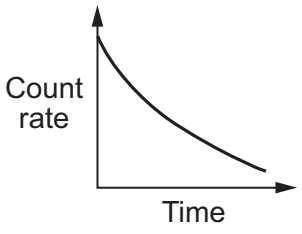
**1**



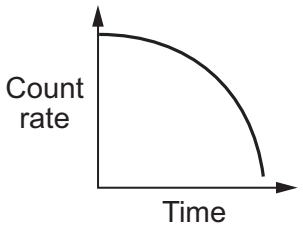

**2**




**3**




**4**




**END OF TEST**

### 4.4.3.2 Different half-lives of radioactive isotopes

**Question 24**

January 2011 | PHY1F | Original Q3 | Legacy

**3 (a)** The names of the three types of nuclear radiation are given in **List A**.
Some properties of these types of radiation are given in **List B**.

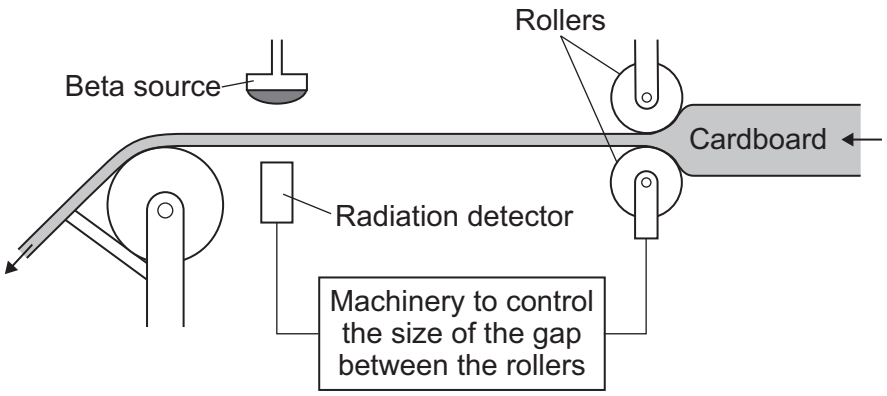
Draw a straight line to link each type of radiation in **List A** to its correct property in **List B**.

Draw only **three** lines.

| **List A**<br>**Type of nuclear radiation** | **List B**<br>**Property of radiation** |
|---|---|
| Alpha | Has the same mass as an electron |
| Beta | Very strongly ionising |
| Gamma | Passes through 10 cm of aluminium |
| | Deflected by a magnetic field but not deflected by an electric field |

*(3 marks)*

**3 (b)** The diagram shows a system used to control the thickness of cardboard as it is made.



4.4.3.2 Different half-lives of radioactive isotopes

Question 24 · continued



The cardboard passes through a narrow gap between a beta radiation source and a radiation detector.

The table gives the detector readings over 1 hour.

| Time | Detector reading |
|---|---|
| 08:00 | 150 |
| 08:15 | 148 |
| 08:30 | 151 |
| 08:45 | 101 |
| 09:00 | 149 |

**3 (b) (i)** Between 08:00 and 08:30, the cardboard is produced at the usual, correct thickness.

Explain how you can tell from the detector readings that the cardboard produced at 08:45 is thicker than usual.

.....

.....

.....

.....

*(2 marks)*

**3 (b) (ii)** Which would be the most suitable half-life for the beta source?

Draw a ring around your answer.

**six days** **six months** **six years**

*(1 mark)*

**3 (b) (iii)** This control system would **not** work if the beta radiation source was replaced by an alpha radiation source.

Why not?

.....

.....

*(1 mark)*

7

4.4.3.2 Different half-lives of radioactive isotopes

Question 25

June 2011 | PHY1BP | Original Q8 | Legacy

## QUESTION EIGHT

The following article appeared in a newspaper.

### Radioactive Fruit!

Some supermarkets sell fresh fruit that has been exposed to radiation.

A spokesperson for the supermarkets explained: "The radiation kills bacteria on the surface and inside the fruit. This means that the fruit stays fresh for longer. Scientists have done tests on the treated fruit and are sure that it is safe to eat."

He added: "Fruit that has been treated in this way will be clearly labelled."

A consumer group has said: "We do not believe that fruit treated with radioactivity is safe. We are trying to stop supermarkets from selling it."

**8A** To reassure customers that the treated fruit is safe to eat, the supermarket should . . .

**1** explain that the treated fruit will stay fresh for longer.

**2** sell the treated fruit at a lower price than the untreated fruit.

**3** show that the scientists who did the tests were not biased.

**4** tell customers that the taste of the fruit has not changed.

**8B** The government has said that all fruit should be clearly labelled to show if it has been treated with radiation.

This is because . . .

**1** people can then decide whether or not they want to eat fruit treated with radiation.

**2** the government knows that treated fruit is dangerous to eat.

**3** the government wants to encourage people to eat more fruit.

**4** the labels can make the fruit more attractive.

4.4.3.2 Different half-lives of radioactive isotopes

Question 25 · continued



**8C** The headline of the newspaper says that the fruit is radioactive.

What should scientists do to test if this is true?

**1** measure the time it takes for the fruit to go rotten

**2** put the fruit close to a radiation detector and see if the count rate goes up

**3** put the fruit close to a radiation detector and see if the count rate goes down

**4** see if the fruit glows when placed in a dark room

**8D** The radiation used to treat the fruit kills bacteria both on the surface and inside the fruit.

The radioactive isotope used must emit the right type of radiation. It must also have a suitable half-life.

Which row in the table describes the most suitable radioactive isotope to use?

| Isotope | Radiation emitted | Half-life |
|---|---|---|
| **1** | alpha | 6 hours |
| **2** | alpha | 60 years |
| **3** | gamma | 5 hours |
| **4** | gamma | 5 years |

### 4.4.3.2 Different half-lives of radioactive isotopes

**Question 26**

June 2011 | PHY1F | Original Q8 | Legacy

**8 (a)** By 2023, nearly all of the existing nuclear power stations in the UK will be closed down.

**8 (a) (i)** Before a nuclear power station can be demolished, the remaining nuclear fuel, radioactive waste materials and reactor must be carefully removed.

What is this process called?

Put a tick (✓) in the box next to your answer.

decommissioning ☐

decontaminating ☐

dismantling ☐

*(1 mark)*

**8 (a) (ii)** The workers are exposed to radiation as they remove the reactor. One of the biggest risks is from the isotope cobalt-60, which has a half-life of 5.3 years.

Explain the advantage of waiting 11 years after a nuclear power station has closed down before starting to remove the reactor.

.....

.....

.....

.....

*(2 marks)*

**4.4.3.2 Different half-lives of radioactive isotopes**

**Question 26 · continued**



**8 (b)** It is almost certain that new nuclear power stations will be built in the UK.

The table shows the results of surveys asking people in the UK whether they were in favour of, or against, the building of new nuclear power stations.

| | 2001 | 2005 | 2007 |
|---|---|---|---|
| **Percentage (%) in favour** | 20 | 41 | 65 |
| **Percentage (%) against** | 60 | 28 | 20 |
| **Percentage (%) not sure** | 20 | 31 | 15 |

**8 (b) (i)** From these surveys, how did public opinion on the building of new nuclear power stations change between 2001 and 2007?

.....

.....

*(1 mark)*

**8 (b) (ii)** Suggest a reason why some people may think that the results from these surveys are unreliable.

.....

.....

*(1 mark)*

**8 (b) (iii)** Give **one** reason in favour of building new nuclear power stations.

.....

.....

*(1 mark)*

**Question 8 continues on the next page**

**4.4.3.2 Different half-lives of radioactive isotopes**

**Question 26 · continued**



**8 (c)** The government of one Middle Eastern country has decided to build its first nuclear power station. The oil that would have been used to generate electricity can then be sold to other countries.

On what is this decision based?

Put a tick (✓) in the box next to your answer.

economic issues ☐

ethical issues ☐

social issues ☐

*(1 mark)*

7

### 4.4.3.2 Different half-lives of radioactive isotopes

**Question 27**

June 2013 | PH2FP | Original Q1 | Legacy

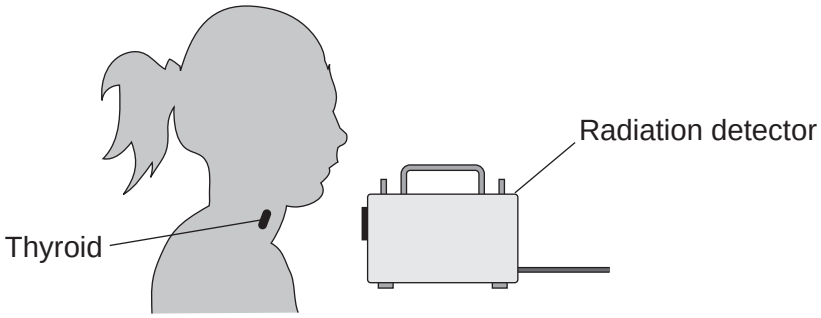
**1 (a)** The names of three types of radiation are given in **List A**. Some properties of these three types of radiation are given in **List B.**

Draw **one** line from each type of radiation in **List A** to its correct property in **List B**.

| List A<br>Type of radiation | List B<br>Property of radiation |
|---|---|
| | will pass through paper but is stopped by thin metal |
| alpha | |
| | has the shortest range in air |
| beta | |
| | will not harm human cells |
| gamma | |
| | is very weakly ionising |

*(3 marks)*

**1 (b)** The radioactive isotope iodine-123 can be used by a doctor to examine the thyroid gland of a patient. The iodine, taken as a tablet, is absorbed by the thyroid gland. The gamma radiation emitted as the iodine atoms decay is detected outside the body.




The doctor uses an isotope emitting gamma radiation to examine the thyroid gland rather than an isotope emitting alpha or beta radiation.

Which **one** of the following gives a reason why gamma radiation is used?

Tick (✓) **one** box.

Gamma radiation will pass through the body. ☐

Gamma radiation is not deflected by a magnet. ☐

Gamma radiation has a long range in air. ☐

*(1 mark)*

### 4.4.3.2 Different half-lives of radioactive isotopes

**Question 27 · continued**



**1 (c)** Iodine-123 has a half-life of 13 hours.

Use a word from the box to complete the sentence.

| all | half | most |
|---|---|---|

After 13 hours ..... of the iodine-123 atoms the thyroid absorbed have decayed.

*(1 mark)*

**1 (d)** Iodine-123 and iodine-131 are two of the isotopes of iodine.

Draw a ring around the correct answer to complete the sentence.

The nucleus of an iodine-123 atom has the same number of | electrons | neutrons | protons | as the

nucleus of an iodine-131 atom.

*(1 mark)*

6

### 4.4.3.2 Different half-lives of radioactive isotopes

**Question 28**

June 2018 | 8463/1F | Original Q5

**0 5** Americium-241 ($^{241}_{95}Am$) is an isotope of americium.

**0 5 . 1** Which of the isotopes given in **Table 1** is **not** an isotope of americium?

**[2 marks]**

**Table 1**

| Isotope | Mass number | Atomic number |
|---|---|---|
| A | 243 | 95 |
| B | 243 | 94 |
| C | 242 | 95 |

Isotope _____

Give a reason for your answer.

_____

_____

_____

**Question 5 continues on the next page**

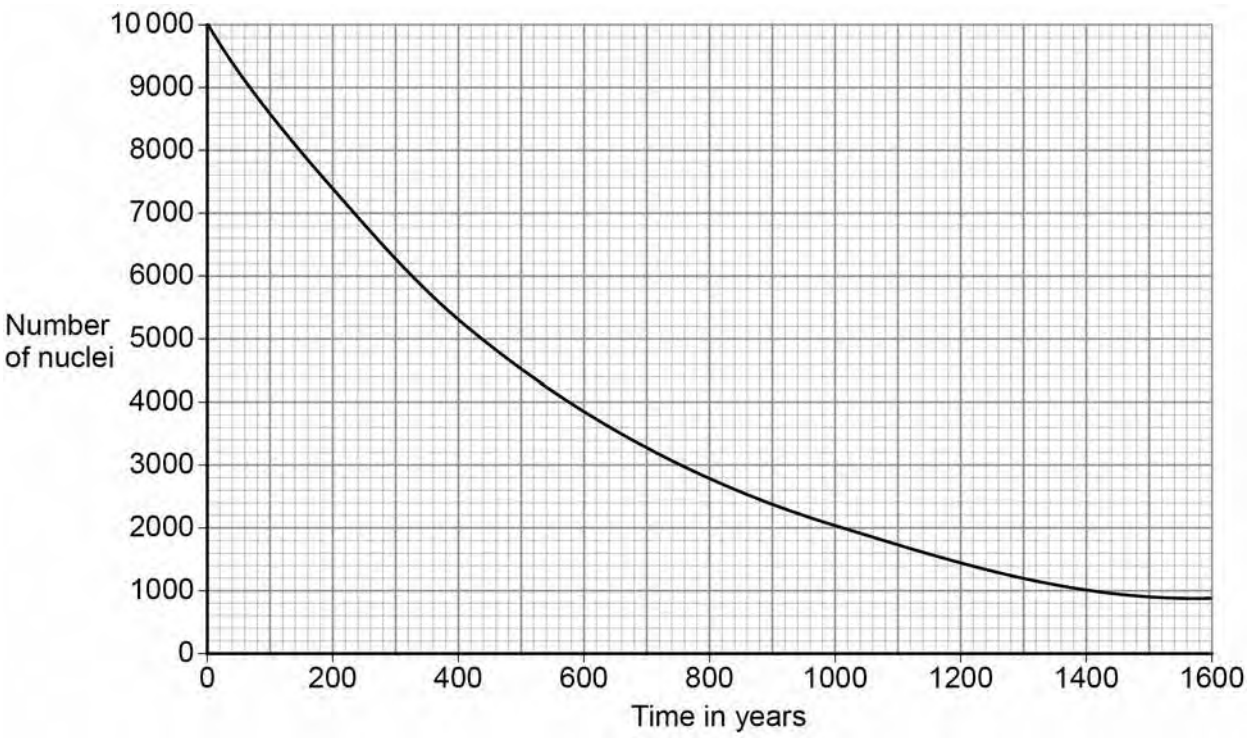
4.4.3.2 Different half-lives of radioactive isotopes

Question 28 · continued

June 2018 | 8463/1F | Original Q5

**Figure 5** shows how the number of americium-241 nuclei in a sample changes with time.

**Figure 5**




**0 5 . 2** How many years does it take for the number of americium-241 nuclei to decrease from 10 000 to 5000?

**[1 mark]**

Time = _____ years

**0 5 . 3** What is the half-life of americium-241?

**[1 mark]**

Half-life = _____ years

4

### 4.4.3.2 Different half-lives of radioactive isotopes

**Question 29**

November 2020 | 8463/1F | Original Q5

**0 5** Radioactive waste from nuclear power stations is a man-made source of background radiation.

**0 5 . 1** Which of the following is also a man-made source of background radiation?

**[1 mark]**

Tick (✓) **one** box.

- cosmic rays ☐
- radiotherapy ☐
- rocks ☐
- stars ☐

**0 5 . 2** Nuclear power stations use the process of nuclear fission.

Complete the sentences to describe the process of nuclear fission.

Choose answers from the box.

**[3 marks]**

| | | | |
|---|---|---|---|
| **a neutron** | **a proton** | | **an electron** |
| **cosmic rays** | **energy** | **gamma rays** | **x-rays** |

An unstable nucleus absorbs _____ and splits into two parts.

Two or three neutrons are released, as well as _____

and _____ .

4.4.3.2 Different half-lives of radioactive isotopes

Question 29 · continued



**0 5 . 3** Plutonium-239 is one type of radioactive waste from nuclear power stations.

The following nuclear equation represents the decay of plutonium-239 (Pu-239).

$$^{239}_{94}Pu \rightarrow {}^{235}_{92}U + {}^{4}_{2}He$$

How does the nuclear equation show that alpha radiation is emitted when plutonium-239 decays?

**[1 mark]**

Tick (✓) **one** box.

An alpha particle contains 92 protons. ☐

An alpha particle has a mass number of 235. ☐

An alpha particle is the same as a helium nucleus. ☐

**Question 5 continues on the next page**

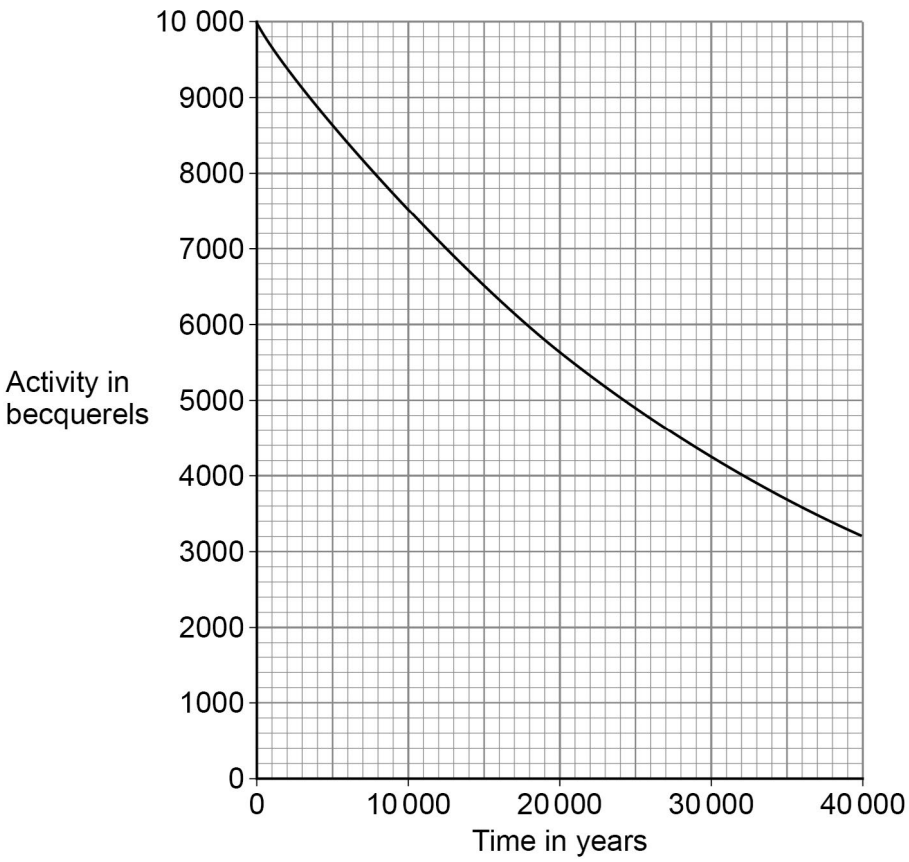
4.4.3.2 Different half-lives of radioactive isotopes

Question 29 · continued



**Figure 8** shows how the activity of a sample of plutonium-239 varies with time.

**Figure 8**




**0 5 . 4** How much time will it take for the activity of the sample of plutonium-239 to fall to half of its initial activity?

**[1 mark]**

Time = _____ years

**0 5 . 5** What is the half-life of plutonium-239?

**[1 mark]**

Half-life = _____ years

4.4.3.2 Different half-lives of radioactive isotopes

Question 29 · continued



**0 5 . 6** The radioactive waste from a nuclear power station is buried underground.

People are warned to stay away from places where radioactive waste is buried.

Suggest **one** risk of going near the place where radioactive waste is buried.

**[1 mark]**

8

**Turn over for the next question**

### 4.4.3.2 Different half-lives of radioactive isotopes

**Question 30**

November 2021 | 8463/1F | Original Q5

**0 5** Atoms of different elements have different properties.

**0 5 . 1** Which of the following is the same for all atoms of the same element?

**[1 mark]**

Tick (✓) **one** box.

- Atomic number ☐
- Mass number ☐
- Neutron number ☐

**0 5 . 2** Which of the following is different for isotopes of the same element?

**[1 mark]**

Tick (✓) **one** box.

- Number of electrons ☐
- Number of neutrons ☐
- Number of protons ☐

**Question 5 continues on the next page**

4.4.3.2 Different half-lives of radioactive isotopes

Question 30 · continued

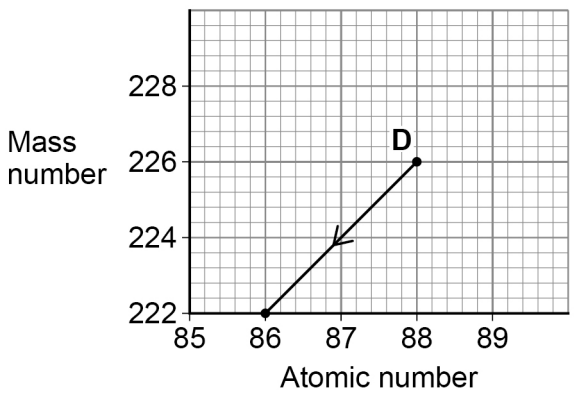


**0 5 . 3** A nucleus emits radiation.

**Figure 7** shows how the mass number and the atomic number change.

The nucleus is labelled **D**.

**Figure 7**




Which type of radiation is emitted when nucleus **D** decays?

**[1 mark]**

Tick (✓) **one** box.

Alpha ☐

Beta ☐

Neutron ☐

4.4.3.2 Different half-lives of radioactive isotopes

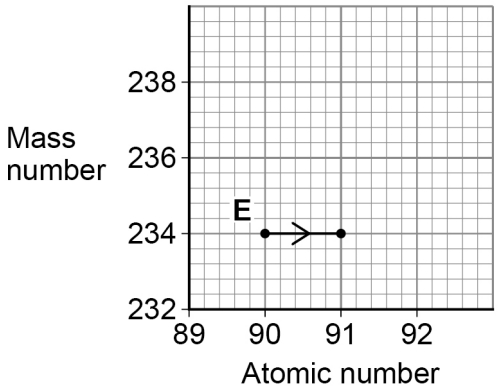
Question 30 · continued



**0 5 . 4** Nucleus **E** also emits radiation.

**Figure 8** shows how the mass number and the atomic number change for nucleus **E**.

**Figure 8**




Which type of radiation is emitted when nucleus **E** decays?

**[1 mark]**

Tick (✓) **one** box.

Alpha ☐

Beta ☐

Neutron ☐

**Question 5 continues on the next page**

4.4.3.2 Different half-lives of radioactive isotopes

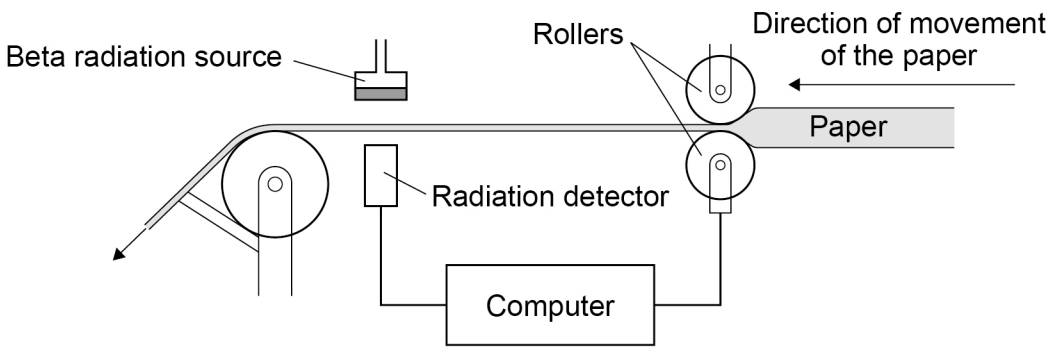
Question 30 · continued



Beta radiation can be used to monitor the thickness of paper during production.

**Figure 9** shows how the radiation is used.

**Figure 9**




The computer uses information from the radiation detector to change the size of the gap between the rollers.

**0 5 . 5** Complete the sentences.

Choose answers from the box.

Each answer can be used once, more than once or not at all.

| | | |
|---|---|---|
| **decrease** | **stay the same** | **increase** |

The thickness of the paper between the beta source and the detector increases.

**[2 marks]**

The reading on the detector will _____.

This is because the amount of radiation absorbed by the paper

will _____.

4.4.3.2 Different half-lives of radioactive isotopes

Question 30 · continued



**0 5 . 6** All radioactive elements have a half-life.

What is meant by 'half-life'?

**[1 mark]**

Tick (✓) **one** box.

- The time it takes for all the nuclei in a radioactive sample to split in half. ☐
- The time it takes for the count rate of a radioactive sample to halve. ☐
- The time it takes for the radiation to travel half of its range in air. ☐

**0 5 . 7** Why should the radiation source used in **Figure 9** have a long half-life?

**[1 mark]**

Tick (✓) **one** box.

- So the activity of the source is approximately constant. ☐
- So the amount of radiation decreases quickly. ☐
- So the radiation has a long range in air. ☐

8

4.4.3.2 Different half-lives of radioactive isotopes

Question 31

June 2023 | 8463/1F | Original Q3

**0 3** Some isotopes emit nuclear radiation.

**0 3 . 1** Carbon-12 and carbon-14 are both isotopes of carbon.

Complete the sentences.

Choose answers from the box.

**[2 marks]**

| | | | |
|---|---|---|---|
| **alpha particles** | **electrons** | **neutrons** | **protons** |

The nucleus of a carbon-12 atom and the nucleus of a carbon-14 atom have the **same** number of _____ .

The nucleus of a carbon-12 atom and the nucleus of a carbon-14 atom have a **different** number of _____ .

**0 3 . 2** Different radioactive isotopes have different half-lives.

What does 'half-life' mean?

**[1 mark]**

Tick (✓) **one** box.

- Half the time taken for all of the nuclei in a sample to decay. ☐
- The time taken for half the nuclei in a sample to decay. ☐
- The time taken for one nucleus to split in half. ☐

**Question 3 continues on the next page**

4.4.3.2 Different half-lives of radioactive isotopes

Question 31 · continued



**0 3 . 3** **Table 2** shows the half-life of some different isotopes of carbon.

**Table 2**

| Isotope | Half-life in seconds |
|---|---|
| Carbon-15 | 2.45 |
| Carbon-16 | 0.75 |
| Carbon-17 | 0.19 |
| Carbon-18 | 0.09 |

Which isotope is the least stable?

**[1 mark]**

Tick (✓) **one** box.

Carbon-15 ☐

Carbon-16 ☐

Carbon-17 ☐

Carbon-18 ☐

4.4.3.2 Different half-lives of radioactive isotopes

Question 31 · continued



**0 3 . 4** Workers in nuclear power stations must be aware of nuclear irradiation and radioactive contamination.

Draw **one** line from each term to an example of the term.

**[2 marks]**

| Term | Example |
| --- | --- |
| Radioactive contamination | Exposure to a beam of gamma rays |
| Nuclear irradiation | Exposure to ultraviolet radiation from the Sun |
| | Accidental transfer of plutonium onto a human body |
| | Using a mobile phone |

**Question 3 continues on the next page**

4.4.3.2 Different half-lives of radioactive isotopes

Question 31 · continued



**0 3 . 5** Why are workers required to walk across a sticky floor before leaving the nuclear power station?

**[1 mark]**

Tick (✓) **one** box.

To remove alpha particles from their shoes. ☐

To remove gamma radiation from their shoes. ☐

To remove radioactive dust from their shoes. ☐

**0 3 . 6** The places where people work and live contribute to the nuclear radiation they are exposed to.

**Table 3** shows the mean daily dose of radiation caused by two different jobs.

**Table 3**

| Job | Mean daily dose in mSv |
|---|---|
| Aeroplane pilot | 0.072 |
| Nuclear power station worker | 0.00050 |

Calculate the number of days a nuclear power station worker must work before receiving the same dose that an aeroplane pilot receives in one day.

**[2 marks]**

Number of days = _____

4.4.3.2 Different half-lives of radioactive isotopes

Question 31 · continued



**0 3 . 7** The process of nuclear fission takes place in nuclear power stations.

The process of nuclear fusion takes place in the Sun.

Draw **one** line from each process to its fuel.

**[2 marks]**

| Process | Fuel |
|---|---|
| | Hydrogen |
| Nuclear fission | Iron |
| Nuclear fusion | Lead |
| | Uranium |

11

### 4.4.3.2 Different half-lives of radioactive isotopes

**Question 32**

June 2024 | 8463/1F | Original Q6

**0 6** A teacher measured the background radiation in a laboratory.

**0 6 . 1** Which sources of background radiation are natural and which are man-made?

**[2 marks]**

Tick (✓) **one** box in **each** row.

| Source of background radiation | Natural | Man-made |
|---|---|---|
| Cosmic rays | | |
| Medical X-rays | | |
| Nuclear accidents | | |
| Radon gas | | |

**Question 6 continues on the next page**

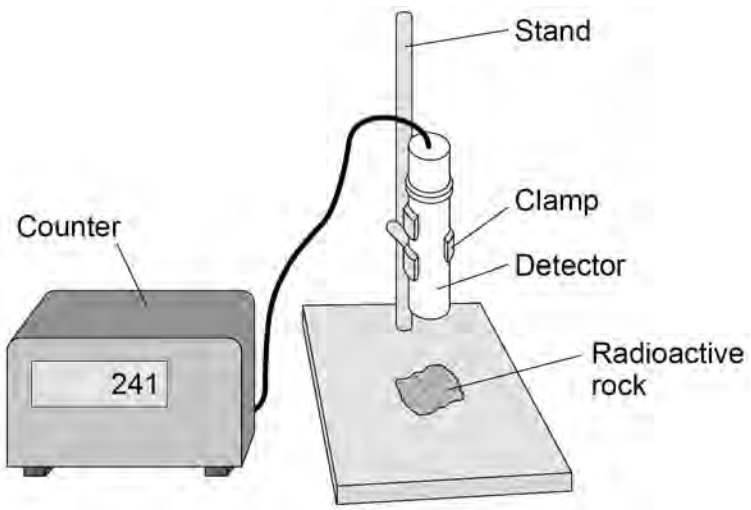
Question 32 · continued



The teacher measured the radiation emitted by four different types of radioactive rock.

**Figure 12** shows the equipment used.

**Figure 12**




Each radioactive rock was placed below the detector one at a time.

The radiation was recorded as the number of counts in 1 minute.

The experiment was repeated with different materials between each rock and the detector.

**Table 2** shows the results.

**Table 2**

| | **Number of counts in 1 minute** | | |
|---|---|---|---|
| | No material | One sheet of paper | Thick aluminium sheet |
| No rock | 21 | 20 | 22 |
| Rock **A** | 450 | 448 | 18 |
| Rock **B** | 385 | 387 | 356 |
| Rock **C** | 870 | 21 | 20 |
| Rock **D** | 620 | 473 | 214 |

4.4.3.2 Different half-lives of radioactive isotopes

Question 32 · continued



**0 6 . 2** Which radioactive rock emitted only alpha radiation?

Give a reason for your answer.

**[2 marks]**

Tick (✓) **one** box.

Rock **A** ☐

Rock **B** ☐

Rock **C** ☐

Rock **D** ☐

Reason _____

_____

**0 6 . 3** Which radioactive rock emitted only beta radiation?

Give a reason for your answer.

**[2 marks]**

Tick (✓) **one** box.

Rock **A** ☐

Rock **B** ☐

Rock **C** ☐

Rock **D** ☐

Reason _____

_____

4.4.3.2 Different half-lives of radioactive isotopes

Question 32 · continued



**0 6 . 4** The teacher took safety precautions during the experiment.

Which precaution would prevent the teacher from becoming contaminated by the radioactive rocks?

**[1 mark]**

Tick (✓) **one** box.

- Displaying the radiation hazard symbol ☐
- Handling the rocks with clean hands ☐
- Wearing protective gloves ☐

**0 6 . 5** What is the activity of each rock after one half-life?

**[1 mark]**

Tick (✓) **one** box.

- The activity is a quarter of the original activity. ☐
- The activity is half the original activity. ☐
- The activity is double the original activity. ☐
- The activity is zero. ☐

4.4.3.2 Different half-lives of radioactive isotopes

Question 32 · continued



**0 6 . 6** How does the activity of a radioactive source affect the risk of harm from the source?

**[1 mark]**

Tick (✓) **one** box.

The smaller the activity, the greater the risk of harm. ☐

The activity does not affect the risk of harm. ☐

The greater the activity, the greater the risk of harm. ☐

9

**Turn over for the next question**

### 4.4.3.2 Different half-lives of radioactive isotopes

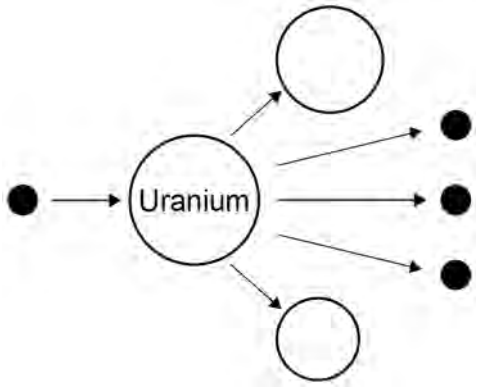
**Question 33**

June 2024 | 8463/1F | Original Q10

**1 0** The process of nuclear fission is used in nuclear power stations.

**Figure 17** shows the process of nuclear fission.

**Figure 17**




**1 0 . 1** Complete the sentences.

Choose answers from the box.

**[3 marks]**

| | | | | |
|---|---|---|---|---|
| **electrons** | **gamma rays** | **neutrons** | **nuclei** | **protons** |

In nuclear power stations, energy is released from

uranium _____.

The uranium in **Figure 17** splits into two parts and

releases three _____.

The process of nuclear fission releases electromagnetic radiation in the

form of _____.

4.4.3.2 Different half-lives of radioactive isotopes

Question 33 · continued



Use the Physics Equations Sheet to answer questions **10.2** and **10.3**.

**10.2** Write down the equation which links energy (*E*), power (*P*) and time (*t*).

**[1 mark]**

**10.3** A nuclear power station has a power output of 500 MW.

Calculate the energy output in 3600 s.

Give your answer in J.

**[3 marks]**

Energy output = _____ J

**10.4** Radioactive waste produced by nuclear power stations has a long half-life.

Suggest **one** precaution taken to reduce the hazard caused by radioactive waste from power stations.

**[1 mark]**

4.4.3.2 Different half-lives of radioactive isotopes

Question 33 · continued



**1 0 . 5** Nuclear power stations do **not** generate electricity every day of the year.

One nuclear power station generated electricity for 92% of a year.

one year = 365 days

Calculate the number of days during the year that the nuclear power station generated electricity.

**[2 marks]**

Number of days = _____

10

**Turn over for the next question**

### 4.4.3.2 Different half-lives of radioactive isotopes

**Question 34**

June 2025 | 8463/1F | Original Q3

**0 3** Different radioactive isotopes emit different types of radiation.

**0 3 . 1** One isotope of uranium (U) decays into thorium (Th) by emitting an alpha particle (He).

Which nuclear equation shows the decay of this isotope of uranium?

**[1 mark]**

Tick (✓) **one** box.

$^{230}_{92}U \rightarrow {}^{226}_{90}Th + {}^{4}_{2}He$ ☐

$^{226}_{90}Th \rightarrow {}^{230}_{92}U + {}^{4}_{2}He$ ☐

$^{230}_{92}U + {}^{226}_{90}Th \rightarrow {}^{4}_{2}He$ ☐

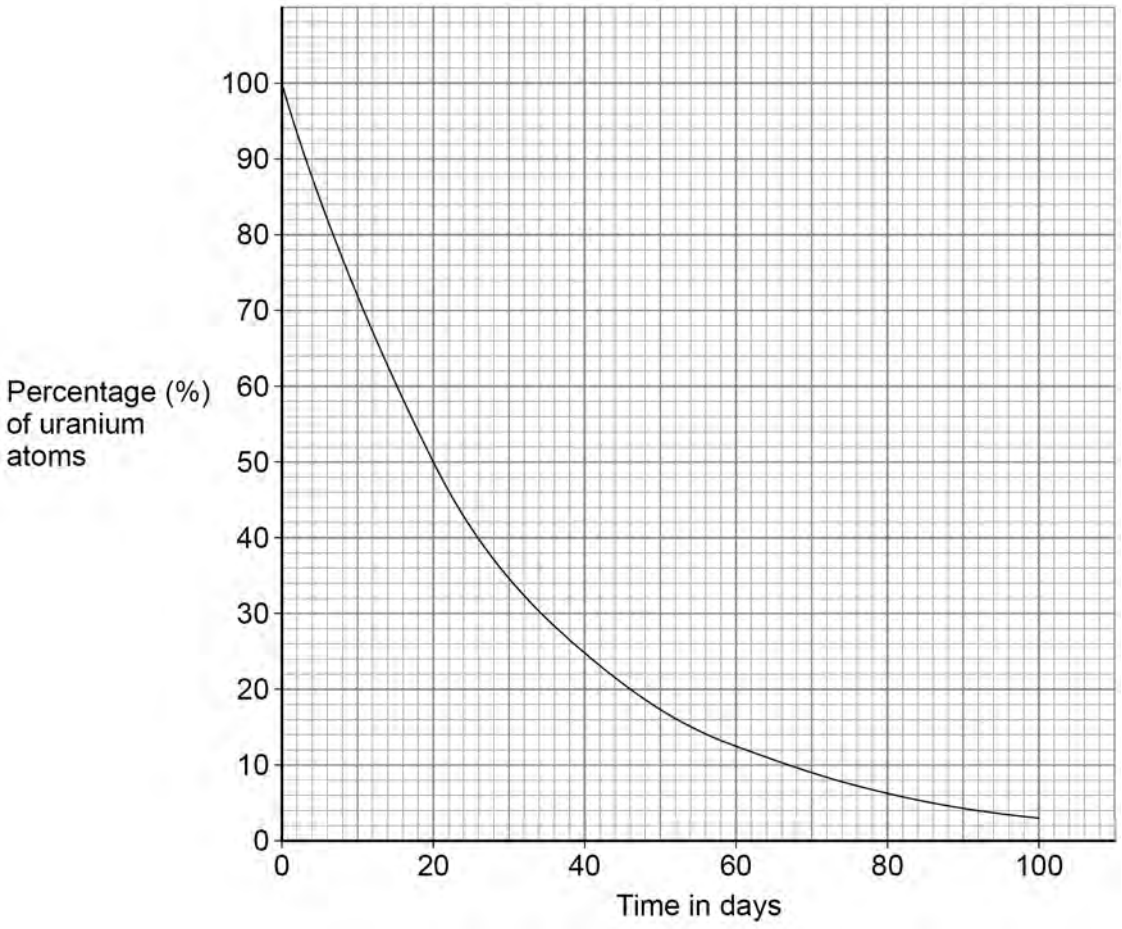
4.4.3.2 Different half-lives of radioactive isotopes

Question 34 · continued



**Figure 4** shows how the percentage of uranium atoms in a sample of one uranium isotope varies with time.

**Figure 4**




**0 3 . 2** What is the time taken for 50% of the atoms of this uranium isotope to decay?

Use **Figure 4**.

**[1 mark]**

Time taken = _____ days

**0 3 . 3** What is the half-life of this uranium isotope?

**[1 mark]**

Half-life = _____ days

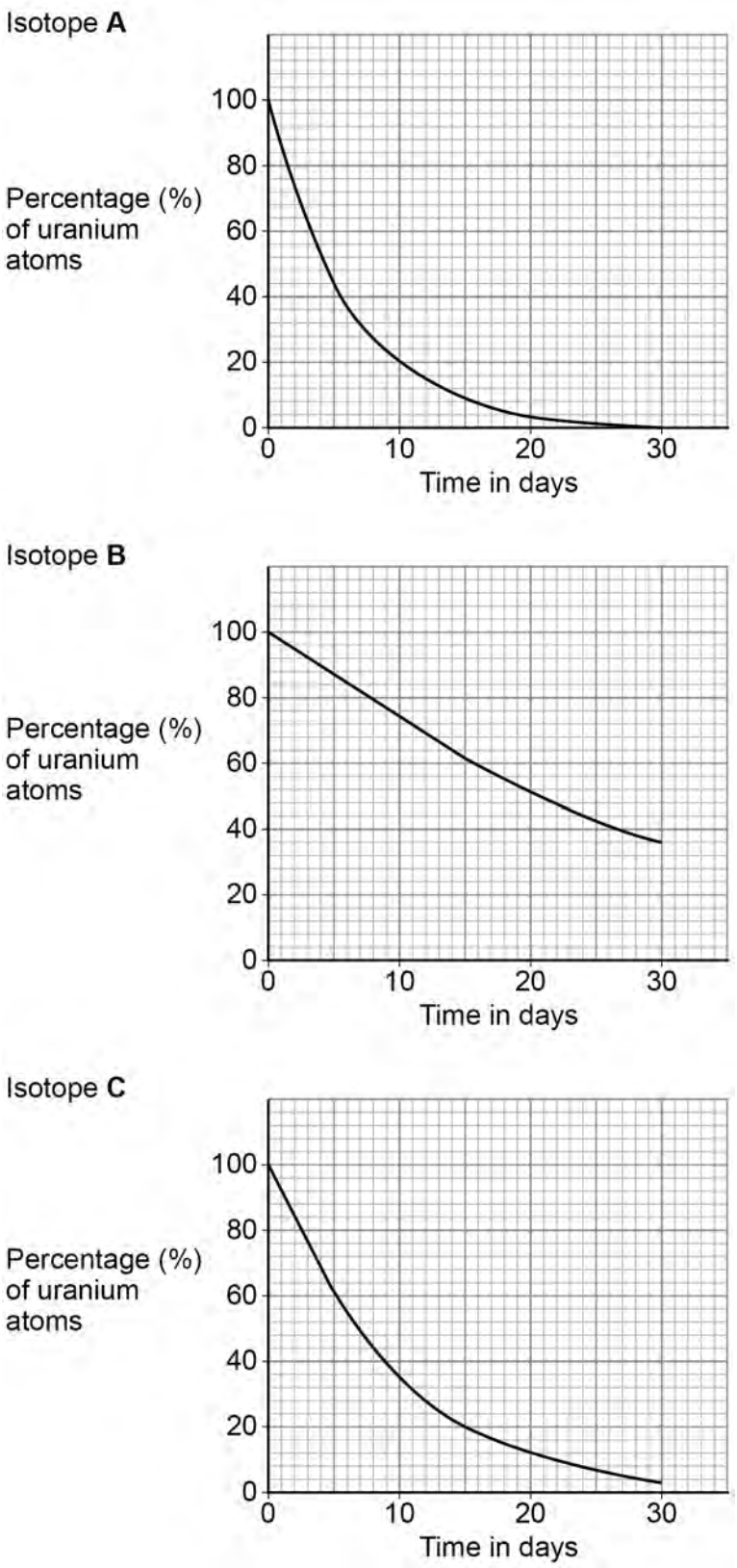
**4.4.3.2 Different half-lives of radioactive isotopes**

**Question 34 · continued**



**0 3 . 4** **Figure 5** shows how the percentage of uranium atoms varies with time for three different isotopes of uranium, **A**, **B** and **C**.

**Figure 5**



### 4.4.3.2 Different half-lives of radioactive isotopes

**Question 34 · continued**



Which isotope is the most unstable?

Give a reason for your answer.

**[2 marks]**

Tick (✓) **one** box.

Isotope **A** ☐

Isotope **B** ☐

Isotope **C** ☐

Reason _____

_____

_____

**Question 3 continues on the next page**

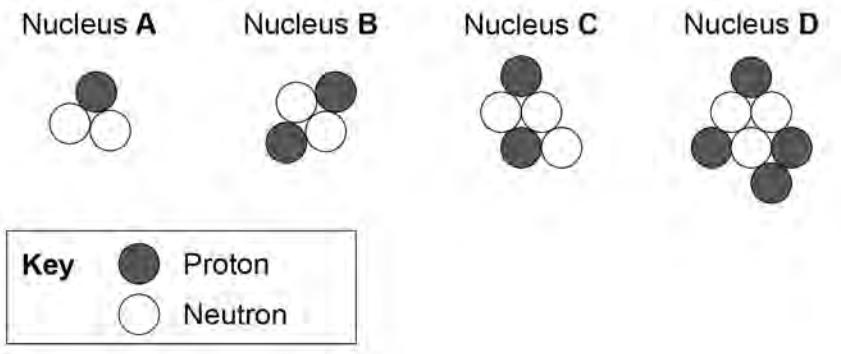
4.4.3.2 Different half-lives of radioactive isotopes

Question 34 · continued



**Figure 6** shows the nuclei of four different atoms.

**Figure 6**




**0 3 . 5** Which nucleus in **Figure 6** has the smallest **mass** number?

**[1 mark]**

Tick (✓) **one** box.

**A** ☐ **B** ☐ **C** ☐ **D** ☐

**0 3 . 6** Which nucleus in **Figure 6** has an **atomic** number of 4?

**[1 mark]**

Tick (✓) **one** box.

**A** ☐ **B** ☐ **C** ☐ **D** ☐

4.4.3.2 Different half-lives of radioactive isotopes

Question 34 · continued



**0 3 . 7** Which **two** nuclei in **Figure 6** are isotopes of the same element?

Give a reason for your answer.

**[2 marks]**

Nucleus ☐ and nucleus ☐

Reason _____

_____

Scientists have replaced old models of the atom with newer models.

The nuclear model of the atom has a nucleus at the centre.

**0 3 . 8** Which model of the atom was replaced by the nuclear model?

**[1 mark]**

Tick (✓) **one** box.

Bohr model ☐

Plum pudding model ☐

Tiny spheres that cannot be divided ☐

**0 3 . 9** What does the nuclear model state about the mass of an atom?

**[1 mark]**

Tick (✓) **one** box.

The mass of the atom is concentrated in the electrons. ☐

The mass of the atom is concentrated in the nucleus. ☐

The mass of the atom is spread throughout the atom. ☐

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