AQA GCSE Physics | 8463

SPECIFICATION POINT 4.4.2.1

# Radioactive decay and nuclear radiation

## Past-paper questions

| | |
|---|---|
| Tier | **Foundation** |
| Question groups | **141** |
| 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:** _____

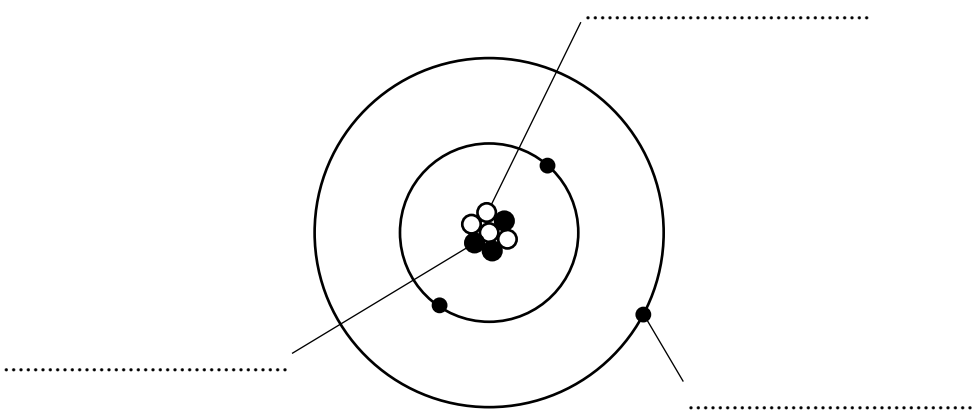
Whole questions are retained for context, so some parts assess other specification points. Current and legacy sources are labelled. Continue on extra paper if needed.

### 4.4.2.1 Radioactive decay and nuclear radiation

**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)*

**4.4.2.1 Radioactive decay and nuclear radiation**

**Question 01 · continued**



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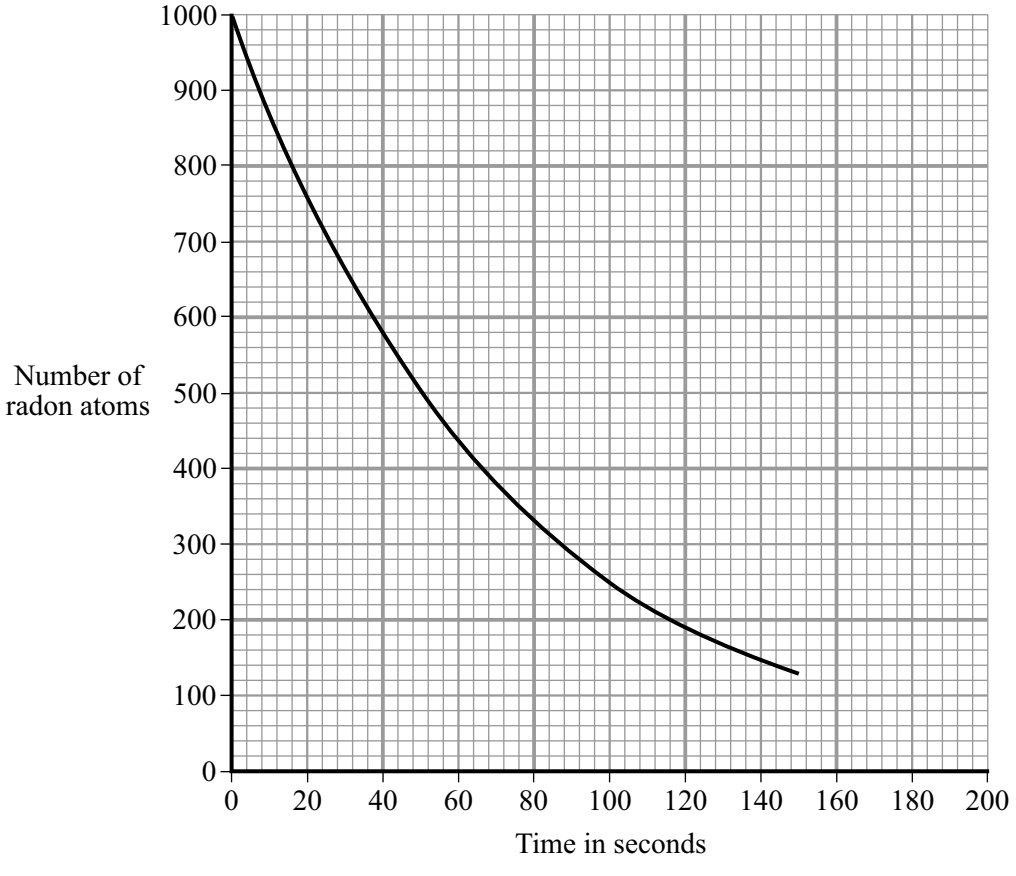
(b) Radon is a radioactive element. The graph shows how the number of radon atoms in a sample of air changes with time.




(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)*

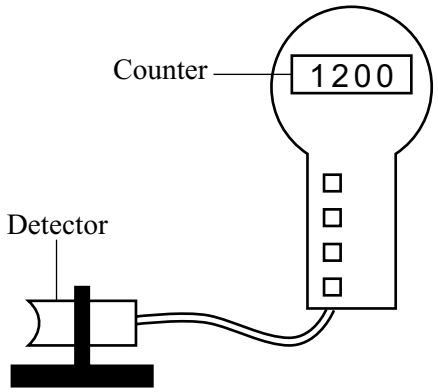
9

**4.4.2.1 Radioactive decay and nuclear radiation**

**Question 02**

June 2003 | 3451F | Original Q14 | Legacy

**14** (a) The diagram shows a radiation detector and counter being used to measure background radiation. The number shows the count ten minutes after the counter was reset to zero.




(i) Name **one** source of background radiation.

.....

*(1 mark)*

(ii) Calculate the average background radiation level, in counts per second. Show clearly how you work out your answer.

.....

.....

Background radiation level = .....counts per second

*(2 marks)*

**4.4.2.1 Radioactive decay and nuclear radiation**

**Question 02 · continued**





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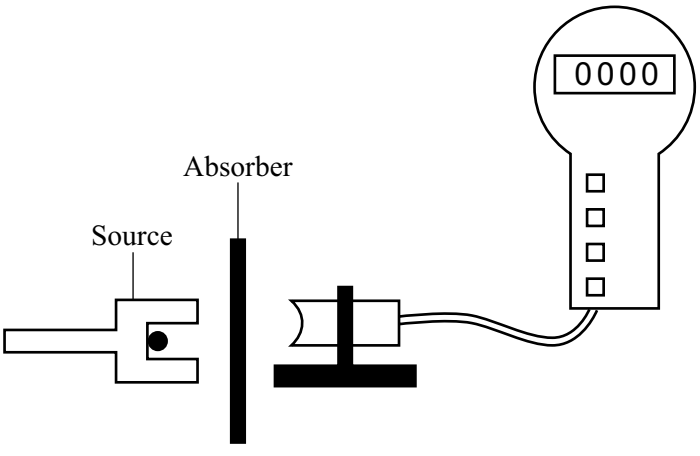
(b) The detector and counter are used in an experiment to show that a radioactive source gives out alpha and beta radiation only.




Two different types of absorber are placed one at a time between the detector and the source. For each absorber, a count is taken over ten minutes and the average number of counts per second worked out. The results are shown in the table.

| Absorber used | Average counts per second |
|---|---|
| No absorber | 33 |
| Card 1 mm thick | 20 |
| Metal 3 mm thick | 2 |

Explain how these results show that alpha and beta radiation is being given out, but gamma radiation is **not** being given out.

.....

.....

.....

.....

.....

.....

*(3 marks)*

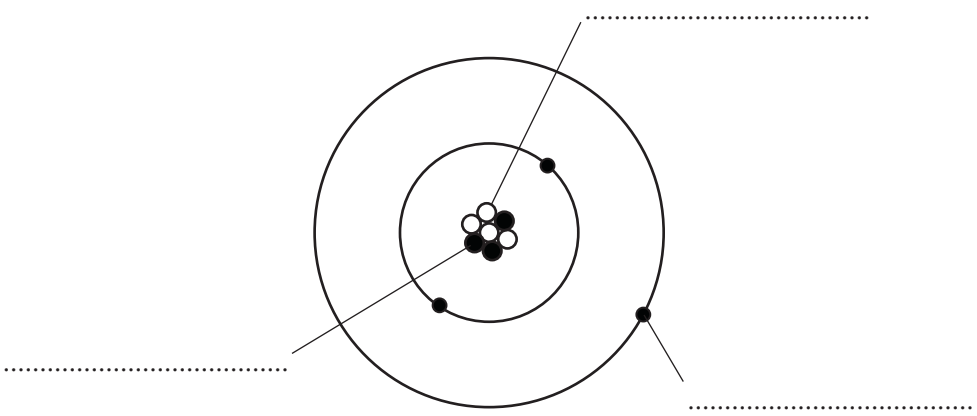
6

**4.4.2.1 Radioactive decay and nuclear radiation**

**Question 03**

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?

.....

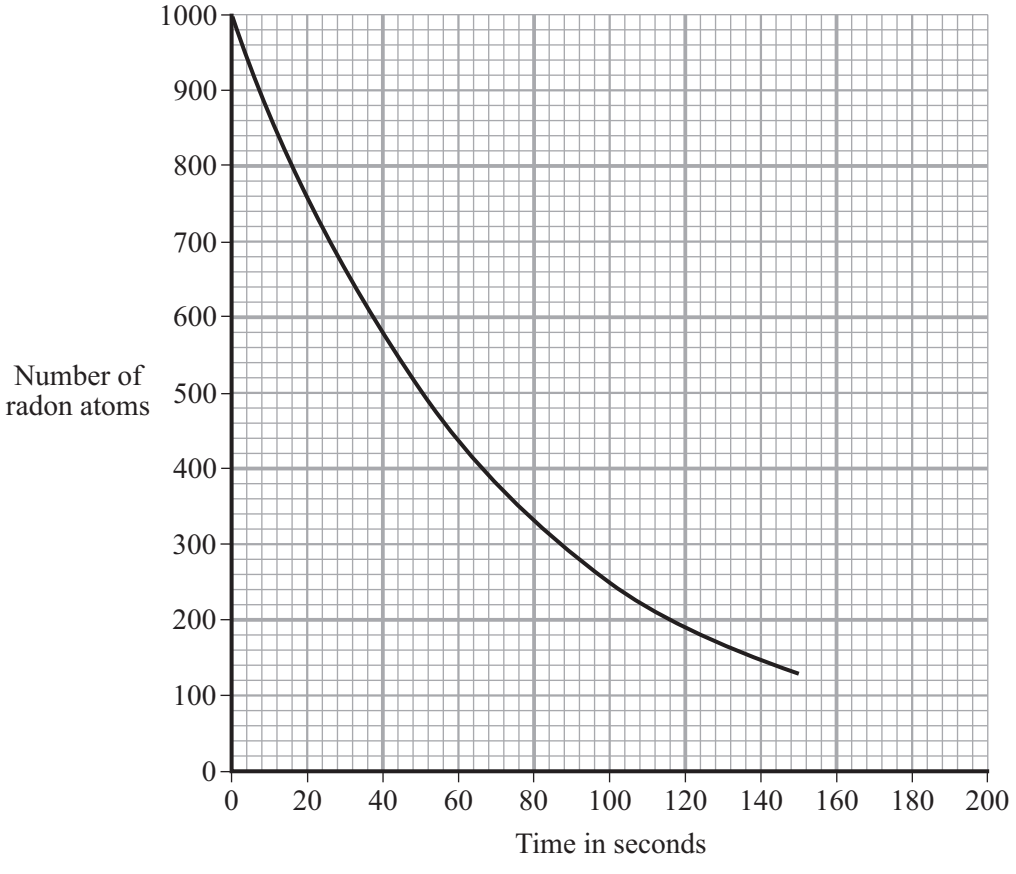
Give a reason for your choice.

.....

.....

*(2 marks)*

(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)*

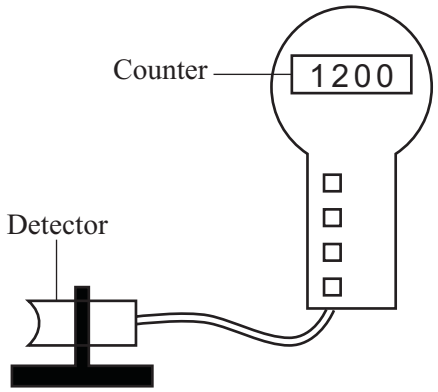
9

### 4.4.2.1 Radioactive decay and nuclear radiation

**Question 04**

June 2003 | 3462F3 | Original Q12 | Legacy

**12** (a) The diagram shows a radiation detector and counter being used to measure background radiation. The number shows the count ten minutes after the counter was reset to zero.




(i) Name **one** source of background radiation.

.....

*(1 mark)*

(ii) Calculate the average background radiation level, in counts per second. Show clearly how you work out your answer.

.....

.....

Background radiation level = .....counts per second

*(2 marks)*

**4.4.2.1 Radioactive decay and nuclear radiation**

**Question 04 · continued**





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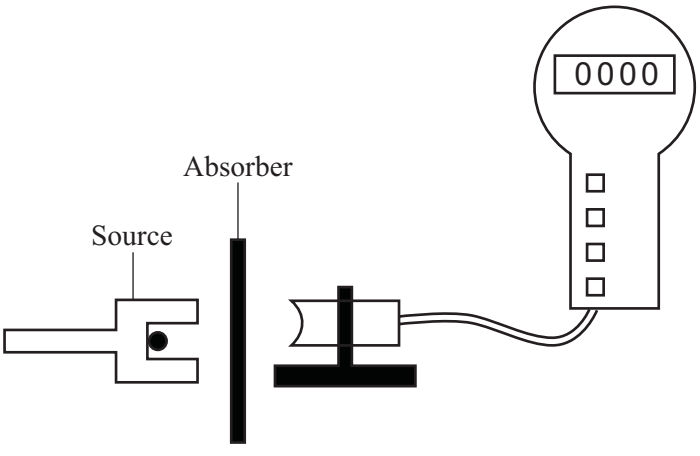
(b) The detector and counter are used in an experiment to show that a radioactive source gives out alpha and beta radiation only.




Two different types of absorber are placed one at a time between the detector and the source. For each absorber, a count is taken over ten minutes and the average number of counts per second worked out. The results are shown in the table.

| Absorber used | Average counts per second |
|---|---|
| No absorber | 33 |
| Card 1 mm thick | 20 |
| Metal 3 mm thick | 2 |

Explain how these results show that alpha and beta radiation is being given out, but gamma radiation is **not** being given out.

.....

.....

.....

.....

.....

.....

*(3 marks)*

6

### 4.4.2.1 Radioactive decay and nuclear radiation

**Question 05**

June 2004 | 3451F | Original Q2 | Legacy

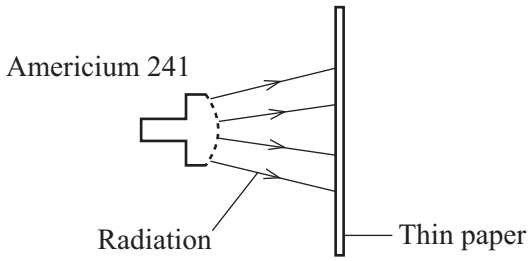
**2** A smoke detector fitted inside a house contains a radioactive source, americium 241.

(a) Complete the following table of information for an atom of americium 241.

| | |
|---|---|
| Number of neutrons | 146 |
| Number of protons | 95 |
| Number of electrons | |

*(1 mark)*

(b) The diagram shows that the radiation given out by americium 241 does not go through paper.




Which type of radiation, alpha (α), beta (β), or gamma (γ) is given out by americium 241?

.....

*(1 mark)*

(c) Explain why the radiation given out by the americium 241 is unlikely to do any harm to people living in the house.

.....

.....

.....

.....

*(2 marks)*

(d) Complete the sentence by choosing an answer from the box.

| | | |
|---|---|---|
| **less than** | **more than** | **the same as** |

After many years the radiation emitted by americium 241 will be ..... when the smoke detector was new.

*(1 mark)*

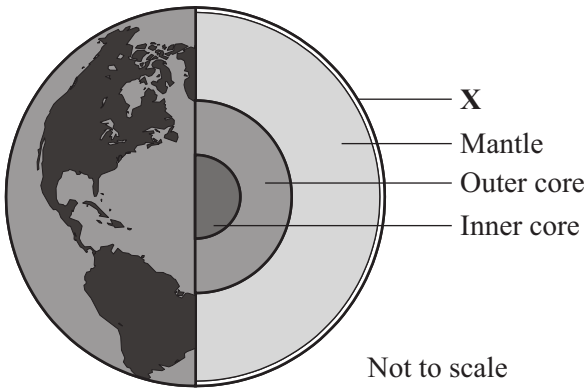
5

### 4.4.2.1 Radioactive decay and nuclear radiation

**Question 06**

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)*

**4.4.2.1 Radioactive decay and nuclear radiation**

**Question 06 · 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

### 4.4.2.1 Radioactive decay and nuclear radiation

**Question 07**

June 2004 | 3451F | Original Q11 | Legacy

**11** The diagram represents the electromagnetic spectrum.

| Gamma rays | X-rays | Ultraviolet | Visible light | Infra red | Microwaves | Radio waves |
|---|---|---|---|---|---|---|

(a) Name the type of electromagnetic radiation that is used:

(i) to sterilise surgical instruments;

.....

*(1 mark)*

(ii) to send a signal to a TV from a remote control.

.....

*(1 mark)*

(b) Valuable items can be security marked using special ink. The ink can only be seen in ultraviolet radiation.



Explain what happens to make the ink visible.

.....

.....

.....

.....

*(2 marks)*

**4.4.2.1 Radioactive decay and nuclear radiation**

**Question 07 · continued**





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(c) Explain why skin cells need to be protected from ultraviolet radiation.

.....

.....

.....

.....

*(2 marks)*

(d) The following information is from an oven that combines a microwave and a grill.

| | |
|---|---|
| Voltage | 230 V |
| Microwave power | 0.65 kW |
| Grill power | 1.15 kW |

(i) Name the **two** types of electromagnetic radiation that the oven can use to cook food.

..... and .....

*(1 mark)*

(ii) A joint of meat is cooked using both the microwave and the grill. Both are switched on at full power for half an hour.

Use the following equation to calculate the energy transferred, in kilowatt-hours, by the oven. Show clearly how you obtain your answer.

energy transferred = power × time

.....

.....

.....

energy transferred =.....kWh

*(2 marks)*

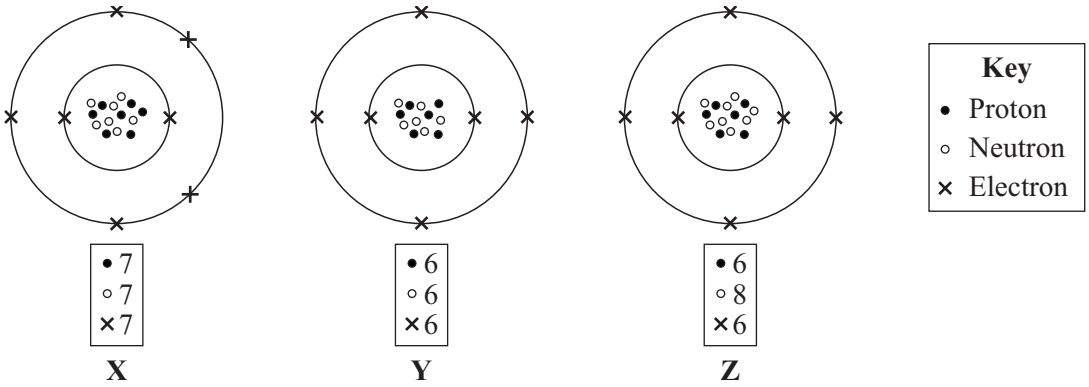
9

**4.4.2.1 Radioactive decay and nuclear radiation**

**Question 08**

June 2004 | 3451F | Original Q16 | Legacy

**16** (a) The diagrams represent three atoms **X**, **Y** and **Z**.




Which **two** of the atoms are from the same element?

.....

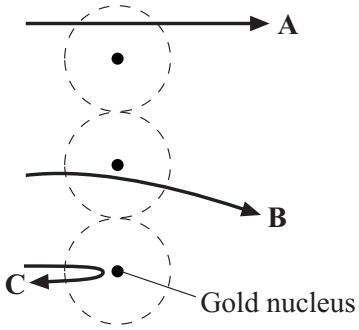
Give a reason for your answer.

.....

.....

*(2 marks)*

(b) In the early part of the 20th century some scientists investigated the paths taken by positively charged alpha particles into and out of a very thin piece of gold foil. The diagram shows the paths of three alpha particles.




Explain the different paths **A**, **B** and **C** of the alpha particles.

*To gain full marks in this question you should write your ideas in good English. Put them into a sensible order and use the correct scientific words.*

.....

.....

.....

.....

.....

*(3 marks)*

5

### 4.4.2.1 Radioactive decay and nuclear radiation

**Question 09**

June 2004 | 3462F3 | Original Q2 | Legacy

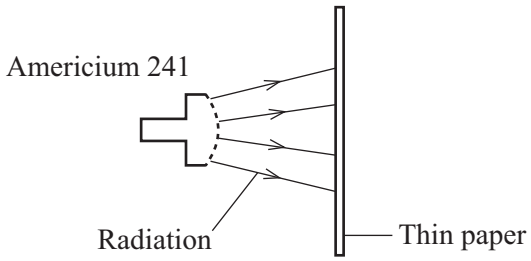
**2** A smoke detector fitted inside a house contains a radioactive source, americium 241.

(a) Complete the following table of information for an atom of americium 241.

| | |
|---|---|
| Number of neutrons | 146 |
| Number of protons | 95 |
| Number of electrons | |

*(1 mark)*

(b) The diagram shows that the radiation given out by americium 241 does not go through paper.




Which type of radiation, alpha (α), beta (β), or gamma (γ) is given out by americium 241?

.....

*(1 mark)*

(c) Explain why the radiation given out by the americium 241 is unlikely to do any harm to people living in the house.

.....

.....

.....

.....

*(2 marks)*

(d) Complete the sentence by choosing an answer from the box.

| | | |
|---|---|---|
| **less than** | **more than** | **the same as** |

After many years the radiation emitted by americium 241 will be ..... when the smoke detector was new.

*(1 mark)*

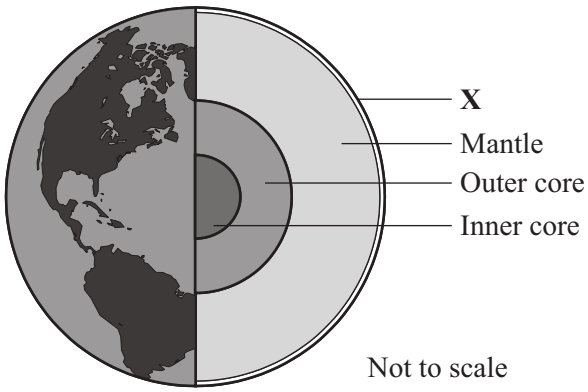
5

### 4.4.2.1 Radioactive decay and nuclear radiation

**Question 10**

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)*

**4.4.2.1 Radioactive decay and nuclear radiation**

**Question 10 · 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

### 4.4.2.1 Radioactive decay and nuclear radiation

**Question 11**

June 2004 | 3462F3 | Original Q9 | Legacy

**9** The diagram represents the electromagnetic spectrum.

| Gamma rays | X-rays | Ultraviolet | Visible light | Infra red | Microwaves | Radio waves |
|---|---|---|---|---|---|---|

(a) Name the type of electromagnetic radiation that is used:

(i) to sterilise surgical instruments;

.....

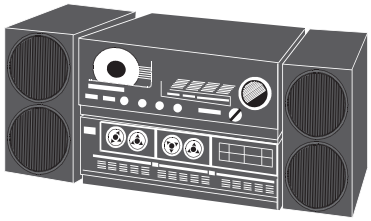
*(1 mark)*

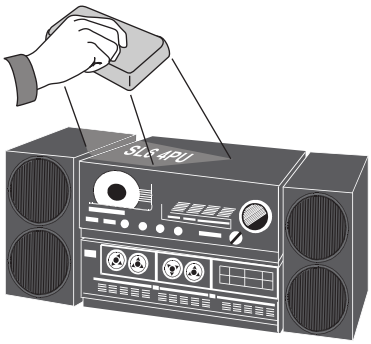
(ii) to send a signal to a TV from a remote control.

.....

*(1 mark)*

(b) Valuable items can be security marked using special ink. The ink can only be seen in ultraviolet radiation.





Explain what happens to make the ink visible.

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.....

.....

.....

*(2 marks)*

**4.4.2.1 Radioactive decay and nuclear radiation**

**Question 11 · continued**





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(c) Explain why skin cells need to be protected from ultraviolet radiation.

.....

.....

.....

.....

*(2 marks)*

(d) The following information is from an oven that combines a microwave and a grill.

| | |
|---|---|
| Voltage | 230 V |
| Microwave power | 0.65 kW |
| Grill power | 1.15 kW |

(i) Name the **two** types of electromagnetic radiation that the oven can use to cook food.

..... and .....

*(1 mark)*

(ii) A joint of meat is cooked using both the microwave and the grill. Both are switched on at full power for half an hour.

Use the following equation to calculate the energy transferred, in kilowatt-hours, by the oven. Show clearly how you obtain your answer.

energy transferred = power × time

.....

.....

.....

energy transferred =.....kWh

*(2 marks)*

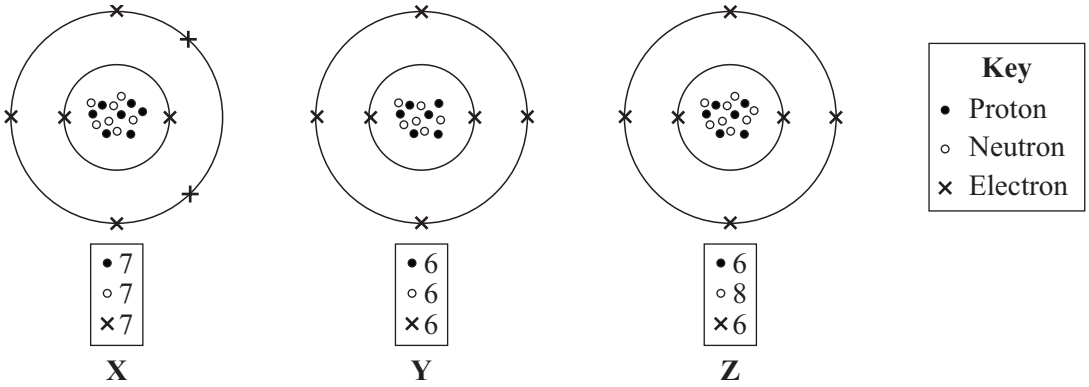
9

### 4.4.2.1 Radioactive decay and nuclear radiation

**Question 12**

June 2004 | 3462F3 | Original Q12 | Legacy

**12** (a) The diagrams represent three atoms **X**, **Y** and **Z**.




Which **two** of the atoms are from the same element?

.....

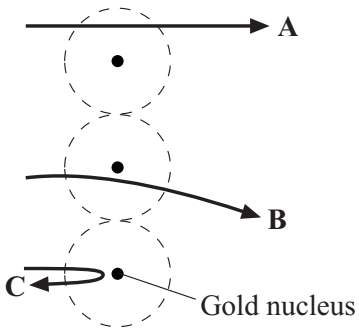
Give a reason for your answer.

.....

.....

*(2 marks)*

(b) In the early part of the 20th century some scientists investigated the paths taken by positively charged alpha particles into and out of a very thin piece of gold foil. The diagram shows the paths of three alpha particles.




Explain the different paths **A**, **B** and **C** of the alpha particles.

*To gain full marks in this question you should write your ideas in good English. Put them into a sensible order and use the correct scientific words.*

.....

.....

.....

.....

.....

*(3 marks)*

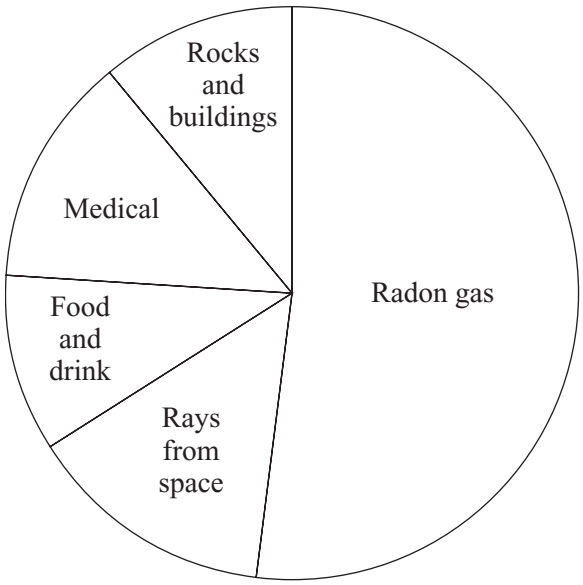
5

### 4.4.2.1 Radioactive decay and nuclear radiation

**Question 13**

June 2005 | 3451 | Original Q5 | Legacy

**5** (a) Radiation is around us all of the time. The pie chart shows the sources of this radiation.




(i) What is the main source of this radiation?

.....

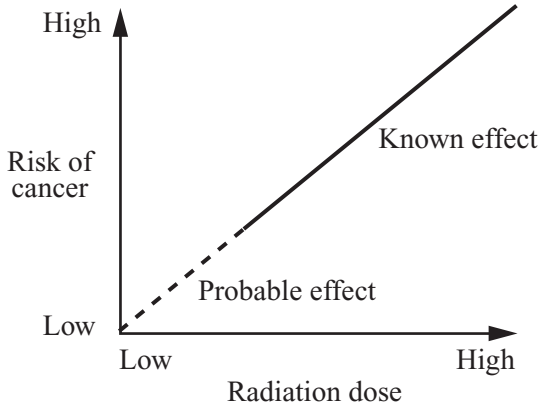
*(1 mark)*

(ii) What name is given to the radiation that is around us all of the time?

.....

*(1 mark)*

(b) Radiation can cause cancer. The graph shows that the risk of cancer depends on the radiation dose a person is exposed to.




Complete the following sentence.

The ..... the dose of radiation a person gets, the greater the risk of cancer.

*(1 mark)*

**4.4.2.1 Radioactive decay and nuclear radiation**

**Question 13 · continued**





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(c) A worker in a nuclear power station wears a special badge (diagram **1**). Diagram **2** shows what is inside the badge. When the film inside the badge is developed, it will be dark in the places where it has absorbed radiation.

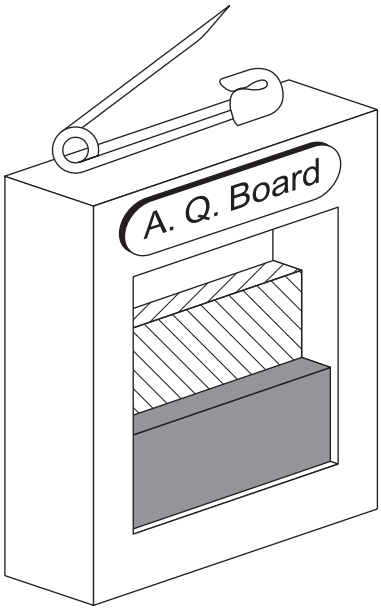



**Diagram 1**

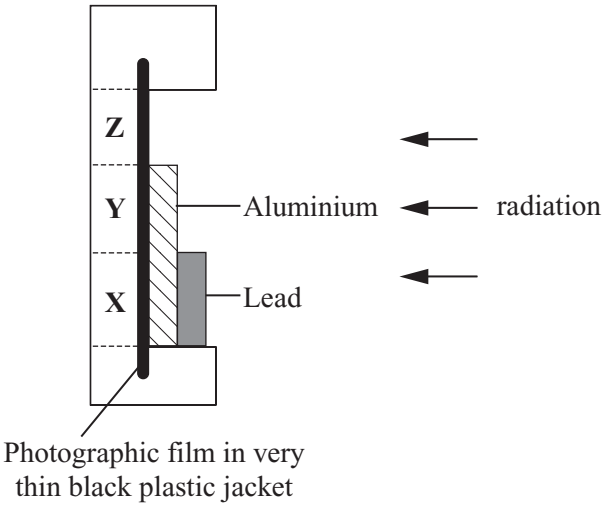



**Diagram 2**

Which part of the film, **X**, **Y** or **Z**, would darken if the worker had received a dose of alpha radiation?

.....

Give a reason for your answer.

.....

.....

*(2 marks)*

5

**TURN OVER FOR THE NEXT QUESTION**

### 4.4.2.1 Radioactive decay and nuclear radiation

**Question 14**

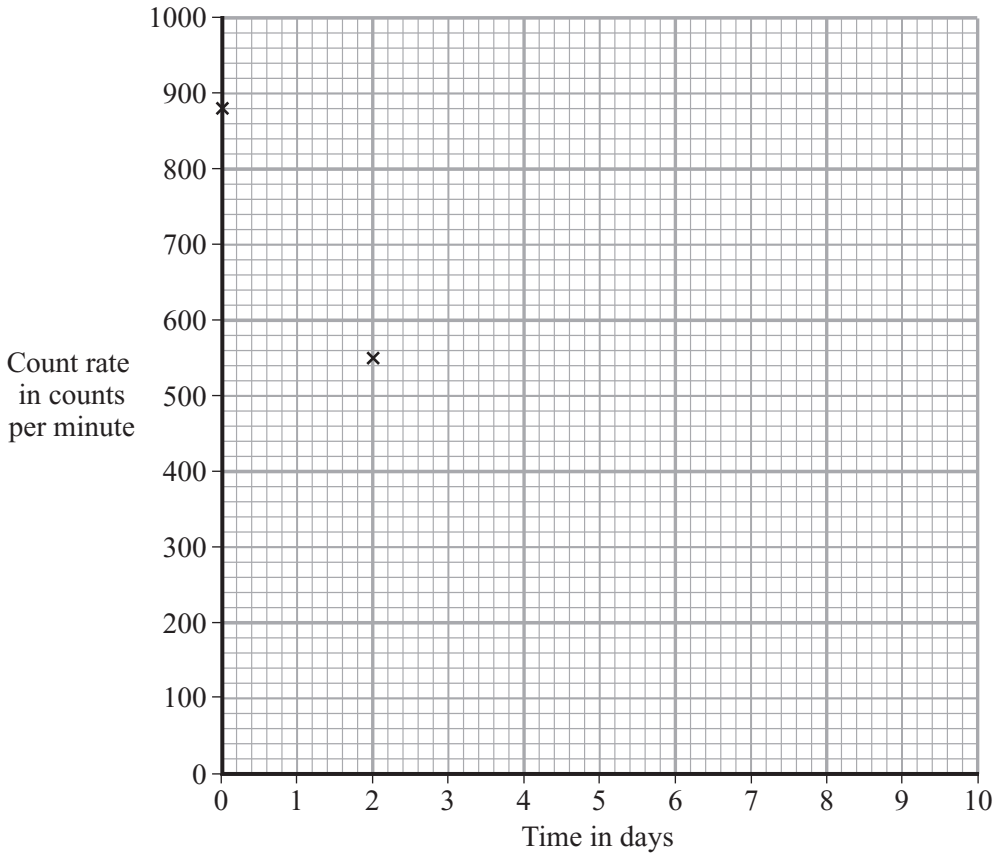
June 2005 | 3451 | Original Q7 | Legacy

**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)*

**4.4.2.1 Radioactive decay and nuclear radiation**

**Question 14 · 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

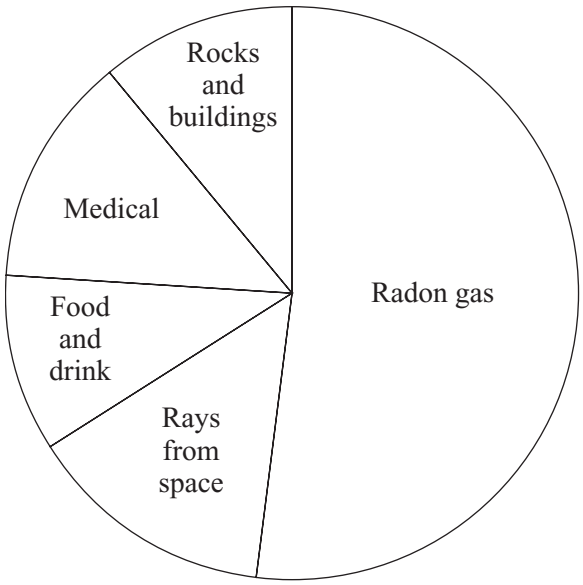
**TURN OVER FOR THE NEXT QUESTION**

### 4.4.2.1 Radioactive decay and nuclear radiation

**Question 15**

June 2005 | 3462 | Original Q5 | Legacy

**5** (a) Radiation is around us all of the time. The pie chart shows the sources of this radiation.




(i) What is the main source of this radiation?

.....

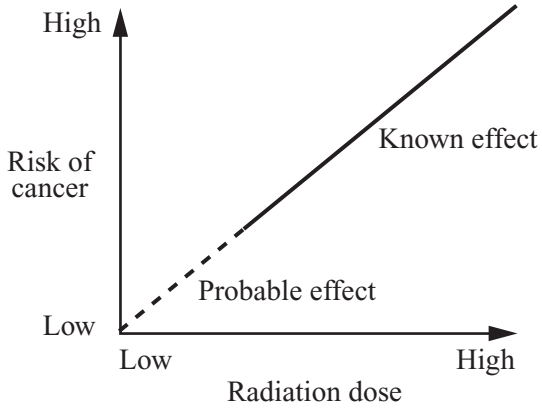
*(1 mark)*

(ii) What name is given to the radiation that is around us all of the time?

.....

*(1 mark)*

(b) Radiation can cause cancer. The graph shows that the risk of cancer depends on the radiation dose a person is exposed to.




Complete the following sentence.

The ..... the dose of radiation a person gets, the greater the risk of cancer.

*(1 mark)*

**Question 15 · continued**





MARGIN BLANK

(c) A worker in a nuclear power station wears a special badge (diagram **1**). Diagram **2** shows what is inside the badge. When the film inside the badge is developed, it will be dark in the places where it has absorbed radiation.

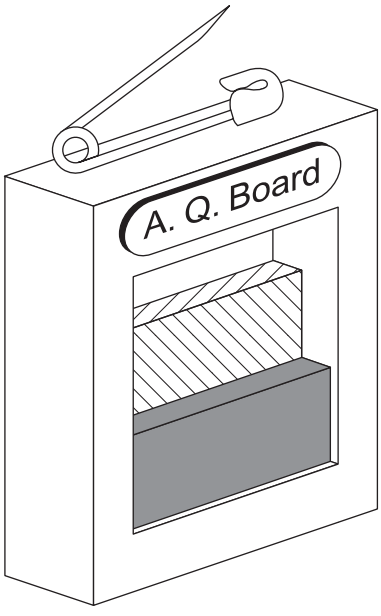



**Diagram 1**

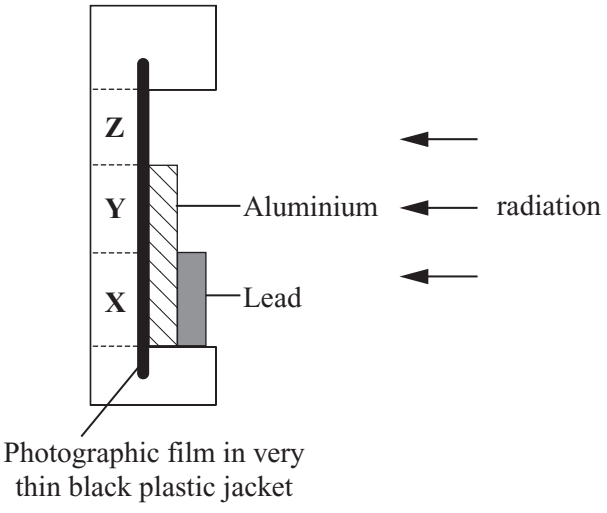



**Diagram 2**

Which part of the film, **X**, **Y** or **Z**, would darken if the worker had received a dose of alpha radiation?

.....

Give a reason for your answer.

.....

.....

*(2 marks)*

5

**TURN OVER FOR THE NEXT QUESTION**

### 4.4.2.1 Radioactive decay and nuclear radiation

**Question 16**

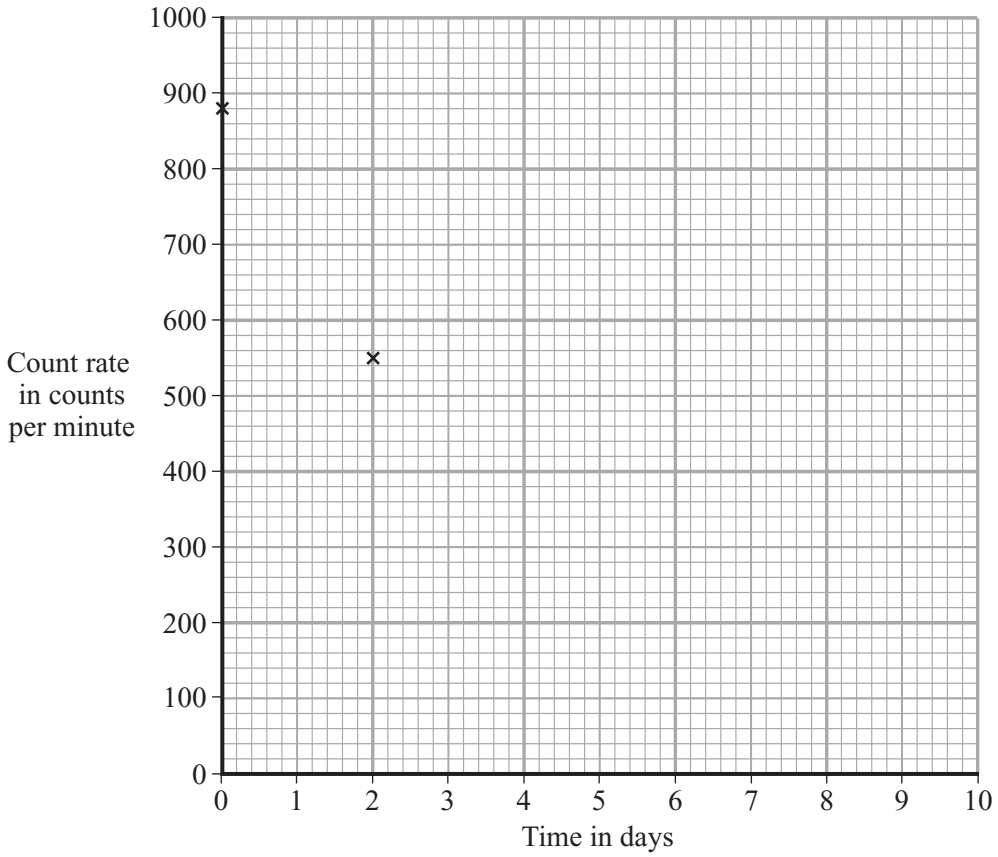
June 2005 | 3462 | Original Q7 | Legacy

**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)*

**4.4.2.1 Radioactive decay and nuclear radiation**

**Question 16 · continued**





MARGIN
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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**

**4.4.2.1 Radioactive decay and nuclear radiation**

**Question 17**

June 2006 | 3451 | Original Q4 | Legacy

**4** (a) The diagrams, **A**, **B** and **C**, represent three different nuclei.

**Diagram A**



2 protons ⊕
4 neutrons ○

**Diagram B**



3 protons ⊕
3 neutrons ○

**Diagram C**



2 protons ⊕
2 neutrons ○

(i) Which **two** nuclei are isotopes of the same element?

..... and .....

*(1 mark)*

(ii) Which **two** nuclei have the same mass number?

..... and .....

*(1 mark)*

(iii) Give a reason for your choice of answer to part (a)(ii).

.....

.....

*(1 mark)*

**4.4.2.1 Radioactive decay and nuclear radiation**

**Question 17 · continued**



*BLANK*

(b) The tables below give examples of some stable nuclei and some unstable nuclei.

| Stable nuclei |
|---|
| boron-11 |
| carbon-12 |
| oxygen-16 |
| lead-207 |

| Unstable nuclei |
|---|
| boron-12 |
| carbon-14 |
| oxygen-15 |
| lead-209 |

(i) Write down, from the tables, the names of **two** radioactive nuclei.

..... and .....

*(1 mark)*

(ii) Write down, from the tables, the names of **two** non-radioactive nuclei.

..... and .....

*(1 mark)*

(c) Complete the following sentence by crossing out the **two** words in the box that are wrong.

The lungs of a person who has breathed in a radioactive gas will be most damaged if the gas gives out

| alpha |
|---|
| beta |
| gamma |

radiation.

*(1 mark)*

**6**

4.4.2.1 Radioactive decay and nuclear radiation

Question 18

June 2006 | 3451 | Original Q9 | Legacy

**9** **Diagram 1** shows how beta (β) and gamma (γ) radiation pass through aluminium.

**Diagram 1**

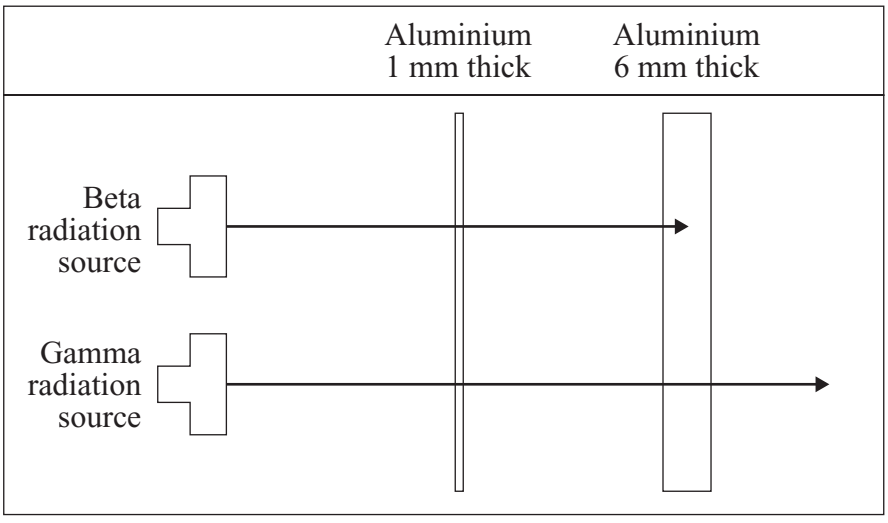
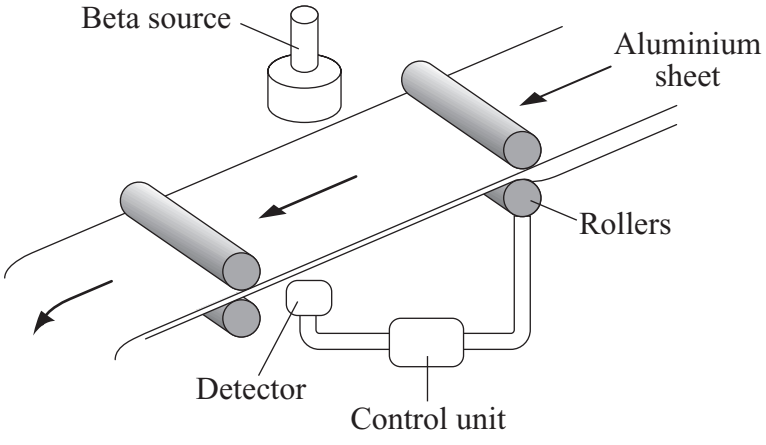



**Diagram 2** shows how a beta radiation source is used to monitor and control the thickness of an aluminium sheet as it is made.

**Diagram 2**



**4.4.2.1 Radioactive decay and nuclear radiation**

**Question 18 · continued**



BLANK

(a) Explain why a gamma radiation source cannot be used to monitor the thickness of the aluminium sheet.

*To gain full marks in this question you should write your ideas in good English. Put them into a sensible order and use the correct scientific words.*

.....

.....

.....

.....

.....

.....

.....

*(3 marks)*

(b) The following sentences describe what happens if the aluminium sheet is being made too thin.

The sentences are in the wrong order.

**S** The aluminium sheet absorbs less beta radiation so more reaches the detector.

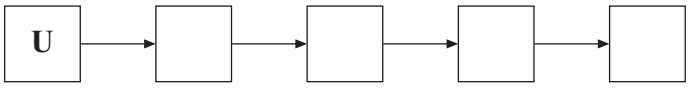
**T** The gap between the rollers is increased.

**U** The gap between the rollers is too small, making the aluminium sheet too thin.

**V** The aluminium sheet is now rolled a little thicker.

**W** A signal goes from the detector to the control unit.

Arrange the sentences in the right order. Start with sentence **U**.




*(3 marks)*

**6**

**4.4.2.1 Radioactive decay and nuclear radiation**

**Question 19**

June 2006 | 3462 | Original Q4 | Legacy

**4** (a) The diagrams, **A**, **B** and **C**, represent three different nuclei.

**Diagram A**



2 protons ⊕
4 neutrons ○

**Diagram B**



3 protons ⊕
3 neutrons ○

**Diagram C**



2 protons ⊕
2 neutrons ○

(i) Which **two** nuclei are isotopes of the same element?

..... and .....

*(1 mark)*

(ii) Which **two** nuclei have the same mass number?

..... and .....

*(1 mark)*

(iii) Give a reason for your choice of answer to part (a)(ii).

.....

.....

*(1 mark)*

**4.4.2.1 Radioactive decay and nuclear radiation**

**Question 19 · continued**



*BLANK*

(b) The tables below give examples of some stable nuclei and some unstable nuclei.

| Stable nuclei |
|---|
| boron-11 |
| carbon-12 |
| oxygen-16 |
| lead-207 |

| Unstable nuclei |
|---|
| boron-12 |
| carbon-14 |
| oxygen-15 |
| lead-209 |

(i) Write down, from the tables, the names of **two** radioactive nuclei.

..... and .....

*(1 mark)*

(ii) Write down, from the tables, the names of **two** non-radioactive nuclei.

..... and .....

*(1 mark)*

(c) Complete the following sentence by crossing out the **two** words in the box that are wrong.

The lungs of a person who has breathed in a radioactive gas will be most damaged if the gas gives out

| alpha<br>beta<br>gamma |
|---|

radiation.

*(1 mark)*

**6**

4.4.2.1 Radioactive decay and nuclear radiation

Question 20

June 2006 | 3462 | Original Q9 | Legacy

**9** **Diagram 1** shows how beta (β) and gamma (γ) radiation pass through aluminium.

**Diagram 1**

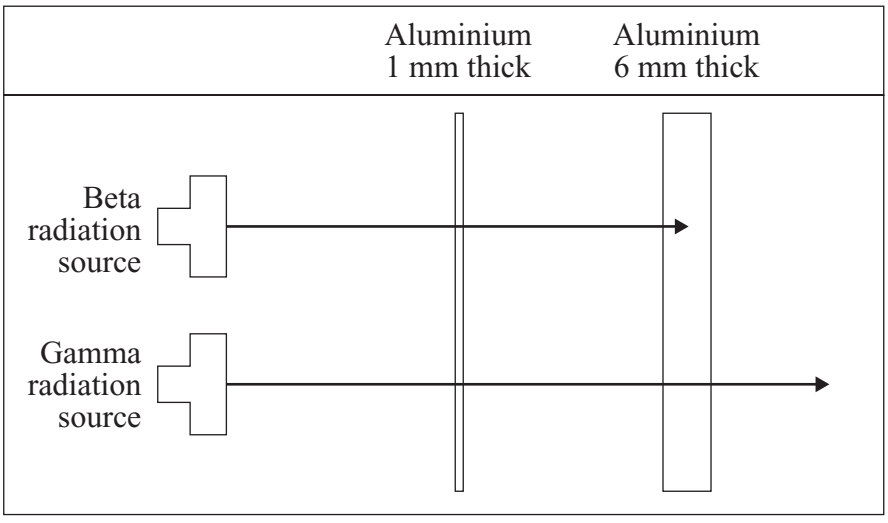
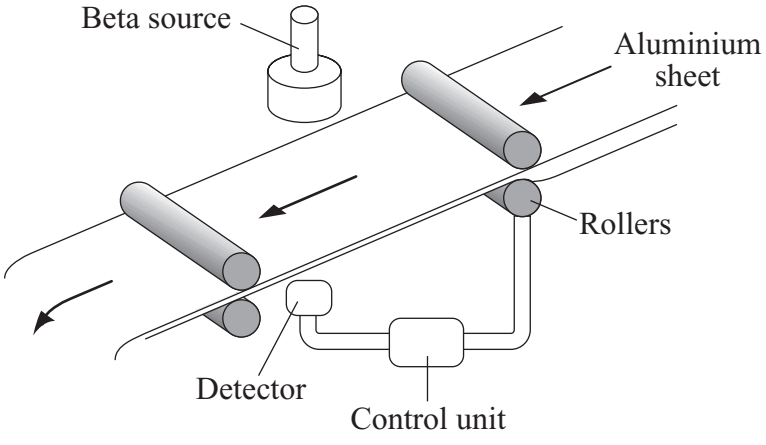



**Diagram 2** shows how a beta radiation source is used to monitor and control the thickness of an aluminium sheet as it is made.

**Diagram 2**



**4.4.2.1 Radioactive decay and nuclear radiation**

**Question 20 · continued**



BLANK

(a) Explain why a gamma radiation source cannot be used to monitor the thickness of the aluminium sheet.

*To gain full marks in this question you should write your ideas in good English. Put them into a sensible order and use the correct scientific words.*

.....

.....

.....

.....

.....

.....

.....

*(3 marks)*

(b) The following sentences describe what happens if the aluminium sheet is being made too thin.

The sentences are in the wrong order.

**S** The aluminium sheet absorbs less beta radiation so more reaches the detector.

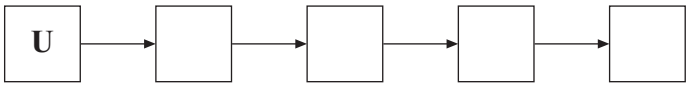
**T** The gap between the rollers is increased.

**U** The gap between the rollers is too small, making the aluminium sheet too thin.

**V** The aluminium sheet is now rolled a little thicker.

**W** A signal goes from the detector to the control unit.

Arrange the sentences in the right order. Start with sentence **U**.




*(3 marks)*

6

4.4.2.1 Radioactive decay and nuclear radiation

Question 21

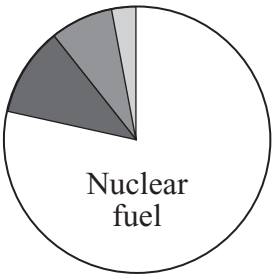
November 2006 | PHY1A | Original Q3 | Legacy

## QUESTION THREE

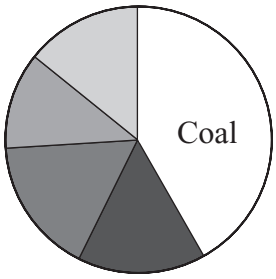
Different countries generate their electricity from different sources of energy.

The pie charts are for four different countries.

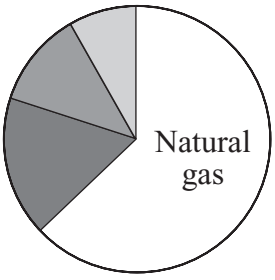
On each pie chart, the main source of energy used to generate electricity is named.



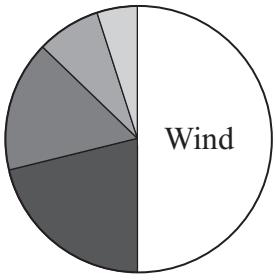

1




2




3




4

Match the countries, **A**, **B**, **C** and **D**, in the table, with the pie charts **1–4**.

| Country | Most likely pollution |
|---|---|
| **A** | Atmosphere becomes polluted with extra carbon dioxide and with sulfur dioxide |
| **B** | Atmosphere becomes polluted with extra carbon dioxide but not with sulfur dioxide |
| **C** | Noise pollution produced |
| **D** | Environment may become polluted with radioactive substances |

4.4.2.1 Radioactive decay and nuclear radiation

Question 22

November 2006 | PHY1B | Original Q2 | Legacy

## QUESTION TWO

Electromagnetic radiation can be grouped into types, each with a different range of wavelengths.

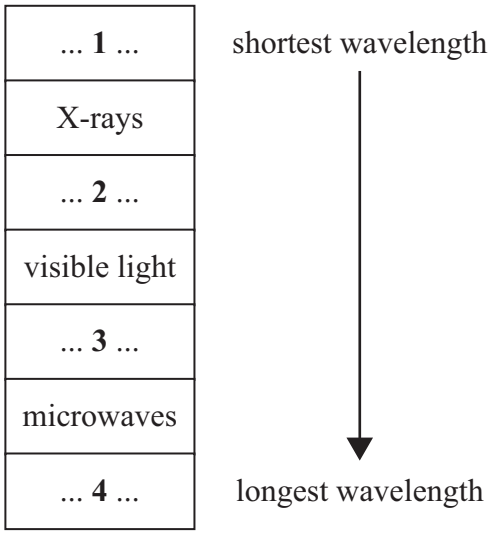
Match types of electromagnetic radiation, **A**, **B**, **C** and **D**, with the numbers **1–4** in the list.

**A** gamma rays

**B** infra red rays

**C** radio waves

**D** ultraviolet waves



4.4.2.1 Radioactive decay and nuclear radiation

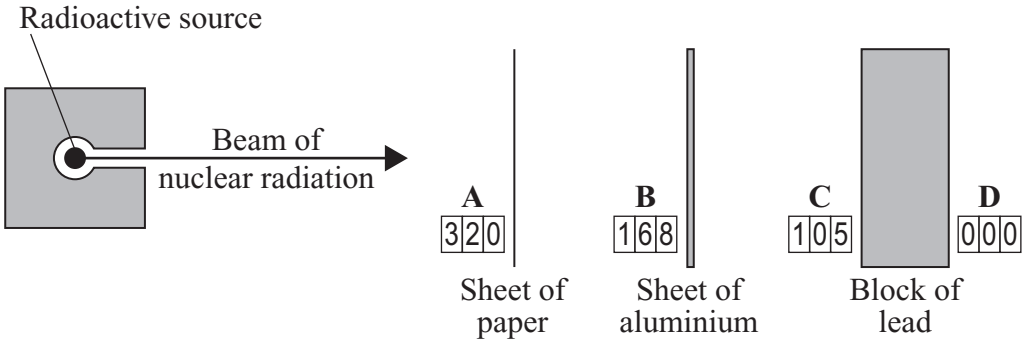
Question 23

November 2006 | PHY1B | Original Q4 | Legacy

## QUESTION FOUR

A radioactive source gives out a beam of nuclear radiation.

The diagram shows three different absorbers in the path of the beam. The diagram also shows the readings, in counts per second, on radiation detectors placed at positions **A**, **B**, **C** and **D**.




Match the positions, **A**, **B**, **C** and **D**, with the types of radiation **1–4** in the table.

| | **Type of radiation** |
|---|---|
| **1** | gamma only |
| **2** | gamma and beta only |
| **3** | gamma, beta and alpha |
| **4** | no radiation |

4.4.2.1 Radioactive decay and nuclear radiation

Question 24

November 2006 | PHY1B | Original Q7 | Legacy

## QUESTION SEVEN

Hospital patients are sometimes injected with radioactive tracers.



**7A** The purpose of a radioactive tracer is . . .

**1** to identify the patient's blood group.

**2** to sedate the patient before an operation.

**3** to track the movement of substances in the patient's body.

**4** to track the patient's movements in the hospital.

**7B** Which of the following is the most suitable radioactive substance to use as a tracer?

**1** a gamma emitter with a long half-life

**2** a gamma emitter with a short half-life

**3** an alpha emitter with a long half-life

**4** an alpha emitter with a short half-life

**4.4.2.1 Radioactive decay and nuclear radiation**

**Question 24 · continued**



**7C** Which of the following statements is correct for gamma radiation?

**1** It is a stream of electrons.

**2** It is a stream of protons.

**3** It is deflected by an electric field.

**4** It is **not** deflected by a magnetic field.

**7D** Which description is correct for the nucleus of a medium-sized atom?

It is a group of . . .

**1** electrons and neutrons.

**2** electrons, neutrons and protons.

**3** electrons and protons.

**4** neutrons and protons.

4.4.2.1 Radioactive decay and nuclear radiation

Question 25

November 2006 | PHY1B | Original Q9 | Legacy

**QUESTION NINE**

Read this extract from a science magazine.

## Stone Age campfire found in Norfolk

Material made from something which was once alive can be dated by measuring its radioactivity. This is because all living things contain a small proportion of radioactive carbon-14 atoms.

Carbon-14 decays by emitting beta (β) particles and its half-life is 5730 years.

**9A** An example of something which can be dated by using carbon-14 measurements is . . .

**1** a copper coin.

**2** a gold brooch.

**3** a leather belt.

**4** an iron horseshoe.

**9B** A sample of charcoal from the Stone Age campfire contains 12 billion carbon-14 atoms.

Approximately how many carbon-14 atoms would the sample have contained 6000 years ago?

**1** 6 billion

**2** 12 billion

**3** 24 billion

**4** 48 billion

**9C** Carbon-14 **cannot** be used to date samples more than 45 000 years old.

Four students discuss this.

Which student, **1**, **2**, **3** or **4**, has the correct explanation?

**1** 'It will take too long to make the measurements.'

**2** 'No carbon-14 atoms will be left in the specimen.'

**3** 'The proportion of carbon-14 atoms will be too small to measure.'

**4** 'There are no samples more than 45 000 years old.'

**9D** A beta (β) particle from an atom of carbon-14 is . . .

**1** an electron from the inner part (nucleus) of the atom.

**2** an electron from the outer part of the atom.

**3** a helium nucleus.

**4** a neutron.

**END OF TEST**

**4.4.2.1 Radioactive decay and nuclear radiation**

**Question 26**

January 2007 | PHY1F | Original Q2 | Legacy

**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)*

**4.4.2.1 Radioactive decay and nuclear radiation**

**Question 26 · continued**



*BLANK*

(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.

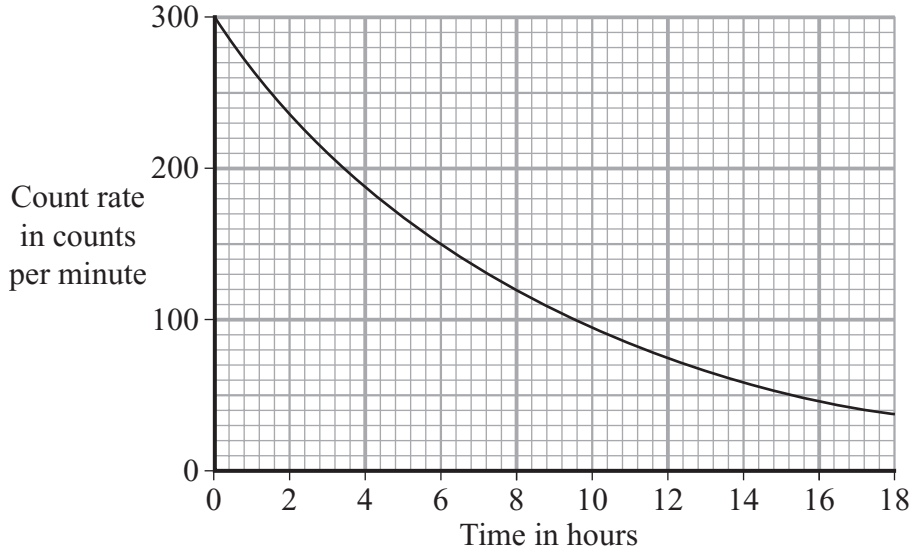
It can travel through a vacuum. ☐

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

### 4.4.2.1 Radioactive decay and nuclear radiation

**Question 27**

March 2007 | PHY1A | Original Q2 | Legacy

**QUESTION TWO**

Various types of power station use different energy sources and affect the environment in various ways.

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

**A** Coal-fired power stations

**B** Geothermal power stations

**C** Nuclear power stations

**D** Tidal power stations

. . . **1** . . . use energy from the natural decay of radioactive substances in the Earth.

. . . **2** . . . use no fuel but river estuaries have to be flooded.

. . . **3** . . . use uranium as a fuel in reactors.

. . . **4** . . . can pollute the atmosphere with sulfur dioxide.

4.4.2.1 Radioactive decay and nuclear radiation

Question 28

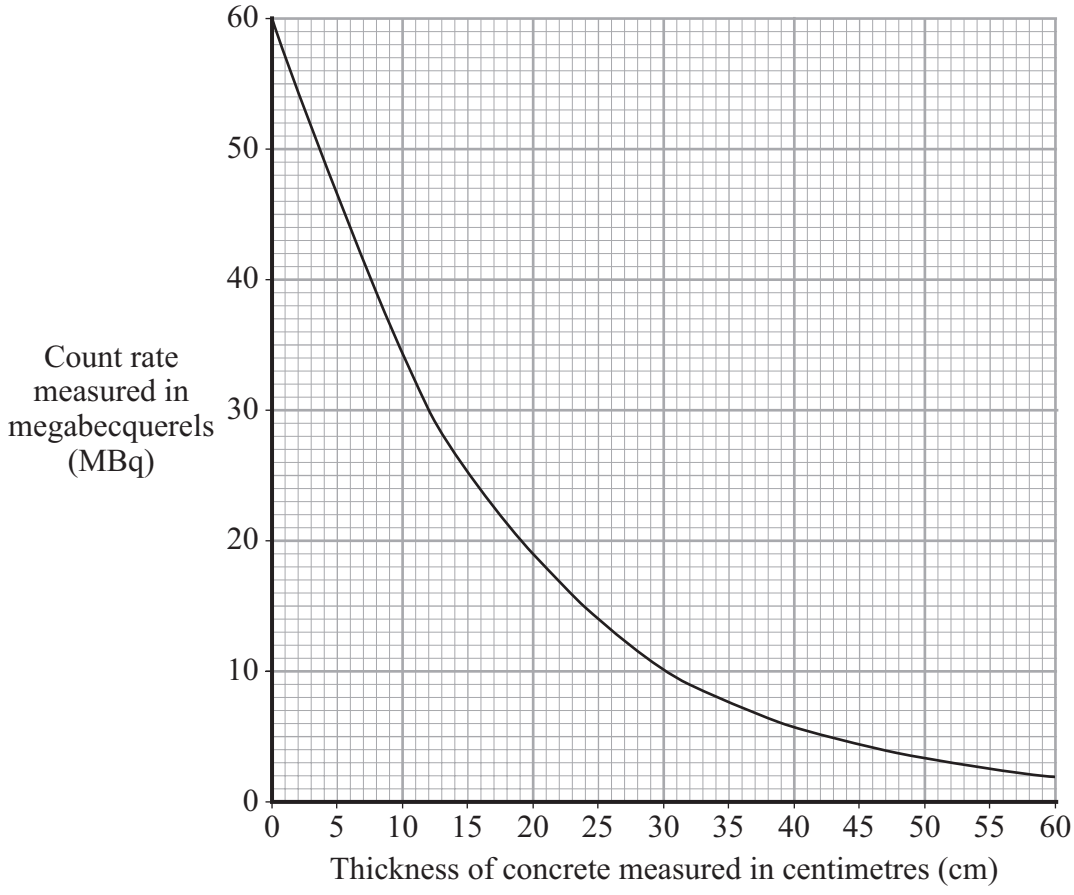
March 2007 | PHY1B | Original Q5 | Legacy

**QUESTION FIVE**

Gamma radiation is the most penetrating type of ionising radiation.

Concrete is sometimes used to protect people from the harmful effects of gamma radiation.

The graph shows the count rate from a source of gamma radiation after it has passed through various thicknesses of concrete.




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

**A** 6

**B** 8

**C** 12

**D** 19

Count rate when the thickness is 20 cm = . . . **1** . . . MBq.

Thickness when count rate is 39 MBq = . . . **2** . . . cm.

Reduction in count rate when thickness is increased from 12 cm to 16 cm = . . . **3** . . . MBq.

Thickness needed to reduce the original count rate by half = . . . **4** . . . cm.

4.4.2.1 Radioactive decay and nuclear radiation

Question 29

March 2007 | PHY1B | Original Q7 | Legacy

**QUESTION SEVEN**

# Electromagnetic radiation fills the Universe

Electromagnetic radiations belong to a spectrum of radiations which have many features in common.

**7A** In the box, the electromagnetic radiations are meant to be in order of increasing wavelength from left to right. Which one is in the wrong position?

| | | | |
|---|---|---|---|
| X-rays | Infra red rays | Radio waves | Gamma rays |
| **1** | **2** | **3** | **4** |

**1** X-rays

**2** infra red rays

**3** radio waves

**4** gamma rays

**7B** Which statement is correct?

**1** All electromagnetic radiation can travel through a vacuum.

**2** All electromagnetic radiation is visible to the human eye.

**3** No electromagnetic radiation can travel through a vacuum.

**4** No electromagnetic radiation is visible to the human eye.

4.4.2.1 Radioactive decay and nuclear radiation

Question 29 · continued



**7C** Which statement about the wavelength of microwaves is correct?

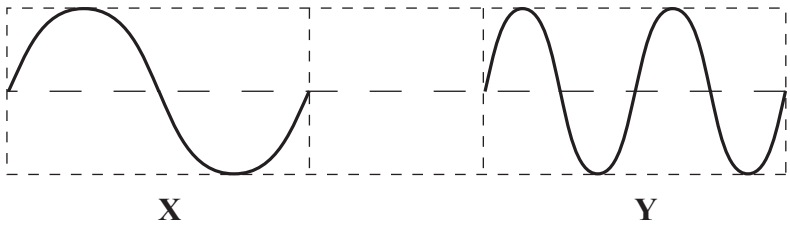
**1** longer than both infra red rays and ultraviolet rays

**2** longer than infra red rays but shorter than ultraviolet rays

**3** shorter than both infra red rays and ultraviolet rays

**4** shorter than infra red rays but longer than ultraviolet rays

**7D** Two electromagnetic waves are shown in the diagrams, which are drawn to the same scale.




Which sentence is correct?

**1** The frequency of wave **X** is double that of wave **Y**.

**2** The frequency of wave **Y** is double that of wave **X**.

**3** The wavelength of wave **Y** is double that of wave **X**.

**4** The wavelength of wave **Y** is four times that of wave **X**.

### 4.4.2.1 Radioactive decay and nuclear radiation

**Question 30**

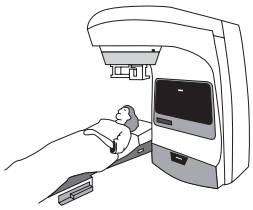
June 2007 | PHY1B | Original Q1 | Legacy

**QUESTION ONE**

Each of these applications uses electromagnetic radiation.

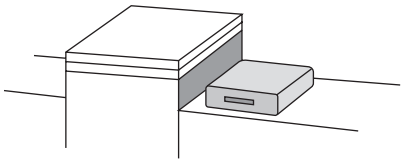
**1**

Killing cancer cells



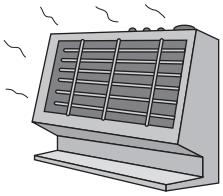
**2**

Checking bags at an airport



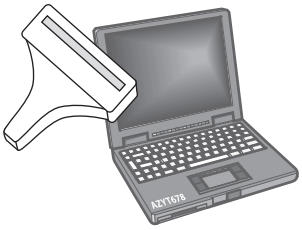
**3**

In radiant heaters



**4**

Seeing security markings



Match the parts of the electromagnetic spectrum, **A**, **B**, **C** and **D**, with the drawings labelled **1–4**.

**A** gamma rays

**B** infra red rays

**C** ultraviolet rays

**D** X-rays

4.4.2.1 Radioactive decay and nuclear radiation

Question 31

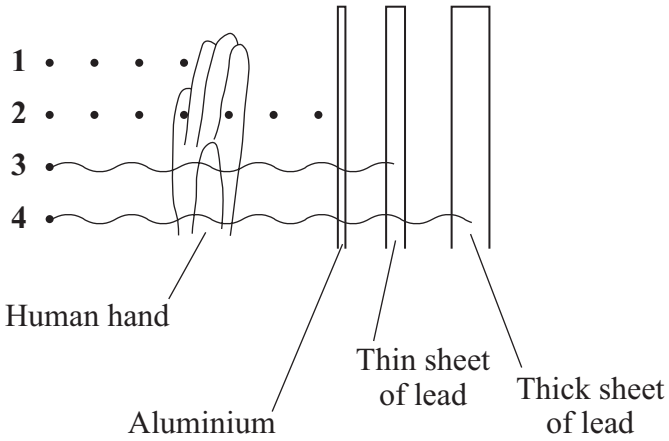
June 2007 | PHY1B | Original Q5 | Legacy

**QUESTION FIVE**

Technicians in hospitals may be exposed to various types of electromagnetic or nuclear radiation.

The penetrating power of four types of radiation is shown in the diagram.

Technicians in the X-ray department wear aprons containing a thin sheet of lead for protection.




Match the types of nuclear and electromagnetic radiation, **A**, **B**, **C**, and **D**, with the labels **1–4** on the diagram.

**A** gamma radiation

**B** X-ray radiation

**C** alpha radiation

**D** beta radiation

4.4.2.1 Radioactive decay and nuclear radiation

Question 32

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

4.4.2.1 Radioactive decay and nuclear radiation

Question 32 · 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**

**4.4.2.1 Radioactive decay and nuclear radiation**

**Question 33**

June 2007 | PHY1F | Original Q6 | Legacy

**6** Some types of food are treated with *gamma* radiation. Low doses of radiation slow down the ripening of fresh fruit and vegetables while higher doses of radiation kill the bacteria that make the food go off.

(a) (i) What is *gamma* radiation?

.....

*(1 mark)*

(ii) Food packed in crates or boxes can be treated using this method.

Why must a source that emits *gamma* radiation be used?

.....

.....

*(1 mark)*

(iii) A suitable source of gamma radiation is the isotope caesium 137.

Complete the following sentence by choosing the correct word from the box.

| **electrons** | **neutrons** | **protons** |
|---|---|---|

An atom of caesium 137 has two more ..... than an atom of caesium 135.

*(1 mark)*

**Question 6 continues on the next page**

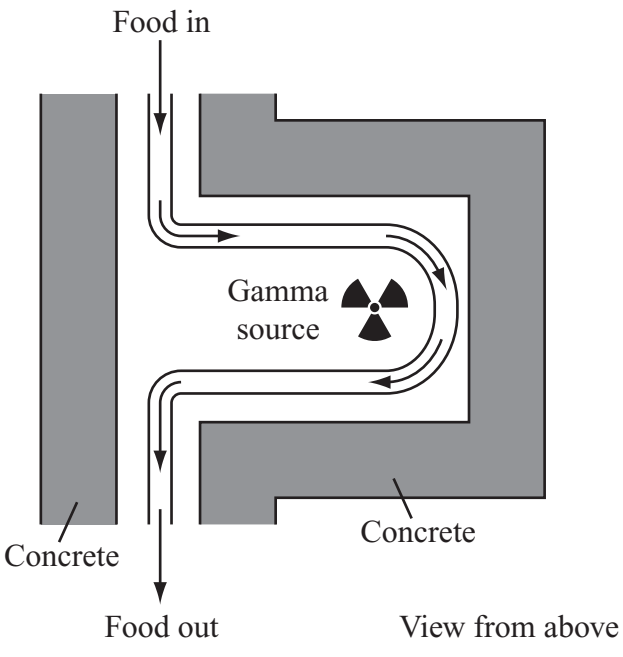
**4.4.2.1 Radioactive decay and nuclear radiation**

**Question 33 · continued**



*BLANK*

(b) The diagram shows how a conveyor belt can be used to move food past the radioactive source.




(i) How do the concrete walls reduce the radiation hazard to workers outside the food treatment area?

.....

.....

*(1 mark)*

(ii) Suggest **one** way that the dose of radiation received by the food could be increased other than by changing the radioactive source.

.....

.....

*(1 mark)*

**4.4.2.1 Radioactive decay and nuclear radiation**

**Question 33 · continued**



*BLANK*

(c) Some people may not like the idea of eating food treated with radiation.

(i) What evidence could a food scientist produce to show that food treated with radiation is safe to eat?

.....

.....

.....

.....

*(2 marks)*

(ii) The diagram shows the sign displayed on food treated with radiation.



Why is it important for people to know which foods have been treated with radiation?

.....

.....

*(1 mark)*

**8**

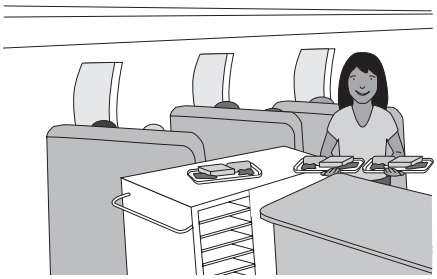
**4.4.2.1 Radioactive decay and nuclear radiation**

**Question 34**

November 2007 | PHY1B | Original Q1 | Legacy

## QUESTION ONE

The drawing shows meals being served on an aircraft.



Match types of electromagnetic waves, **A**, **B**, **C** and **D**, with the numbers **1–4** in the sentences.

**A** gamma rays

**B** infra red rays

**C** radio waves

**D** visible light

The food was heated in ovens by . . . **1** . . . .

The fruit in the meal pack does not go mouldy because it has been treated with . . . **2** . . . .

The lamps in the cabin are designed to give off . . . **3** . . . .

The pilot keeps in touch with air traffic control by using . . . **4** . . . .

**4.4.2.1 Radioactive decay and nuclear radiation**

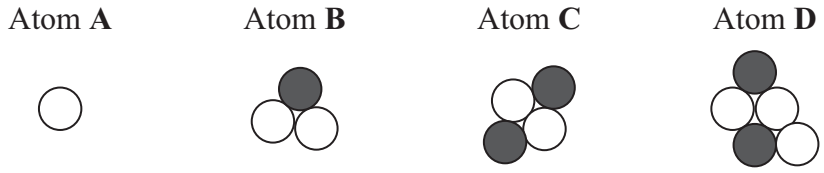
**Question 35**

November 2007 | PHY1B | Original Q4 | Legacy

## QUESTION FOUR

The diagram shows the nuclei of four different atoms, **A**, **B**, **C** and **D**. The protons and neutrons are shaded differently.

Two of the atoms are isotopes of the same element.




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

| | |
|---|---|
| **1** | the nucleus contains one proton |
| **2** | the nucleus contains three protons |
| **3** | the nucleus is an alpha particle |
| **4** | the atom is an isotope of atom **C** |

**4.4.2.1 Radioactive decay and nuclear radiation**

**Question 36**

November 2007 | PHY1B | Original Q8 | Legacy

## QUESTION EIGHT

Radon is a radioactive gas which seeps up from the ground into houses in some parts of the country.

The table shows the results of a survey of radioactive emissions due to radon gas in four houses in one local authority.

| House | Radioactive emissions in Bq per $m^3$ of air |
|---|---|
| **1** | 11 |
| **2** | 33 |
| **3** | 15 |
| **4** | 21 |

**8A** What was the average of the radioactive emissions in the four houses?

**1** 20.0 Bq per $m^3$

**2** 26.6 Bq per $m^3$

**3** 40.0 Bq per $m^3$

**4** 80.0 Bq per $m^3$

**8B** The local authority wanted a more reliable average for the houses in their area.

Scientists could obtain more reliable results by . . .

**1** increasing the number of houses sampled.

**2** measuring radioactive emissions in 1 $cm^3$ of air in each house.

**3** using a different unit for the radioactive emissions.

**4** sampling the air outside the houses.

4.4.2.1 Radioactive decay and nuclear radiation

Question 36 · continued



**8C** Radon gas causes cancer.

Which part of the body is most likely to be the site of a cancer caused by radon gas?

**1** brain

**2** legs

**3** stomach

**4** lungs

**8D** What advice would you give to a householder whose house has a high level of radioactive emissions from radon gas?

**1** keep the house well ventilated

**2** fit double glazing

**3** take up all the carpets

**4** place draught excluders around all the windows and doors

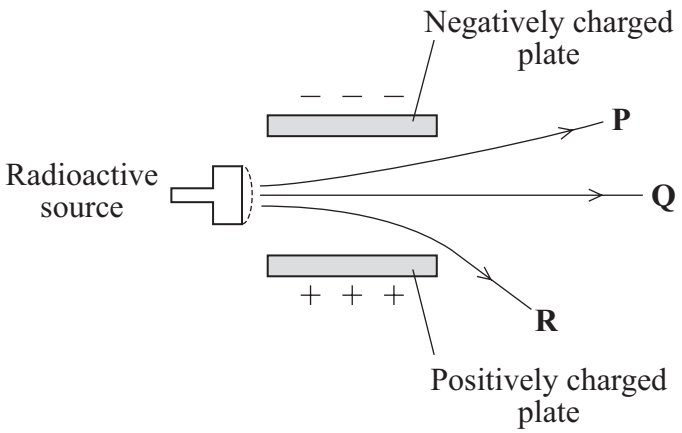
**4.4.2.1 Radioactive decay and nuclear radiation**

**Question 37**

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)*

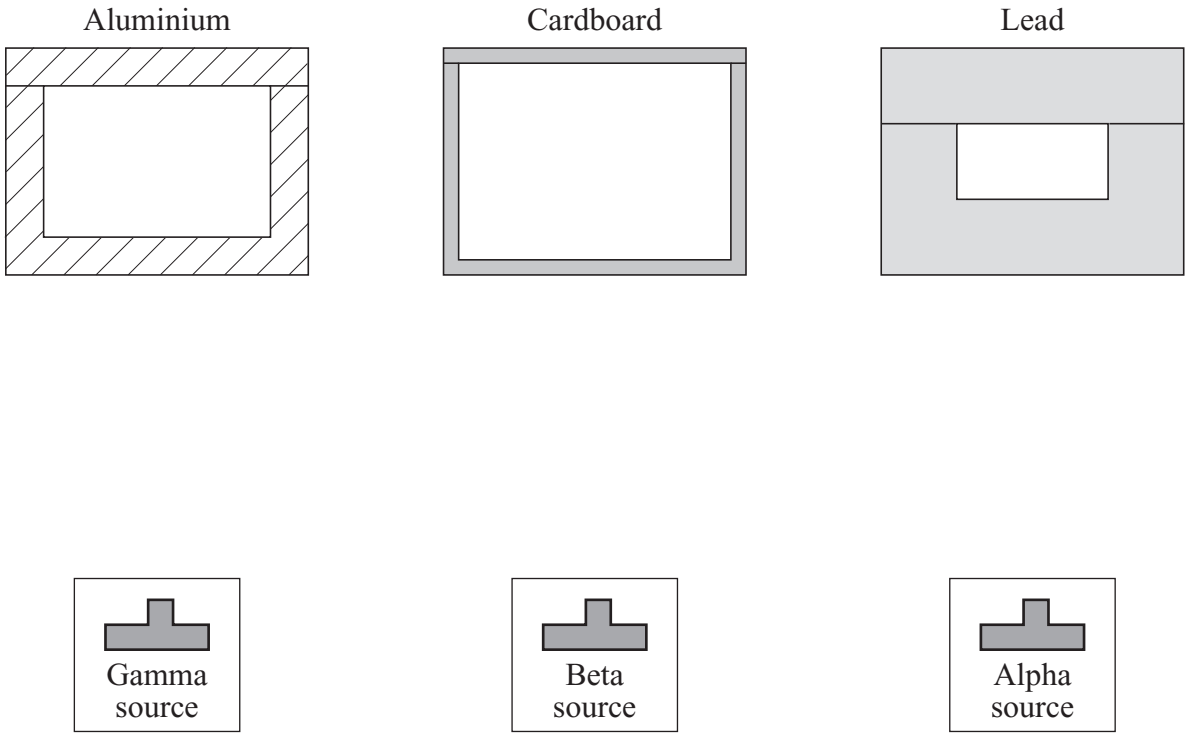
**4.4.2.1 Radioactive decay and nuclear radiation**

**Question 37 · continued**



*BLANK*

(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**

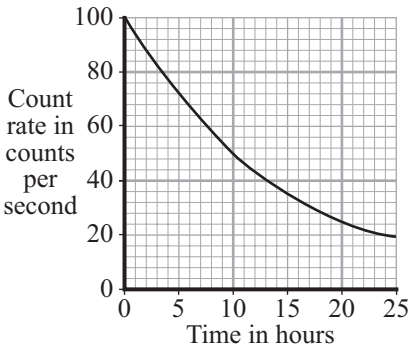
**4.4.2.1 Radioactive decay and nuclear radiation**

**Question 37 · continued**

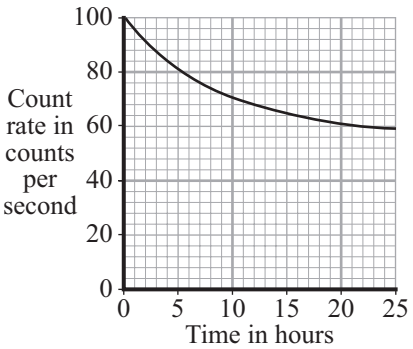


*BLANK*

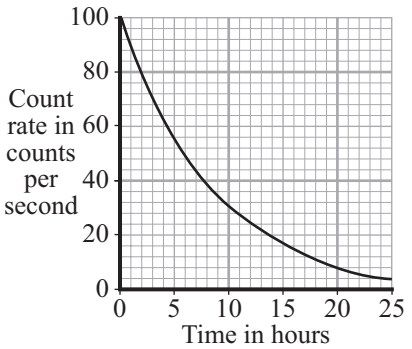
(c) The graphs show how the count rates from three different radioactive sources, **J**, **K**, and **L**, change with time.




**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

**4.4.2.1 Radioactive decay and nuclear radiation**

**Question 38**

March 2008 | PHY1AP | Original Q3 | Legacy

## QUESTION THREE

Generating electricity causes problems for the environment.

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

**A** acid rain

**B** global warming

**C** noise pollution

**D** radioactive waste

Nuclear power stations produce . . . **1** . . . .

Wind farms produce . . . **2** . . . .

Coal-fired power stations produce sulfur dioxide which causes . . . **3** . . . .

All fossil-fuel power stations produce carbon dioxide which causes . . . **4** . . . .

### 4.4.2.1 Radioactive decay and nuclear radiation

**Question 39**

March 2008 | PHY1BP | Original Q1 | Legacy

**QUESTION ONE**

We use electromagnetic radiation in many different ways.

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

**A** infra red radiation

**B** gamma radiation

**C** visible light

**D** ultraviolet radiation

| | |
|---|---|
| **1** | is used to send messages using a torch |
| **2** | is used in sunbeds |
| **3** | is used in heaters |
| **4** | is used to treat cancer |

**4.4.2.1 Radioactive decay and nuclear radiation**

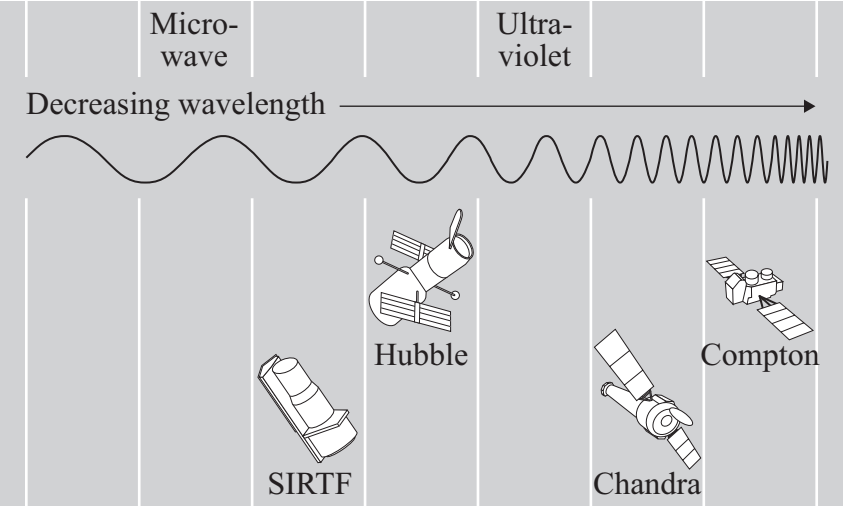
**Question 40**

March 2008 | PHY1BP | Original Q3 | Legacy

## QUESTION THREE

Space telescopes are designed to detect different types of electromagnetic radiation.

The diagram shows part of the electromagnetic spectrum and four different telescopes.




Match telescopes, **A**, **B**, **C** and **D**, with the types of electromagnetic radiation **1–4** in the table that each is designed to detect.

**A** SIRTF

**B** Hubble

**C** Chandra

**D** Compton

| | **Type of electromagnetic radiation** |
|---|---|
| **1** | gamma radiation |
| **2** | infra red radiation |
| **3** | X-rays |
| **4** | visible light |

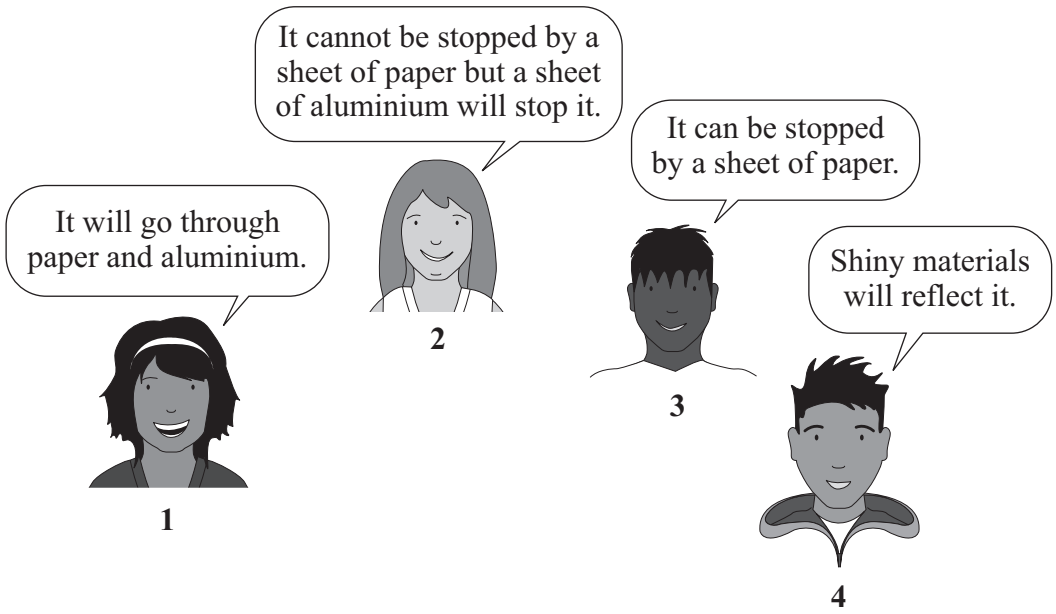
### 4.4.2.1 Radioactive decay and nuclear radiation

**Question 41**

March 2008 | PHY1BP | Original Q4 | Legacy

**QUESTION FOUR**

Some students are talking about radiation.




Match words, **A**, **B**, **C** and **D**, with the students' statements **1–4**.

**A** alpha

**B** beta

**C** gamma

**D** visible light

**4.4.2.1 Radioactive decay and nuclear radiation**

**Question 42**

June 2008 | PHY1AP | Original Q5 | Legacy

**QUESTION FIVE**

Different energy sources are used to generate electricity. Each energy source has its own problems.

Match the ways of producing electricity, **A**, **B**, **C** and **D**, with the statements **1–4** in the table.

**A** power stations using fossil fuels

**B** power stations using nuclear fuels

**C** solar cells

**D** wind turbines

| | |
|---|---|
| **1** | give off polluting gases |
| **2** | useful for applications in remote regions or for small-scale uses |
| **3** | waste remains radioactive for a very long time |
| **4** | can be unsightly and cause noise pollution |

### 4.4.2.1 Radioactive decay and nuclear radiation

**Question 43**

June 2008 | PHY1BP | Original Q1 | Legacy

**QUESTION ONE**

This question is about electromagnetic radiation.

Match types of electromagnetic radiation, **A**, **B**, **C** and **D**, with the numbers **1–4** in the table.

**A** infra red

**B** ultraviolet

**C** visible light

**D** gamma

| | |
|---|---|
| can be used to send messages using a torch | **1** |
| can cause a suntan | **2** |
| can be used in a television remote control | **3** |
| can travel through a person's body | **4** |

**4.4.2.1 Radioactive decay and nuclear radiation**

**Question 44**

June 2008 | PHY1BP | Original Q4 | Legacy

## QUESTION FOUR

The diagram shows the electromagnetic spectrum.

| | | | | | | |
|---|---|---|---|---|---|---|
| **1** | X-rays | **2** | Visible light | **3** | Micro waves | **4** |

Increasing wavelength ⟶

Match the types of radiation, **A**, **B**, **C** and **D**, with the numbers **1–4** in the electromagnetic spectrum.

**A** gamma

**B** infra red

**C** radio waves

**D** ultraviolet

**Turn over for the next question**

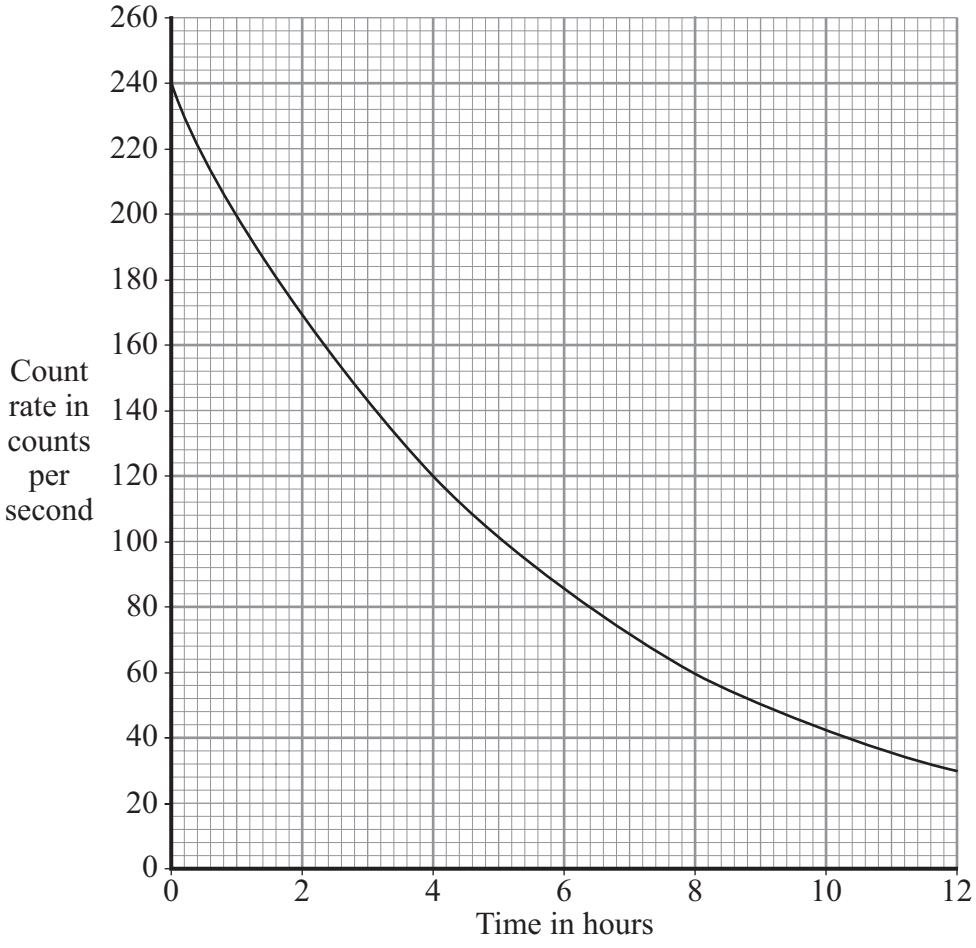
**4.4.2.1 Radioactive decay and nuclear radiation**

**Question 45**

June 2008 | PHY1BP | Original Q5 | Legacy

## QUESTION FIVE

The graph shows the count rate of a radioactive isotope over 12 hours.




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

**A** 4

**B** 12

**C** 60

**D** 90

| | |
|---|---|
| the count rate at 8 hours | **1** |
| the number of hours it took the count rate to fall to 30 | **2** |
| the decrease in count rate between 4 and 12 hours | **3** |
| the number of hours it took for the count rate to halve | **4** |

**4.4.2.1 Radioactive decay and nuclear radiation**

**Question 46**

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.

4.4.2.1 Radioactive decay and nuclear radiation

Question 46 · 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**

### 4.4.2.1 Radioactive decay and nuclear radiation

**Question 47**

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**

4.4.2.1 Radioactive decay and nuclear radiation

Question 47 · 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**

**4.4.2.1 Radioactive decay and nuclear radiation**

**Question 48**

June 2008 | PHY1F | Original Q3 | Legacy

**3** (a) The names of three types of nuclear radiation are given in **List A**. Some properties of these three 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 | not deflected by an electric field |
| beta | stopped by thin metal but not paper |
| gamma | the most strongly ionising |
| | will not harm living cells |

*(3 marks)*

**4.4.2.1 Radioactive decay and nuclear radiation**

**Question 48 · continued**



*for mark*

**3** (b) Nuclear radiation is given out from the centre of some types of atom.

What name is given to the centre of an atom? .....

*(1 mark)*

**3** (c) One of the substances in the table is used as a radioactive tracer. A hospital patient breathes in air containing the tracer. The radiation given out is measured by a doctor using a detector outside the patient's body.

| Substance | Radiation given out | Solid, liquid or gas |
|---|---|---|
| **X** | alpha | gas |
| **Y** | gamma | gas |
| **Z** | gamma | solid |

Which **one** of the substances, **X**, **Y** or **Z**, should be used as the tracer? .....

Give **two** reasons for your answer.

1 .....

.....

2 .....

.....

*(3 marks)*

**3** (d) Radiation can also be used to kill the bacteria on fresh food.

Give **one** reason why farmers, shop owners or consumers may want food to be treated with radiation.

.....

.....

*(1 mark)*

**8**

**4.4.2.1 Radioactive decay and nuclear radiation**

**Question 49**

June 2008 | PHY1F | Original Q4 | Legacy

**4** The table gives data about two space telescopes. The Hubble telescope is already in space, but the James Webb telescope is still being built.

| Name of telescope | Mirror diameter in metres | Launch Year | Orbit distance from the Earth in kilometres |
|---|---|---|---|
| Hubble | 2.4 | 1990 | 575 |
| James Webb | 6.5 | 2013 | 1 500 000 |

**4** (a) Give **one** reason why the image from an optical telescope on the Earth may not be as clear as the image produced by a space telescope.

.....

.....

*(1 mark)*

**4** (b) Explain why it is easier for astronauts to service the Hubble telescope than it will be for astronauts to service the James Webb telescope.

.....

.....

.....

.....

*(2 marks)*

**4** (c) The large mirror for the James Webb telescope will be folded, launched into space and then opened out. This will be a complicated process so a working scale model of the mirror system has been built.

Which statement gives a reason for building the scale model?

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

To see what the mirror system will look like ☐

To test the design to make sure it will work ☐

To measure the power needed by the telescope ☐

*(1 mark)*

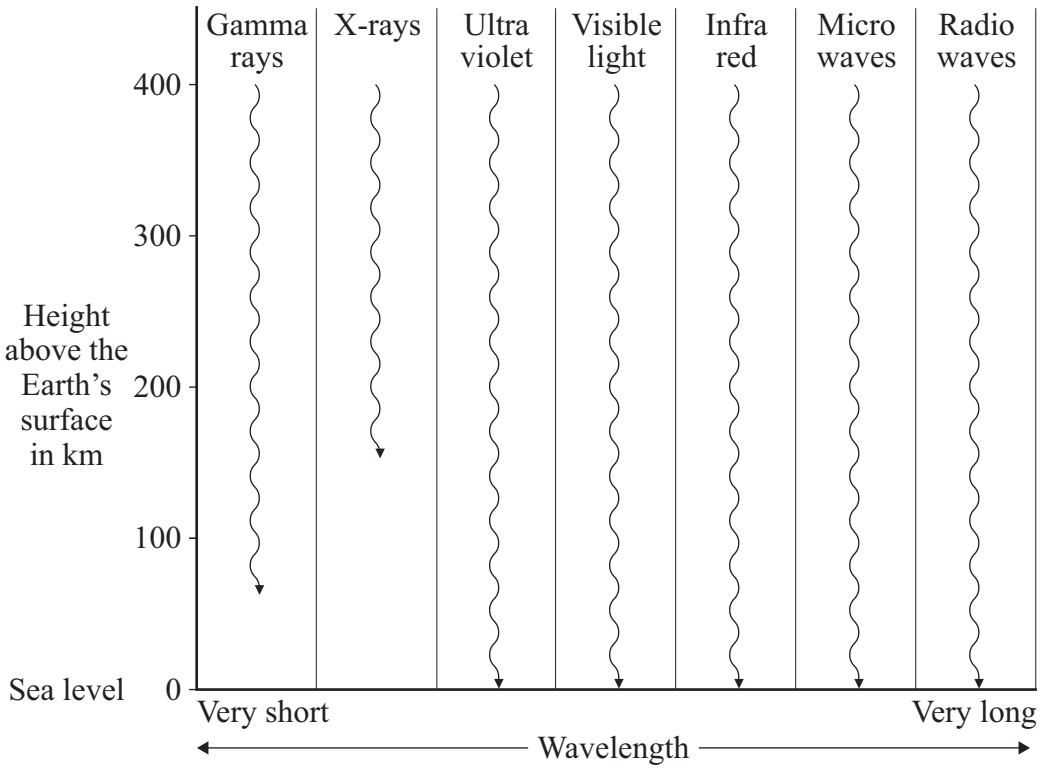
**4.4.2.1 Radioactive decay and nuclear radiation**

**Question 49 · continued**



*for mark*

**4** (d) The diagram shows how far different types of electromagnetic wave can travel through the Earth's atmosphere before being absorbed.




Name **two** types of electromagnetic wave that can be detected by a space telescope but cannot be detected by a telescope positioned on Earth.

1 .....

2 .....

*(2 marks)*

**4** (e) Observations of distant galaxies have given evidence to support the theory that the universe began from a very small point.

What name is given to this theory?

.....

*(1 mark)*

7

**4.4.2.1 Radioactive decay and nuclear radiation**

**Question 50**

June 2008 | PHY2F | Original Q6 | Legacy

**6** (a) The table gives information about the radioactive isotope, radon-222.

| | |
|---|---|
| mass number | 222 |
| atomic number | 86 |
| radiation emitted | alpha particle |

**6** (a) (i) Complete the following sentence.

The mass number is the total number of..... and

..... inside an atom.

*(2 marks)*

**6** (a) (ii) Radon-222 is an isotope of radon.

How many protons are there in an atom of radon-222?

..... *(1 mark)*

**6** (a) (iii) When an atom of radon-222 emits an alpha particle, the radon-222 changes into an atom of polonium-218.

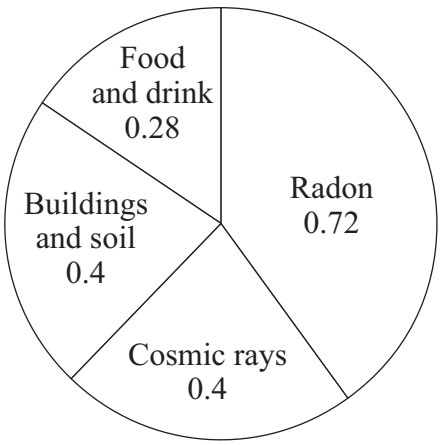
An alpha particle consists of 2 protons and 2 neutrons.

How is the structure of the nucleus of a polonium-218 atom different from the structure of the nucleus of a radon-222 atom?

.....

*(1 mark)*

**6** (b) The pie chart shows the average radiation dose that a person in the UK receives each year from natural background radiation.
The doses are measured in millisieverts (mSv).



**4.4.2.1 Radioactive decay and nuclear radiation**

**Question 50 · continued**



*for mark*

**6** (b) (i) Calculate the proportion of natural background radiation that comes from radon. Show clearly how you work out your answer.

.....

.....

Proportion of radon = .....

*(2 marks)*

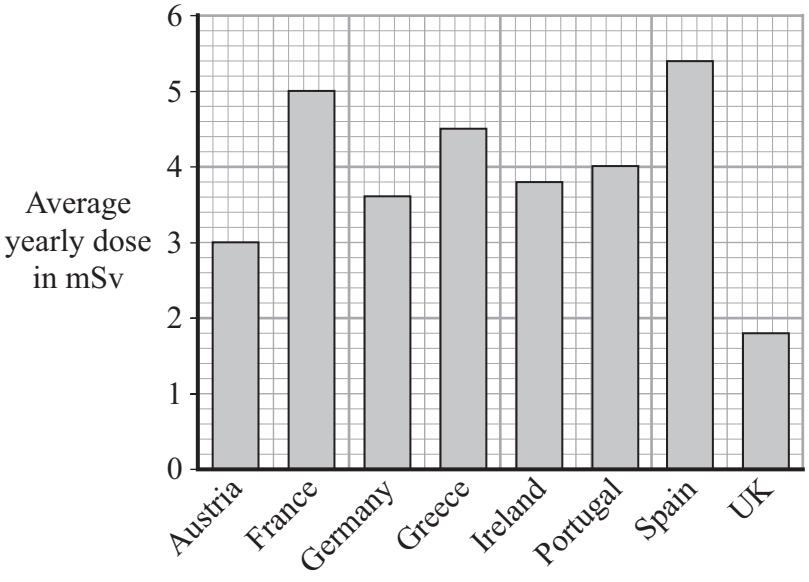
**6** (b) (ii) Not all background radiation is from natural sources.

Name **one** source of background radiation that is not natural.

.....

*(1 mark)*

**6** (c) The bar chart shows the average yearly dose from natural background radiation in different European countries.




**6** (c) (i) How many times bigger is the average annual background dose in Germany compared to the UK?

.....

*(1 mark)*

**Question 6 continues on the next page**

**4.4.2.1 Radioactive decay and nuclear radiation**

**Question 50 · continued**



*for mark*

**6** (c) (ii) The following table gives the effects of different radiation doses on the human body.

| Radiation dose in mSv | Effects |
|---|---|
| 10 000 | Immediate illness; death within a few weeks |
| 1 000 | Radiation sickness; unlikely to cause death |
| 50 | Lowest dose with evidence of causing cancer |

A family goes to Germany for a two-week holiday. Should they be concerned about the higher level of background radiation in Germany?

Draw a ring around your answer.

**Yes** **No**

Explain your answer.

.....

.....

.....

.....

*(2 marks)*

10

### 4.4.2.1 Radioactive decay and nuclear radiation

**Question 51**

November 2008 | PHY1BP | Original Q2 | Legacy

**QUESTION TWO**

The diagram shows parts of the electromagnetic spectrum.

| | | | | | | |
|---|---|---|---|---|---|---|
| **1** | X-rays | **2** | **3** | Infra red rays | Microwaves | **4** |

Match types of radiation, **A**, **B**, **C** and **D**, with the numbers **1–4** in the diagram.

**A** gamma rays

**B** radio waves

**C** ultraviolet rays

**D** visible light

**4.4.2.1 Radioactive decay and nuclear radiation**

**Question 52**

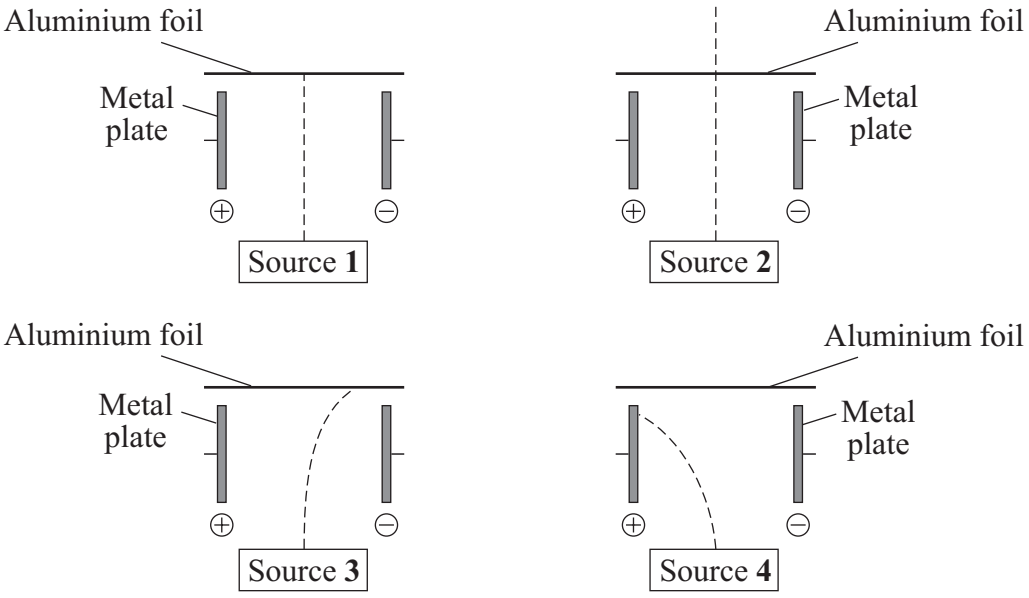
November 2008 | PHY1BP | Original Q5 | Legacy

## QUESTION FIVE

Radiation from four sources, **1**, **2**, **3** and **4**, is directed into an electric field between two metal plates.

There is a sheet of aluminium foil after the gap between the metal plates.

Light waves are not deflected in electric fields.




In each diagram, the dashed line (----------) shows the path of the radiation.

Match the types of radiation, **A**, **B**, **C** and **D**, with the sources **1–4**.

**A** alpha radiation

**B** beta radiation

**C** gamma radiation

**D** visible light

**4.4.2.1 Radioactive decay and nuclear radiation**

**Question 53**

November 2008 | PHY1BP | Original Q7 | Legacy

## QUESTION SEVEN

Pierre and Marie Curie made many important discoveries about radioactivity.

Pierre was killed in 1906 when he slipped and fell under a horse-drawn cart. He was having dizzy spells at the time. Marie lived until 1934 when she died of leukaemia, a form of cancer.

**7A** The most likely cause of their sickness was . . .

**1** the very long hours they worked.

**2** the lack of proper equipment in their laboratory.

**3** the cold temperatures in which they worked.

**4** the radiation emitted by the radioactive materials they worked with.

**7B** Marie's notebooks are still so radioactive that they are kept in a lead-lined safe.

The notebooks are radioactive because they . . .

**1** are made of radioactive materials.

**2** became contaminated with the radioactive materials in her laboratory.

**3** absorbed ultraviolet radiation from the radioactive materials in her laboratory.

**4** absorbed ultraviolet radiation from the Sun.

**7C** The safe is lined with thick lead because . . .

**1** radioactive materials cannot pass through thick lead.

**2** thick lead is needed to stop alpha radiation.

**3** thick lead is needed to stop beta radiation.

**4** thick lead is needed to stop gamma radiation.

4.4.2.1 Radioactive decay and nuclear radiation



**7D** The notebooks are removed from the safe occasionally. Careful safety precautions are taken. One safety precaution is to keep people several metres away from the notebooks.

This would provide protection from alpha radiation because alpha particles . . .

**1** have a very short half-life.

**2** can be stopped by a sheet of paper.

**3** have a short range in air.

**4** do not kill human body cells.

**Turn over for the next question**

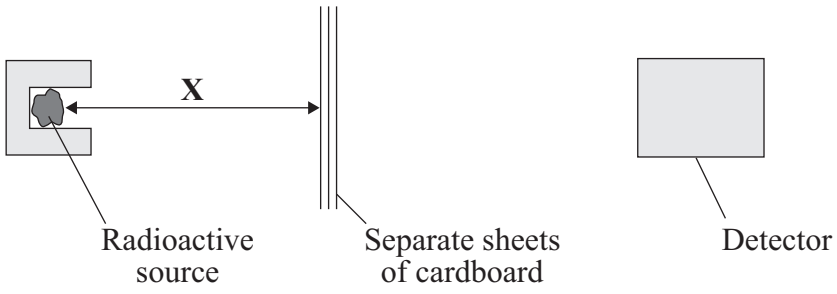
4.4.2.1 Radioactive decay and nuclear radiation

Question 54

November 2008 | PHY1BP | Original Q8 | Legacy

## QUESTION EIGHT

The diagram shows apparatus used by a scientist investigating the effectiveness of cardboard for absorbing radiation.




The detector measured the count rate for different numbers of sheets of cardboard.
The distance **X** was kept constant.

**8A** Which is the control variable in the experiment?

**1** the number of sheets of cardboard

**2** the total thickness of the cardboard

**3** the distance **X**

**4** the count rate

**8B** Which row of the table gives the correct variables?

| | Independent variable | Dependent variable |
|---|---|---|
| **1** | count rate | number of sheets |
| **2** | number of sheets | count rate |
| **3** | distance **X** | count rate |
| **4** | count rate | distance **X** |

**4.4.2.1 Radioactive decay and nuclear radiation**

**Question 54 · continued**



**8C** The scientist recorded the results of the experiment in a table with the following headings:

| Number of sheets of cardboard | Count rate in counts per second |
|---|---|
| | |

These results were plotted on a graph.

The graph was a . . .

**1** bar chart because both variables were categoric.

**2** line graph because both variables were continuous.

**3** line graph because one variable was categoric.

**4** bar chart because one variable was continuous and the other was discrete.

**8D** Another scientist said that the data used for the graph was not reliable.

How could the reliability of the data be tested?

**1** by measuring the distance in millimetres

**2** by using sheets of card with different thicknesses

**3** by measuring the time to the nearest second

**4** by asking another group to carry out the same experiment

**4.4.2.1 Radioactive decay and nuclear radiation**

**Question 55**

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?

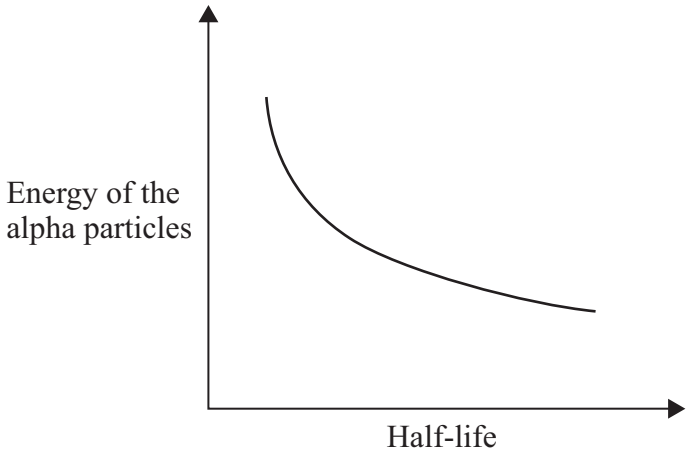
**1** by changing the temperature of the nucleus

**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.



**4.4.2.1 Radioactive decay and nuclear radiation**

**Question 55 · 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**

**4.4.2.1 Radioactive decay and nuclear radiation**

**Question 56**

January 2009 | PHY1F | Original Q1 | Legacy

**1** The table shows the electromagnetic spectrum.
Three types of wave have been missed out.

| | | | | | | |
|---|---|---|---|---|---|---|
| Gamma rays | | Ultraviolet rays | Visible light | | Micro-waves | |

Shortest wavelength ⟷ Longest wavelength

**1** (a) (i) Use words from the box to complete the table.

| | | |
|---|---|---|
| **infra red rays** | **radio waves** | **X-rays** |

*(2 marks)*

**1** (a) (ii) Which **one** of the following gives a use of gamma rays?

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

to communicate with satellites ☐

to see objects ☐

to kill cancer cells ☐

*(1 mark)*

**1** (a) (iii) Complete the following sentence by drawing a ring around the correct word in the box.

All electromagnetic waves move | energy / gases / particles | from one place to another.

*(1 mark)*

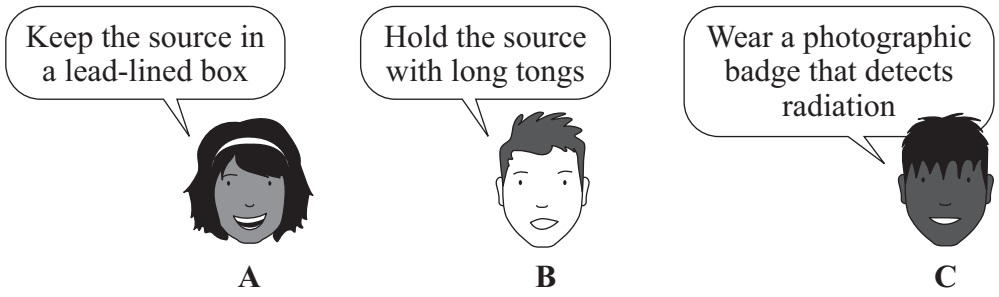
4

### 4.4.2.1 Radioactive decay and nuclear radiation

**Question 57**

January 2009 | PHY1F | Original Q4 | Legacy

**4** Before using a radioactive source, a teacher asked her students to suggest safety procedures that would reduce her exposure to the radiation. The students made the following suggestions.




**A** **B** **C**

**4** (a) Which suggestion, **A**, **B** or **C**, would **not** reduce the exposure of the teacher to radiation?

.....

*(1 mark)*

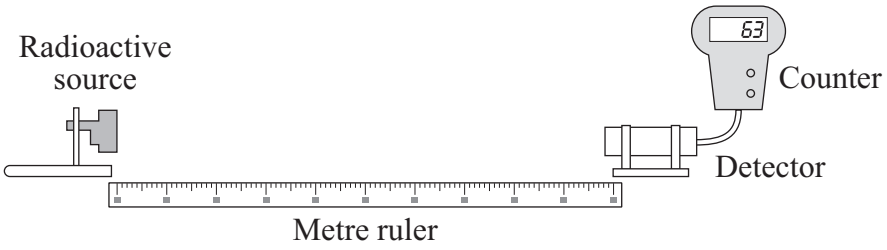
**4.4.2.1 Radioactive decay and nuclear radiation**

**Question 57 · continued**



*for mark*

**4** (b) The diagram shows how the teacher measured the distance that the radiation travelled from the source. The count-rate at different distances from the source was measured and recorded in the table.




| Distance from source to detector in cm | Count-rate in counts per minute |
|---|---|
| 20 | 85 |
| 40 | 81 |
| 60 | 58 |
| 80 | 53 |
| 100 | 23 |

What type of radiation was the source emitting, alpha, beta or gamma?

.....

Explain the reasons for your choice.

.....

.....

.....

.....

*(3 marks)*

**Question 4 continues on the next page**

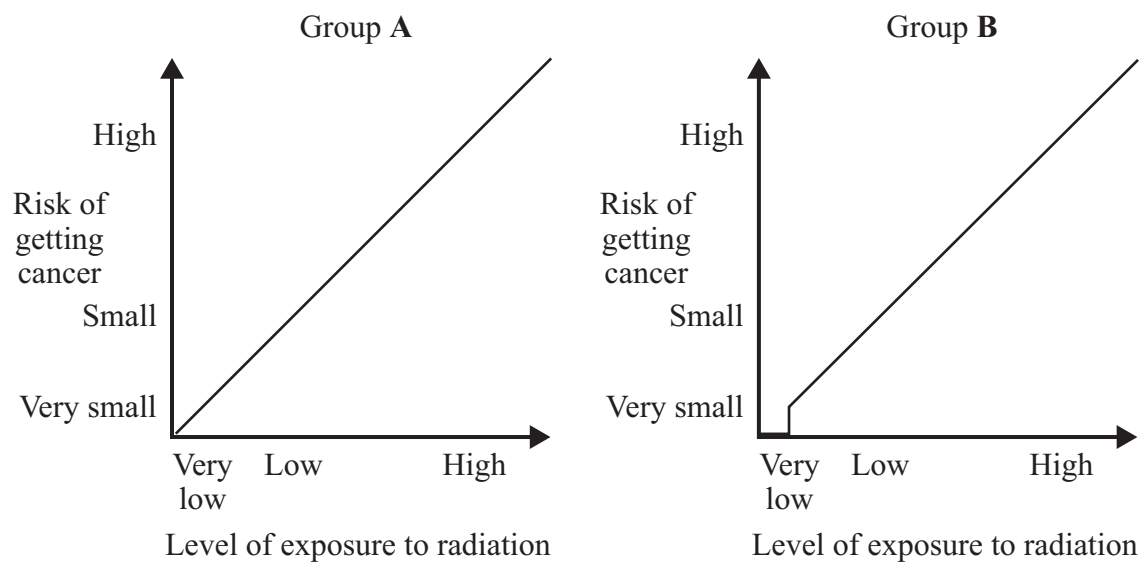
**4.4.2.1 Radioactive decay and nuclear radiation**

**Question 57 · continued**



*for mark*

**4** (c) The graphs show how two groups of scientists, **A** and **B**, link exposure to radiation and the risk of getting cancer.




**4** (c) (i) Complete the following sentence using a word or phrase from the box.

| | | |
|---|---|---|
| **decreases** | **has no effect on** | **increases** |

Both groups of scientists agree that a high level of exposure to radiation

..... the risk of getting cancer.

*(1 mark)*

**4** (c) (ii) Use the graphs to describe carefully how the two groups of scientists disagree when the level of exposure to radiation is very low.

.....

.....

.....

.....

*(2 marks)*

7

### 4.4.2.1 Radioactive decay and nuclear radiation

**Question 58**

January 2009 | PHY2F | Original Q1 | Legacy

**1** Four different processes are described in **List A**. The names of these processes are given in **List B**.

Draw a line to link each description in **List A** to its correct name in **List B**.
Draw only **four** lines.

| List A | List B |
|---|---|
| the nuclei of two atoms joining together | gamma emission |
| the nucleus of an atom splitting into several pieces | electric current |
| an atom losing an electron | ionisation |
| an electric charge moving through a metal | nuclear fission |
| | nuclear fusion |

*(4 marks)*

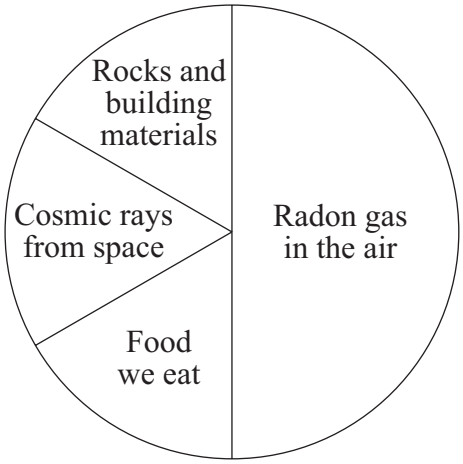
4

### 4.4.2.1 Radioactive decay and nuclear radiation

**Question 59**

January 2009 | PHY2F | Original Q5 | Legacy

**5** (a) The pie chart shows the average proportions of natural background radiation from various sources in one part of the UK.




**5** (a) (i) What proportion of the background radiation comes from radon gas?

.....

*(1 mark)*

**5** (a) (ii) Suggest why our bodies are slightly radioactive.

.....

.....

*(1 mark)*

**4.4.2.1 Radioactive decay and nuclear radiation**

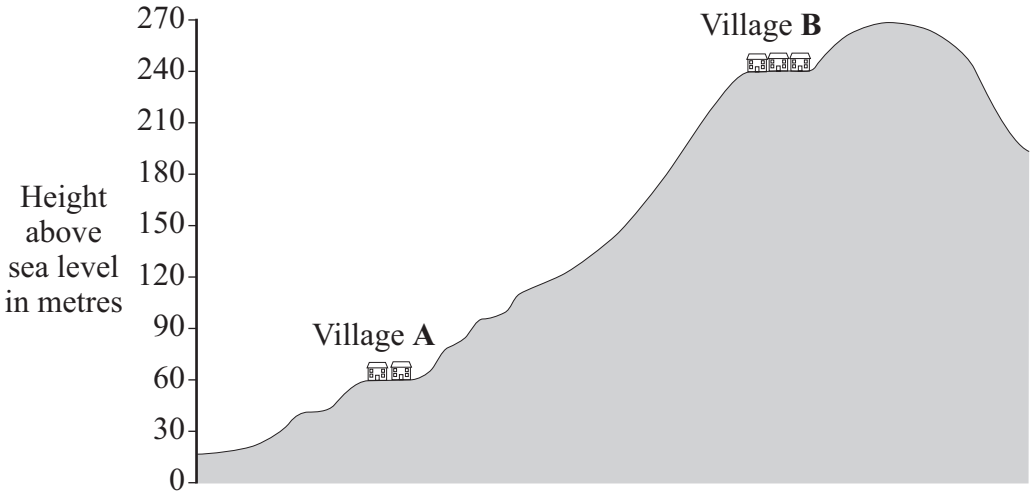
**Question 59 · continued**



*for mark*

**5** (b) The level of background radiation from cosmic rays is not the same everywhere. For every 30 metres above sea level, the amount of background radiation increases by one unit.

The diagram shows the position of two villages, **A** and **B**, built on a hill.




How is the amount of background radiation from cosmic rays different in village **A** compared to village **B**?

To obtain full marks you must include a calculation in your answer.

.....

.....

.....

.....

.....

.....

*(3 marks)*

5

**4.4.2.1 Radioactive decay and nuclear radiation**

**Question 60**

March 2009 | PHY1AP | Original Q3 | Legacy

## QUESTION THREE

Some people feel strongly about the environment. They can use posters to protest against the location of new power stations.




Match energy sources, **A**, **B**, **C**, and **D**, with the protesters' posters **1–4**.

**A** fossil fuels

**B** nuclear

**C** tides

**D** wind

### 4.4.2.1 Radioactive decay and nuclear radiation

**Question 61**

March 2009 | PHY1BP | Original Q2 | Legacy

**QUESTION TWO**

A radioactive material gives out radiation all the time.

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

**A** alpha

**B** beta

**C** electron

**D** gamma

The radiation that is most penetrating is . . . **1** . . . .

The radiation that is stopped by a sheet of paper is . . . **2** . . . .

The radiation that passes through a sheet of paper but is stopped by aluminium foil is . . . **3** . . . .

A beta particle is an . . . **4** . . . .

**4.4.2.1 Radioactive decay and nuclear radiation**

**Question 62**

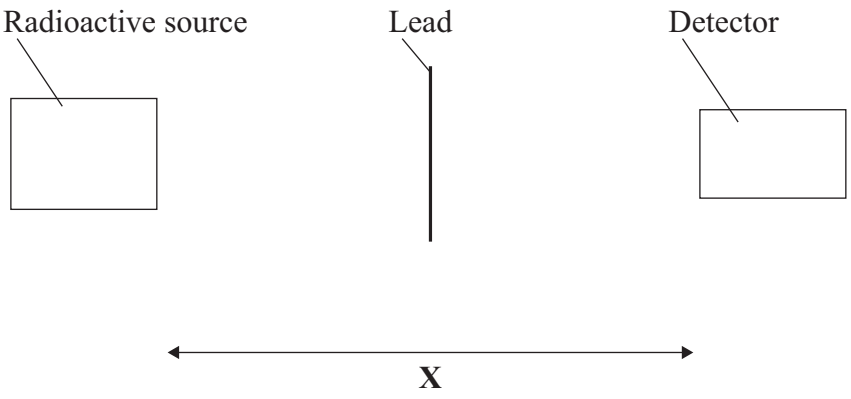
March 2009 | PHY1BP | Original Q3 | Legacy

## QUESTION THREE

A student investigated how much gamma radiation was absorbed by lead.

She used different thicknesses of lead.

She plotted a graph of her results.




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

**A** conclusion

**B** control variable

**C** prediction

**D** independent variable

| | |
|---|---|
| **1** | She thought that the amount of radiation absorbed would decrease with thickness. |
| **2** | She kept the distance **X** the same. |
| **3** | She changed the thickness of the lead. |
| **4** | From her graph, she decided that the amount of radiation absorbed increased with thickness. |

**4.4.2.1 Radioactive decay and nuclear radiation**

**Question 63**

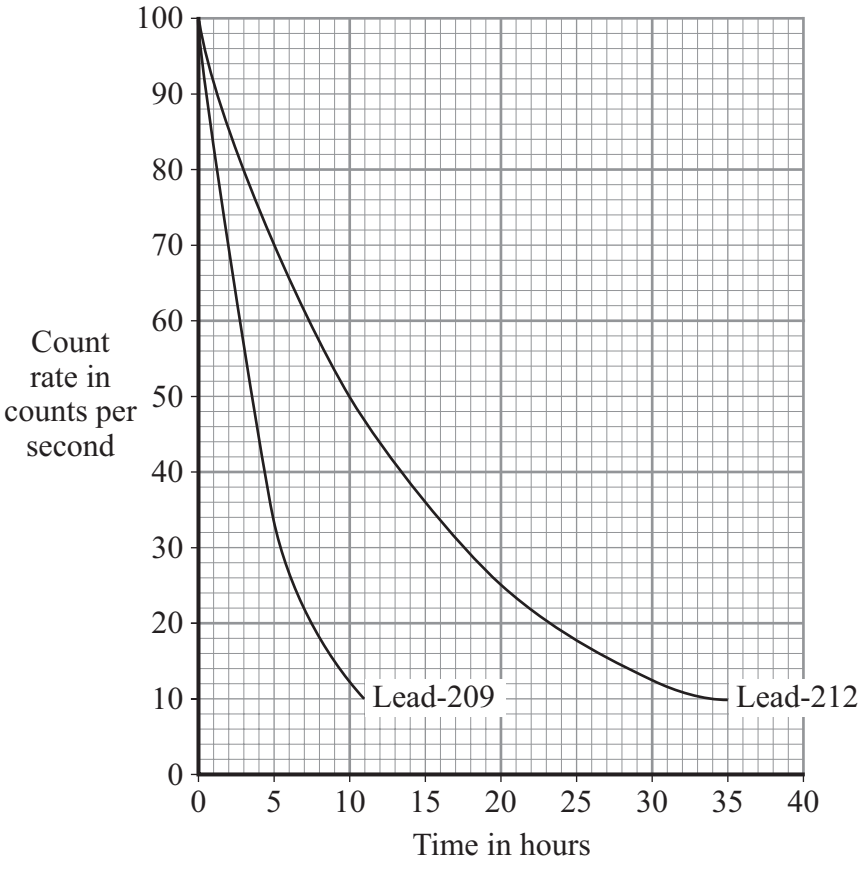
March 2009 | PHY1BP | Original Q5 | Legacy

**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.

**4.4.2.1 Radioactive decay and nuclear radiation**

**Question 64**

March 2009 | PHY1BP | Original Q6 | Legacy

## QUESTION SIX

The table shows part of the electromagnetic spectrum.

| | | | | | |
|---|---|---|---|---|---|
| gamma rays | X-rays | ultraviolet | visible light | infra red | microwaves |

**6A** Which one of the following parts of the electromagnetic spectrum has the longest wavelength?

**1** gamma rays

**2** microwaves

**3** ultraviolet

**4** visible light

**6B** Which one of the following parts of the electromagnetic spectrum has the highest frequency?

**1** gamma rays

**2** microwaves

**3** ultraviolet

**4** visible light

**6C** Which part of the electromagnetic spectrum is used to show up invisible security marking on valuable equipment?

**1** microwaves

**2** ultraviolet

**3** visible light

**4** X-rays

**4.4.2.1 Radioactive decay and nuclear radiation**

**Question 64 · continued** March 2009 | PHY1BP | Original Q6 | Legacy

**6D** Which part of the electromagnetic spectrum is emitted by mobile phone transmitters?

**1** microwaves

**2** ultraviolet

**3** visible light

**4** X-rays

**Turn over for the next question**

4.4.2.1 Radioactive decay and nuclear radiation

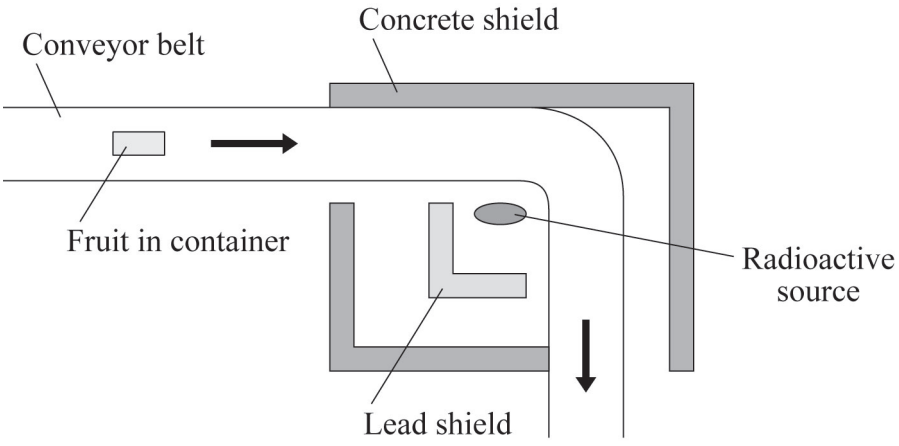
Question 65

March 2009 | PHY1BP | Original Q8 | Legacy

## QUESTION EIGHT

In some countries, fruit is passed in front of a radioactive source. The gamma radiation from the source kills bacteria. This keeps the fruit fresh for longer.

The main process is shown in the diagram.




**8A** Gamma radiation is used because it is . . .

**1** able to penetrate the container and fruit.

**2** stopped by the lead shield.

**3** not harmful to people.

**4** the only radiation that can kill bacteria.

**8B** The amount of radiation absorbed by the fruit can be increased by . . .

**1** moving the source further from the fruit.

**2** packing the fruit in thicker containers.

**3** slowing down the conveyor belt.

**4** speeding up the conveyor belt.

**4.4.2.1 Radioactive decay and nuclear radiation**

**Question 65 · continued**



**8C** Some fruit growers use X-ray machines instead of gamma ray sources.

The X-rays are safer to work with because . . .

**1** gamma ray sources are used in hospitals.

**2** X-ray machines can be switched on and off.

**3** gamma rays have a lower frequency than X-rays.

**4** X-rays have a shorter wavelength than gamma rays.

**8D** Some scientists investigated the effect of radiation on the vitamin C content of fruit.

They measured the amount of radiation absorbed by some fruit.

They also measured the amount of vitamin C in the fruit before and after the radiation treatment.

Which row of the table describes the variables for a fair test?

| | Amount of radiation absorbed | Amount of vitamin C lost during irradiation | Size and type of fruit |
|---|---|---|---|
| **1** | independent | dependent | control |
| **2** | independent | control | dependent |
| **3** | dependent | independent | control |
| **4** | control | independent | dependent |

**4.4.2.1 Radioactive decay and nuclear radiation**

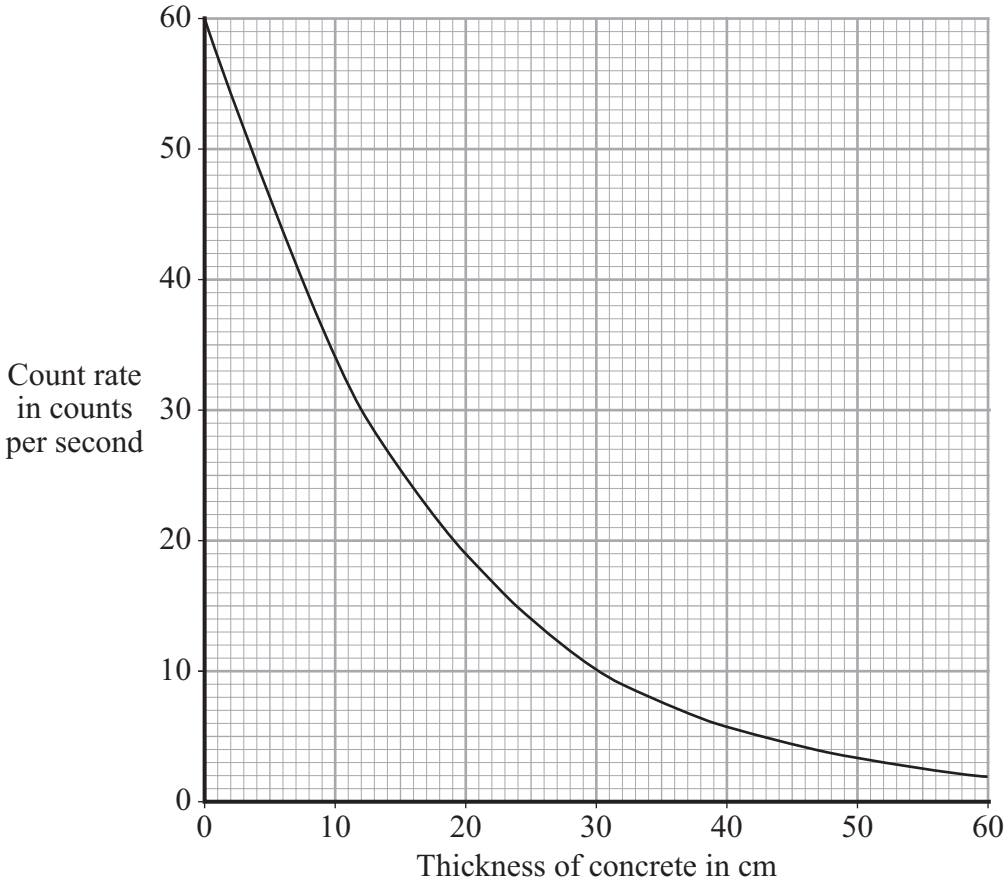
**Question 66**

June 2009 | PHY1BP | Original Q4 | Legacy

## QUESTION FOUR

Concrete is sometimes used to protect people from the harmful effects of gamma radiation.

The graph shows the count rate from a source of gamma radiation after it has passed through different thicknesses of concrete.




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

**A** 8

**B** 12

**C** 30

**D** 60

The count rate when there is no concrete = . . . **1** . . . counts per second.

The thickness of the concrete when the count rate is 10 counts per second = . . . **2** . . . cm.

The thickness of concrete needed to reduce the count rate by half = . . . **3** . . . cm.

The reduction in count rate when the thickness of concrete is increased from 30 cm to 60 cm = . . . **4** . . . counts per second.

### 4.4.2.1 Radioactive decay and nuclear radiation

**Question 67**

June 2009 | PHY1BP | Original Q5 | Legacy

**QUESTION FIVE**

Electromagnetic radiation can be grouped into types. Each type has a different range of wavelengths.

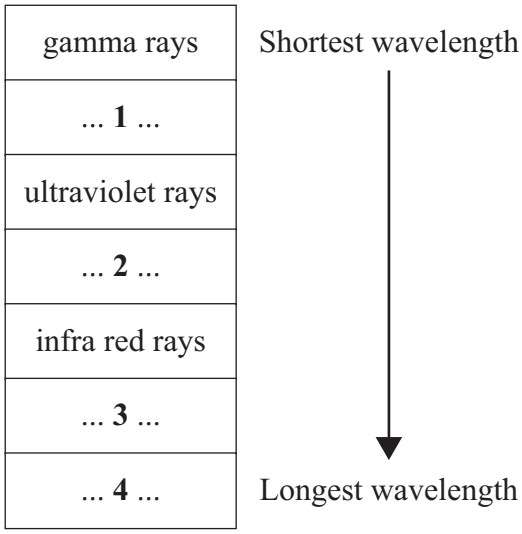
Match types of radiation, **A**, **B**, **C** and **D**, with the numbers **1–4** in the table.

**A** microwaves

**B** X-rays

**C** visible light

**D** radio waves



### 4.4.2.1 Radioactive decay and nuclear radiation

**Question 68**

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.

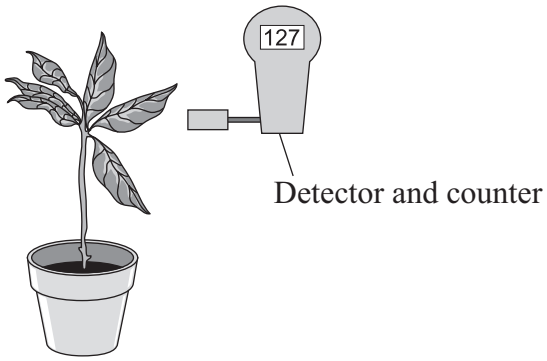
**2** neutrons.

**3** nuclei.

**4** protons.

**4.4.2.1 Radioactive decay and nuclear radiation**

**Question 68 · continued** June 2009 | PHY1BP | Original Q6 | Legacy




**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.

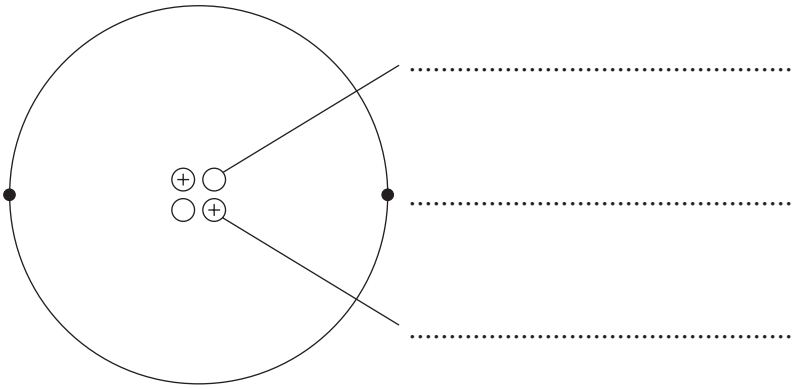
**4** be unchanged in 14 days.

**4.4.2.1 Radioactive decay and nuclear radiation**

**Question 69**

June 2009 | PHY1F | Original Q3 | Legacy

**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)*

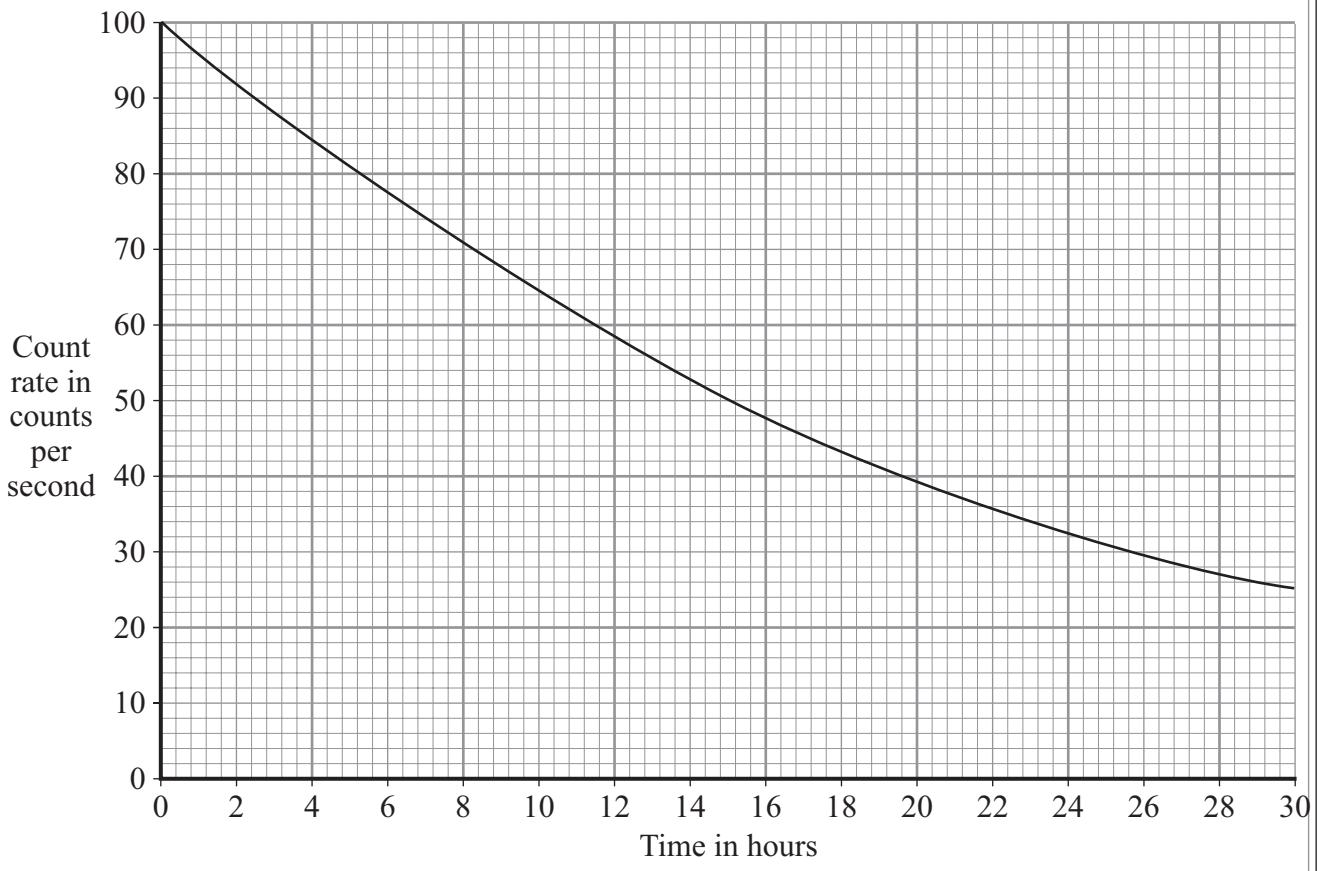
**4.4.2.1 Radioactive decay and nuclear radiation**

**Question 69 · 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**

**4.4.2.1 Radioactive decay and nuclear radiation**

**Question 69 · 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

**4.4.2.1 Radioactive decay and nuclear radiation**

**Question 70**

June 2009 | PHY1F | Original Q6 | Legacy

**6** (a) The table lists the names of seven telescopes. Each one of the telescopes is designed to detect a different one of the seven types of electromagnetic wave.
The table is incomplete.

| Name of telescope | Type of wave detected |
|---|---|
| HESS | Gamma |
| XMM Newton | X-ray |
| FUSE | Ultraviolet |
| William Herschel | Visible light |
| Spitzer | |
| SPT | Microwave |
| Lovell | Radio |

**6** (a) (i) Which **one** of the telescopes is designed to detect the type of wave with the shortest wavelength?

.....

*(1 mark)*

**6** (a) (ii) What type of wave is the Spitzer telescope designed to detect?

.....

*(1 mark)*

**6** (b) The William Herschel telescope is on the Earth's surface. Another telescope, the Hubble telescope, which also detects visible light, orbits the Earth.

How is the image produced by the Hubble telescope better than the image produced by the William Herschel telescope?

.....

Give a reason for your answer.

.....

.....

*(2 marks)*

**4.4.2.1 Radioactive decay and nuclear radiation**

**Question 70 · continued**



*for mark*

**6** (c) Some types of electromagnetic wave are absorbed by water.
The SPT telescope is located in the Antarctic, which is a dry environment.

Explain why it is better to have this type of telescope in a dry environment rather than in a wet, humid environment.

.....

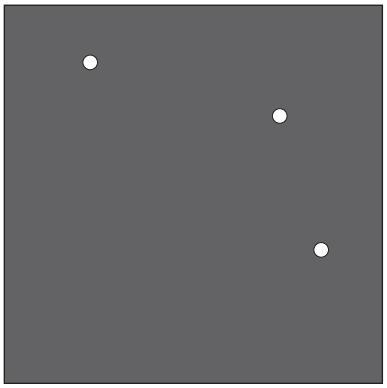
.....

.....

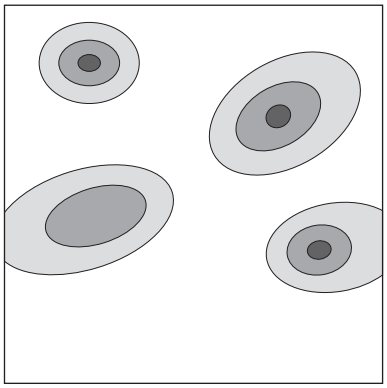
.....

*(2 marks)*

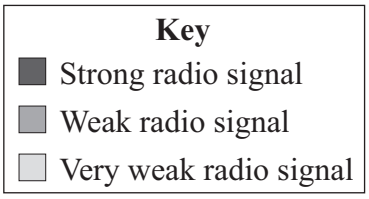
**6** (d) The pictures represent the images produced using a visible light telescope and a radio telescope. Both images are of the same part of the sky. The shading on the radio telescope image represents the strength of the radio signals.



Visible light image



Radio telescope image




Suggest what extra information can be gained from the radio telescope image compared with the visible light image.

.....

.....

*(1 mark)*

7

### 4.4.2.1 Radioactive decay and nuclear radiation

**Question 71**

November 2009 | PHY1BP | Original Q2 | Legacy

## QUESTION TWO

This question is about four types of electromagnetic radiation.

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

**A** gamma

**B** infra red

**C** radio

**D** visible light

The type of electromagnetic radiation with the longest wavelength is . . . **1** . . . .

The type of electromagnetic radiation with the highest frequency is . . . **2** . . . .

The type of electromagnetic radiation that is used to cook food is . . . **3** . . . .

The type of electromagnetic radiation that allows us to see is . . . **4** . . . .

### 4.4.2.1 Radioactive decay and nuclear radiation

**Question 72**

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 |

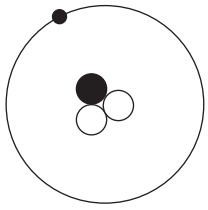
**4.4.2.1 Radioactive decay and nuclear radiation**

**Question 73**

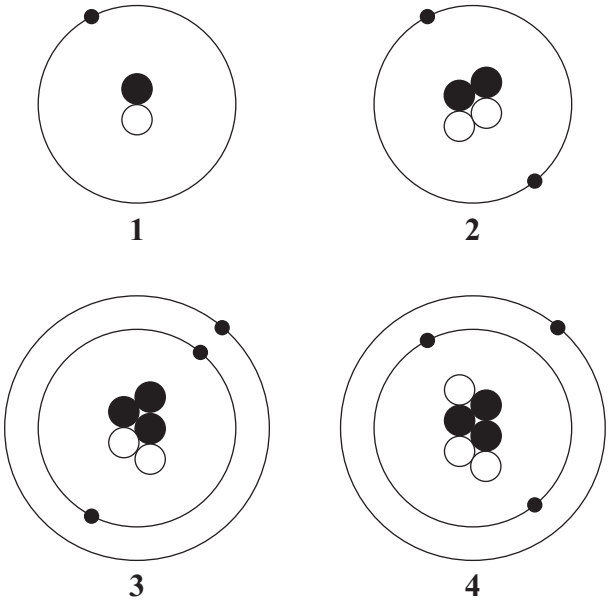
November 2009 | PHY1BP | Original Q4 | Legacy

## QUESTION FOUR

The diagram shows an isotope of hydrogen. It contains one electron, one proton and two neutrons.



Four other atoms are labelled **1–4**.




Match statements, **A**, **B**, **C** and **D**, with the atoms labelled **1–4**.

**A** contains 5 particles in its nucleus

**B** has a nucleus that is identical in structure to an alpha particle

**C** has the same number of electrons as atom **3**

**D** is a different isotope of hydrogen

**4.4.2.1 Radioactive decay and nuclear radiation**

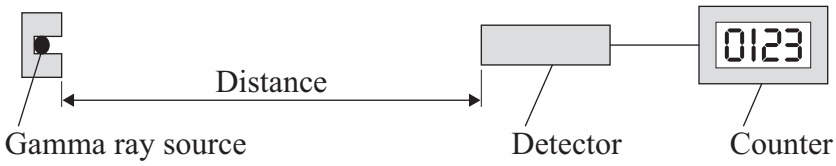
**Question 74**

November 2009 | PHY1BP | Original Q8 | Legacy

## QUESTION EIGHT

**Harmful Gamma Radiation? .... Keep safe, keep away!**

A sixth form student decided to test the truth of the newspaper headline. She used a gamma ray source and a detector to measure the amount of radiation reaching the detector per second. She repeated the experiment and calculated the mean count rates. She then moved the detector further away from the source and repeated the procedure.




Her results are shown in the table.

| Distance from source in metres | Count rate in counts per second | | |
|---|---|---|---|
| | Test 1 | Test 2 | Mean |
| 0.2 | 480 | 484 | 482 |
| 0.4 | 121 | 127 | 124 |
| 0.6 | 55 | 55 | 55 |
| 0.8 | 30 | 32 | 31 |
| 1.0 | 20 | 18 | 19 |

**8A** The results with the greatest range of count rate occur at a distance from the source of . . .

**1** 0.2 m

**2** 0.4 m

**3** 0.8 m

**4** 1.0 m

**4.4.2.1 Radioactive decay and nuclear radiation**

**Question 74 · continued**



**8B** She repeated the experiment and calculated the mean to make her results more . . .

**1** accurate.

**2** controlled.

**3** varied.

**4** reliable.

**8C** A valid conclusion based on her results would be that . . .

**1** 1.0 m is a safe distance to be from the source.

**2** the count rate decreases as the distance from the source increases.

**3** the count rate will be almost zero at a distance of 1.2 m from the source.

**4** there is no such thing as a safe distance from a gamma source.

**8D** Another way in which the count rate could be reduced would be to . . .

**1** reduce the air temperature between the source and detector.

**2** place a thick sheet of lead between the source and detector.

**3** produce a strong electric field between the source and detector.

**4** produce a strong magnetic field between the source and detector.

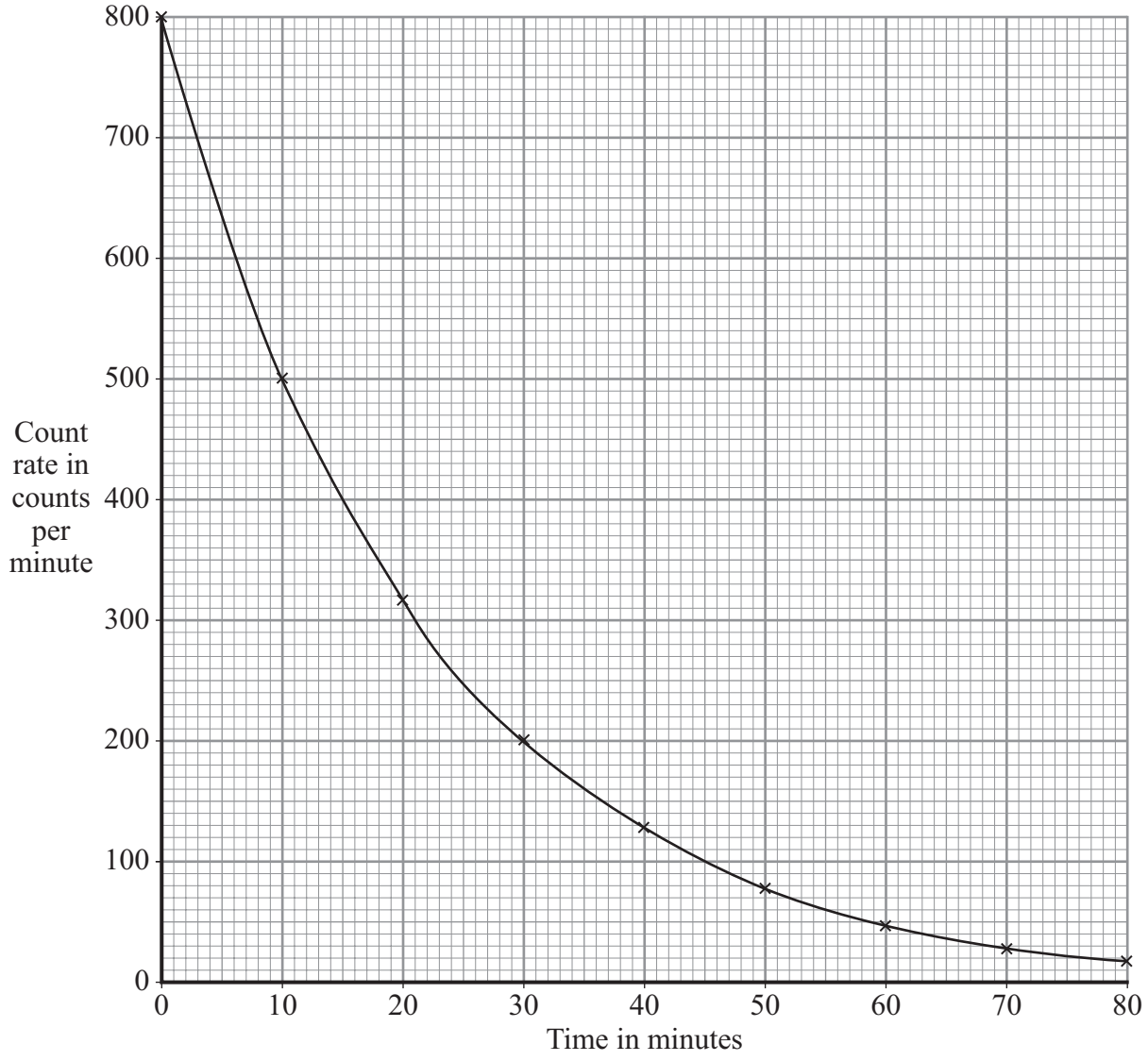
**4.4.2.1 Radioactive decay and nuclear radiation**

**Question 75**

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 75 · 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**

### 4.4.2.1 Radioactive decay and nuclear radiation

**Question 76**

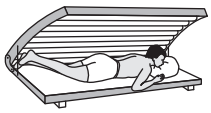
January 2010 | PHY1F | Original Q1 | Legacy

**1** (a) The diagram shows the electromagnetic spectrum.
The pictures show four devices that use electromagnetic waves. Each device uses a different type of electromagnetic wave.

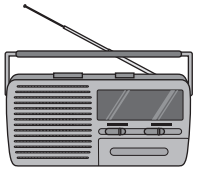
Draw a line from each device to the type of electromagnetic wave that it uses.
One has been done for you.

| Gamma rays | X-rays | Ultraviolet rays | Visible light | Infra red rays | Microwaves | Radio waves |
|---|---|---|---|---|---|---|

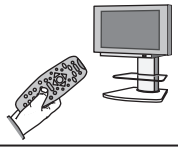
Sunbed



Radio



TV remote control



Filament lamp



*(3 marks)*

**1** (b) A headline from a recent newspaper article is shown below.




**1** (b) (i) What serious health problem may be caused by using a sunbed too much?

.....

*(1 mark)*

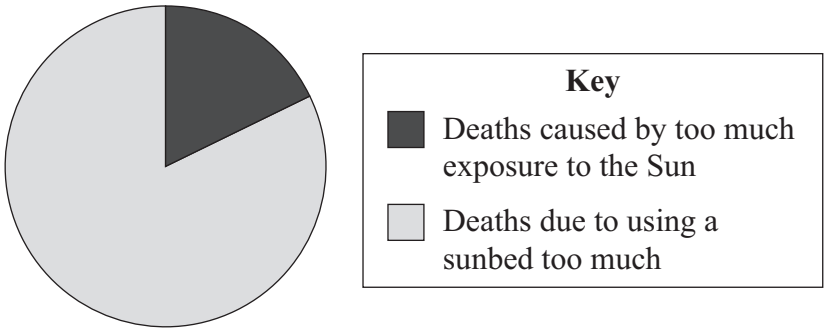
**4.4.2.1 Radioactive decay and nuclear radiation**

**Question 76 · continued**



*for mark*

**1** (b) (ii) The pie chart compares the number of deaths in Britain each year, which may have been caused by using sunbeds too much, with those which may have been caused by too much exposure to the Sun.




It is difficult for a doctor to be certain that a person has died because of using a sunbed too much.

Suggest why.

.....

.....

*(1 mark)*

**1** (b) (iii) A spokesperson for a leading cancer charity said:

> 'We want people, especially young people, to know the possible dangers of using a sunbed.'

Why is it important that you know the possible dangers of using a sunbed?

.....

.....

*(1 mark)*

**6**

**4.4.2.1 Radioactive decay and nuclear radiation**

**Question 77**

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.

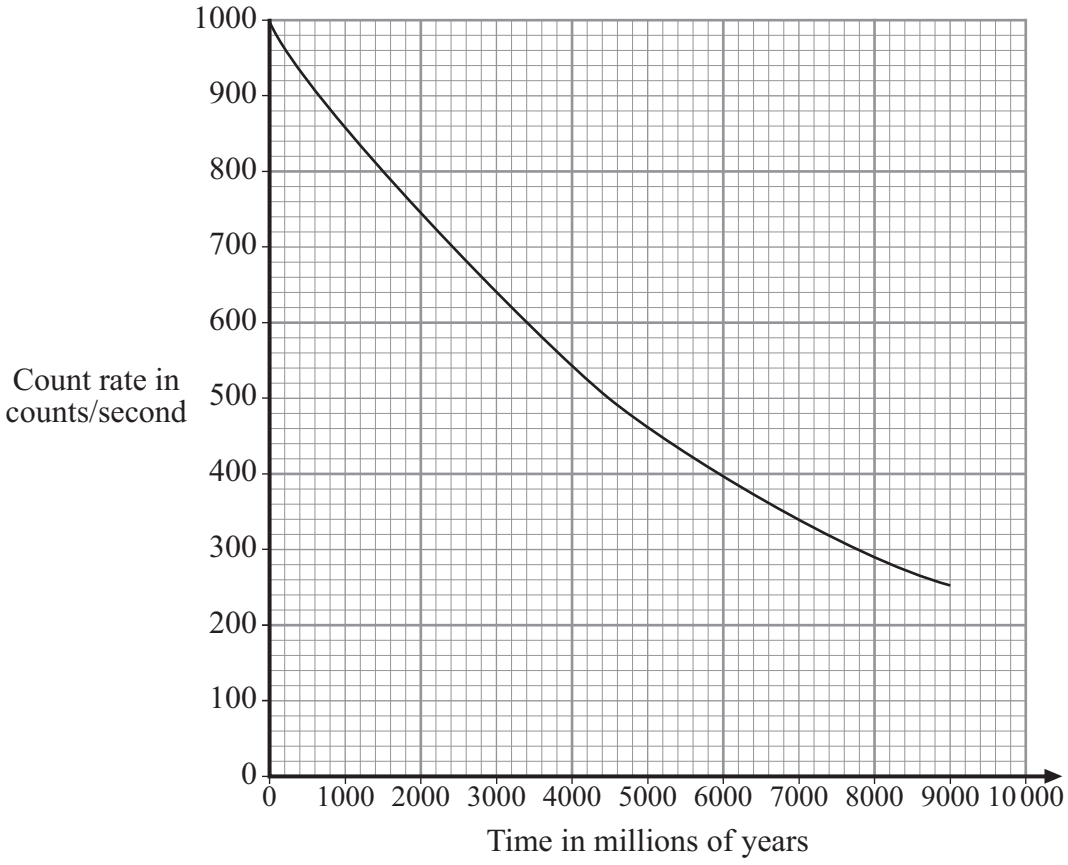
Write down your **new** statement.

.....

.....

*(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)*

**4.4.2.1 Radioactive decay and nuclear radiation**

**Question 77 · 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**

**4.4.2.1 Radioactive decay and nuclear radiation**

**Question 78**



**5** (a) An optical telescope, used to observe stars, is to be built either at the bottom or at the top of a high mountain.

**5** (a) (i) What type of electromagnetic radiation is detected by an optical telescope?

.....

*(1 mark)*

**5** (a) (ii) Give **one** advantage of having the telescope at the top of the high mountain rather than at the bottom.

.....

.....

*(1 mark)*

**5** (b) Gamma radiation from the Sun is absorbed by the atmosphere.

Where should a telescope designed to detect gamma radiation be positioned?

.....

.....

*(1 mark)*

**5** (c) By observing distant galaxies, scientists have found evidence to support the 'Big Bang' theory.

Which statement about the 'Big Bang' theory is correct?

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

Scientists have proved beyond doubt that it happened. ☐

It is the only way of explaining the origin of the Universe. ☐

The Universe began from a very small point. ☐

*(1 mark)*

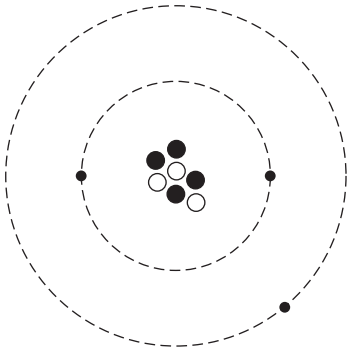
4

### 4.4.2.1 Radioactive decay and nuclear radiation

**Question 79**

January 2010 | PHY2F | Original Q4 | Legacy

**4** The diagram represents an atom of lithium.



**4** (a) (i) Complete the following table of information for an atom of lithium.

| | |
|---|---|
| Number of protons | |
| Number of electrons | |
| Number of neutrons | |

*(2 marks)*

**4** (a) (ii) What is the mass number of a lithium atom?

Draw a ring around your answer.

| | | | |
|---|---|---|---|
| **3** | **4** | **7** | **10** |

Give a reason for your answer.

.....

.....

*(2 marks)*

**4** (b) Complete the following sentence by drawing a ring around the correct line in the box.

An atom that has lost an electron is called

| |
|---|
| an ion |
| an isotope |
| a positive atom |

.

*(1 mark)*

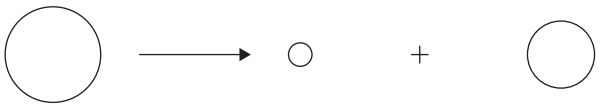
**4.4.2.1 Radioactive decay and nuclear radiation**

**Question 79 · continued**



*for mark*

**4** (c) When an alpha particle is emitted from the nucleus of a radon atom, the radon changes into polonium.



Radon — Alpha particle — Polonium

**Not to scale**

An alpha particle consists of 2 protons and 2 neutrons.

**4** (c) (i) Complete the following sentence by drawing a ring around the correct line in the box.

The mass of a polonium atom is

| |
|---|
| greater than |
| the same as |
| smaller than |

the mass of a radon atom.

*(1 mark)*

**4** (c) (ii) Give a reason for your answer to part (c)(i).

.....

.....

*(1 mark)*

7

**4.4.2.1 Radioactive decay and nuclear radiation**

**Question 80**

March 2010 | PHY1BP | Original Q2 | Legacy

## QUESTION TWO

The table shows part of the electromagnetic spectrum.

| | | | | | | |
|---|---|---|---|---|---|---|
| Gamma | | Ultraviolet | | Infra red | | Radio |

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

**A** gamma

**B** infra red

**C** radio

**D** ultraviolet

The part of the electromagnetic spectrum with the longest wavelengths is . . . **1** . . . .

Between X-rays and visible light in the electromagnetic spectrum is . . . **2** . . . radiation.

Some radioactive isotopes emit . . . **3** . . . radiation.

Signals can be sent from remote controls to a television by . . . **4** . . . radiation.

### 4.4.2.1 Radioactive decay and nuclear radiation

**Question 81**

March 2010 | PHY1BP | Original Q4 | Legacy

## QUESTION FOUR

This question is about types of radiation.

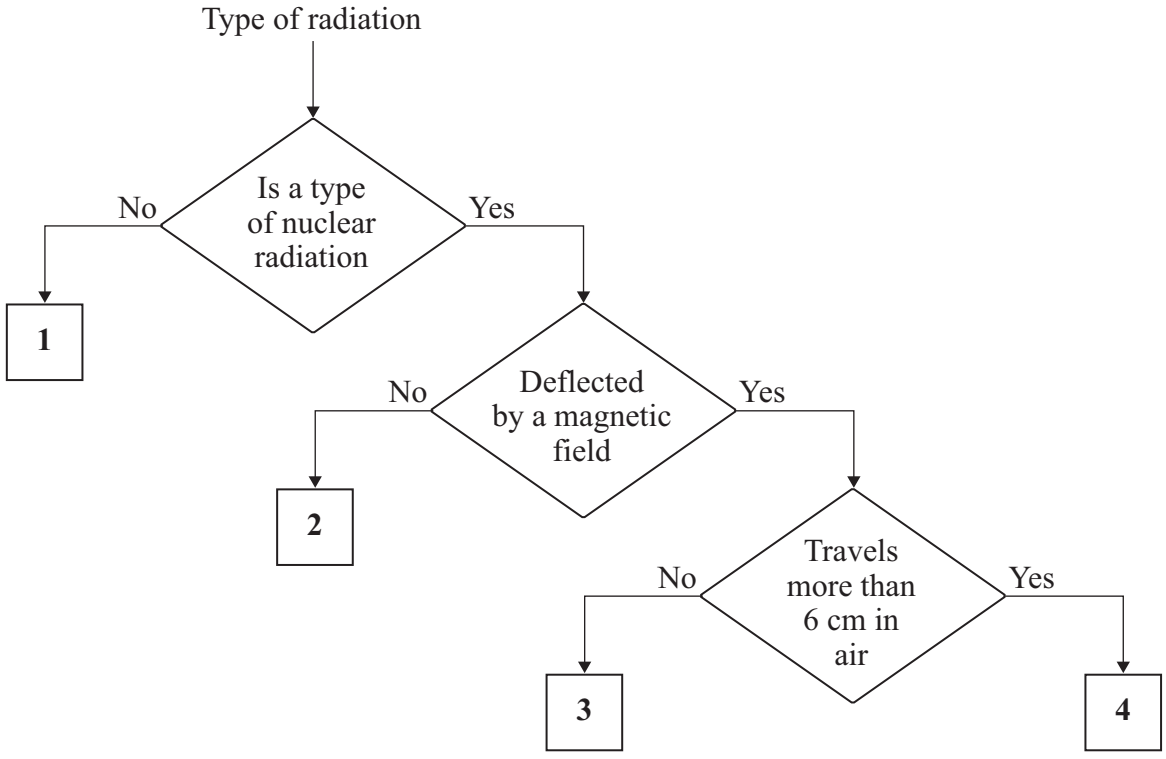
Match radiations, **A**, **B**, **C** and **D**, with the boxes **1–4** on the flow diagram.

**A** alpha

**B** beta

**C** gamma

**D** X-rays



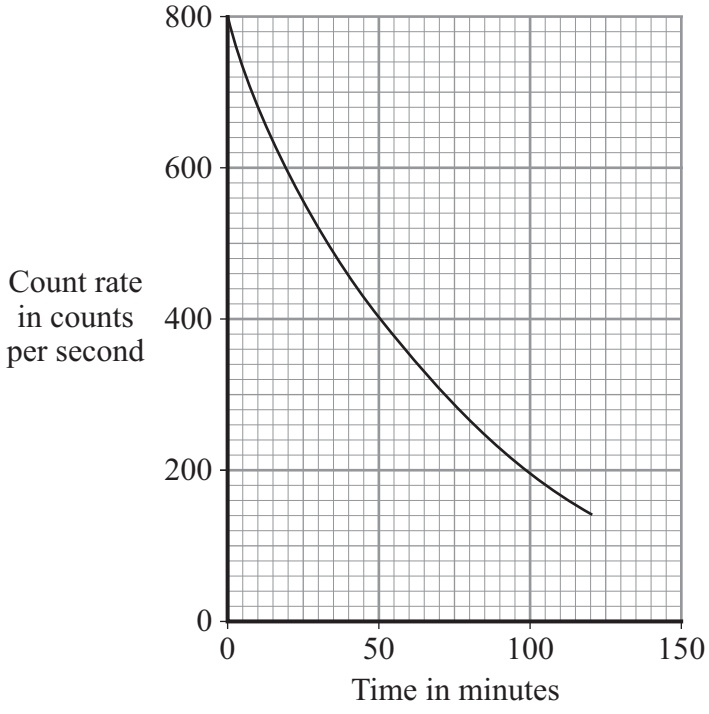
**4.4.2.1 Radioactive decay and nuclear radiation**

**Question 82**

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 |

**4.4.2.1 Radioactive decay and nuclear radiation**

**Question 83**

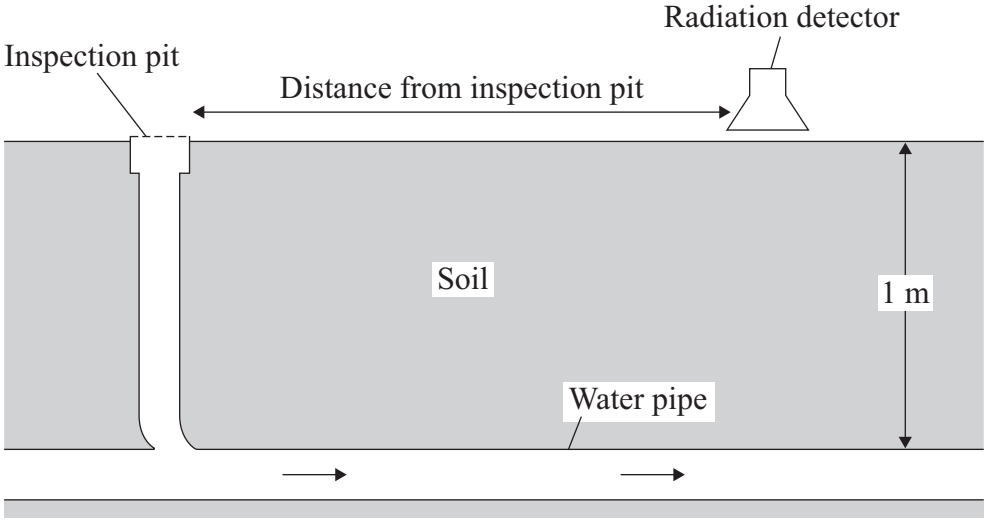
March 2010 | PHY1BP | Original Q8 | Legacy

## 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 |

**4.4.2.1 Radioactive decay and nuclear radiation**

**Question 83 · 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.

### 4.4.2.1 Radioactive decay and nuclear radiation

**Question 84**

June 2010 | PHY1AP | Original Q4 | Legacy

**QUESTION FOUR**

The use of various types of power station raises different environmental issues.

Match types of power station, **A**, **B**, **C** and **D**, with the numbers **1–4** in the table.

**A** gas-fired

**B** hydroelectric

**C** nuclear

**D** wind farm

| | **Environmental issue** |
|---|---|
| **1** | large areas of land are flooded to form reservoirs |
| **2** | pollutes the atmosphere with carbon dioxide |
| **3** | produces radioactive waste |
| **4** | rotating blades may kill birds |

### 4.4.2.1 Radioactive decay and nuclear radiation

**Question 85**

June 2010 | PHY1BP | Original Q1 | Legacy

**QUESTION ONE**

Electromagnetic radiation can be grouped into types. Each type has a different range of wavelengths.

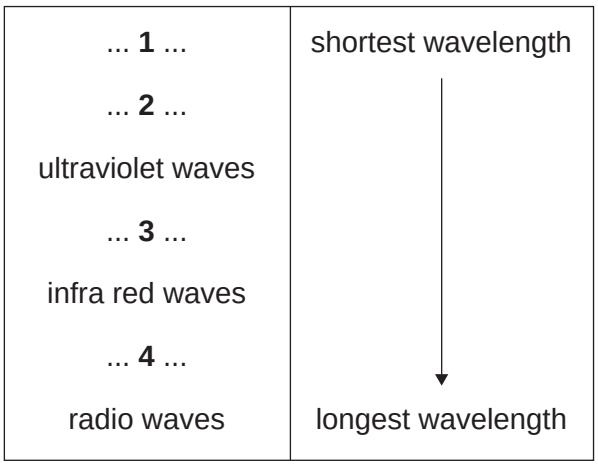
Match types of radiation, **A**, **B**, **C** and **D**, with the numbers **1–4** in the diagram.

**A** gamma rays

**B** microwaves

**C** visible light

**D** X-rays



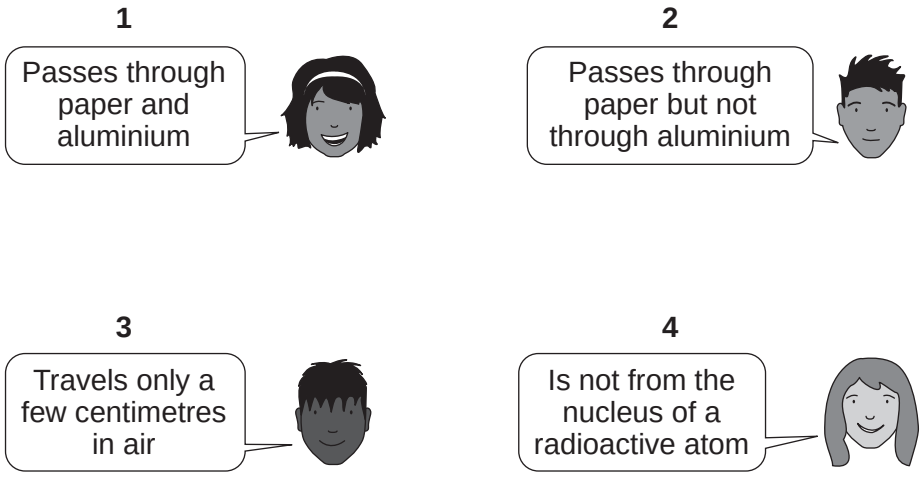
### 4.4.2.1 Radioactive decay and nuclear radiation

**Question 86**

June 2010 | PHY1BP | Original Q2 | Legacy

**QUESTION TWO**

Four students are describing the properties of different types of radiation.




Match types of radiation, **A**, **B**, **C** and **D**, with the descriptions **1–4**.

**A** alpha

**B** beta

**C** gamma

**D** X-rays

### 4.4.2.1 Radioactive decay and nuclear radiation

**Question 87**

June 2010 | PHY1BP | Original Q3 | Legacy

**QUESTION THREE**

The table gives uses for four types of radiation.

Match types of radiation, **A**, **B**, **C** and **D**, with the uses **1–4** in the table.

**A** alpha

**B** beta

**C** gamma

**D** X-rays

| | **Use** |
|---|---|
| **1** | in medical tracers |
| **2** | in smoke detectors |
| **3** | to control the thickness of paper during manufacture |
| **4** | usually used to take shadow photographs of bones |

### 4.4.2.1 Radioactive decay and nuclear radiation

**Question 88**

June 2010 | PHY1BP | Original Q6 | Legacy

**QUESTION SIX**

In 1896, Henri Becquerel was doing an experiment with uranium.

**6A** Becquerel thought that uranium absorbed energy from the Sun, and then re-emitted the energy as X-rays.

This was . . .

**1** a conclusion.

**2** an estimate.

**3** an observation.

**4** a theory.

**6B** Becquerel found that the uranium emitted radiation even when the sample was sealed in black paper.

He had discovered radioactivity.

Becquerel had to change his ideas because . . .

**1** the Sun does not provide energy on a cloudy day.

**2** sunlight could not pass through the black paper.

**3** X-rays could not pass through the black paper.

**4** radiation could not pass through the black paper.

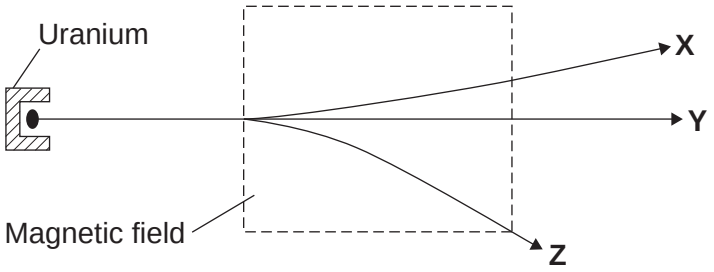
### 4.4.2.1 Radioactive decay and nuclear radiation

**Question 88 · continued**



**6C** When Becquerel passed the radiation emitted by uranium through a magnetic field, he found that there were three different types of radiation.

The diagram shows the paths of the three types of radiation, **X**, **Y** and **Z**, in the magnetic field.




Which of the following is the path of gamma radiation?

**1** **X**

**2** **Y**

**3** **Z**

**4** **X** and **Z**

**6D** Two types of radiation were deflected in the magnetic field.

These two types of radiation were deflected because they are . . .

**1** electrically charged.

**2** electrically neutral.

**3** have a smaller mass than the third type of radiation.

**4** have a bigger mass than the third type of radiation.

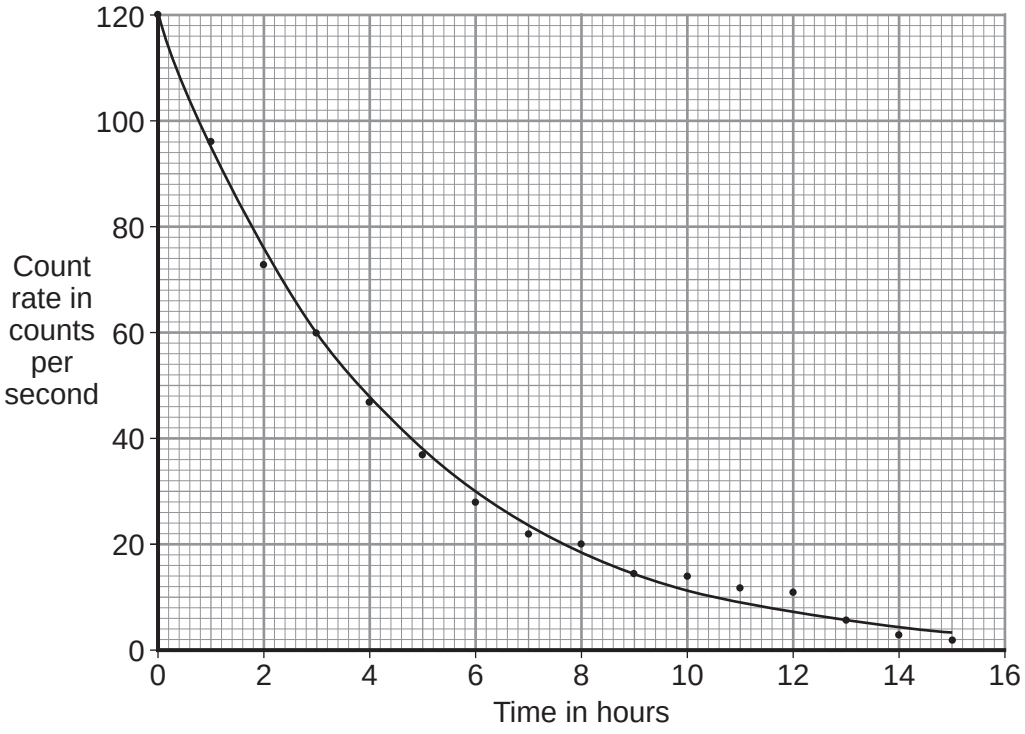
### 4.4.2.1 Radioactive decay and nuclear radiation

**Question 89**

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.

4.4.2.1 Radioactive decay and nuclear radiation

Question 89 · 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**

### 4.4.2.1 Radioactive decay and nuclear radiation

**Question 90**

June 2010 | PHY1F | Original Q2 | Legacy

**2** The diagram shows the seven types of wave that make up the electromagnetic spectrum.

| | | | | | | |
|---|---|---|---|---|---|---|
| Gamma rays | X-rays | Ultraviolet rays | Visible light | Infra red rays | Micro-waves | Radio waves |

**2 (a) (i)** Microwaves and visible light can be used for communications.

Name **one** more type of electromagnetic wave that can be used for communications.

.....

*(1 mark)*

**2 (a) (ii)** Name **one** type of electromagnetic wave that has a longer wavelength than microwaves.

.....

*(1 mark)*

**2 (b)** Wi-Fi is a system that joins a laptop computer to the internet without using wires. A 2400 megahertz microwave signal is used to link a computer to a device called a router.

What quantity is measured in hertz?

Draw a ring around your answer.

**frequency** **wavelength** **wave speed**

*(1 mark)*

**2 (c)** A politician commented on the increasing use of Wi-Fi. He said: 'I believe that these systems may be harmful to children.'

**2 (c) (i)** Suggest **one** reason why more scientific research into the safety of Wi-Fi systems is needed.

.....

.....

*(1 mark)*

4.4.2.1 Radioactive decay and nuclear radiation

Question 90 · continued



**2 (c) (ii)** Complete the following sentence by drawing a ring around the correct line in the box.

What the politician said was

| |
|---|
| a fact. |
| an opinion. |
| a prediction. |

*(1 mark)*

5

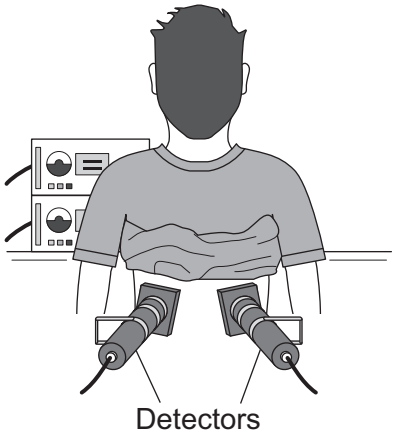
**Turn over for the next question**

### 4.4.2.1 Radioactive decay and nuclear radiation

**Question 91**

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)*

4.4.2.1 Radioactive decay and nuclear radiation

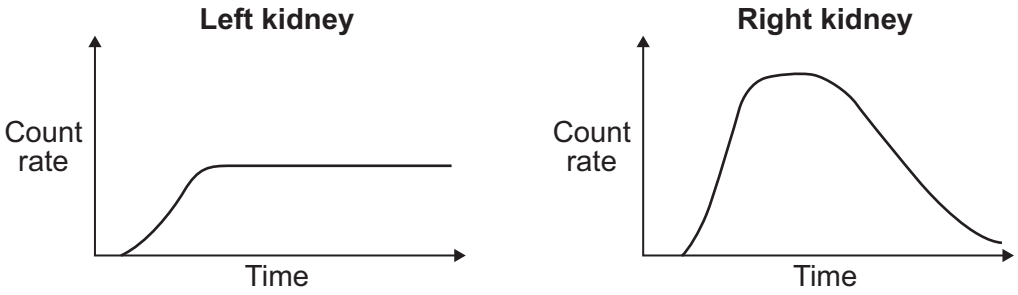
Question 91 · continued



**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**

### 4.4.2.1 Radioactive decay and nuclear radiation

**Question 91 · 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

### 4.4.2.1 Radioactive decay and nuclear radiation

Question 92

November 2010 | PHY1AP | Original Q4 | Legacy

**QUESTION FOUR**

Power stations used to generate electricity affect the environment in different ways.

Match types of power station, **A**, **B**, **C** and **D**, with effects on the environment **1**–**4** in the table.

**A** coal-fired

**B** hydroelectric

**C** nuclear

**D** tidal barrage

| | Effect on environment |
|---|---|
| **1** | destroys the habitats of wading birds |
| **2** | produces waste that is radioactive |
| **3** | destroys large areas of farmland by flooding |
| **4** | produces gases that pollute the atmosphere |

### 4.4.2.1 Radioactive decay and nuclear radiation

Question 93

November 2010 | PHY1BP | Original Q4 | Legacy

**QUESTION FOUR**

The diagram shows part of the electromagnetic spectrum.

| | | | | | | |
|---|---|---|---|---|---|---|
| **1** | X-rays | **2** | Visible light | **3** | Microwaves | **4** |

Match types of radiation, **A**, **B**, **C** and **D**, with the numbers **1**–**4** on the diagram.

**A** gamma

**B** infra red

**C** radio

**D** ultraviolet

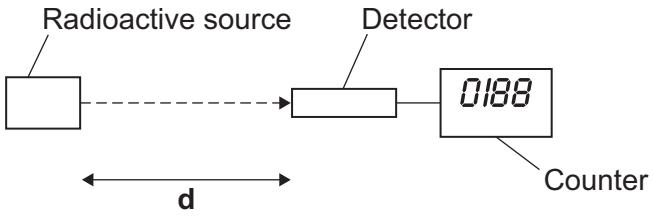
### 4.4.2.1 Radioactive decay and nuclear radiation

**Question 94**

November 2010 | PHY1BP | Original Q6 | Legacy

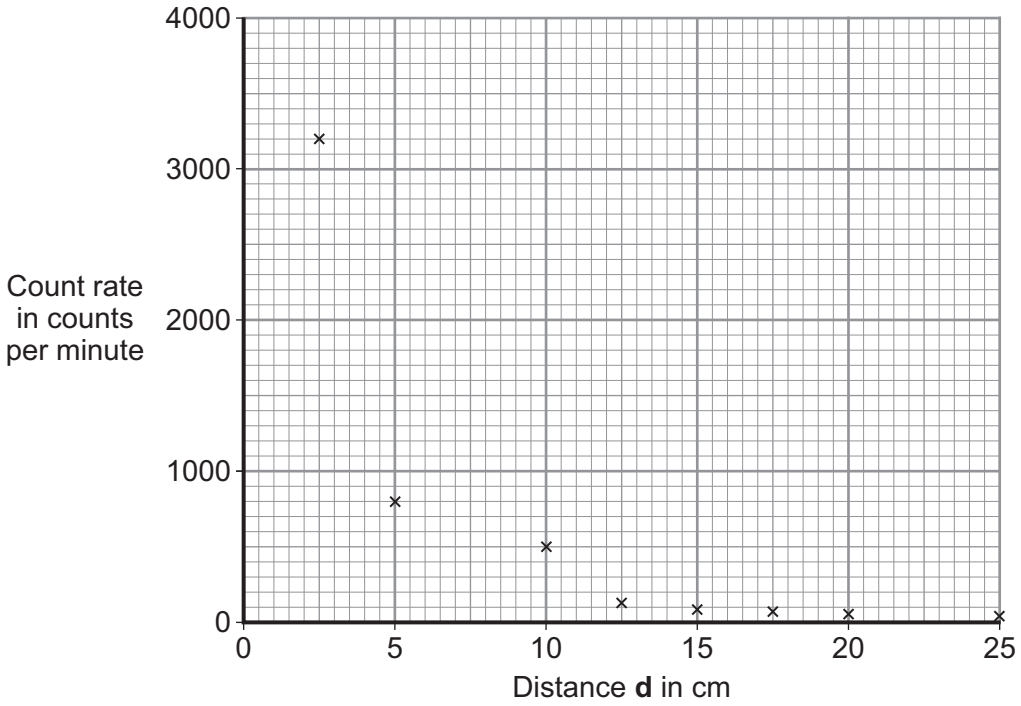
**QUESTION SIX**

A radioactive source gives out gamma radiation. A student wanted to know how the count rate from the source changes as the distance from the source increases. The following apparatus was set up.




The count rate was measured for a number of different distances, **d**.

The student plotted the results on graph paper.



4.4.2.1 Radioactive decay and nuclear radiation



**6A** A line graph should be drawn because . . .

**1** both variables are categoric.

**2** both variables are continuous.

**3** both variables are ordered.

**4** one variable is categoric and the other variable is continuous.

**6B** The range of distance measurements is . . .

**1** 2.5 – 5.0 cm

**2** 2.5 – 10.0 cm

**3** 2.5 – 20.0 cm

**4** 2.5 – 25.0 cm

**6C** Each reading was repeated twice and the mean calculated.

This made the data more . . .

**1** accurate.

**2** discrete.

**3** reliable.

**4** sensitive.

**6D** The result shown at 10 cm is anomalous and . . .

**1** the graph line should be drawn to pass through this result.

**2** was caused by a systematic error in the ruler.

**3** was caused by a systematic error in the counter.

**4** should be ignored when drawing the graph line.

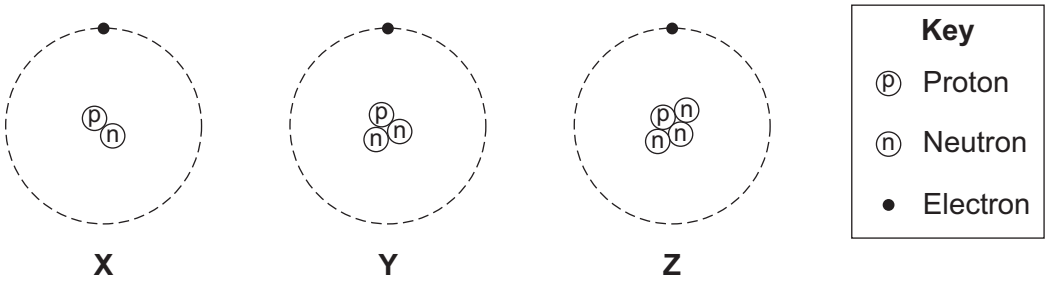
### 4.4.2.1 Radioactive decay and nuclear radiation

**Question 95**

November 2010 | PHY1BP | Original Q8 | Legacy

**QUESTION EIGHT**

The diagram shows three atoms, **X**, **Y** and **Z**.




**8A** Which of these atoms are isotopes of the same element?

**1** **X**, **Y** and **Z**

**2** **X** and **Y** only

**3** **X** and **Z** only

**4** **Y** and **Z** only

**8B** Some substances are radioactive.

What does this mean?

**1** Radio signals make these substances emit radiation.

**2** These substances can take part in chemical reactions.

**3** These substances emit radiation from the nuclei of their atoms.

**4** These substances glow in the dark.

**8C** Some substances emit beta radiation.

What is beta radiation?

**1** a helium nucleus

**2** an electron from outside the nucleus

**3** an electron from inside the nucleus

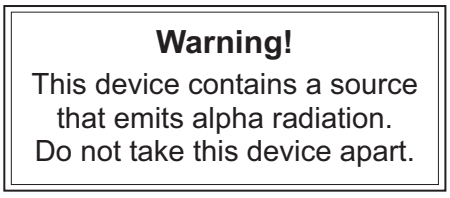
**4** an electromagnetic wave

4.4.2.1 Radioactive decay and nuclear radiation

Question 95 · continued

November 2010 | PHY1BP | Original Q8 | Legacy

**8D** The warning label is from a smoke detector.




What is the reason for this warning?

**1** Alpha radiation is very dangerous if the source gets inside the body.

**2** Alpha radiation can travel very long distances in the air.

**3** Alpha radiation has the longest half-life.

**4** Alpha radiation is the most penetrating of all radiations.

**Turn over for the next question**

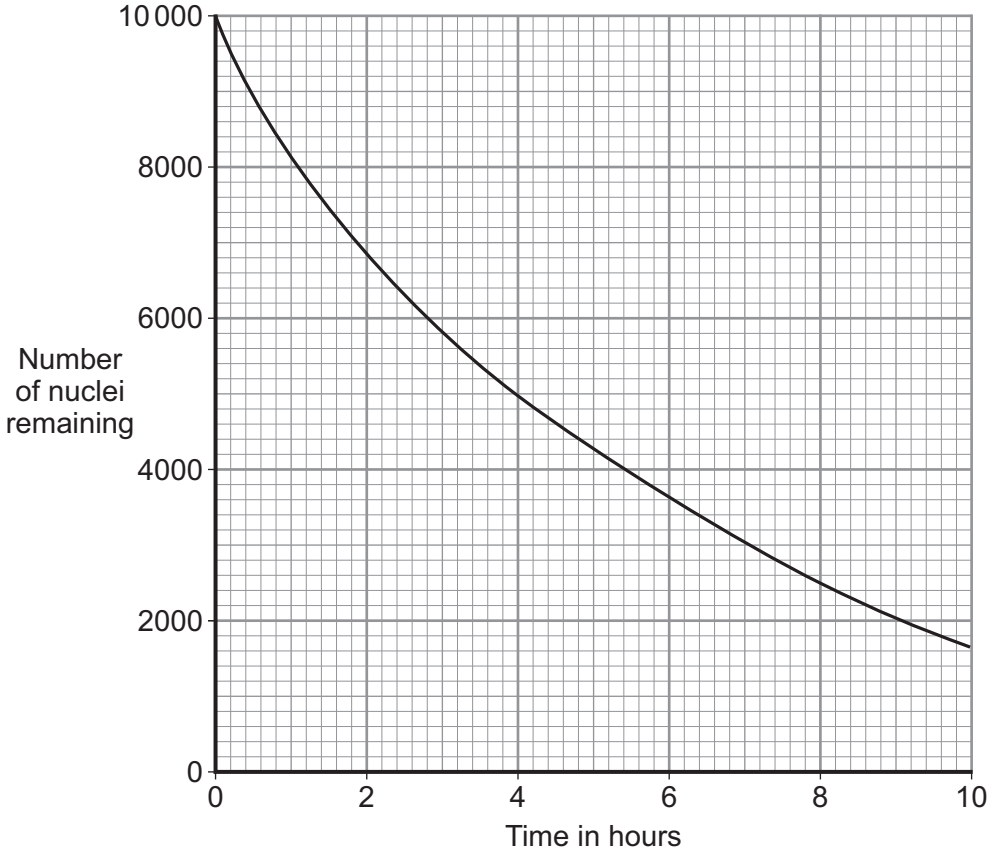
### 4.4.2.1 Radioactive decay and nuclear radiation

**Question 96**

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

4.4.2.1 Radioactive decay and nuclear radiation

Question 96 · continued



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

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

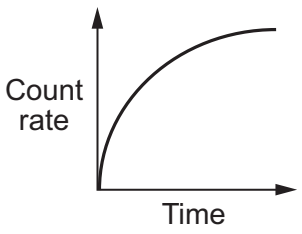
**2** as a source of radiation to monitor the thickness of paper in a paper mill.

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

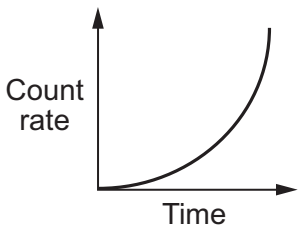
**4** to use in finding the age of an ancient bone.

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

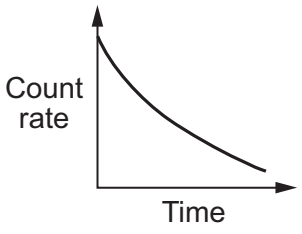
**1**



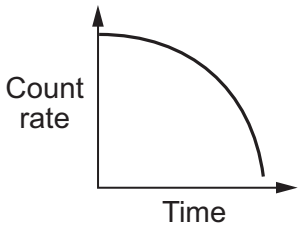

**2**




**3**




**4**




**END OF TEST**

### 4.4.2.1 Radioactive decay and nuclear radiation

**Question 97**

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**.

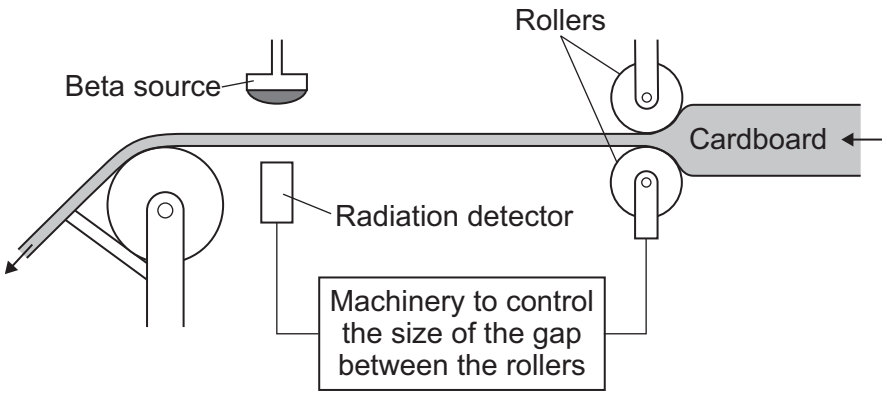
Draw a straight line to link each type of radiation in **List A** to its correct property in **List B**.

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.



4.4.2.1 Radioactive decay and nuclear radiation

Question 97 · 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

### 4.4.2.1 Radioactive decay and nuclear radiation

**Question 98**



**1** The names of three different processes are given in **List A**.
Where these processes happen is given in **List B**.

Draw a line to link each process in **List A** to where the process happens in **List B**.

Draw only **three** lines.

| List A<br>Process | List B<br>Where it happens |
|---|---|
| fusion | in a star |
| chain reaction | in a nuclear reactor |
| alpha decay | in a smoke precipitator |
| | in the nucleus of an atom |

*(3 marks)*

3

### 4.4.2.1 Radioactive decay and nuclear radiation

**Question 99**

March 2011 | PHY1AP | Original Q4 | Legacy

**QUESTION FOUR**

This question is about different types of power station.

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

**A** coal-fired

**B** geothermal

**C** nuclear

**D** wind farm

| | |
|---|---|
| **1** | produces greenhouse gases |
| **2** | produces long-lasting radioactive waste |
| **3** | uses heat from underground |
| **4** | the energy source drives a turbine directly |

**Question 100**

March 2011 | PHY1BP | Original Q3 | Legacy

**QUESTION THREE**

This question is about gamma radiation.

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

**A** bacteria

**B** cells

**C** isotopes

**D** particles

Gamma radiation is emitted by the nuclei of radioactive . . . **1** . . . .

Gamma radiation can be used by doctors to kill cancer . . . **2** . . . .

Gamma radiation can be used to kill . . . **3** . . . that cause food to rot.

Unlike alpha and beta radiation, gamma radiation does not consist of . . . **4** . . . .

### 4.4.2.1 Radioactive decay and nuclear radiation

**Question 101**

March 2011 | PHY1BP | Original Q4 | Legacy

**QUESTION FOUR**

The waves in the electromagnetic spectrum can be grouped in order of wavelength.

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

**A** gamma rays

**B** infra red rays

**C** radio waves

**D** ultraviolet rays

| |
|---|
| . . . **1** . . . |
| X-rays |
| . . . **2** . . . |
| visible light |
| . . . **3** . . . |
| microwaves |
| . . . **4** . . . |

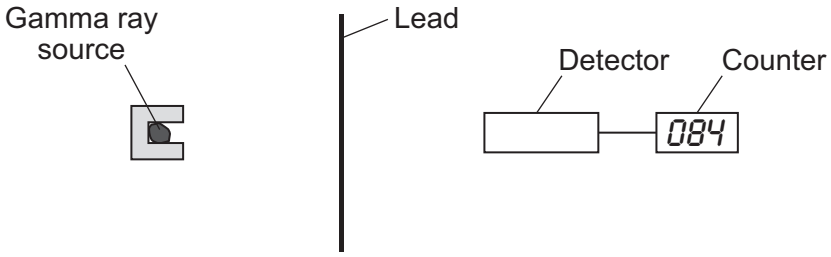
4.4.2.1 Radioactive decay and nuclear radiation

Question 102

March 2011 | PHY1BP | Original Q7 | Legacy

**QUESTION SEVEN**

A student investigated the absorption of gamma rays. He used lead of different thicknesses.




He increased the thickness of the lead by 1 mm each time and measured the count rate.

His results are shown in the table.

| Thickness of lead in mm | Count rate in counts per second |
|---|---|
| 0 | 100 |
| 1 | 84 |
| 2 | 70 |
| 3 | 60 |
| 4 | 50 |
| 5 | 44 |
| 6 | 35 |
| 7 | 30 |
| 8 | 25 |

**7A** What was the interval used in the thickness of the lead sheets?

**1** 1 mm

**2** 2 mm

**3** 5 mm

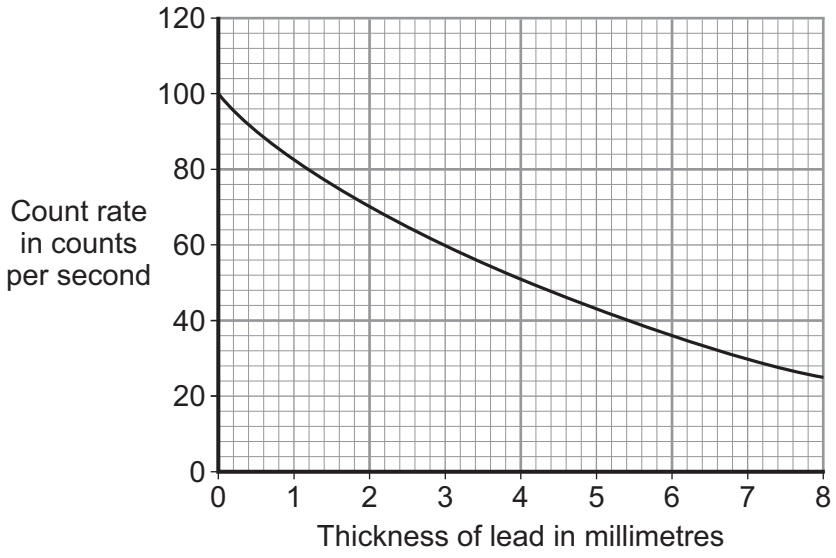
**4** 10 mm

4.4.2.1 Radioactive decay and nuclear radiation

Question 102 · continued



The graph shows the results.




**7B** The graph shows that . . .

**1** doubling the thickness of lead doubles the count rate.

**2** there is no relationship between thickness and count rate.

**3** doubling the thickness of lead makes the count rate three times bigger.

**4** the thicker the lead, the lower the count rate.

**7C** A thickness of 2 mm of lead will reduce the count rate by . . .

**1** 30 counts per second.

**2** 40 counts per second.

**3** 50 counts per second.

**4** 70 counts per second.

**7D** What thickness of lead reduced the count rate to half of its original value?

**1** 1 mm

**2** 4 mm

**3** 9 mm

**4** 10 mm

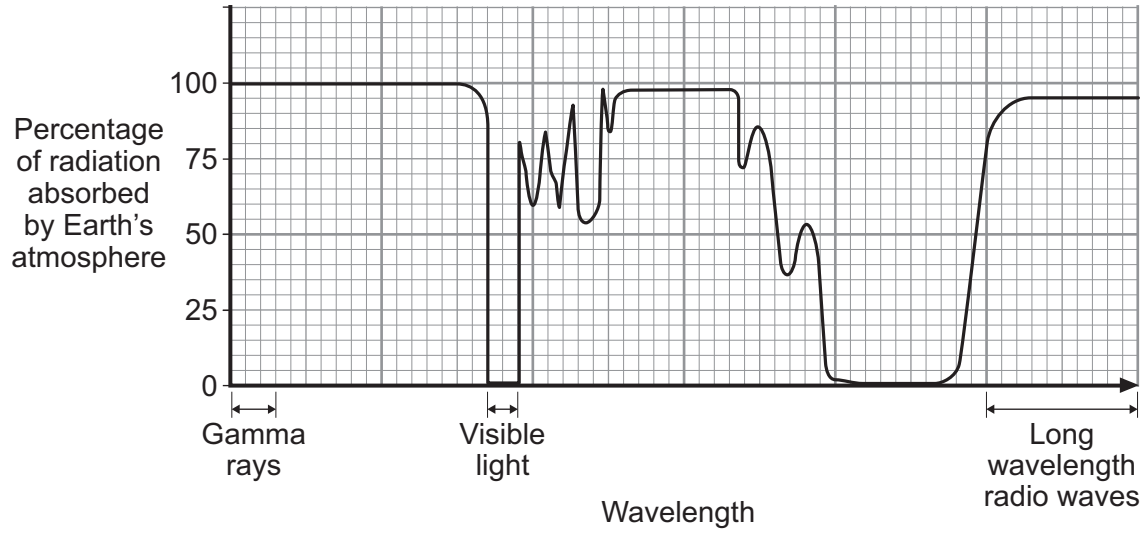
4.4.2.1 Radioactive decay and nuclear radiation

Question 103

March 2011 | PHY1BP | Original Q9 | Legacy

## QUESTION NINE

The diagram shows the absorption of electromagnetic radiation by the Earth's atmosphere.




**9A** The diagram shows that . . .

**1** all wavelengths of gamma radiation reach the Earth's surface.

**2** all wavelengths of radio waves reach the Earth's surface.

**3** all wavelengths of ultraviolet radiation reach the Earth's surface.

**4** all wavelengths of visible light reach the Earth's surface.

**9B** Some objects in space emit X-rays.

Where would you put a telescope to detect these X-rays?

**1** above the Earth's atmosphere

**2** at the top of a hill

**3** at ground level in a hot desert

**4** at ground level in the Antarctic

4.4.2.1 Radioactive decay and nuclear radiation

Question 103 · continued

March 2011 | PHY1BP | Original Q9 | Legacy

The table gives information about some space telescopes.

| Name | Hubble | Compton | Chandra | Spitzer |
|---|---|---|---|---|
| Launched in | 1990 | 1991 | 1999 | 2003 |
| Detects | infra red rays<br>ultraviolet rays<br>visible light | gamma rays | X-rays | infra red rays |

**9C** Which statement about these space telescopes can be deduced from the information in the table?

**1** They all collect data using mirrors.

**2** They all detect electromagnetic radiation.

**3** They are all in space at present.

**4** They were all used to study the Earth.

**9D** From the information in the table, which one of the following emissions could be detected by one of these space telescopes?

**1** alpha particles

**2** nuclear radiation

**3** radio waves

**4** sound waves

**END OF TEST**

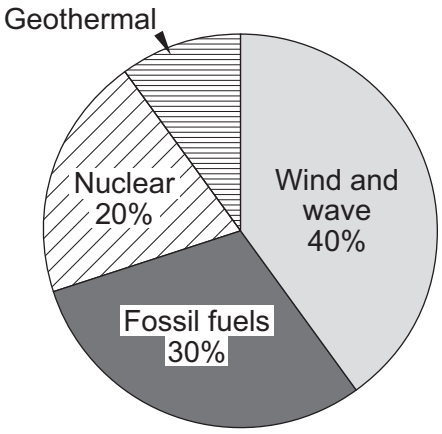
### 4.4.2.1 Radioactive decay and nuclear radiation

**Question 104**

June 2011 | PHY1AP | Original Q5 | Legacy

**QUESTION FIVE**

The pie chart shows how a country's electricity demands are met using different energy sources.




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

**A** 10 %

**B** 20 %

**C** 40 %

**D** 50 %

The percentage of electricity generated from non-renewable sources is . . . **1** . . . .

The percentage of electricity generated from geothermal sources is . . . **2** . . . .

The percentage of electricity generated using a source that produces radioactive waste is . . . **3** . . . .

The percentage of electricity generated using the kinetic energy of the source directly is . . . **4** . . . .

### 4.4.2.1 Radioactive decay and nuclear radiation

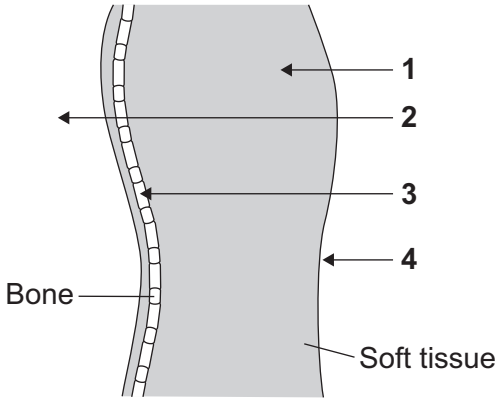
**Question 105**

June 2011 | PHY1BP | Original Q2 | Legacy

**QUESTION TWO**

The human body can be exposed to different types of radiation.

The arrows on the diagram show how far four types of radiation would penetrate.




Match types of radiation, **A**, **B**, **C** and **D**, with the arrows **1**–**4** on the diagram.

**A** alpha

**B** beta

**C** gamma

**D** X-rays

### 4.4.2.1 Radioactive decay and nuclear radiation

**Question 106**

June 2011 | PHY1BP | Original Q3 | Legacy

**QUESTION THREE**

Electromagnetic waves can be dangerous.

People using electromagnetic waves have to protect themselves.

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

**A** leaving the room to switch on the equipment

**B** looking through blackened glass

**C** wearing thick, insulating gloves

**D** using remotely controlled equipment

An astronomer watching an eclipse of the Sun protects his eyes by . . . **1** . . . .

A radiographer taking X-rays of patients protects herself by . . . **2** . . . .

A steelworker opening the door of a furnace protects himself by . . . **3** . . . .

A scientist working with radioactive materials protects himself by . . . **4** . . . .

4.4.2.1 Radioactive decay and nuclear radiation

Question 107

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.

4.4.2.1 Radioactive decay and nuclear radiation

Question 107 · 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 |

4.4.2.1 Radioactive decay and nuclear radiation

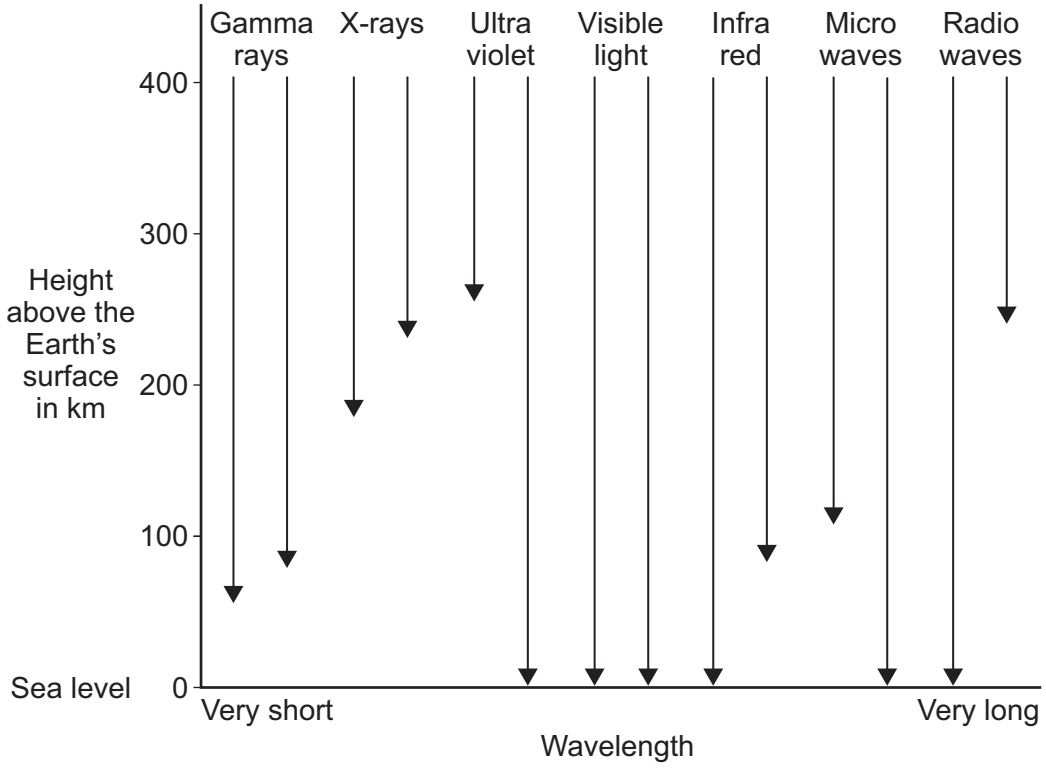
Question 108

June 2011 | PHY1BP | Original Q9 | Legacy

**QUESTION NINE**

Telescopes can be based on the Earth's surface or put into orbit in space.

The diagram shows how far electromagnetic waves penetrate the Earth's atmosphere. For some types of electromagnetic radiation, longer and shorter waves penetrate the atmosphere to different depths.




**9A** Telescopes on Earth detect **all** wavelengths of . . .

**1** radio waves only.

**2** visible light only.

**3** radio waves and visible light.

**4** visible light and X-rays.

**9B** Which of the following statements about the use of telescopes in space is true?

**1** The atmosphere distorts the image produced by the telescope.

**2** The telescopes are affected by light pollution from the Earth.

**3** The telescopes can detect electromagnetic waves that cannot reach the Earth's surface.

**4** The telescopes are easy to repair and maintain.

4.4.2.1 Radioactive decay and nuclear radiation

Question 108 · continued

June 2011 | PHY1BP | Original Q9 | Legacy

The table gives information about some space telescopes. Each telescope detects a different type of electromagnetic radiation.

| Telescope | Wavelength detected in nanometres |
|---|---|
| INTEGRAL | less than 0.01 |
| Chandra | 0.01 – 20 |
| FUSE | 20 – 400 |
| Hubble | 400 – 700 |
| Spitzer | 1000 – 1 000 000 |

**9C** The Hubble telescope detects visible light.

Which telescope detects infra red radiation?

**1** Chandra

**2** FUSE

**3** INTEGRAL

**4** Spitzer

**9D** Which telescope detects X-rays?

**1** Chandra

**2** FUSE

**3** INTEGRAL

**4** Spitzer

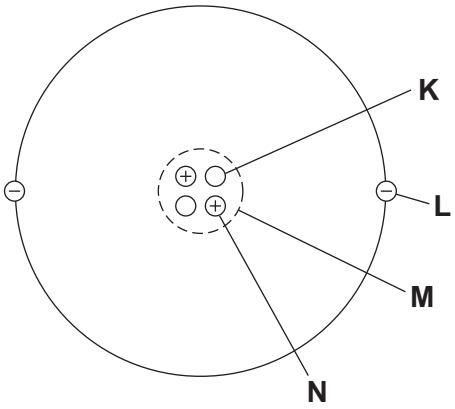
**END OF TEST**

### 4.4.2.1 Radioactive decay and nuclear radiation

**Question 109**

June 2011 | PHY1F | Original Q1 | Legacy

**1 (a)** The diagram represents a helium atom.




**1 (a) (i)** Which part of the atom, **K**, **L**, **M** or **N**, is an electron?

Part ☐

*(1 mark)*

**1 (a) (ii)** Which part of the atom, **K**, **L**, **M** or **N**, is the same as an alpha particle?

Part ☐

*(1 mark)*

**1 (b)** A radioactive source emits alpha particles.

What might this source be used for?

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

to monitor the thickness of aluminium foil as it is made in a factory ☐

to make a smoke detector work ☐

to inject into a person as a medical tracer ☐

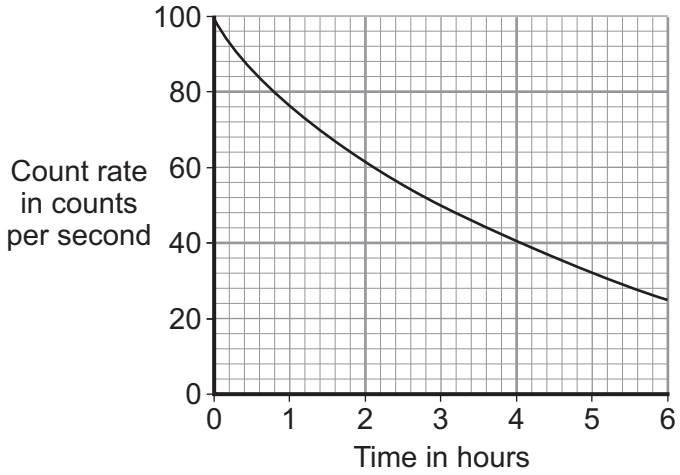
*(1 mark)*

### 4.4.2.1 Radioactive decay and nuclear radiation

**Question 109 · continued**



**1 (c)** The graph shows how the count rate from a source of alpha radiation changes with time.




What is the count rate after 4 hours?

..... counts per second
*(1 mark)*

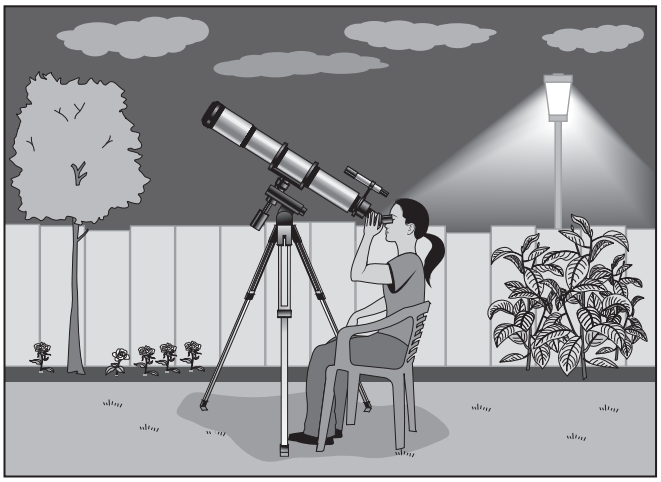
4

### 4.4.2.1 Radioactive decay and nuclear radiation

**Question 110**

June 2011 | PHY1F | Original Q4 | Legacy

**4 (a)** The picture shows a person using an optical telescope to look at stars.



Give **two** reasons why it can be difficult to see distant stars using this type of telescope.

1 .....

.....

2 .....

.....

*(2 marks)*

**4 (b)** As well as optical telescopes, other types of telescope are on satellites in orbit above the Earth.

Give **one disadvantage** of having a telescope in orbit above the Earth.

.....

.....

*(1 mark)*

4.4.2.1 Radioactive decay and nuclear radiation

Question 110 · continued



**4 (c)** In 2008, a new gamma ray telescope, called Fermi, was launched into space. The telescope orbits 560 km above the Earth.

**4 (c) (i)** Which statement gives a reason why gamma ray telescopes are usually in orbit above the Earth?

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

The telescopes need to be closer to the stars. ☐

The atmosphere absorbs gamma rays. ☐

The telescopes can be used to look at the Earth. ☐

*(1 mark)*

**4 (c) (ii)** Some theories predict that particles called WIMPs exist. The theories predict that WIMPs produce a background of gamma rays in very distant galaxies.

Complete the following sentence by drawing a ring around the line in the box that is correct.

If a background of gamma rays in very distant galaxies is detected using the Fermi telescope, this will

- prove that WIMPs exist.
- support the theories that predict that WIMPs exist.
- make scientists change the existing theories.

*(1 mark)*

5

### 4.4.2.1 Radioactive decay and nuclear radiation

**Question 111**

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)*

4.4.2.1 Radioactive decay and nuclear radiation

Question 111 · 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**

### 4.4.2.1 Radioactive decay and nuclear radiation

**Question 111 · 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)*

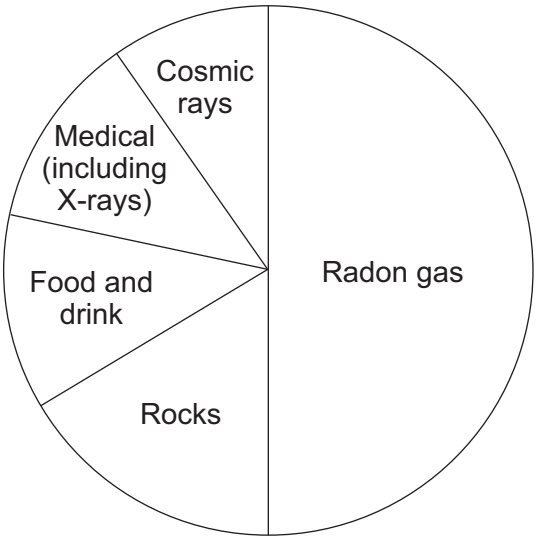
7

### 4.4.2.1 Radioactive decay and nuclear radiation

**Question 112**

June 2011 | PHY2F | Original Q1 | Legacy

**1** The pie chart shows the average proportions of background radiation from various sources in the UK.




Three sources of background radiation are given in **List A**.
Statements about sources of background radiation are given in **List B**.

Draw **one** line to link each source of background radiation in **List A** to the statement about that source given in **List B**.

Draw only **three** lines.

| List A | List B |
|---|---|
| X-rays | Are used to show broken bones. |
| Cosmic rays | The radiation comes from outer space. |
| Radon gas | Comes from soil containing a radioactive isotope of potassium. |
| | Gives about 50% of all background radiation. |

*(3 marks)*

3

### 4.4.2.1 Radioactive decay and nuclear radiation

**Question 113**

November 2011 | PHY1BP | Original Q1 | Legacy

**QUESTION ONE**

Different types of electromagnetic waves are used in hospitals.

Match types of electromagnetic wave, **A**, **B**, **C** and **D**, with the numbers **1**–**4** in the sentences.

**A** gamma rays

**B** infra red rays

**C** radio waves

**D** visible light

Surgical instruments are sterilised using . . . **1** . . . .

Laser eye surgery uses . . . **2** . . . .

Damaged muscles are given heat treatment using . . . **3** . . . .

A doctor can be contacted by a bleeper that uses . . . **4** . . . .

### 4.4.2.1 Radioactive decay and nuclear radiation

**Question 114**

November 2011 | PHY1BP | Original Q2 | Legacy

**QUESTION TWO**

This question is about nuclear and electromagnetic radiation.

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

**A** alpha particle

**B** beta particle

**C** gamma ray

**D** X-rays

| | |
|---|---|
| **1** | an electromagnetic wave emitted from the nucleus of an atom |
| **2** | an electron from the nucleus of an atom |
| **3** | absorbed by bone but not absorbed by soft tissue |
| **4** | very good at ionising the atoms of a gas |

### 4.4.2.1 Radioactive decay and nuclear radiation

**Question 115**

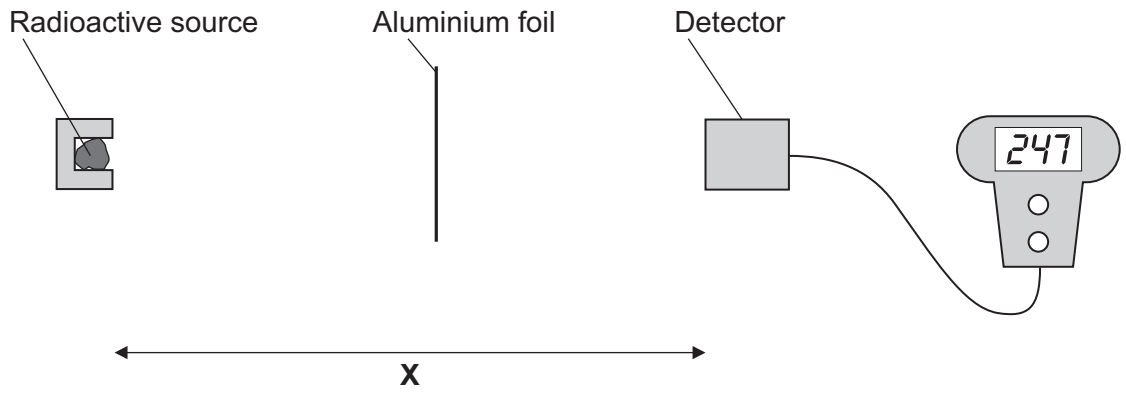
November 2011 | PHY1BP | Original Q4 | Legacy

**QUESTION FOUR**

A student investigated how much beta radiation was absorbed by aluminium foil.

He used several different thicknesses of aluminium foil.

He plotted a graph of his results.




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

**A** conclusion

**B** control variable

**C** independent variable

**D** prediction

| | |
|---|---|
| **1** | He thought that the amount of radiation absorbed would decrease with increasing thickness. |
| **2** | From his graph, he decided that the amount of radiation absorbed increased with increasing thickness. |
| **3** | He changed the thickness of the aluminium foil. |
| **4** | He kept the distance **X** the same. |

### 4.4.2.1 Radioactive decay and nuclear radiation

**Question 116**

November 2011 | PHY1BP | Original Q5 | Legacy

**QUESTION FIVE**

The frequencies of the waves in the electromagnetic spectrum can be grouped into types.

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

**A** gamma rays

**B** infra red rays

**C** radio waves

**D** ultraviolet rays

| | |
|---|---|
| **1** | They have a higher frequency than X-rays. |
| **2** | They have a lower frequency than microwaves. |
| **3** | They have a lower frequency than visible light but a higher frequency than microwaves. |
| **4** | They have a lower frequency than X-rays but a higher frequency than visible light. |

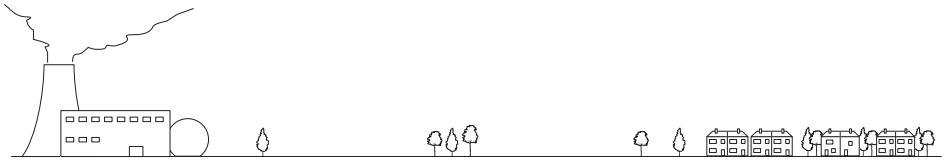
4.4.2.1 Radioactive decay and nuclear radiation

Question 117

November 2011 | PHY1BP | Original Q9 | Legacy

## QUESTION NINE

A nuclear power station is built a few miles away from a village.



The nuclear power station uses radioactive uranium as its fuel. After a few years, there are more cases of cancer than usual occurring in the village. The villagers think that this is because of radiation from the power station.

**9A** Any radiation reaching the village directly from the power station will be . . .

**1** alpha radiation only.

**2** beta radiation only.

**3** gamma radiation only.

**4** alpha, beta and gamma radiation.

**9B** The increased number of cancer cases near the power station . . .

**1** proves that the power station is the only cause of these cancers.

**2** proves that the power station is one possible cause of these cancers.

**3** suggests that the power station is the only cause of these cancers.

**4** suggests that the power station is one possible cause of these cancers.

**9C** Checks are to be made for any link between the power station and the increased number of cancer cases in the village.

This is most likely to be done by . . .

**1** shutting down the power station to see if the number of cases decreases.

**2** re-housing the villagers away from the power station to see if the number of cancer cases decreases.

**3** re-housing the villagers closer to the power station to see if the number of cancer cases increases.

**4** comparing the villagers' health records with those of people who do not live near nuclear power stations.

4.4.2.1 Radioactive decay and nuclear radiation

Question 117 · continued



**9D** Exposure to radiation from radioactive sources used in schools must be kept to a minimum.

The best way to do this is to store the source in a box lined with . . .

**1** aluminium.

**2** glass.

**3** lead.

**4** wood.

**END OF TEST**

### 4.4.2.1 Radioactive decay and nuclear radiation

**Question 118**

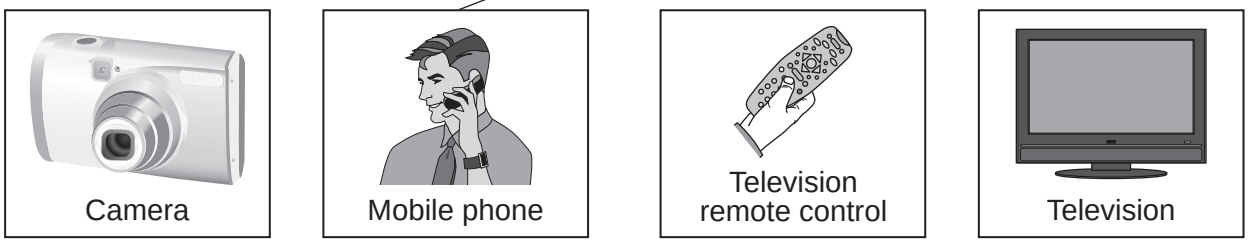
June 2012 | PH1FP | Original Q2 | Legacy

**2 (a)** The diagram shows the electromagnetic spectrum.

The pictures show four devices. Each device uses a different type of electromagnetic wave.

Draw **one** line from each device to the type of electromagnetic wave the device uses. One line has been drawn for you.

| Gamma rays | X-rays | Ultraviolet waves | Visible light waves | Infrared waves | Microwaves | Radio waves |
|---|---|---|---|---|---|---|




*(3 marks)*

**2 (b)** Visible light waves travel through space at a speed of 300 000 km/s.

How fast do infrared waves travel through space?

.....

*(1 mark)*

**2 (c)** Draw a ring around the correct answer in the box to complete the sentence.

Infrared waves have

| |
|---|
| a longer wavelength than |
| the same wavelength as |
| a shorter wavelength than |

visible light waves.

*(1 mark)*

4.4.2.1 Radioactive decay and nuclear radiation

Question 118 · continued



**2 (d)** The two diagrams, **A** and **B**, show a light ray travelling into a glass block.

**Diagram A**

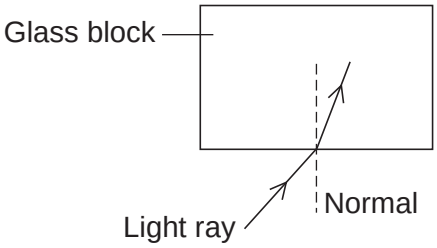
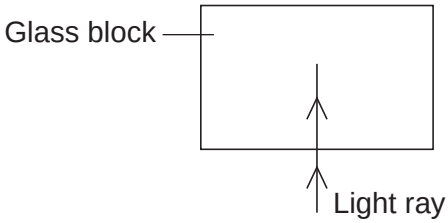



**Diagram B**




**2 (d) (i)** Look at **Diagram A**.

What name is given to the process that happens as the light enters the glass block?

.....

*(1 mark)*

**2 (d) (ii)** Look at **Diagram B**.

The light enters the glass block without changing direction.

Why?

.....

.....

*(1 mark)*

7

### 4.4.2.1 Radioactive decay and nuclear radiation

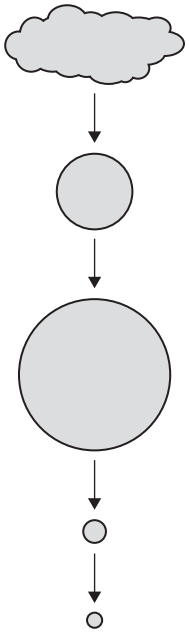
**Question 119**

June 2012 | PH2FP | Original Q1 | Legacy

**1 (a)** The diagram shows the lifecycle of a star.

**1 (a) (i)** Use words or phrases from the box to complete the sentences contained in the diagram.

| | | | |
|---|---|---|---|
| **black dwarf** | **black hole** | **protostar** | **red giant** |



Gas and dust are pulled together to form a

..... .

The star gives out energy as a main sequence star.

The star expands forming a ..... .

The star shrinks to form a white dwarf.

The star fades away as a ..... .

*(3 marks)*

**4.4.2.1 Radioactive decay and nuclear radiation**

**Question 119 · continued**



**1 (a) (ii)** The table compares the approximate size of three stars with the size of the Sun.

| Star | Size |
|---|---|
| Alpha Centauri A | the same as the Sun |
| Betelgeuse | 1120 times bigger than the Sun |
| Cephei | 1520 times bigger than the Sun |

Which **one** of these three stars has the lifecycle shown in part **(a)(i)**?

.....

Give a reason for your answer.

.....

.....

*(2 marks)*

**1 (b)** Which **one** of the following describes the process by which energy is given out in stars?

Tick (✓) **one** box.

Atomic nuclei inside the star join together. ☐

Atomic nuclei inside the star split apart. ☐

Gases inside the star burn. ☐

*(1 mark)*

6

### 4.4.2.1 Radioactive decay and nuclear radiation

**Question 120**



**2 (a)** Sources of background radiation are either natural or man-made.

Which **two** of the sources listed in the box are *natural* sources of background radiation?

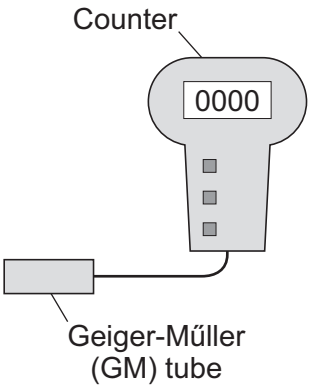
Draw a ring around each of your answers.

| | | | |
|---|---|---|---|
| **cosmic rays** | **nuclear accidents** | **X-rays** | **radon gas** |

*(2 marks)*

**2 (b)** A teacher used a Geiger-Műller (GM) tube and counter to measure the background radiation in her laboratory. The teacher reset the counter to zero, waited one minute and then took the count reading. The teacher repeated this two more times.

The three readings taken by the teacher are given in the table.




| Count |
|---|
| 17 |
| 21 |
| 19 |

**2 (b) (i)** The three readings are different.

What is the most likely reason for this?

Tick (✓) **one** box.

The teacher did not reset the counter to zero. ☐

Radioactive decay is a random process. ☐

The temperature in the laboratory changed. ☐

*(1 mark)*

**2 (b) (ii)** Calculate the mean (average) value of the three readings given in the table.

.....

Mean (average) value = ..... counts

*(1 mark)*

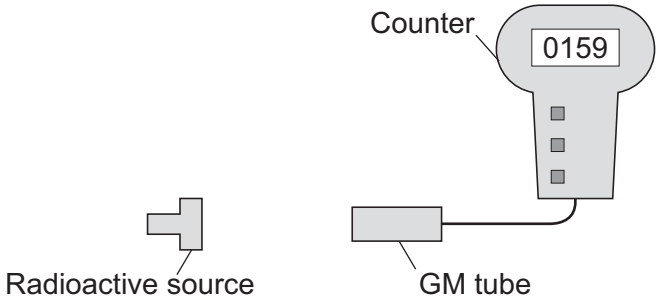
4.4.2.1 Radioactive decay and nuclear radiation

Question 120 · continued



**2 (b) (iii)** The diagram shows how the teacher used the GM tube and counter to measure the radiation emitted from a radioactive source.

The counter was reset to zero. The count after one minute was 159.




Calculate how many counts were due to the radiation from the radioactive source.

.....

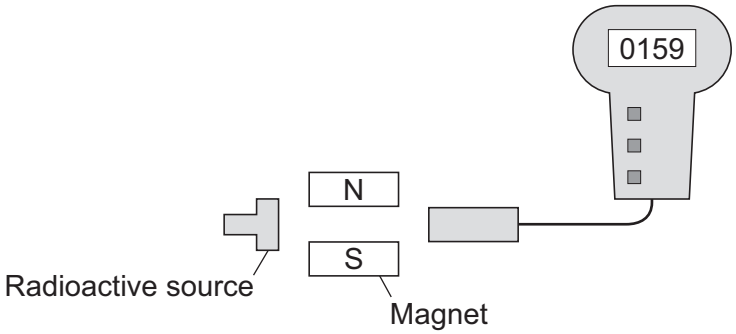
.....

Counts due to the radiation from the radioactive source = .....

*(1 mark)*

**2 (b) (iv)** The teacher then put a powerful magnet between the radioactive source and the GM tube.

The counter was reset to zero. The number on the counter shows the count after one minute.




What type of radiation was being emitted from the radioactive source?

Draw a ring around your answer.

**alpha** **beta** **gamma**

Explain the reason for your answer.

.....

.....

.....

.....

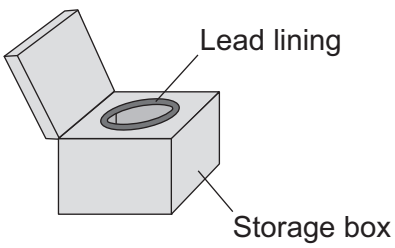
*(3 marks)*

**4.4.2.1 Radioactive decay and nuclear radiation**

**Question 120 · continued**



**2 (c)** At the end of the lesson the teacher put the radioactive source back inside its storage box.




Why is the inside of the box lined with lead?

.....

.....

*(1 mark)*

**2 (d)** Which **one** of the following questions **cannot** be answered by scientific study?

Tick (✓) **one** box.

Where does background radiation come from? ☐

What is meant by the half-life of a radioactive source? ☐

Should radioactive waste be dumped in the oceans? ☐

*(1 mark)*

10

### 4.4.2.1 Radioactive decay and nuclear radiation

**Question 121**

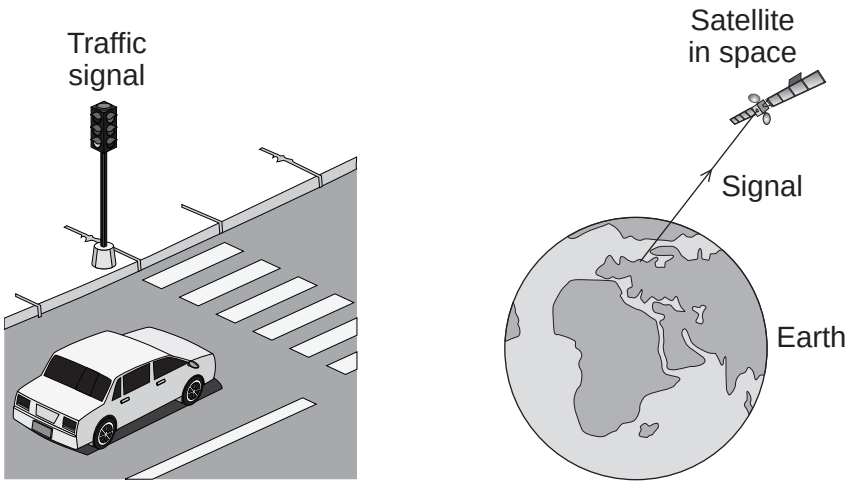
June 2013 | PH1FP | Original Q2 | Legacy

**2** **Diagram 1** shows four of the seven types of wave in the electromagnetic spectrum.

**Diagram 1**

| | | | | | | |
|---|---|---|---|---|---|---|
| **J** | **K** | **L** | Visible light | Infrared | Microwaves | Radio waves |

**2 (a)** The **four** types of electromagnetic wave named in **Diagram 1** above are used for communication.




**2 (a) (i)** Which type of electromagnetic wave is used when a traffic signal communicates with a car driver?

.....

*(1 mark)*

**2 (a) (ii)** Which type of electromagnetic wave is used to communicate with a satellite in space?

.....

*(1 mark)*

**2 (b)** Gamma rays are part of the electromagnetic spectrum.

Which letter, **J**, **K** or **L**, shows the position of gamma rays in the electromagnetic spectrum?

Draw a ring around the correct answer.

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

*(1 mark)*

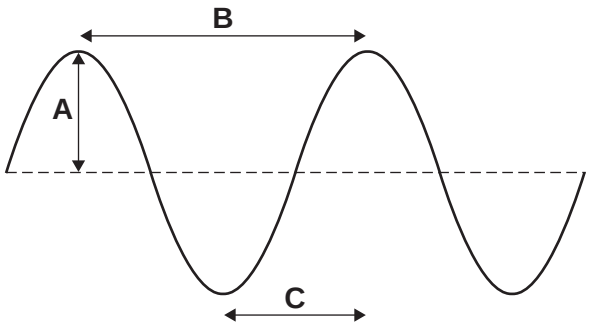
4.4.2.1 Radioactive decay and nuclear radiation

Question 121 · continued



**2 (c)** **Diagram 2** shows an infrared wave.

**Diagram 2**




**2 (c) (i)** Which **one** of the arrows, labelled **A**, **B** or **C**, shows the wavelength of the wave?

Write the correct answer, **A**, **B** or **C**, in the box. ☐

*(1 mark)*

**2 (c) (ii)** Draw a ring around the correct answer to complete the sentence.

The wavelength of infrared waves is [shorter than / the same as / longer than] the wavelength of radio waves.

*(1 mark)*

**Question 2 continues on the next page**

4.4.2.1 Radioactive decay and nuclear radiation

Question 121 · continued



**2 (d)** Mobile phone networks send signals using microwaves. Some people think the energy a person's head absorbs when using a mobile phone may be harmful to health.

**2 (d) (i)** Scientists have compared the health of people who use mobile phones with the health of people who do not use mobile phones.

Which **one** of the following statements gives a reason why scientists have done this?

Tick (✓) **one** box.

To find out if using a mobile phone is harmful to health. ☐

To find out if mobile phones give out radiation. ☐

To find out why some people are healthy. ☐

*(1 mark)*

**2 (d) (ii)** The table gives the specific absorption rate (SAR) value for two different mobile phones.

The SAR value is a measure of the maximum energy a person's head absorbs when a mobile phone is used.

| Mobile Phone | SAR value in W/kg |
|---|---|
| **X** | 0.28 |
| **Y** | 1.35 |

A parent buys mobile phone **X** for her daughter.

Using the information in the table, suggest why buying mobile phone **X** was the best choice.

.....

.....

.....

.....

*(2 marks)*

8

### 4.4.2.1 Radioactive decay and nuclear radiation

**Question 122**

June 2013 | PH2FP | Original Q1 | Legacy

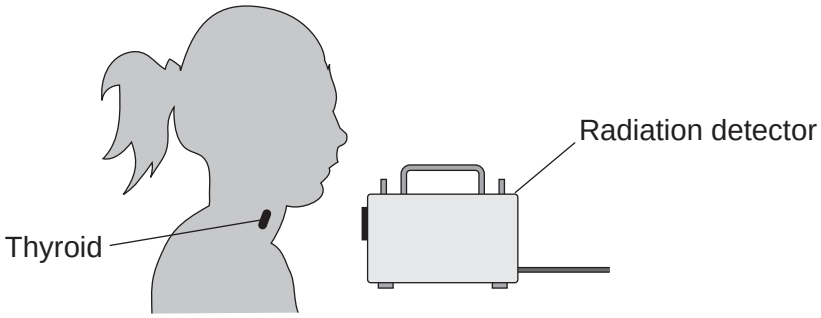
**1 (a)** The names of three types of radiation are given in **List A**. Some properties of these three types of radiation are given in **List B.**

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)*

### 4.4.2.1 Radioactive decay and nuclear radiation

**Question 122 · 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

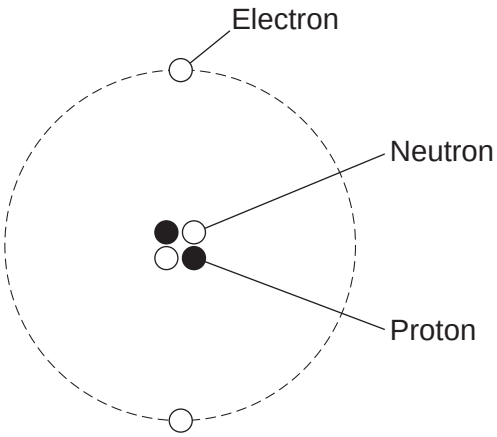
4.4.2.1 Radioactive decay and nuclear radiation

Question 123

June 2014 | PH2FP | Original Q5 | Legacy

**5 (a)** **Figure 9** shows a helium atom.

**Figure 9**




**5 (a) (i)** Which **one** of the particles in the atom is **not** charged?

Draw a ring around the correct answer.

**[1 mark]**

**electron** **neutron** **proton**

**5 (a) (ii)** Which **two** types of particle in the atom have the same mass?

**[1 mark]**

..... and .....

**5 (a) (iii)** What is the atomic number of a helium atom?

Draw a ring around the correct answer.

**[2 marks]**

**2** **4** **6**

Give a reason for your answer.

.....

.....

4.4.2.1 Radioactive decay and nuclear radiation

Question 123 · continued

June 2014 | PH2FP | Original Q5 | Legacy

**5 (b)** Alpha particles are one type of nuclear radiation.

**5 (b) (i)** Name **one** other type of nuclear radiation.

**[1 mark]**

.....

**5 (b) (ii)** Use the correct answer from the box to complete the sentence.

**[1 mark]**

| | | |
|---|---|---|
| **electrons** | **neutrons** | **protons** |

The difference between an alpha particle and a helium atom is that the alpha particle does **not** have any ..... .

**5 (b) (iii)** Which **one** of the following is a property of alpha particles?

Tick (✓) **one** box.

**[1 mark]**

Have a long range in air ☐

Are highly ionising ☐

Will pass through metals ☐

**Question 5 continues on the next page**

4.4.2.1 Radioactive decay and nuclear radiation

Question 123 · continued



**5 (c)** Doctors may use nuclear radiation to treat certain types of illness.

Treating an illness with radiation may also harm a patient.

**5 (c) (i)** Complete the following sentence.

**[1 mark]**

The risk from treating a patient with radiation is that the radiation may

..... healthy body cells.

**5 (c) (ii)** Draw a ring around the correct answer to complete the sentence.

**[1 mark]**

Radiation may be used to treat a patient if the risk from the

radiation is

- much bigger than
- about the same as
- much smaller than

the possible benefit of having the treatment.

9

### 4.4.2.1 Radioactive decay and nuclear radiation

**Question 124**

June 2015 | PH2FP | Original Q6 | Legacy

**6 (a)** Radioactive sources that emit alpha, beta or gamma radiation can be dangerous.

What is a possible risk to health caused by using a radioactive source?

**[1 mark]**

.....

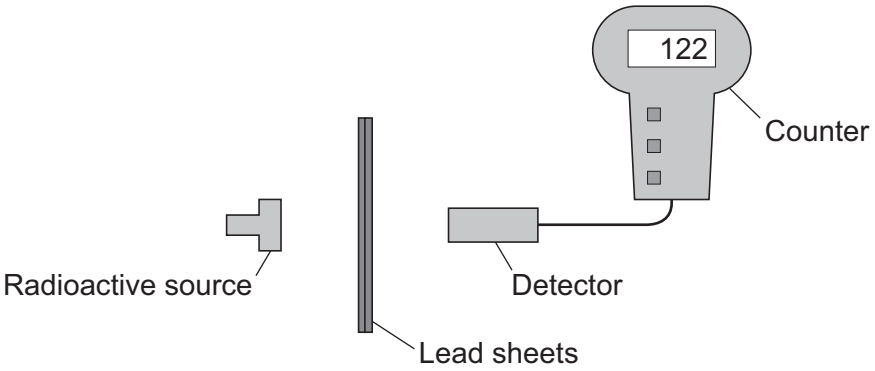
.....

**6 (b)** In an experiment, a teacher put a 2 mm thick lead sheet in front of a radioactive source. She used a detector and counter to measure the radiation passing through the lead sheet in one minute.

She then put different numbers of lead sheets, each 2 mm thick, in front of the radioactive source and measured the radiation passing through in one minute.

The apparatus the teacher used is shown in **Figure 7**.

**Figure 7**




**6 (b) (i)** When using a radioactive source in an experiment, how could the teacher reduce the risk to her health?

Suggest **one** way.

**[1 mark]**

.....

.....

**Question 6 continues on the next page**

4.4.2.1 Radioactive decay and nuclear radiation

Question 124 · continued



**6 (b) (ii)** The number recorded on the counter is actually higher than the amount of radiation detected from the source.

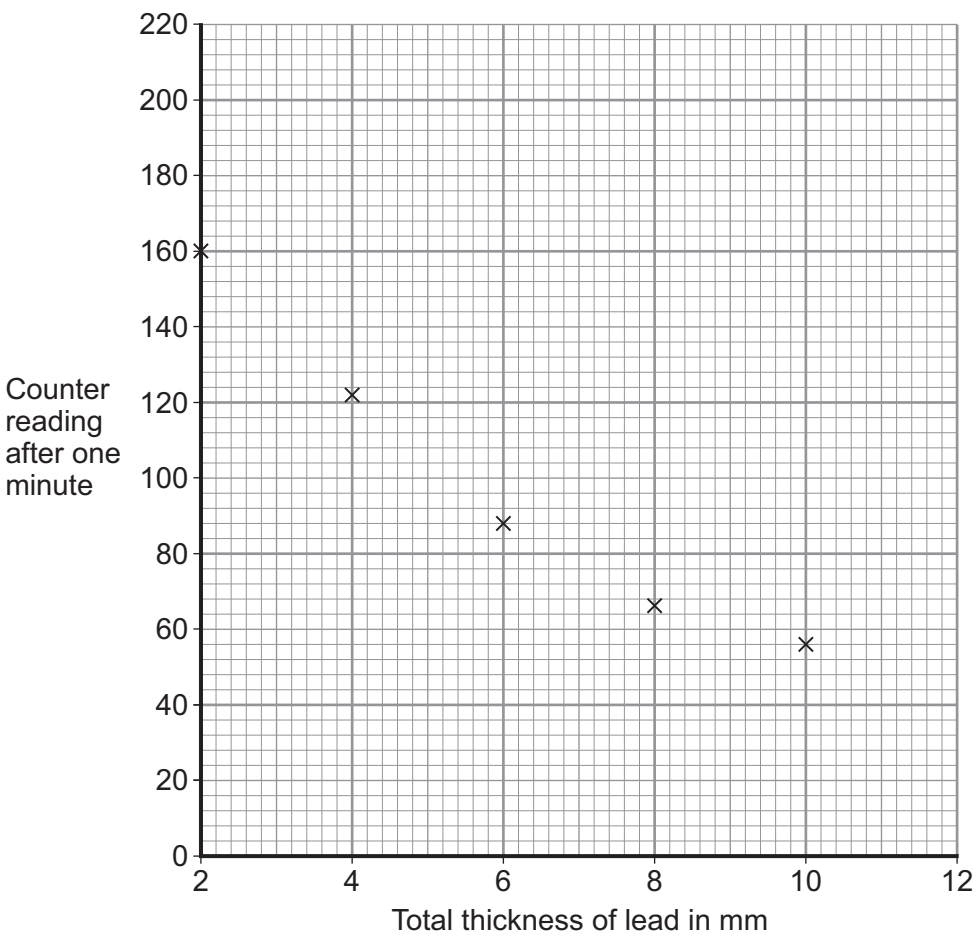
Complete the following word equation.

**[1 mark]**

| | | | | |
|---|---|---|---|---|
| The number recorded on the counter | = | The amount of radiation detected from the source | + | ..... radiation |

**6 (c)** The readings taken by the teacher are plotted in **Figure 8**.

**Figure 8**




**6 (c) (i)** Draw a line of best fit to complete **Figure 8**.

**[1 mark]**

### 4.4.2.1 Radioactive decay and nuclear radiation

**Question 124 · continued**



**6 (c) (ii)** How does the amount of radiation **absorbed** by the lead change as the total thickness of the lead is increased?

**[1 mark]**

.....

.....

**6 (c) (iii)** Use **Figure 8** to estimate the reading on the counter when the total thickness of the lead is increased to 12 mm.

**[1 mark]**

Estimated counter reading = .....

**6 (d)** What type of radiation was emitted from the radioactive source?

**[2 marks]**

Draw a ring around the correct answer.

**alpha** **beta** **gamma**

Give a reason for your answer.

.....

.....

8

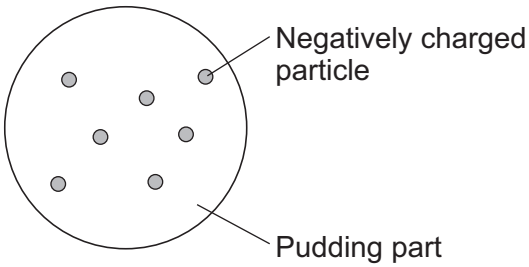
### 4.4.2.1 Radioactive decay and nuclear radiation

**Question 125**

June 2015 | PH2FP | Original Q8 | Legacy

**8 (a)** Over 100 years ago, scientists thought the atom was like a 'plum pudding'.
**Figure 11** shows the plum pudding model of the atom.

**Figure 11**




The scientists knew that an atom has negatively charged particles. They also knew that an atom has no overall charge.

What did the scientists conclude about the **charge** on the 'pudding part' of the atom?
**[1 mark]**

.....

.....

**Question 8 continues on the next page**

4.4.2.1 Radioactive decay and nuclear radiation

Question 125 · continued



**8 (b)** Two scientists named Rutherford and Marsden devised an experiment to investigate the plum pudding model of the atom. The experiment involved firing alpha particles at a thin sheet of gold. The scientists measured how many of the alpha particles were scattered.

Using the plum pudding model, the scientists predicted that only a few of the alpha particles would be scattered by more than 4°.

Over several months, more than 100 000 measurements were made.

**8 (b) (i)** The results from this experiment caused the plum pudding model to be replaced by a new model of the atom.

Explain why.

**[2 marks]**

.....

.....

.....

.....

.....

.....

**8 (b) (ii)** Suggest **one** reason why other scientists thought this experiment provided valid evidence for a new model of the atom.

**[1 mark]**

.....

.....

.....

4.4.2.1 Radioactive decay and nuclear radiation

Question 125 · continued



**8 (c)** **In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.**

Describe the model now used for the structure of an atom.

In your answer you should:
- give details of the individual particles that make up an atom
- include the relative masses and relative charges of these particles.

Do **not** include a diagram in your answer.

**[6 marks]**

.....

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Extra space .....

.....

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.....

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10

### 4.4.2.1 Radioactive decay and nuclear radiation

**Question 126**

June 2016 | PH2FP | Original Q9 | Legacy

**9** Alpha particles, beta particles and gamma rays are types of nuclear radiation.

**9 (a)** Describe the structure of an alpha particle.

**[1 mark]**

_____

_____

**9 (b)** Nuclear radiation can change atoms into ions by the process of ionisation.

**9 (b) (i)** Which type of nuclear radiation is the least ionising?

**[1 mark]**

Tick (✓) **one** box.

alpha particles ☐ beta particles ☐ gamma rays ☐

**9 (b) (ii)** What happens to the structure of an atom when the atom is ionised?

**[1 mark]**

_____

_____

**9 (c)** People working with sources of nuclear radiation risk damaging their health.

State **one** precaution these people should take to reduce the risk to their health.

**[1 mark]**

_____

_____

4.4.2.1 Radioactive decay and nuclear radiation

Question 126 · continued



**9 (d)** **In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.**

The type of radiation emitted from a radioactive source can be identified by comparing the properties of the radiation to the properties of alpha, beta and gamma radiation.

Describe the properties of alpha, beta and gamma radiation in terms of their:

- penetration through materials
- range in air
- deflection in a magnetic field.

**[6 marks]**

Extra space

10

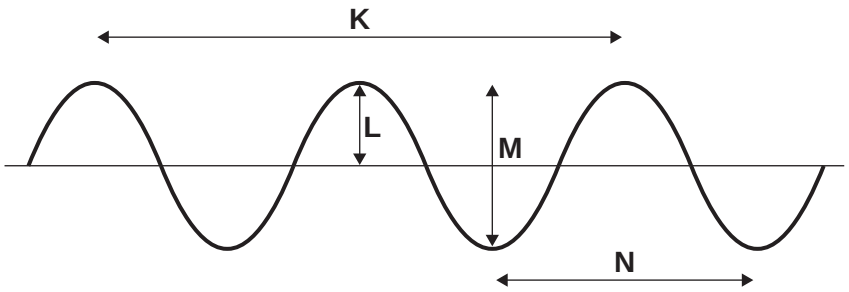
### 4.4.2.1 Radioactive decay and nuclear radiation

**Question 127**

June 2017 | PH1FP | Original Q3 | Legacy

**3 (a)** **Figure 4** shows an electromagnetic wave.

**Figure 4**




**3 (a) (i)** Which arrow, **K**, **L**, **M** or **N**, shows the wavelength of the wave?

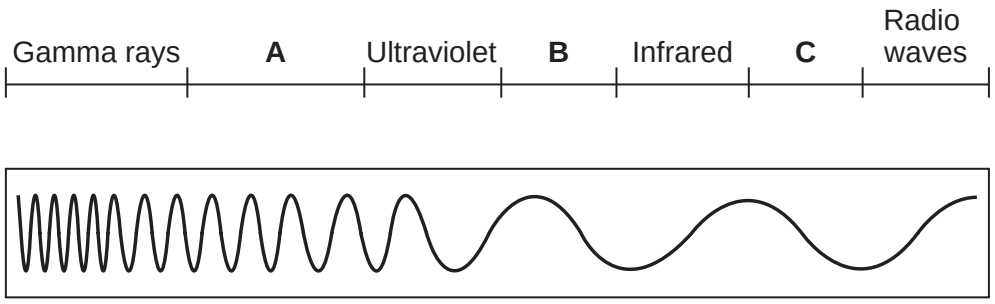
**[1 mark]**

**3 (a) (ii)** Which arrow, **K**, **L**, **M** or **N**, shows the amplitude of the wave?

**[1 mark]**

**3 (b)** **Figure 5** shows the electromagnetic spectrum.

**Figure 5**




A laser emits visible light.

Which letter, **A**, **B** or **C**, on **Figure 5** shows the position of visible light?

**[1 mark]**

4.4.2.1 Radioactive decay and nuclear radiation

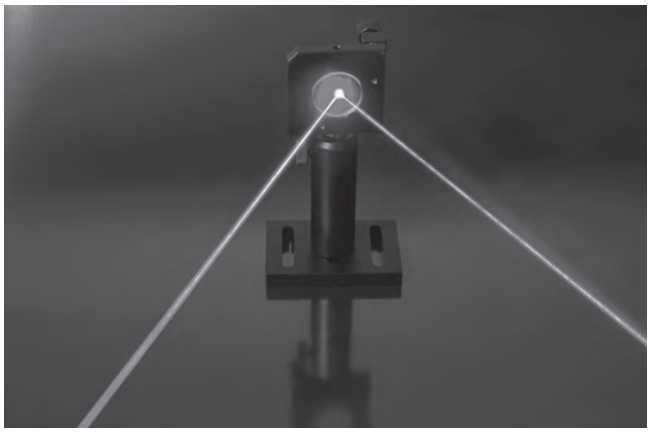
Question 127 · continued



**3 (c)** Laser light is used in some burglar alarms.

**Figure 6** shows laser light being reflected by a mirror. The light then reaches a detector.

**Figure 6**



**3 (c) (i)** How does the size of the angle of incidence compare with the size of the angle of reflection?

**[1 mark]**

_____

_____

**3 (c) (ii)** When a burglar gets in the way of the laser light, the light no longer reaches the detector.

Suggest **one** reason why.

**[1 mark]**

_____

_____

5

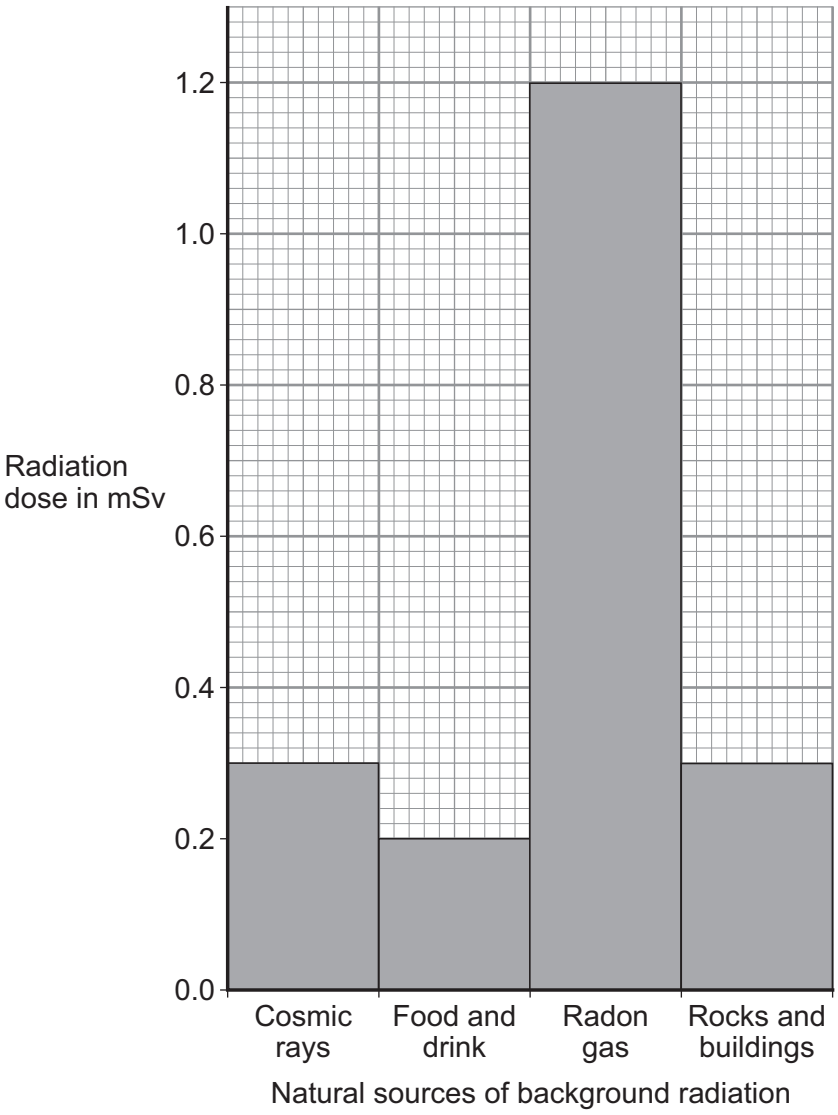
### 4.4.2.1 Radioactive decay and nuclear radiation

**Question 128**

June 2017 | PH2FP | Original Q7 | Legacy

**7** **Figure 13** shows the total radiation dose that the average person in the UK gets from natural background radiation sources in one year.

**Figure 13**




**7 (a) (i)** Calculate the percentage of the total radiation dose the average person in the UK receives from cosmic rays.

**[2 marks]**

Percentage radiation dose from cosmic rays = _____ %

4.4.2.1 Radioactive decay and nuclear radiation

Question 128 · continued



**7 (a) (ii)** Over one year, a person may get a higher than average dose of radiation from cosmic rays.

Suggest **one** reason why.

**[1 mark]**

_____

_____

**7 (a) (iii)** Some sources of background radiation are man-made.

Name **one** man-made source of background radiation.

**[1 mark]**

_____

_____

**7 (b)** Before using a radioactive source a teacher measured the background radiation in her laboratory. She did this three times. The measurements were taken correctly but the three measurements were different.

Why were the three background measurements different?

**[1 mark]**

_____

_____

**Question 7 continues on the next page**

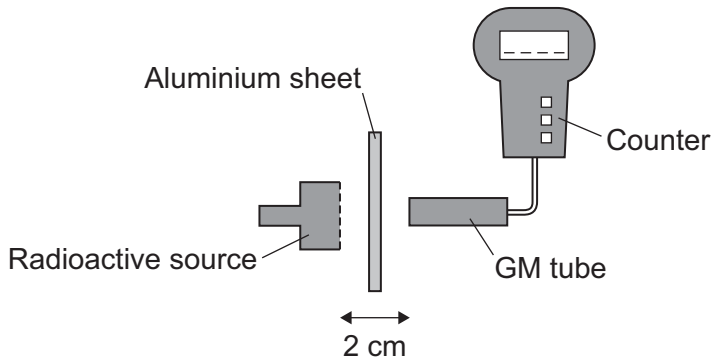
4.4.2.1 Radioactive decay and nuclear radiation

Question 128 · continued



**7 (c)** **Figure 14** shows the apparatus the teacher used to investigate the radiation emitted by a source.

**Figure 14**




The teacher changed the thickness of the aluminium between the source and the Geiger-Müller (GM) tube.

The number of counts recorded for each thickness is given in **Table 1**.
The mean background measurement was 20 counts in one minute.

**Table 1**

| Thickness of aluminium in millimetres | Counts in one minute |
|---|---|
| 2 | 350 |
| 4 | 68 |
| 6 | 20 |

**7 (c) (i)** A student concluded that the radioactive source emits beta radiation.

Explain how the information in **Table 1** supports this conclusion.

**[2 marks]**

4.4.2.1 Radioactive decay and nuclear radiation

Question 128 · continued



**7 (c) (ii)** The teacher said that the source also emits alpha radiation.

Describe how the investigation could be changed in order to show that the source emits alpha radiation.

**[2 marks]**

9

**Turn over for the next question**

4.4.2.1 Radioactive decay and nuclear radiation

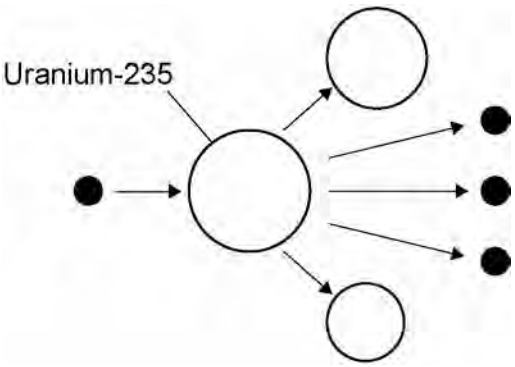
Question 129

June 2018 | 8463/1F | Original Q6

**0 6** Nuclear power can be used to generate electricity through nuclear fission.

**Figure 6** shows the process of nuclear fission.

**Figure 6**




**0 6 . 1** Complete the sentences.

Choose answers from the box.

**[3 marks]**

| | | | | | |
|---|---|---|---|---|---|
| **gamma rays** | **light rays** | **proton** | **neutron** | **nucleus** | **X-rays** |

During the process of nuclear fission a uranium _____

absorbs a _____ .

Electromagnetic radiation is released in the form of _____ .

**0 6 . 2** The UK needs at least 25 000 000 kW of electrical power at any time.

A nuclear power station has an electrical power output of 2 400 000 kW

Calculate how many nuclear power stations are needed to provide 25 000 000 kW of electrical power.

**[2 marks]**

Number of nuclear power stations = _____

4.4.2.1 Radioactive decay and nuclear radiation

Question 129 · continued



**0 6 . 3** State **two** environmental issues caused by generating electricity using nuclear power stations.

**[2 marks]**

1 _____

_____

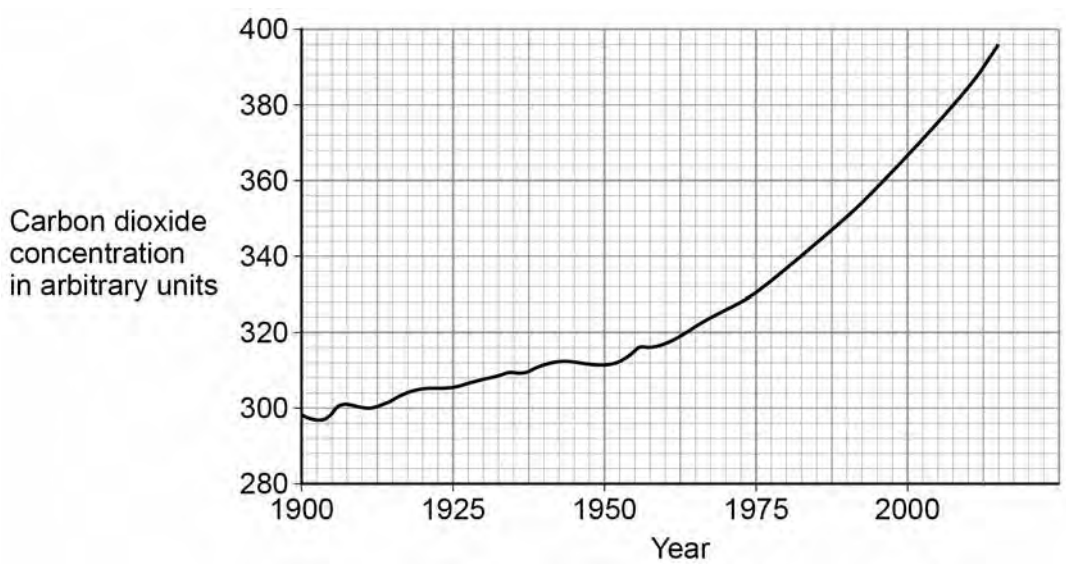
2 _____

_____

**0 6 . 4** The UK currently generates a lot of electricity by burning natural gas. This process releases carbon dioxide into the atmosphere.

**Figure 7** shows how the concentration of carbon dioxide in the atmosphere has changed over the past 115 years.

**Figure 7**



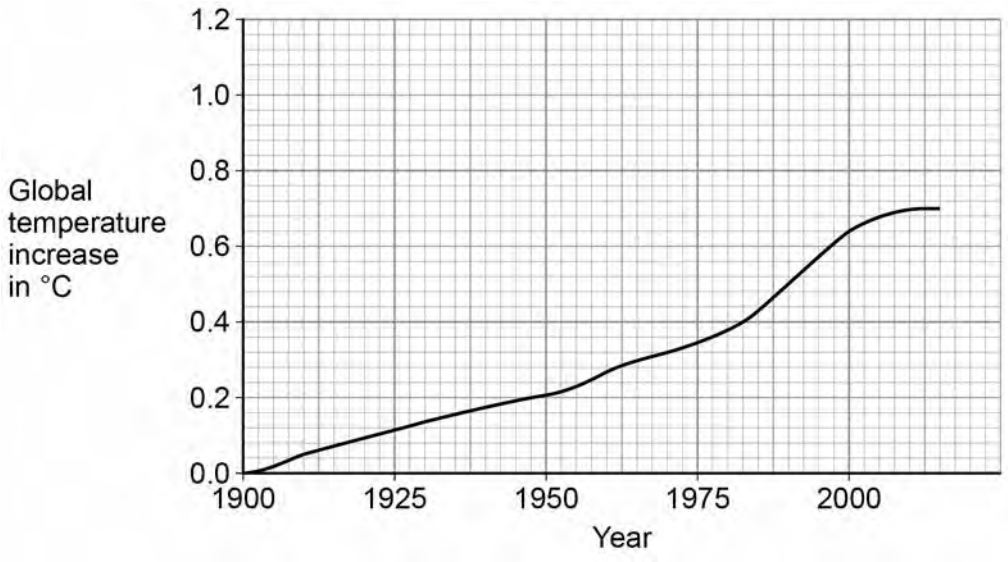
4.4.2.1 Radioactive decay and nuclear radiation

Question 129 · continued



**Figure 8** shows how the global temperature has changed over the past 115 years.

**Figure 8**




Give **one** similarity and **one** difference between the data in **Figure 7** and **Figure 8**.

**[2 marks]**

Similarity _____

_____

_____

Difference _____

_____

_____

9

### 4.4.2.1 Radioactive decay and nuclear radiation

**Question 130**

June 2018 | 8463/1F | Original Q11

**1 1** A teacher used a Geiger-Muller tube and counter to measure the number of counts in 60 seconds for a radioactive rock.

**1 1 . 1** The counter recorded 819 counts in 60 seconds. The background radiation count rate was 0.30 counts per second.

Calculate the count rate for the rock.

**[3 marks]**

Count rate = _____ per second

**1 1 . 2** A householder is worried about the radiation emitted by the granite worktop in his kitchen.

1 kg of granite has an activity of 1250 Bq. The kitchen worktop has a mass of 180 kg.

Calculate the activity of the kitchen worktop in Bq.

**[2 marks]**

Activity = _____ Bq

4.4.2.1 Radioactive decay and nuclear radiation

Question 130 · continued



**1 1 . 3** The average total radiation dose per year in the UK is 2.0 millisieverts.

**Table 2** shows the effects of radiation dose on the human body.

**Table 2**

| Radiation dose in millisieverts | Effects |
|---|---|
| 10 000 | Immediate illness; death within a few weeks |
| 1000 | Radiation sickness; unlikely to cause death |
| 100 | Lowest dose with evidence of causing cancer |

The average radiation dose from the granite worktop is 0.003 millisieverts per day.

Explain why the householder should **not** be concerned about his yearly radiation dose from the granite worktop.

One year is 365 days.

**[2 marks]**

**1 1 . 4** Bananas are a source of background radiation. Some people think that the unit of radiation dose should be changed from sieverts to Banana Equivalent Dose.

Suggest **one** reason why the Banana Equivalent Dose may help the public be more aware of radiation risks.

**[1 mark]**

8

### 4.4.2.1 Radioactive decay and nuclear radiation

**Question 131**

June 2019 | 8463/1F | Original Q2

**0 2** Polonium-210 ($^{210}_{84}Po$) is a radioactive isotope that decays by emitting alpha radiation.

**0 2 . 1** Which is the correct decay equation for polonium-210?

**[1 mark]**

Tick (✓) **one** box.

$^{210}_{84}Po \rightarrow {}^{214}_{86}X + {}^{4}_{2}He$ ☐

$^{210}_{84}Po \rightarrow {}^{206}_{86}X + {}^{4}_{2}He$ ☐

$^{210}_{84}Po \rightarrow {}^{206}_{82}X + {}^{4}_{2}He$ ☐

**0 2 . 2** Why is alpha radiation dangerous inside the human body?

**[1 mark]**

Tick (✓) **one** box.

Alpha radiation is electromagnetic radiation. ☐

Alpha radiation is highly ionising. ☐

Alpha radiation is very penetrating. ☐

**Question 2 continues on the next page**

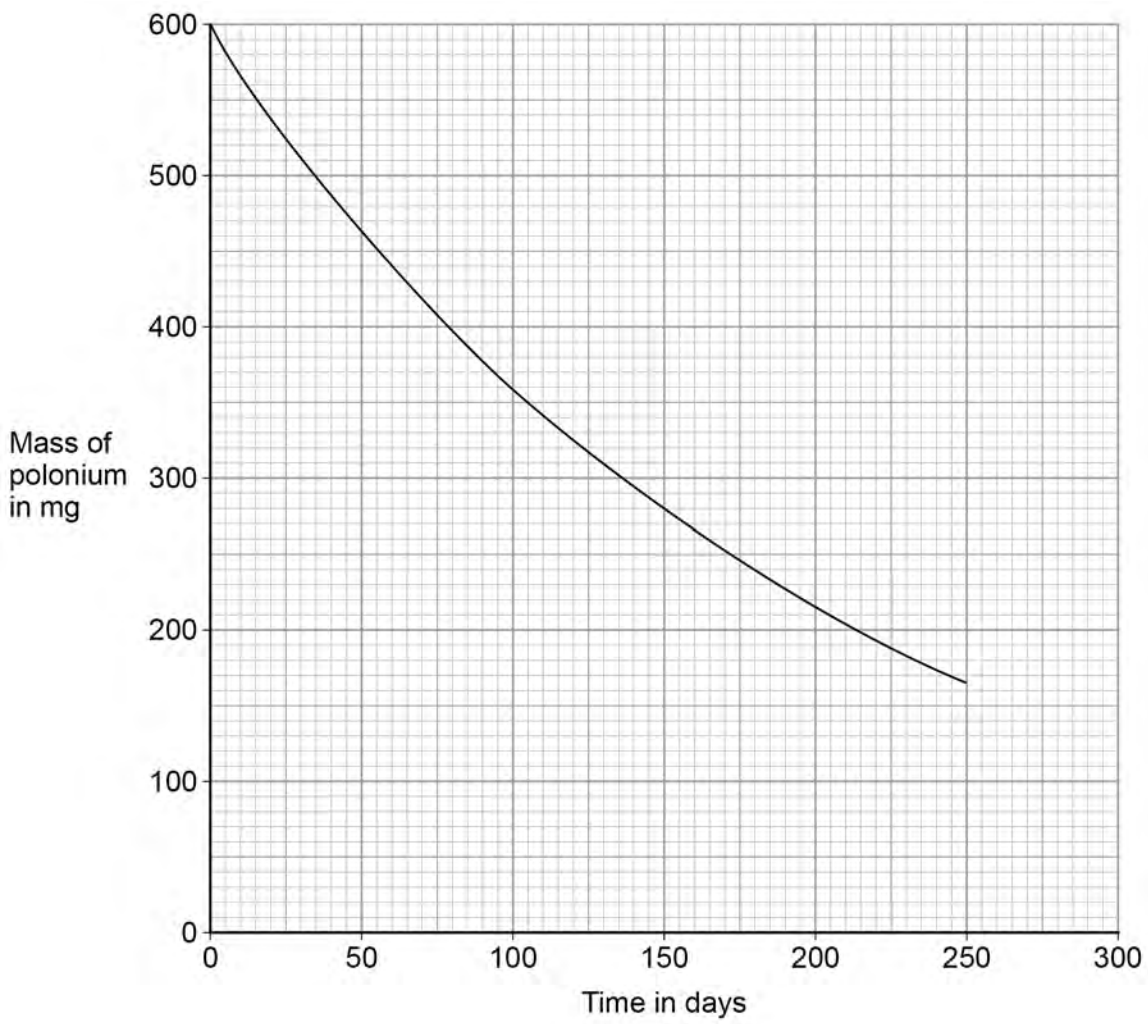
4.4.2.1 Radioactive decay and nuclear radiation

Question 131 · continued



**Figure 3** shows how the mass of a sample of polonium-210 changes with time.

**Figure 3**




**0 2 . 3** Determine the change in mass of the sample of polonium-210 between 50 and 150 days.

**[2 marks]**

Change in mass = _____ mg

4.4.2.1 Radioactive decay and nuclear radiation

Question 131 · continued



**0 2 . 4** Estimate the mass of polonium-210 remaining after 300 days.

**[1 mark]**

Mass = _____ mg

**0 2 . 5** Nuclear radiation can cause ionisation.

Complete the sentences.

Choose answers from the box.

**[2 marks]**

| | | | | | |
|---|---|---|---|---|---|
| **a negative** | **an electron** | **a neutron** | **a positive** | **a proton** | **a zero** |

An atom becomes an ion when it loses _____.

The resulting ion has _____ charge.

### 4.4.2.1 Radioactive decay and nuclear radiation

**Question 132**

June 2019 | 8463/1F | Original Q4

**0 4** The ancient Greeks thought that atoms were tiny spheres that could not be divided into anything smaller.

Since then, different discoveries have led to the model of the atom changing.

Some of the discoveries are given in **Table 1**.

**Table 1**

| | |
|---|---|
| The mass of an atom is concentrated in the nucleus. | **A** |
| Electrons orbit the nucleus at specific distances. | **B** |
| The nucleus contains neutrons. | **C** |
| The nucleus contains positively charged protons. | **D** |

**0 4 . 1** Which discovery was the earliest?

**[1 mark]**

Tick (✓) **one** box.

**A** ☐ **B** ☐ **C** ☐ **D** ☐

**0 4 . 2** Which discovery was the most recent?

**[1 mark]**

Tick (✓) **one** box.

**A** ☐ **B** ☐ **C** ☐ **D** ☐

4.4.2.1 Radioactive decay and nuclear radiation

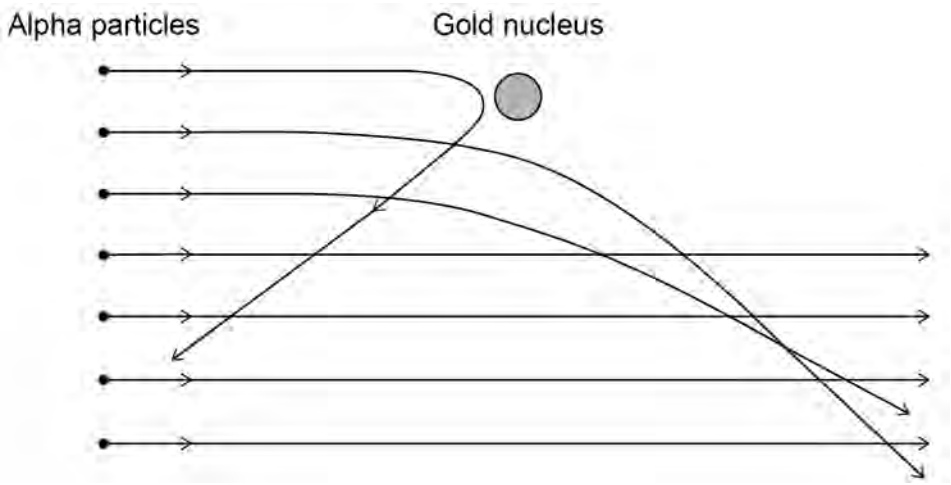
Question 132 · continued



**0 4 . 3** The alpha particle scattering experiment led to the nuclear model of the atom.

**Figure 5** shows the paths of alpha particles travelling close to a gold nucleus.

**Figure 5**




Complete the sentences.

Choose answers from the box.

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

**[3 marks]**

| | | |
|---|---|---|
| **attracts** | **decreases** | **does not change** |
| **increases** | **reflects** | **repels** |

Alpha particles and gold nuclei are both positively charged.

The gold nucleus _____ the alpha particles.

As the alpha particle approaches the gold nucleus, the electric field strength experienced by the alpha particle _____ .

As an alpha particle approaches the gold nucleus, the force experienced by the alpha particle _____ .

4.4.2.1 Radioactive decay and nuclear radiation

Question 132 · continued



**0 4 . 4** The results of the alpha particle scattering experiment were reproducible.

What does reproducible mean?

**[1 mark]**

Tick (✓) **one** box.

- Another scientist repeats the experiment and gets the same results. ☐
- Another scientist repeats the experiment and gets different results. ☐
- The same scientist repeats the experiment and gets the same results. ☐
- The same scientist repeats the experiment and gets different results. ☐

6

### 4.4.2.1 Radioactive decay and nuclear radiation

**Question 133**

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 _____ .

4.4.2.1 Radioactive decay and nuclear radiation

Question 133 · 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**

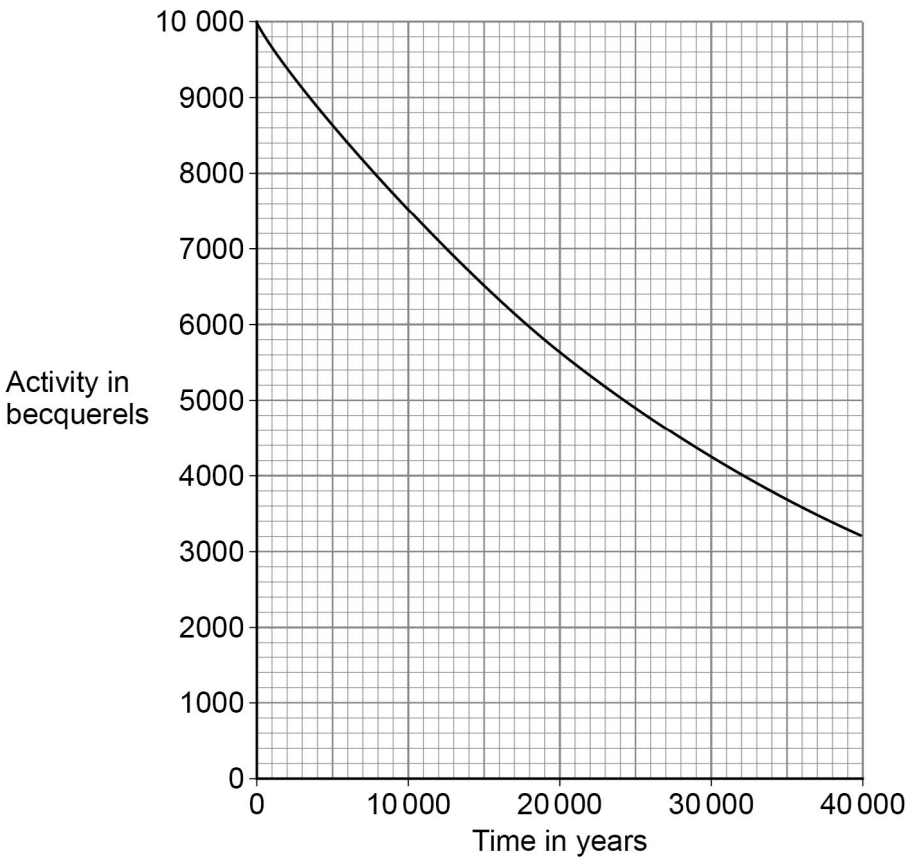
4.4.2.1 Radioactive decay and nuclear radiation

Question 133 · 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

4.4.2.1 Radioactive decay and nuclear radiation

Question 133 · 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**

### 4.4.2.1 Radioactive decay and nuclear radiation

**Question 134**

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**

4.4.2.1 Radioactive decay and nuclear radiation

Question 134 · continued

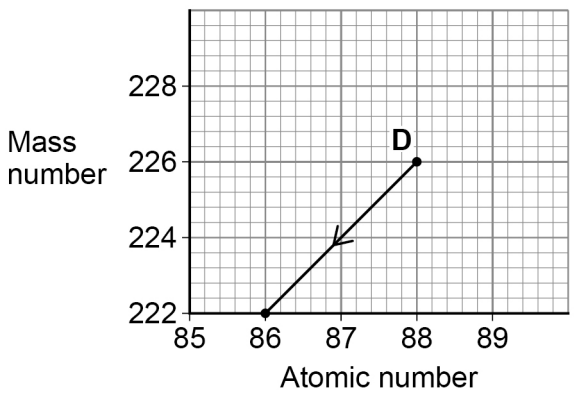


**0 5 . 3** A nucleus emits radiation.

**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 ☐

4.4.2.1 Radioactive decay and nuclear radiation

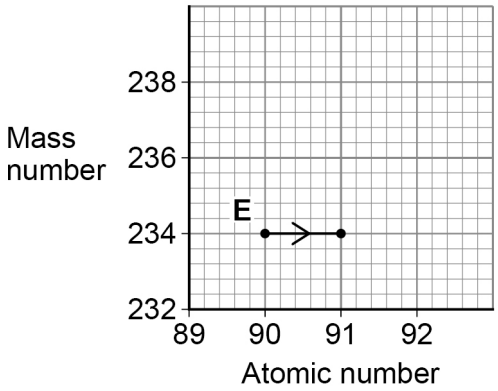
Question 134 · continued



**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**

4.4.2.1 Radioactive decay and nuclear radiation

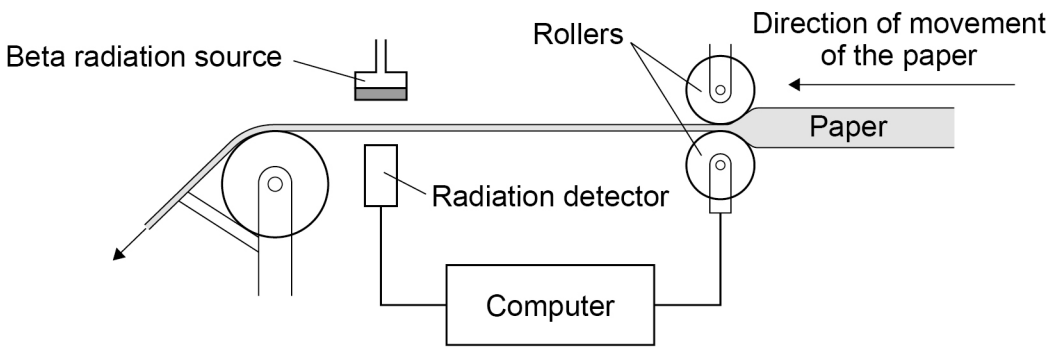
Question 134 · continued



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 _____.

4.4.2.1 Radioactive decay and nuclear radiation

Question 134 · continued

November 2021 | 8463/1F | Original Q5

**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

### 4.4.2.1 Radioactive decay and nuclear radiation

**Question 135**

June 2022 | 8463/1F | Original Q4

**0 4** Radioactive isotopes emit different types of nuclear radiation.

**0 4 . 1** What does an alpha particle consist of?

**[1 mark]**

Tick (✓) **one** box.

- 2 protons and 2 electrons ☐
- 2 protons and 2 neutrons ☐
- 4 protons ☐
- 4 neutrons ☐

**0 4 . 2** What is a beta particle?

**[1 mark]**

Tick (✓) **one** box.

- An electron ☐
- A neutron ☐
- Electromagnetic radiation ☐

**0 4 . 3** A krypton (Kr) nucleus decays into a rubidium (Rb) nucleus by emitting a beta particle.

What is the correct equation for this decay?

**[1 mark]**

Tick (✓) **one** box.

- $^{85}_{36}Kr + {}^{0}_{-1}e \longrightarrow {}^{85}_{37}Rb$ ☐
- $^{85}_{36}Kr \longrightarrow {}^{85}_{37}Rb + {}^{0}_{-1}e$ ☐
- $^{85}_{37}Rb \longrightarrow {}^{85}_{36}Kr + {}^{0}_{-1}e$ ☐

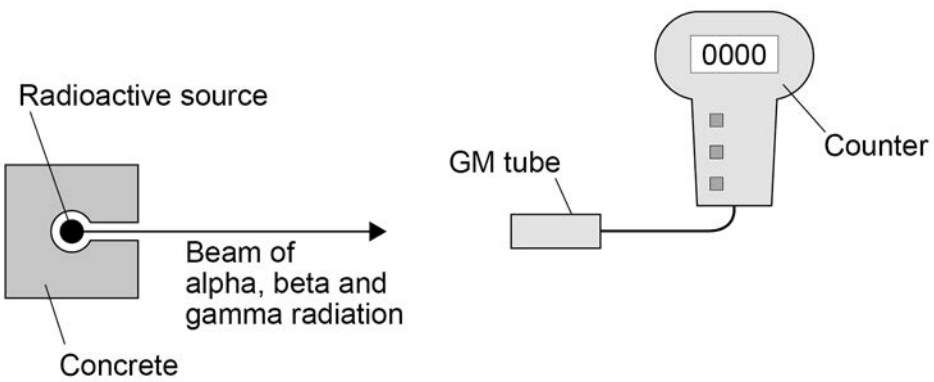
Question 135 · continued



**0 4 . 4** **Figure 5** shows an experiment to demonstrate how alpha, beta and gamma radiation penetrate different materials.

The experiment takes place in a vacuum.

**Figure 5**




Three different materials are used:

- a sheet of paper
- a 0.5 cm thick sheet of aluminium
- a 10 cm block of lead.

Each material is placed one at a time between the radioactive source and the GM tube.

The GM tube and counter show whether the material has stopped the radiation.

Complete **Table 1** to show how alpha, beta and gamma radiation penetrate the materials in **Figure 5**.

Use the words **Yes** and **No**.

Part of **Table 1** has been completed for you.

**[3 marks]**

**Table 1**

| Type of radiation | Most radiation is stopped by: | | |
|---|---|---|---|
| | the sheet of paper | the sheet of aluminium | the block of lead |
| Alpha | | | Yes |
| Beta | No | | |
| Gamma | | No | |

4.4.2.1 Radioactive decay and nuclear radiation

Question 135 · continued



**0 4 . 5** Alpha, beta and gamma radiation have different ionising powers.

Draw **one** line from each radiation type to the correct ionising power.

**[3 marks]**

| Radiation type | Ionising power |
|---|---|
| Alpha | Zero |
| Beta | Low |
| Gamma | Medium |
| | High |

**0 4 . 6** Some sources of background radiation are natural and other sources are man-made.

Which of the following is a man-made source of background radiation?

**[1 mark]**

Tick (✓) **one** box.

Cosmic rays ☐

Nuclear accidents ☐

Rocks ☐

**0 4 . 7** The average background radiation dose per year in the UK is 2.0 millisieverts.

A dental X-ray gives a patient a radiation dose of 0.005 millisieverts.

Calculate how many dental X-rays would be the same as the average background radiation dose per year.

**[2 marks]**

Number of dental X-rays = _____

12

4.4.2.1 Radioactive decay and nuclear radiation

Question 136

June 2022 | 8463/2F | Original Q5

**0 5** Ultraviolet and visible light are both parts of the electromagnetic spectrum.

**0 5 . 1** How does the speed of ultraviolet in a vacuum compare to the speed of visible light in a vacuum?

**[1 mark]**

Tick (✓) **one** box.

Ultraviolet travels at a faster speed than visible light. ☐

Ultraviolet travels at a slower speed than visible light. ☐

Ultraviolet travels at the same speed as visible light. ☐

**0 5 . 2** **Figure 9** shows parts of the electromagnetic spectrum.

**Figure 9**

| Radio waves | A | B | C | D | X-rays | Gamma rays |
|---|---|---|---|---|---|---|

Which letters represent the positions of ultraviolet and visible light in the electromagnetic spectrum?

**[2 marks]**

Ultraviolet _____

Visible light _____

4.4.2.1 Radioactive decay and nuclear radiation

Question 136 · continued



**0 5 . 3** **Table 3** shows the range of wavelengths for different types of ultraviolet.

**Table 3**

| Type | Range of wavelength in nanometres |
|---|---|
| Ultraviolet **A** (UVA) | 315–400 |
| Ultraviolet **B** (UVB) | 280–315 |
| Ultraviolet **C** (UVC) | 100–280 |

Determine which type of ultraviolet shown in **Table 3** has the largest range of wavelengths.

To gain full marks you must calculate the range of wavelengths for each type of ultraviolet.

**[3 marks]**

Type of ultraviolet with the largest range of wavelengths _____

**Question 5 continues on the next page**

4.4.2.1 Radioactive decay and nuclear radiation

Question 136 · continued



**Figure 10** shows how different types of ultraviolet are absorbed by the ozone layer in the Earth's atmosphere.

**Table 4** shows the relative ionising power from each type of ultraviolet.

**Figure 10**

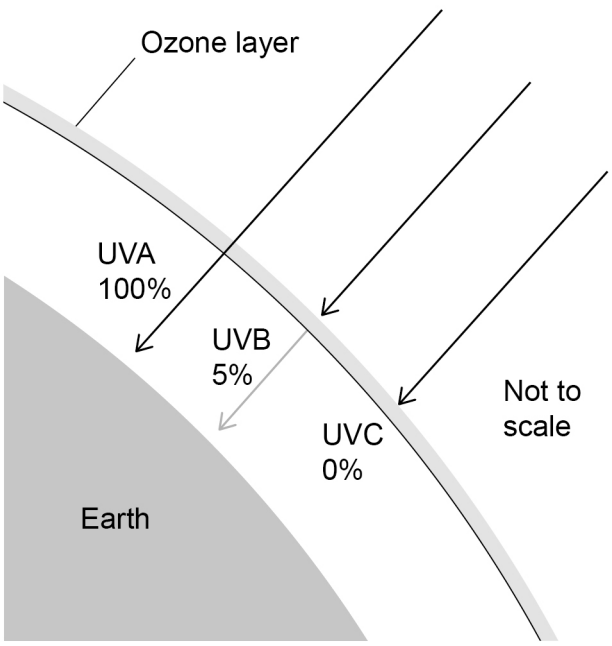



**Table 4**

| Type | Relative ionising power |
|---|---|
| UVA | Low |
| UVB | Medium |
| UVC | High |

**0 5 . 4** Explain the importance of the ozone layer in reducing the risk to people from all types of ultraviolet.

Use **Figure 10** and **Table 4**.

**[4 marks]**

4.4.2.1 Radioactive decay and nuclear radiation

Question 136 · continued



**0 5 . 5** The Sun emits visible light.

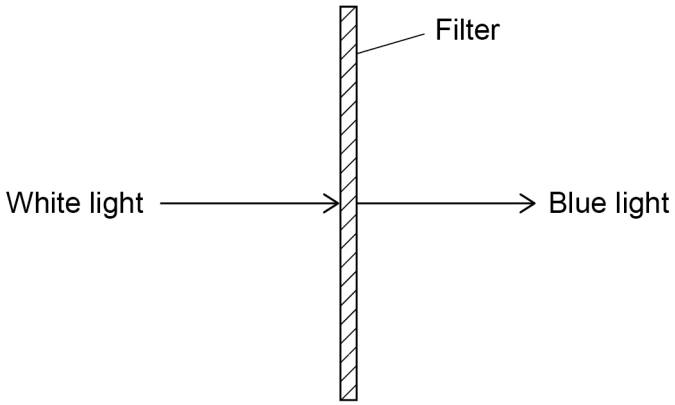
A student concludes that visible light is **not** absorbed by the ozone layer.

Give **one** piece of evidence that shows the student's conclusion is correct.

**[1 mark]**

**0 5 . 6** **Figure 11** shows white light incident on a colour filter.

**Figure 11**




Complete the sentence.

Choose the answers from the box.

**[2 marks]**

| | | | | |
|---|---|---|---|---|
| **absorbed** | **radiated** | **reflected** | **refracted** | **transmitted** |

When white light is incident on the filter, only blue light is _____

and all other colours of light are _____ .

13

### 4.4.2.1 Radioactive decay and nuclear radiation

**Question 137**

June 2023 | 8463/1F | Original Q2

**0 2** Scientists developed different models of the atom as new discoveries were made.

**0 2 . 1** Which particle in the atom was discovered first?

**[1 mark]**

Tick (✓) **one** box.

Electron ☐

Neutron ☐

Proton ☐

**Question 2 continues on the next page**

4.4.2.1 Radioactive decay and nuclear radiation

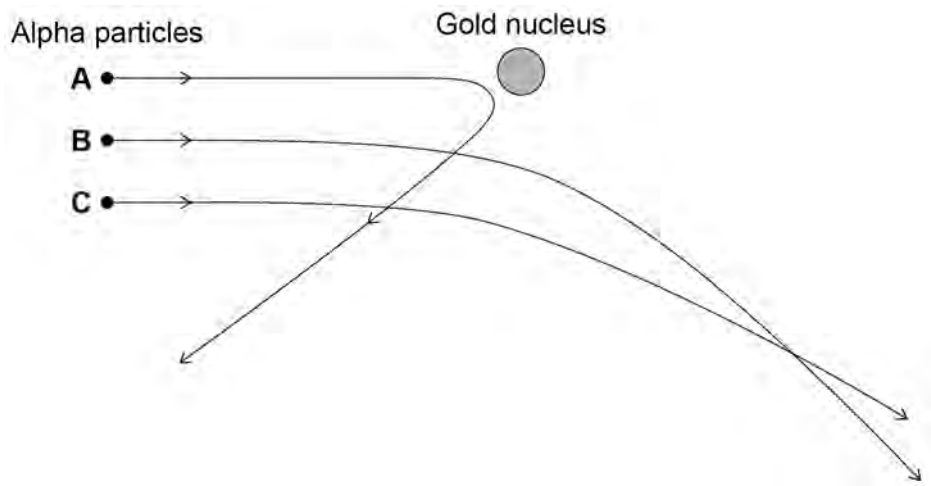
Question 137 · continued



In an experiment that led to the nuclear model of the atom, alpha particles were directed at a sheet of gold foil.

**Figure 3** shows the path of three alpha particles passing close to a gold nucleus.

**Figure 3**




**0 2 . 2** An alpha particle has a radius of 1.7 femtometres.

The radius of a gold nucleus is 4.2 times larger than the radius of an alpha particle.

Calculate the radius of a gold nucleus in femtometres.

**[2 marks]**

Radius of a gold nucleus = _____ femtometres

4.4.2.1 Radioactive decay and nuclear radiation

Question 137 · continued



**0 2 . 3** Alpha particles are deflected by the gold nucleus.

What are the charges on an alpha particle and a gold nucleus?

**[1 mark]**

Tick (✓) **one** box.

An alpha particle and a gold nucleus are both neutral. ☐

An alpha particle and a gold nucleus are both positively charged. ☐

An alpha particle is positively charged and a gold nucleus is neutral. ☐

**0 2 . 4** Which statement describes the force between the alpha particle and the gold nucleus?

**[1 mark]**

Tick (✓) **one** box.

A contact force ☐

A force of attraction ☐

A force of repulsion ☐

There is no force ☐

**0 2 . 5** Which alpha particle in **Figure 3** experiences the largest force from the gold nucleus?

**[1 mark]**

Tick (✓) **one** box.

**A** ☐ **B** ☐ **C** ☐

4.4.2.1 Radioactive decay and nuclear radiation

Question 137 · continued



**Table 1** lists different models of the atom in alphabetical order.

**Table 1**

| **Model** |
|---|
| Bohr |
| Nuclear |
| Plum pudding |
| Tiny spheres that cannot be divided |

**0 2 . 6** Which model in **Table 1** was developed first?

**[1 mark]**

**0 2 . 7** Which model in **Table 1** was developed last?

**[1 mark]**

8

4.4.2.1 Radioactive decay and nuclear radiation

Question 138

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**

4.4.2.1 Radioactive decay and nuclear radiation

Question 138 · 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 ☐

4.4.2.1 Radioactive decay and nuclear radiation

Question 138 · 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**

4.4.2.1 Radioactive decay and nuclear radiation

Question 138 · 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 = _____

4.4.2.1 Radioactive decay and nuclear radiation

Question 138 · 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

4.4.2.1 Radioactive decay and nuclear radiation

Question 139

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**

4.4.2.1 Radioactive decay and nuclear radiation

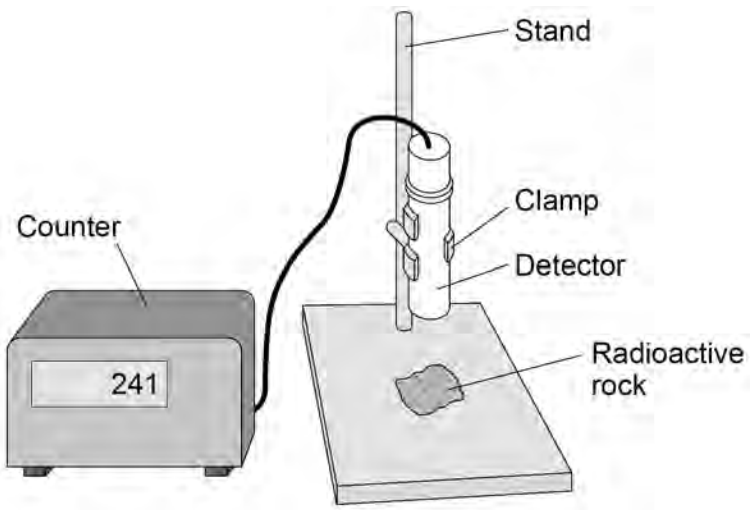
Question 139 · continued



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 |

4.4.2.1 Radioactive decay and nuclear radiation

Question 139 · 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 _____

_____

4.4.2.1 Radioactive decay and nuclear radiation

Question 139 · 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. ☐

4.4.2.1 Radioactive decay and nuclear radiation

Question 139 · 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. ☐

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**Turn over for the next question**

4.4.2.1 Radioactive decay and nuclear radiation

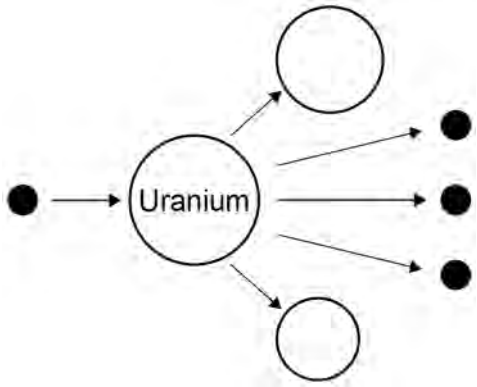
Question 140

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 _____.

4.4.2.1 Radioactive decay and nuclear radiation

Question 140 · 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]**

4.4.2.1 Radioactive decay and nuclear radiation

Question 140 · 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**

### 4.4.2.1 Radioactive decay and nuclear radiation

**Question 141**

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.

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

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

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

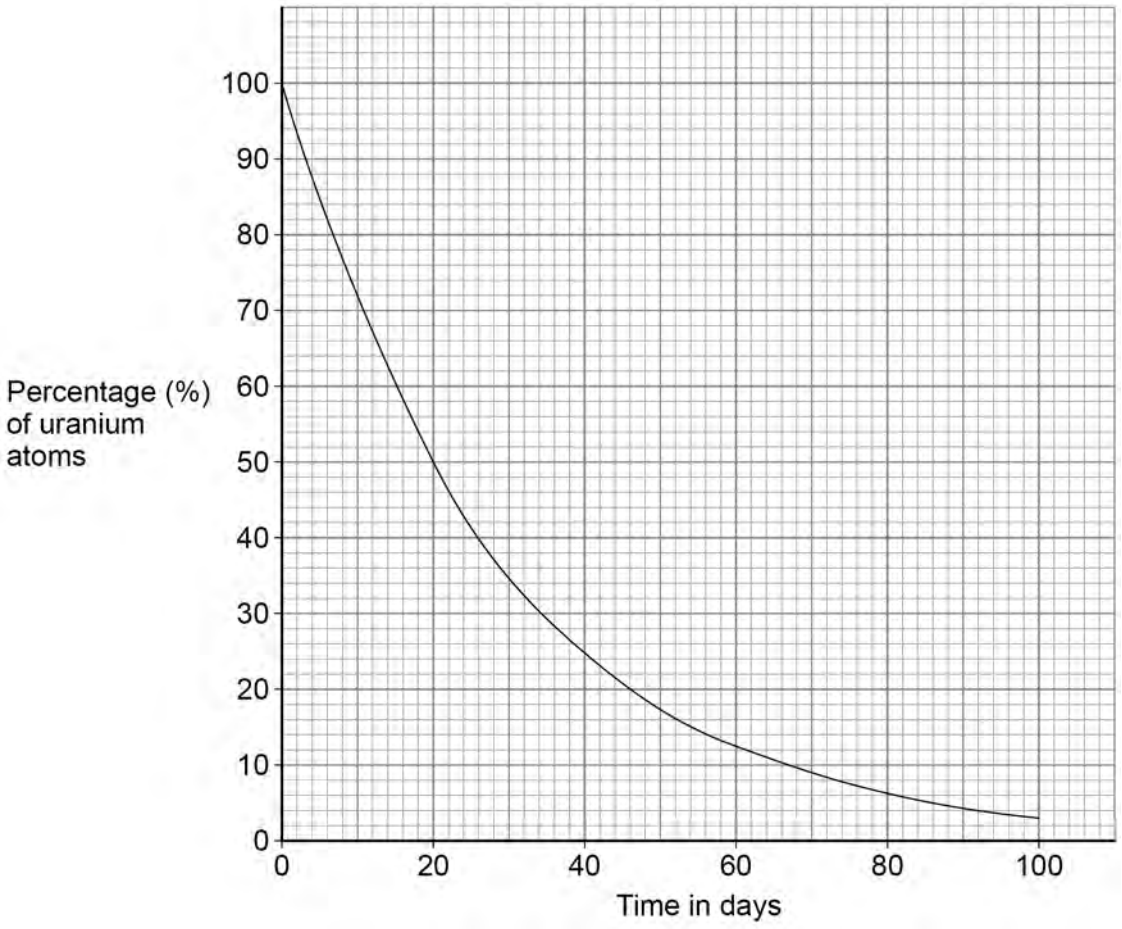
4.4.2.1 Radioactive decay and nuclear radiation

Question 141 · 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

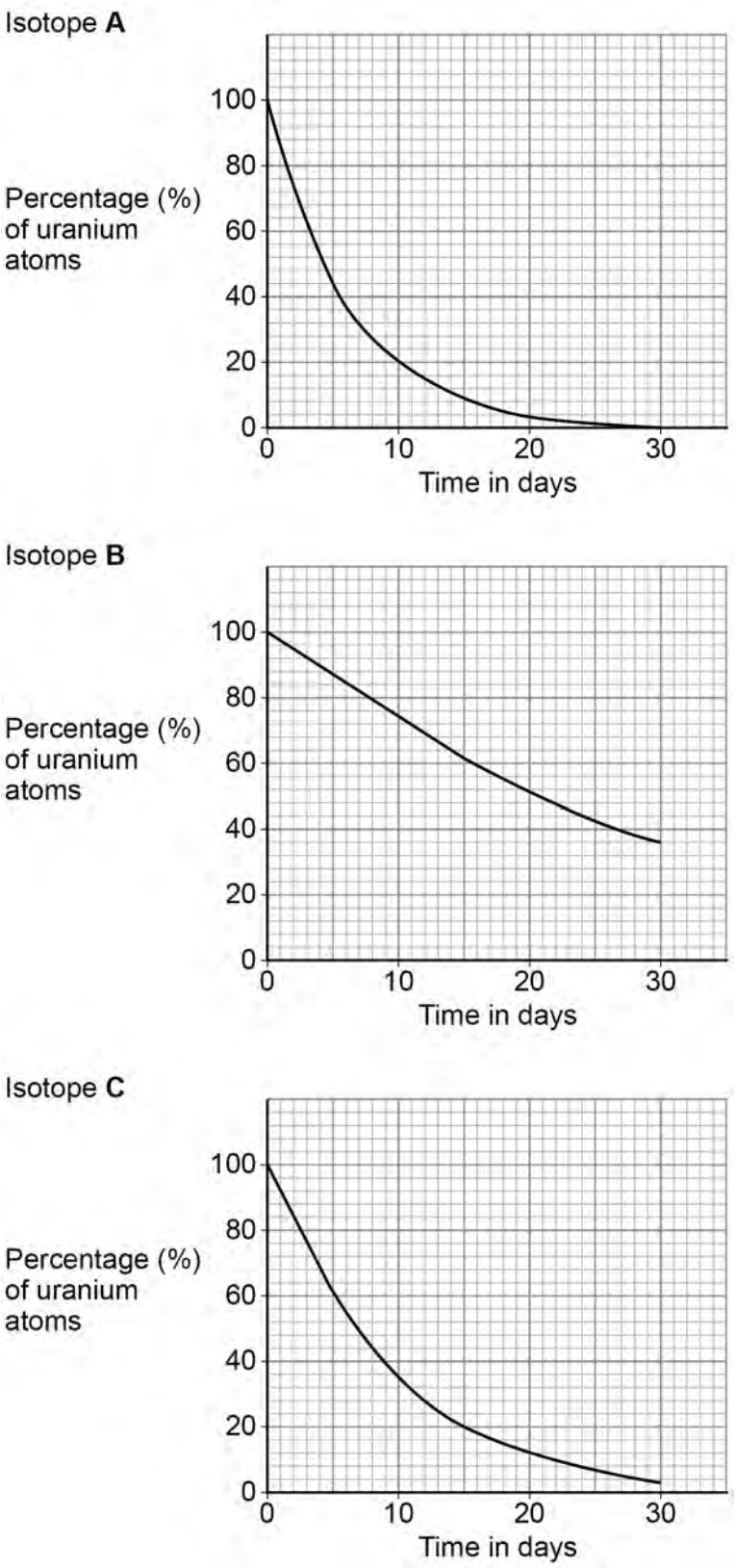
4.4.2.1 Radioactive decay and nuclear radiation

Question 141 · 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**



4.4.2.1 Radioactive decay and nuclear radiation

**Question 141 · 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**

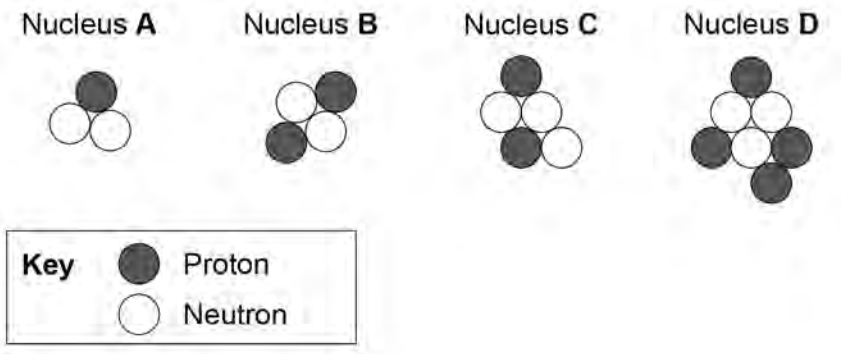
4.4.2.1 Radioactive decay and nuclear radiation

Question 141 · 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** ☐

4.4.2.1 Radioactive decay and nuclear radiation

Question 141 · 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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