AQA GCSE Physics | 8463

SPECIFICATION POINT 4.4.1.1

The structure of an atom

Past-paper questions

Tier	**Higher**
Question groups	**84**
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.

4.4.1.1 The structure of an atom

Question 01

June 2003 | 3451H | Original Q1 | Legacy

1 (a) Some scientists are involved in the search for *extra-terrestrial* intelligence (SETI).

(i) What does *extra-terrestrial* mean?

.....

(1 mark)

(ii) What equipment is used to carry out this search?

.....

(1 mark)

(b) In 1967, radio pulses, one every 1.337 seconds, were discovered coming from a point in space. Some scientists thought the pulses were being produced by intelligent life elsewhere in the *Universe*. Later, it was discovered that the pulses were emitted by a *neutron star*.

(i) Complete this sentence.

The *Universe* is made up of at least a billion .....

(1 mark)

(ii) Suggest **one** reason why scientists might have thought that the pulses were produced by intelligent life.

.....

.....

(1 mark)

(iii) What is the link between a *neutron star* and a *super nova*?

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.....

.....

(2 marks)

4.4.1.1 The structure of an atom

Question 01 · continued

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(c) In 2001, equipment was carried by balloons to a height of 41 km above the Earth's surface. The equipment detected the presence of bacteria.

(i) The natural movement of air in the Earth's atmosphere may have carried the bacteria up **or** the bacteria may have come from outer space.

Suggest **one** other explanation.

.....

.....

(1 mark)

(ii) Suggest **one** way in which bacteria may have travelled through space to reach the edge of our atmosphere.

.....

.....

(1 mark)

8

4.4.1.1 The structure of an atom

Question 02

June 2003 | 3451H | Original Q14 | Legacy

14 (a) The table gives information about six radioactive isotopes.

Isotope	Type of radiation emitted	Half-life
hydrogen-3	beta particle	12 years
iridium-192	gamma ray	74 days
polonium-210	alpha particle	138 days
polonium-213	alpha particle	less than 1 second
technetium-99	gamma ray	6 days
uranium-239	beta particle	24 minutes

(i) What is an alpha particle?

.....

(1 mark)

(ii) Two isotopes of polonium are given in the table. How do the nuclei of these two isotopes differ?

.....

(1 mark)

(iii) A doctor needs to monitor the blood flow through a patient's heart. The doctor injects a radioactive isotope into the patient's bloodstream. The radiation emitted by the isotope is then detected outside the body.

Which **one** of the isotopes in the table would the doctor inject into the bloodstream?

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Explain the reasons for your choice.

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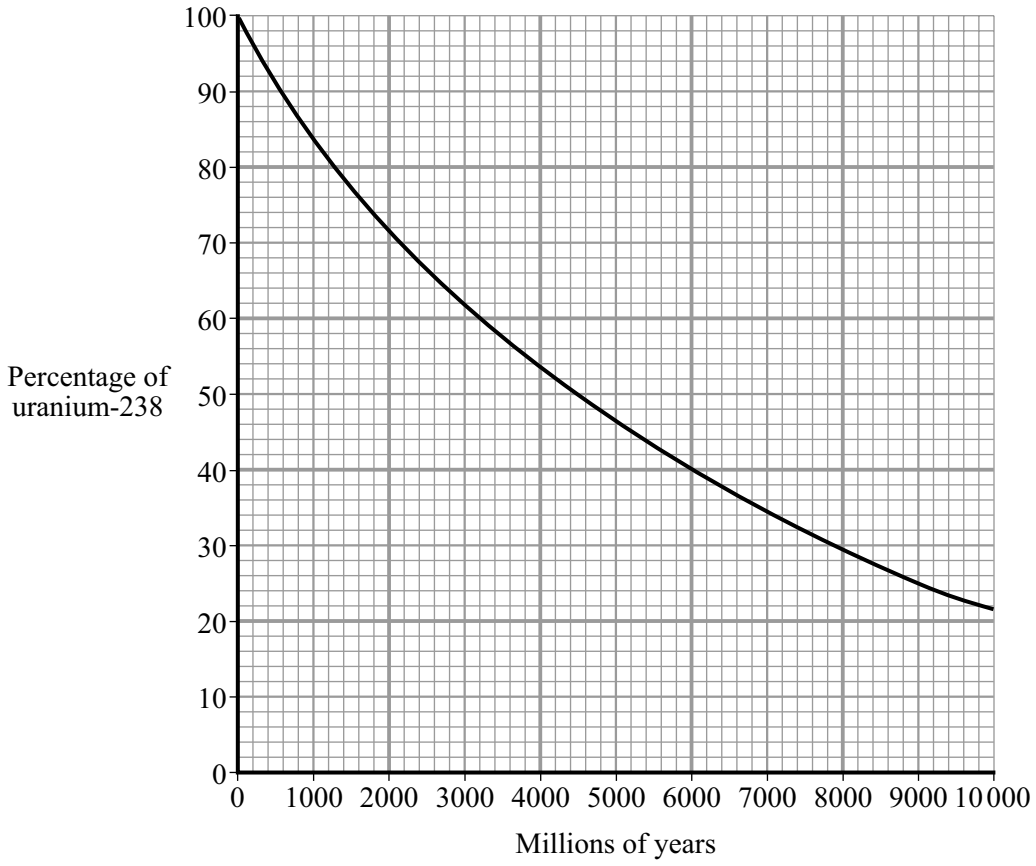
(3 marks)

4.4.1.1 The structure of an atom

Question 02 · continued

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(b) Igneous rock contains uranium-238 which eventually changes to the stable isotope lead-206. The graph shows how the percentage of uranium-238 nuclei present in an igneous rock changes with time.



A rock sample is found to have seven atoms of uranium-238 for every three atoms of lead-206. Use the graph to estimate the age of the rock. Show clearly how you obtain your answer.

.....

.....

Age of rock = ...million years

(2 marks)

7

4.4.1.1 The structure of an atom

Question 03

June 2003 | 3451H | Original Q15 | Legacy

15 (a) An electronic circuit in a freezer contains an alarm. This alarm will sound if the temperature inside the freezer rises above –15 °C. The alarm will also sound if the freezer door is left open for more than 45 seconds.

In the electronic circuit, name:

(i) the logic gate;

.....

(1 mark)

(ii) an input sensor which could detect the temperature rise;

.....

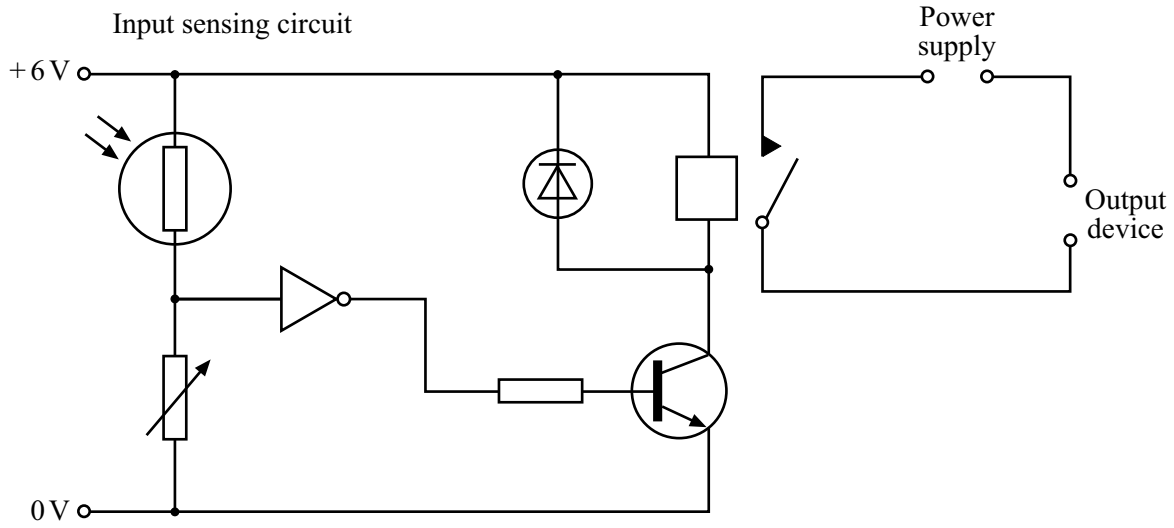
(1 mark)

(iii) a component which could act as a timer.

.....

(1 mark)

(b) The diagram shows a different system which could be used to switch on a security light, outside a house, at night. The diagram shows the input sensing circuit and the circuit for an output device.



4.4.1.1 The structure of an atom

Question 03 · continued

MARGIN BLANK

(i) Complete the **five** spaces in these sentences to give the correct order for the events which occur.

As it gets dark, the resistance of the light dependent resistor (LDR) increases. The input to the logic gate will be ..... so the output will be ..... . Then the ..... will be switched on, the ..... will be switched on and the ..... will be switched on. *(5 marks)*

(ii) Explain why a diode is included in the circuit.

.....

.....

.....

..... *(2 marks)*

(iii) Why is the diode reverse-biased?

.....

..... *(1 mark)*

(iv) The system, in the diagram, can be modified to control a garden water fountain. This can be done by changing the output device to an electric pump.

The input sensing circuit could be modified so that the water fountain would operate only during the day.

Suggest **two** alternative ways in which the input sensing circuit could be modified so that it would have this result.

1 .....

.....

2 .....

..... *(2 marks)*

13

4.4.1.1 The structure of an atom

Question 04

June 2003 | 3462H3 | Original Q1 | Legacy

1 (a) Some scientists are involved in the search for *extra-terrestrial* intelligence (SETI).

(i) What does *extra-terrestrial* mean?

.....

(1 mark)

(ii) What equipment is used to carry out this search?

.....

(1 mark)

(b) In 1967, radio pulses, one every 1.337 seconds, were discovered coming from a point in space. Some scientists thought the pulses were being produced by intelligent life elsewhere in the *Universe*. Later, it was discovered that the pulses were emitted by a *neutron star*.

(i) Complete this sentence.

The *Universe* is made up of at least a billion .....

(1 mark)

(ii) Suggest **one** reason why scientists might have thought that the pulses were produced by intelligent life.

.....

.....

(1 mark)

(iii) What is the link between a *neutron star* and a *super nova*?

.....

.....

.....

(2 marks)

4.4.1.1 The structure of an atom

Question 04 · continued

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(c) In 2001, equipment was carried by balloons to a height of 41 km above the Earth's surface. The equipment detected the presence of bacteria.

(i) The natural movement of air in the Earth's atmosphere may have carried the bacteria up **or** the bacteria may have come from outer space.

Suggest **one** other explanation.

.....

.....

(1 mark)

(ii) Suggest **one** way in which bacteria may have travelled through space to reach the edge of our atmosphere.

.....

.....

(1 mark)

8

4.4.1.1 The structure of an atom

Question 05

June 2003 | 3462H3 | Original Q12 | Legacy

12 (a) The table gives information about six radioactive isotopes.

Isotope	Type of radiation emitted	Half-life
hydrogen-3	beta particle	12 years
iridium-192	gamma ray	74 days
polonium-210	alpha particle	138 days
polonium-213	alpha particle	less than 1 second
technetium-99	gamma ray	6 days
uranium-239	beta particle	24 minutes

(i) What is an alpha particle?

.....

(1 mark)

(ii) Two isotopes of polonium are given in the table. How do the nuclei of these two isotopes differ?

.....

(1 mark)

(iii) A doctor needs to monitor the blood flow through a patient's heart. The doctor injects a radioactive isotope into the patient's bloodstream. The radiation emitted by the isotope is then detected outside the body.

Which **one** of the isotopes in the table would the doctor inject into the bloodstream?

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Explain the reasons for your choice.

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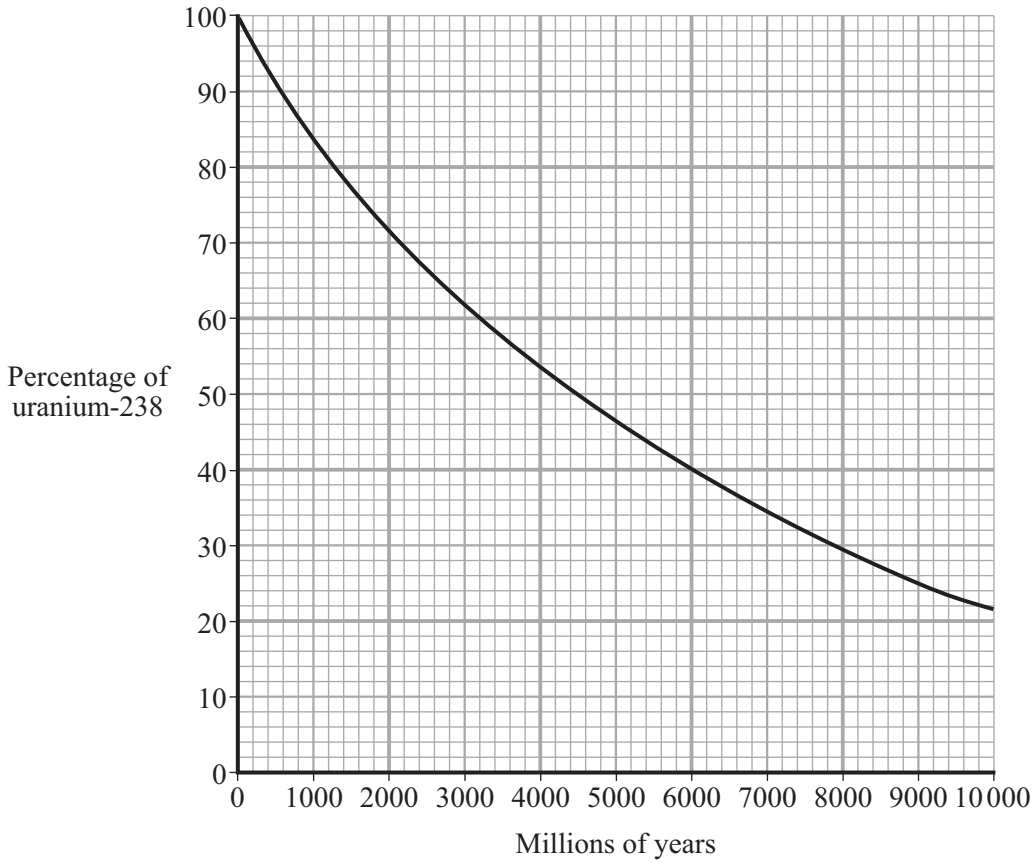
(3 marks)

4.4.1.1 The structure of an atom

Question 05 · continued

MARGIN BLANK

(b) Igneous rock contains uranium-238 which eventually changes to the stable isotope lead-206. The graph shows how the percentage of uranium-238 nuclei present in an igneous rock changes with time.



A rock sample is found to have seven atoms of uranium-238 for every three atoms of lead-206. Use the graph to estimate the age of the rock. Show clearly how you obtain your answer.

.....

.....

Age of rock = ...million years

(2 marks)

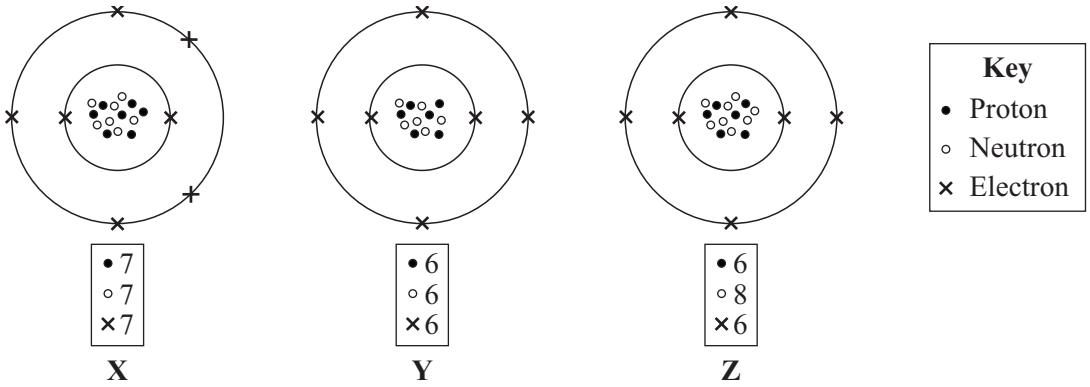
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4.4.1.1 The structure of an atom

Question 06

June 2004 | 3451H | Original Q4 | Legacy

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



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

.....

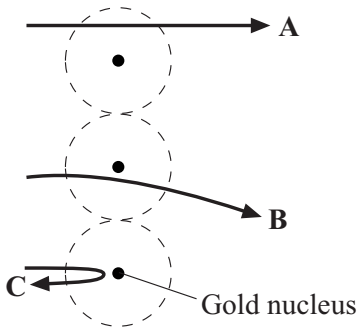
Give a reason for your answer.

.....

.....

(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.

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(3 marks)

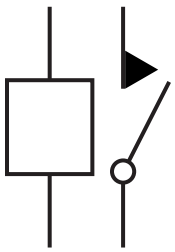
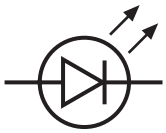
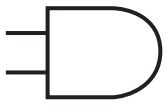
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4.4.1.1 The structure of an atom

Question 07

June 2004 | 3451H | Original Q7 | Legacy

7 (a) In circuit diagrams, symbols are used for the different components. Complete the table by identifying each of these components and finish each sentence which says what the component does.

Symbol	Name of component	What the component does
	.....	It allows a small current to ....
	.....	It lights if a current flows through it ....
	.....	It switches on if ....

(6 marks)

4.4.1.1 The structure of an atom

Question 07 · continued

MARGIN
BLANK

(b) We now make use of many electronic systems. Two of these systems are mobile phones and the Internet.

Apart from their costs, explain **one** benefit and **one** drawback of each of these.

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

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(4 marks)

10

4.4.1.1 The structure of an atom

Question 08

June 2004 | 3451H | Original Q8 | Legacy

8 (a) A physics textbook says that:

"The *flow of electrons* through a circuit can be controlled by using a fixed resistor or a variable resistor."

(i) What word can be used for the *flow of electrons*?

.....

(1 mark)

(ii) The flow of electrons can also be controlled by a *thermistor*.

How is a *thermistor* affected by an increase in temperature?

.....

.....

.....

(2 marks)

(b) Draw straight lines to link each part of an electronic circuit with its description.

Part of electronic circuit	Description
input sensor	controlled by the processor
processor	detects changes in the environment
output device	decides what action is needed

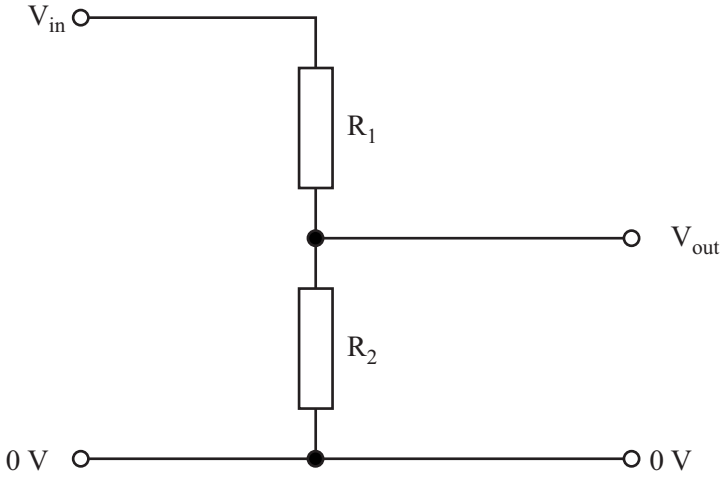
(2 marks)

4.4.1.1 The structure of an atom

Question 08 · continued

MARGIN
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(c) The diagram shows part of an electronic circuit. This part is connected to the processor.



(i) What is the name of this part?

.....

(1 mark)

(ii) The input potential difference (voltage) is 6 volts, the value of R_1 is 15 ohms and the value of R_2 is 30 ohms.

Use the following equation to calculate the value of the output potential difference.

$$V_{out} = V_{in} \times \frac{R_2}{(R_1 + R_2)}$$

.....

.....

Output potential difference = ...volts

(2 marks)

(iii) The resistor R_1 is replaced by another resistor with a higher value. The resistor R_2 is not changed.

What effect will this have on:

the potential difference across the new resistor;

.....

the potential difference across R_2?

.....

(2 marks)

10

4.4.1.1 The structure of an atom

Question 09

June 2004 | 3451H | Original Q17 | Legacy

17 (a) A beta particle is a high-energy electron.

(i) Which part of an atom emits a beta particle?

.....

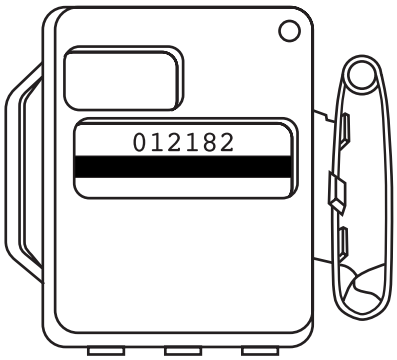
(1 mark)

(ii) How does the composition of an atom change when it emits a beta particle?

.....

(1 mark)

(b) The diagram shows a badge used to monitor radiation. It measures the amount of radiation a worker has been exposed to in one month.



(i) What is used inside the badge to detect radiation?

.....

(1 mark)

(ii) What would indicate that the worker has been exposed to a high level of radiation as opposed to a low level of radiation?

.....

.....

(1 mark)

(iii) Why is it important to monitor the amount of radiation the worker has been exposed to?

.....

.....

(1 mark)

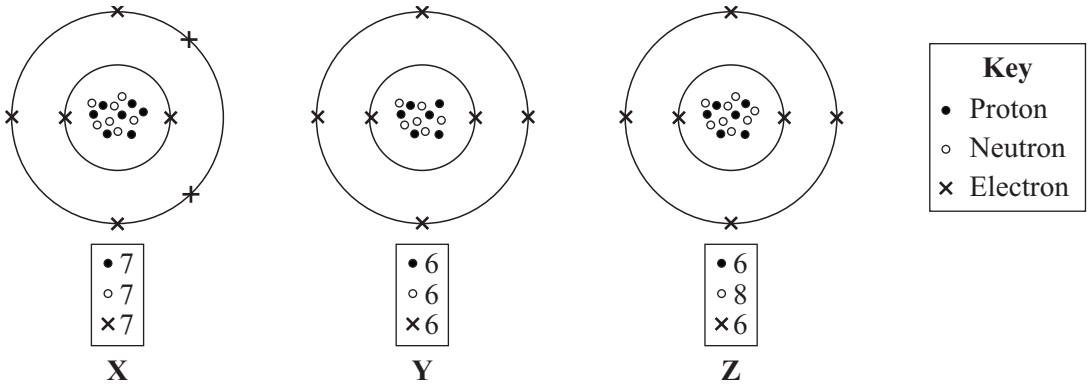
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4.4.1.1 The structure of an atom

Question 10

June 2004 | 3462H3 | Original Q4 | Legacy

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



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

.....

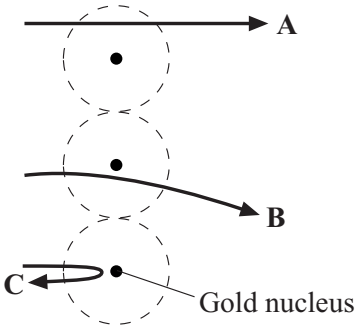
Give a reason for your answer.

.....

.....

(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.

.....

.....

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.....

(3 marks)

5

4.4.1.1 The structure of an atom

Question 11

June 2004 | 3462H3 | Original Q13 | Legacy

13 (a) A beta particle is a high-energy electron.

(i) Which part of an atom emits a beta particle?

.....

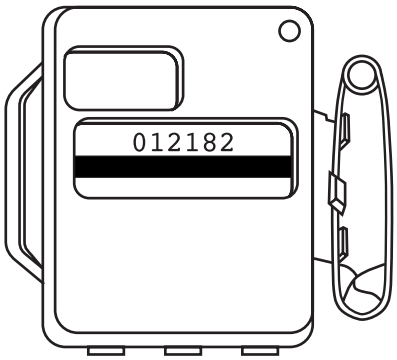
(1 mark)

(ii) How does the composition of an atom change when it emits a beta particle?

.....

(1 mark)

(b) The diagram shows a badge used to monitor radiation. It measures the amount of radiation a worker has been exposed to in one month.



(i) What is used inside the badge to detect radiation?

.....

(1 mark)

(ii) What would indicate that the worker has been exposed to a high level of radiation as opposed to a low level of radiation?

.....

.....

(1 mark)

(iii) Why is it important to monitor the amount of radiation the worker has been exposed to?

.....

.....

(1 mark)

5

4.4.1.1 The structure of an atom

Question 12

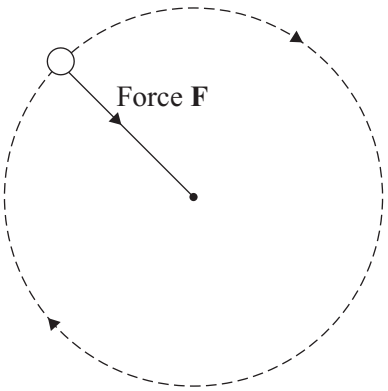
June 2005 | 3451 | Original Q5 | Legacy

5 (a) A student has fastened a ball to a piece of string and is swinging it round in a horizontal circle.



(i) The diagram below shows an overhead view of the movement of the ball.

Add an arrow, from the centre of the ball, to show the direction in which the ball would move if the string broke at this instant.



(1 mark)

(ii) Complete the table to show how force **F** changes if the student changes what he is doing. In each case, all the other factors stay the same.

If the student	Force F needs to
uses a ball with a greater mass	.....
swings the ball at a greater speed	.....
swings the ball with a shorter piece of string	.....

(3 marks)

4.4.1.1 The structure of an atom

Question 12 · continued

MARGIN BLANK

(b) The Moon orbits the Earth in a circular path.

Use words from the box to complete the **three** spaces in the sentence.

direction	**resistance**	**speed**	**velocity**

You may use each word once, more than once or not at all.

The Moon's ..... is constant but its ..... changes because its ..... changes.

(2 marks)

(c) When any object moves in a circular, or nearly circular, path a force must act towards the centre of the circle.

(i) What word is used to describe this force?

.....

(1 mark)

(ii) The Moon orbits the Earth. What provides the force towards the Earth?

.....

(1 mark)

(iii) In an atom, name the particles which are moving in circular paths around the nucleus.

.....

(1 mark)

(iv) In the case of an atom, what word describes the forces which keep these particles moving in circular paths around the nucleus?

.....

(1 mark)

10

TURN OVER FOR THE NEXT QUESTION

4.4.1.1 The structure of an atom

Question 13

June 2005 | 3451 | Original Q8 | Legacy

8 Stars do not stay the same forever.

(a) Over billions of years the amount of hydrogen in a star decreases. Why?

.....

.....

(1 mark)

(b) Describe how a massive star (at least five times bigger than the Sun) will change at the end of the main stable period.

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.

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(4 marks)

(c) The inner planets of the solar system contain atoms of the heaviest elements.

(i) Where did these atoms come from?

.....

.....

(1 mark)

(ii) What does this tell us about the age of the solar system compared with many of the stars in the Universe?

.....

(1 mark)

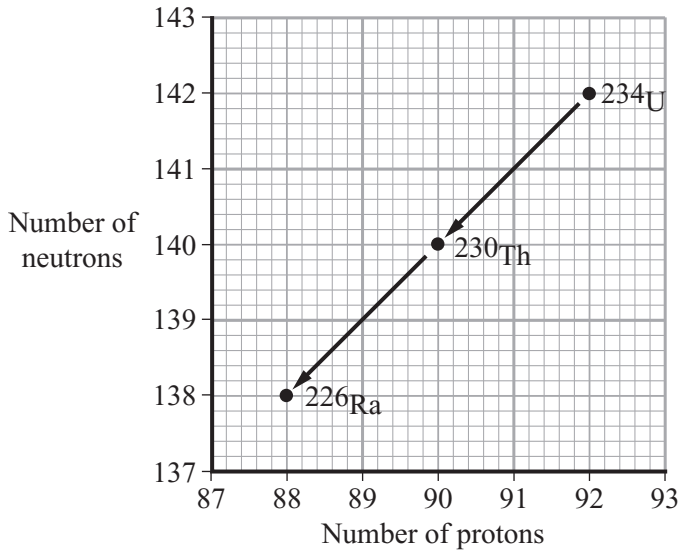
7

4.4.1.1 The structure of an atom

Question 14

June 2005 | 3451 | Original Q9 | Legacy

9 (a) Uranium-234 (^{234}U) is a radioactive element. The graph shows the number of protons and neutrons in the nuclei of the elements formed when uranium-234 decays.



(i) How does the graph show that uranium-234 (^{234}U) and thorium-230 (^{230}Th) emit alpha particles?

.....

(1 mark)

(ii) What makes uranium and thorium different elements?

.....

(1 mark)

(iii) Radioactive decay may also produce gamma radiation.

Why does the emission of gamma radiation **not** cause a new element to be formed?

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.....

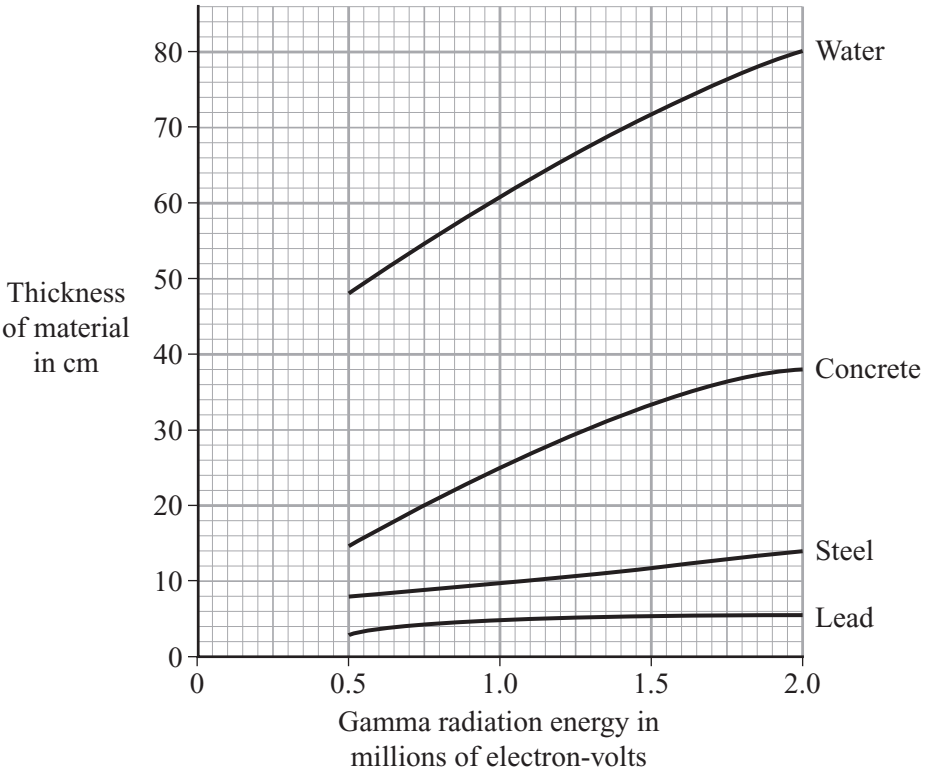
(1 mark)

Question 14 · continued

1 /

MARGIN BLANK

(b) The graph shows how the thickness of different materials needed to absorb 90% of the gamma radiation emitted by a source depends on the energy of the radiation. The energy of the gamma radiation is given in units called electron-volts.



(i) Which of the materials shown is least effective at absorbing gamma radiation? Use the information in the graph to give a reason for your answer.

.....

.....

(1 mark)

(ii) For gamma radiation of energy 1.5 million electron-volts, how many times more effective is steel than water at absorbing the radiation? Show clearly how you obtain your answer.

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(2 marks)

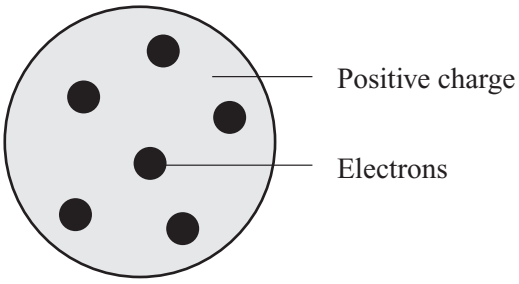
QUESTION 9 CONTINUES ON THE NEXT PAGE

4.4.1.1 The structure of an atom

Question 14 · continued

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(c) Scientists in the early twentieth century thought that atoms were made up of electrons scattered inside a ball of positive charge. This was called the 'plum-pudding' model of the atom.



Plum pudding model

Rutherford and Marsden did an experiment, in which a beam of alpha particles was aimed at a thin sheet of gold.
Explain how the results of this experiment led to a new model of the atom. You may include one or more diagrams in your answer.

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(3 marks)

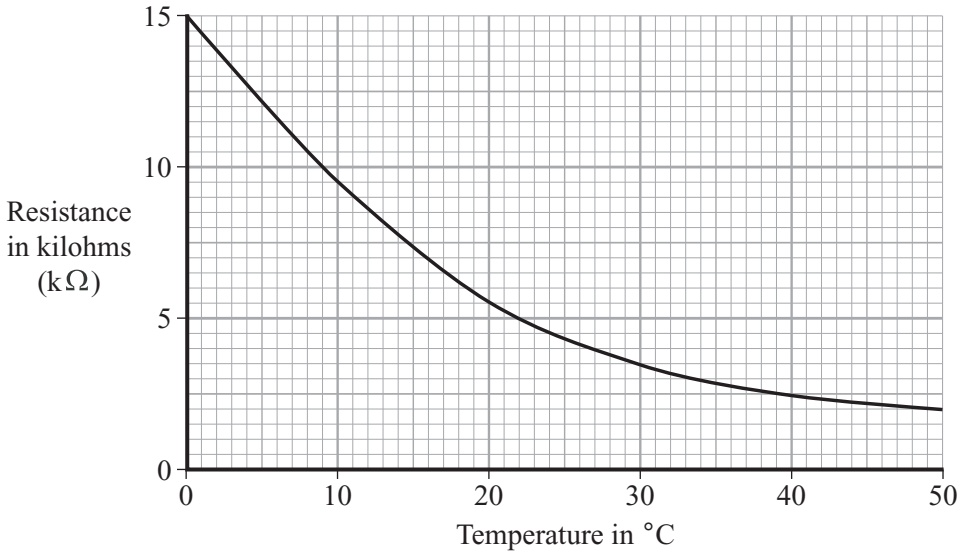
9

4.4.1.1 The structure of an atom

Question 15

June 2005 | 3451 | Original Q12 | Legacy

12 (a) The graph shows how the resistance of a thermistor changes with temperature.



Use the graph to find:

(i) the resistance, in kΩ, of the thermistor at 18 ºC;

Resistance = ... kΩ

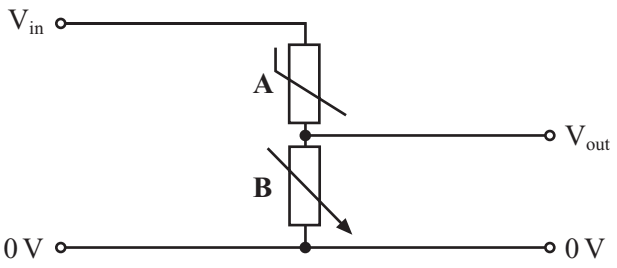
(1 mark)

(ii) the temperature, in ºC, when the resistance of the thermistor is 12 500 ohms (Ω).

Temperature = ... ºC

(1 mark)

(b) The diagram shows how a thermistor is used in part of an electronic circuit.



(i) Name the components **A** and **B**.

A is a ..... and **B** is a .....

(1 mark)

(ii) Name the part of the electronic circuit shown in the diagram.

.....

(1 mark)

Question 15 · continued

MARGIN BLANK

(iii) What will happen to the value of V_{out} as the temperature increases from the freezing point of water to room temperature?

.....

(1 mark)

(iv) Explain your answer to part (b)(iii).

.....

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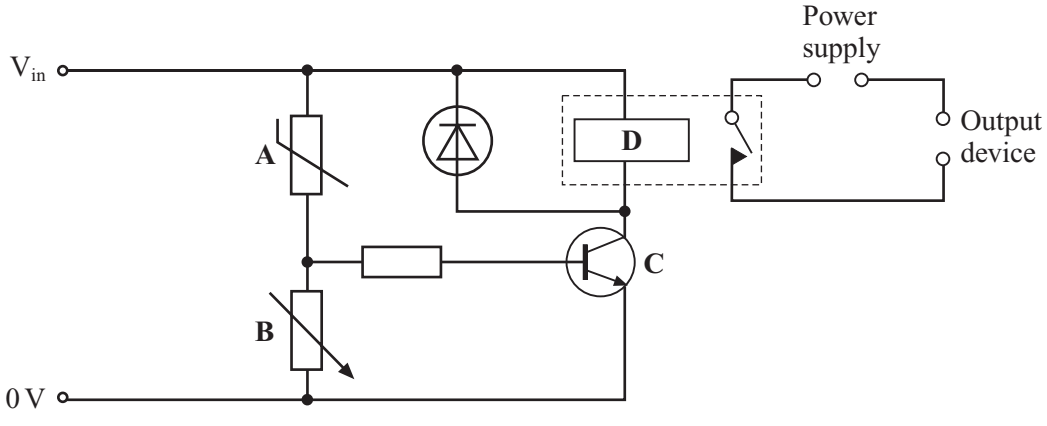
(2 marks)

(c) An electronic circuit switches on an output device when the temperature gets above a certain value. Name a suitable output device.

.....

(1 mark)

(d) The diagram shows an electronic circuit.



(i) Name components **C** and **D**.

C is a ..... and **D** is a .....

(2 marks)

(ii) The circuit is modified by adding a NOT gate. This makes the circuit switch on the output device when the temperature gets too low.

Describe where in the circuit the NOT gate would be put.

.....

.....

(1 mark)

Describe a use for this modified circuit.

.....

.....

(1 mark)

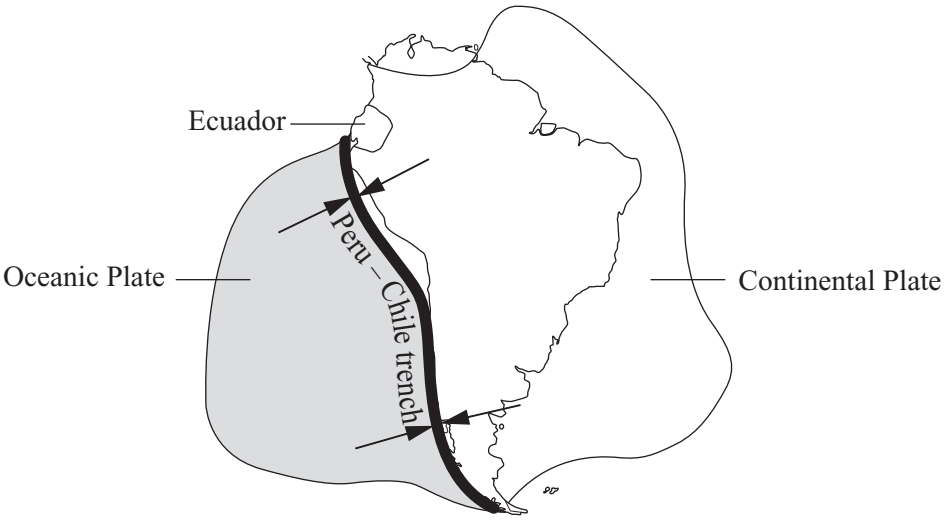
12

4.4.1.1 The structure of an atom

Question 16

June 2005 | 3451 | Original Q15 | Legacy

15 The Peru–Chile trench runs down the west coast of South America. It is the boundary between two tectonic plates that are slowly moving towards each other.



Source: WITNEY, DROZDOWSKA AND MAILE, *AQA GCSE Physics* (Hodder & Stoughton) 2002. Adapted and reproduced by permission of Hodder & Stoughton.

(a) Explain what causes the tectonic plates to move.

.....

.....

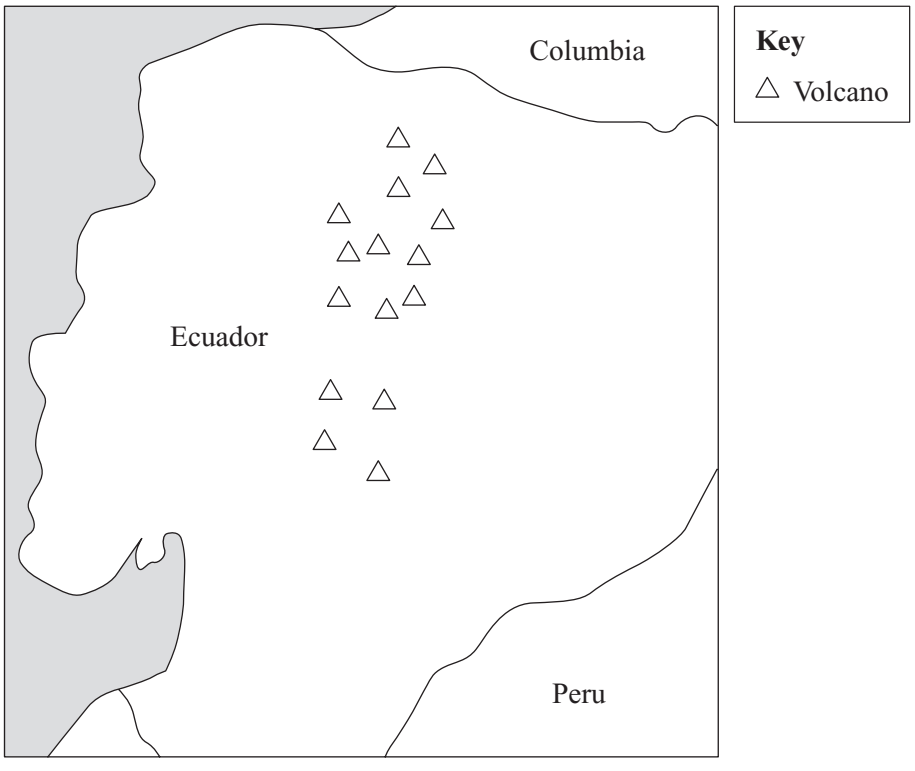
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(2 marks)

MARGIN
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(b) The map shows the location of some of the volcanoes in Ecuador. The volcanoes are all close to the Peru–Chile trench.



Explain how the volcanoes were formed.

.....

.....

.....

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.....

.....

(3 marks)

(c) The eruption of Mount St Helens in the USA is one of the few volcanic eruptions to have been accurately predicted by scientists. The scientists had been monitoring *seismic activity*, levels of sulphur dioxide and changes to the ground level.

(i) What is meant by *seismic activity*?

.....

(1 mark)

QUESTION 15 CONTINUES ON THE NEXT PAGE

Question 16 · continued

MARGIN BLANK

(ii) Suggest why scientists find it difficult to predict accurately when a volcano is going to erupt.

.....

.....

.....

.....

(2 marks)

(d) The molten rock flowing from an erupting volcano can reach a speed of 8 m/s.

(i) Write down the equation that links kinetic energy, mass and speed.

.....

(1 mark)

(ii) Calculate the kinetic energy of 1 tonne of molten rock flowing at 8 m/s.
(1 tonne = 1000 kg)

.....

.....

Kinetic energy = ... joules
(1 mark)

(e) Read the information in the box and then answer the questions.

> Igneous rocks contain potassium-40. This is a radioactive isotope. It has a half-life of 1300 million years.
>
> Potassium-40 decays into argon-40 which is stable.
>
> Argon escapes from molten rock. Any argon found in an igneous rock must have been produced since the rock solidified.
>
> A sample of an igneous rock has one atom of potassium-40 for every three atoms of argon-40.

(i) What fraction of the potassium-40 has not yet decayed?

.....

(1 mark)

(ii) Calculate the age of the rock.

.....

Age of rock = ... million years
(1 mark)

12

4.4.1.1 The structure of an atom

Question 17

June 2005 | 3462 | Original Q6 | Legacy

6 Stars do not stay the same forever.

(a) Over billions of years the amount of hydrogen in a star decreases. Why?

.....

.....

(1 mark)

(b) Describe how a massive star (at least five times bigger than the Sun) will change at the end of the main stable period.

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.

.....

.....

.....

.....

.....

.....

.....

.....

(4 marks)

(c) The inner planets of the solar system contain atoms of the heaviest elements.

(i) Where did these atoms come from?

.....

.....

(1 mark)

(ii) What does this tell us about the age of the solar system compared with many of the stars in the Universe?

.....

(1 mark)

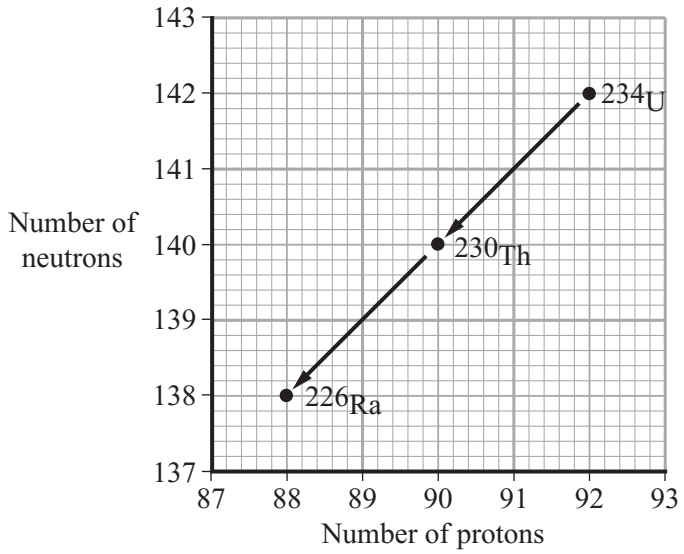
7

4.4.1.1 The structure of an atom

Question 18

June 2005 | 3462 | Original Q7 | Legacy

7 (a) Uranium-234 (^{234}U) is a radioactive element. The graph shows the number of protons and neutrons in the nuclei of the elements formed when uranium-234 decays.



(i) How does the graph show that uranium-234 (^{234}U) and thorium-230 (^{230}Th) emit alpha particles?

.....

(1 mark)

(ii) What makes uranium and thorium different elements?

.....

(1 mark)

(iii) Radioactive decay may also produce gamma radiation.

Why does the emission of gamma radiation **not** cause a new element to be formed?

.....

.....

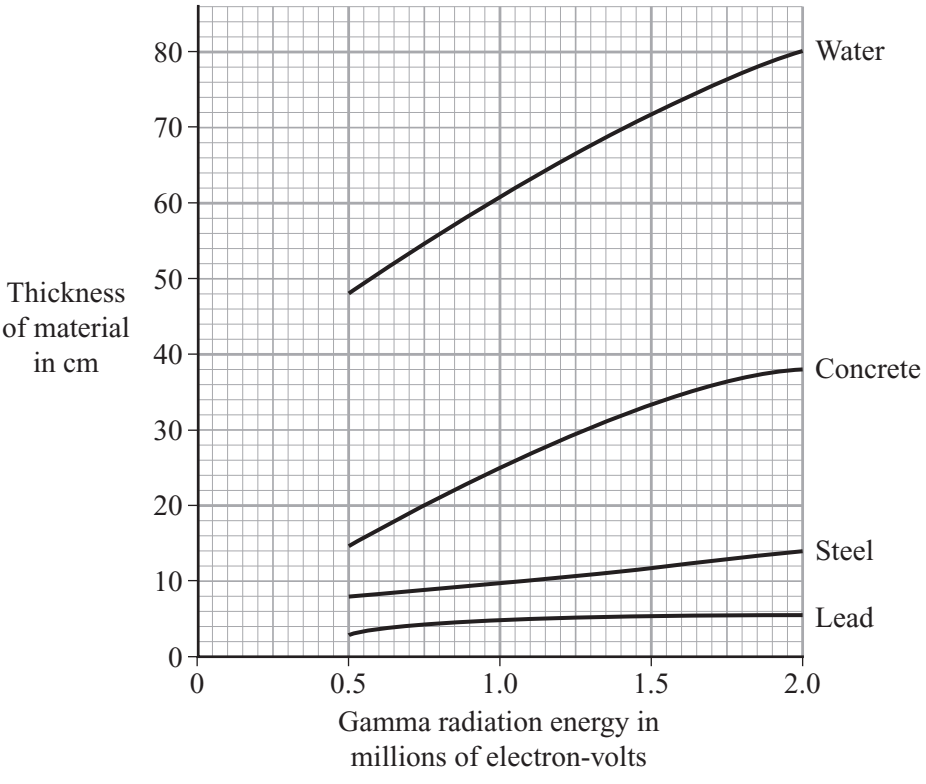
(1 mark)

4.4.1.1 The structure of an atom

Question 18 · continued

MARGIN
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(b) The graph shows how the thickness of different materials needed to absorb 90% of the gamma radiation emitted by a source depends on the energy of the radiation. The energy of the gamma radiation is given in units called electron-volts.



(i) Which of the materials shown is least effective at absorbing gamma radiation? Use the information in the graph to give a reason for your answer.

.....

.....

(1 mark)

(ii) For gamma radiation of energy 1.5 million electron-volts, how many times more effective is steel than water at absorbing the radiation? Show clearly how you obtain your answer.

.....

.....

.....

(2 marks)

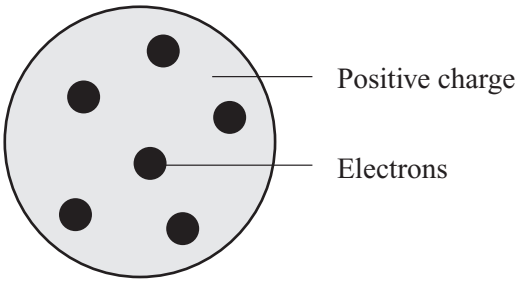
QUESTION 7 CONTINUES ON THE NEXT PAGE

4.4.1.1 The structure of an atom

Question 18 · continued

MARGIN BLANK

(c) Scientists in the early twentieth century thought that atoms were made up of electrons scattered inside a ball of positive charge. This was called the 'plum-pudding' model of the atom.



Plum pudding model

Rutherford and Marsden did an experiment, in which a beam of alpha particles was aimed at a thin sheet of gold.
Explain how the results of this experiment led to a new model of the atom. You may include one or more diagrams in your answer.

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(3 marks)

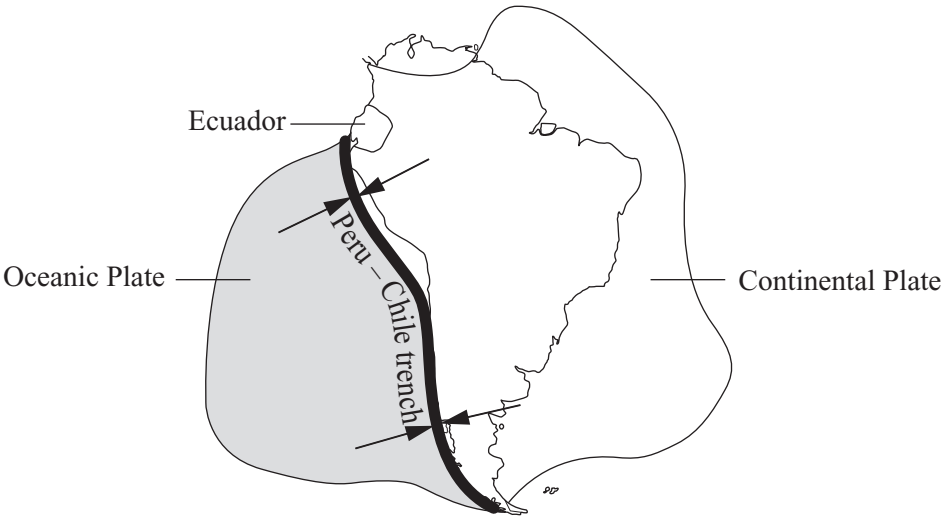
9

4.4.1.1 The structure of an atom

Question 19

June 2005 | 3462 | Original Q11 | Legacy

11 The Peru–Chile trench runs down the west coast of South America. It is the boundary between two tectonic plates that are slowly moving towards each other.



Source: WITNEY, DROZDOWSKA AND MAILE, *AQA GCSE Physics* (Hodder & Stoughton) 2002. Adapted and reproduced by permission of Hodder & Stoughton.

(a) Explain what causes the tectonic plates to move.

.....

.....

.....

.....

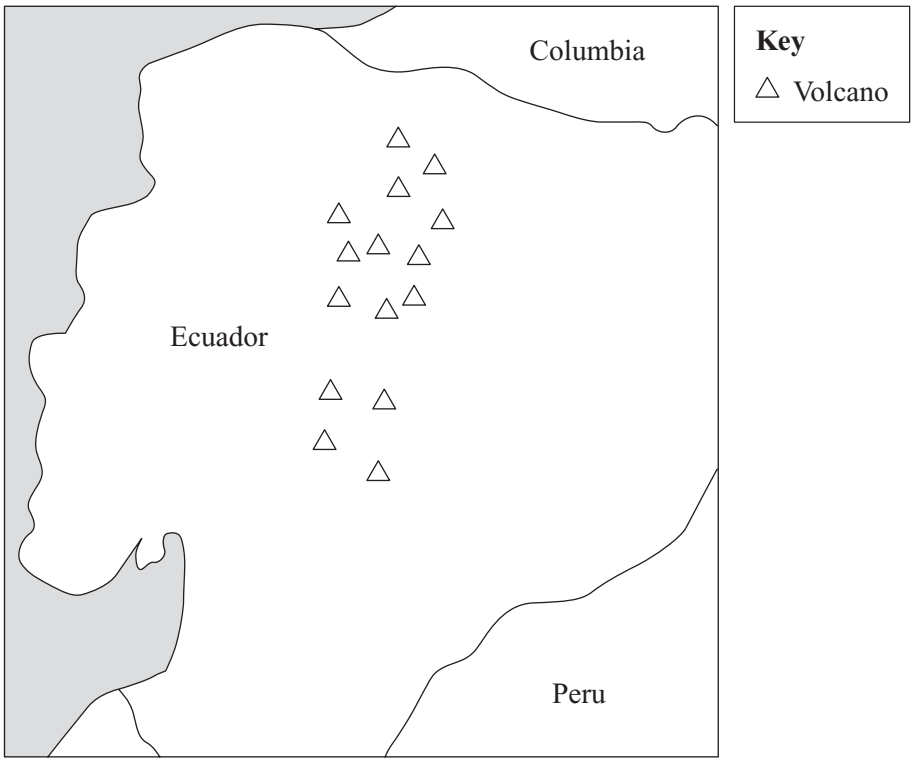
(2 marks)

4.4.1.1 The structure of an atom

Question 19 · continued

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(b) The map shows the location of some of the volcanoes in Ecuador. The volcanoes are all close to the Peru–Chile trench.



Explain how the volcanoes were formed.

.....

.....

.....

.....

.....

.....

(3 marks)

(c) The eruption of Mount St Helens in the USA is one of the few volcanic eruptions to have been accurately predicted by scientists. The scientists had been monitoring *seismic activity*, levels of sulphur dioxide and changes to the ground level.

(i) What is meant by *seismic activity*?

.....

(1 mark)

QUESTION 11 CONTINUES ON THE NEXT PAGE

4.4.1.1 The structure of an atom

Question 19 · continued

MARGIN BLANK

(ii) Suggest why scientists find it difficult to predict accurately when a volcano is going to erupt.

.....

.....

.....

.....

(2 marks)

(d) The molten rock flowing from an erupting volcano can reach a speed of 8 m/s.

(i) Write down the equation that links kinetic energy, mass and speed.

.....

(1 mark)

(ii) Calculate the kinetic energy of 1 tonne of molten rock flowing at 8 m/s.
(1 tonne = 1000 kg)

.....

.....

Kinetic energy = ... joules
(1 mark)

(e) Read the information in the box and then answer the questions.

> Igneous rocks contain potassium-40. This is a radioactive isotope. It has a half-life of 1300 million years.
>
> Potassium-40 decays into argon-40 which is stable.
>
> Argon escapes from molten rock. Any argon found in an igneous rock must have been produced since the rock solidified.
>
> A sample of an igneous rock has one atom of potassium-40 for every three atoms of argon-40.

(i) What fraction of the potassium-40 has not yet decayed?

.....

(1 mark)

(ii) Calculate the age of the rock.

.....

Age of rock = ... million years
(1 mark)

12

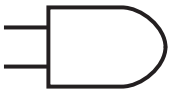
4.4.1.1 The structure of an atom

Question 20

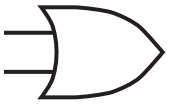
June 2006 | 3451 | Original Q7 | Legacy

7 (a) Electronic circuits have symbols for the components.

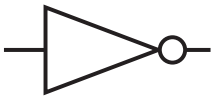
Name the components with these symbols.



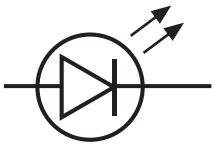
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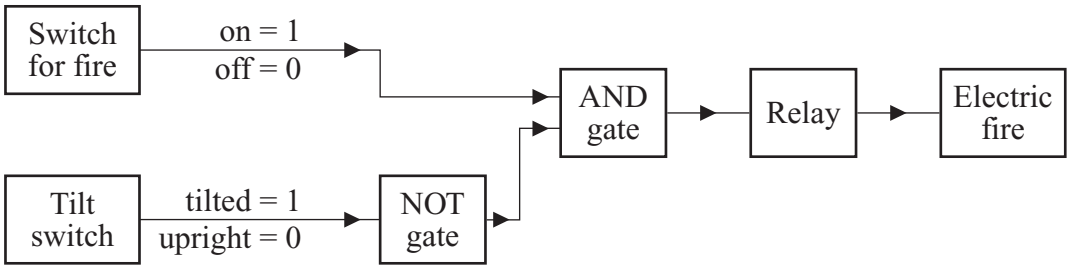


.....

(4 marks)

(b) A 2 kW electric fire has an electronic control system. The system will switch off the fire if it falls over.

The diagram shows the system.



(i) Which parts are the processors in this system?

.....

(1 mark)

4.4.1.1 The structure of an atom

Question 20 · continued

BLANK

(ii) Complete the end column of the truth table by writing **1** or **0** in each of the four spaces.

Switch for fire	Tilt switch	Signal to relay
0	0	.....
0	1	.....
1	0	.....
1	1	.....

(1 mark)

(iii) Explain why the relay is needed.

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.

.....

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(4 marks)

10

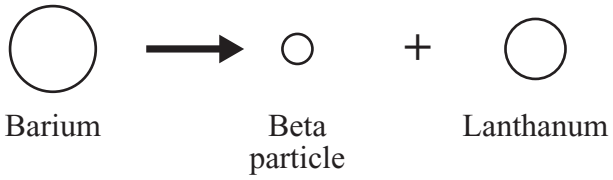
4.4.1.1 The structure of an atom

Question 21

June 2006 | 3451 | Original Q10 | Legacy

10 (a) When an unstable barium nucleus changes into a lanthanum nucleus, a beta particle is emitted.

Not to scale



(i) What is a beta particle?

.....

(1 mark)

(ii) How is the nucleus of a lanthanum atom different from the nucleus of a barium atom?

.....

.....

(1 mark)

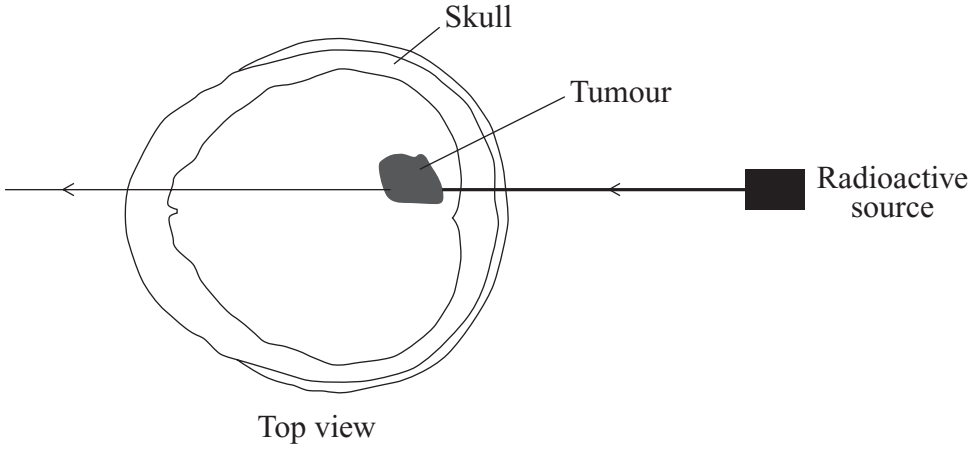
(iii) Describe how a neutral atom may be changed by a collision with a beta particle.

.....

.....

(1 mark)

(b) The diagram shows how radiation can be used to kill the cells of a brain tumour.



Top view

Why is a beta emitting radioactive source unsuitable for this purpose?

.....

.....

(1 mark)

4.4.1.1 The structure of an atom

Question 21 · continued

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(c) The table gives the average radiation dose which someone in the UK receives in one year from background radiation.

Source of radiation	Dose in millisieverts
the ground	0.30
radon gas	0.80
food	0.40
space	0.25
man-made sources	0.25

(i) What percentage of the background radiation comes from space?

.....

.....

(1 mark)

(ii) It is estimated that flying across the Atlantic exposes passengers to an additional radiation dose equivalent to one chest X-ray.

Suggest why flying increases radiation dose and give a possible effect this may have on the health of someone who flies a lot.

.....

.....

.....

.....

(2 marks)

7

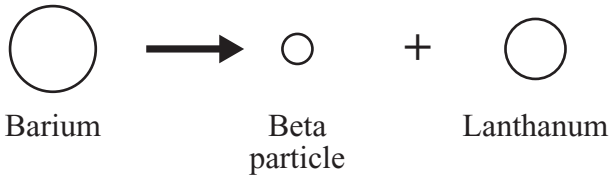
4.4.1.1 The structure of an atom

Question 22

June 2006 | 3462 | Original Q8 | Legacy

8 (a) When an unstable barium nucleus changes into a lanthanum nucleus, a beta particle is emitted.

Not to scale



(i) What is a beta particle?

.....

(1 mark)

(ii) How is the nucleus of a lanthanum atom different from the nucleus of a barium atom?

.....

.....

(1 mark)

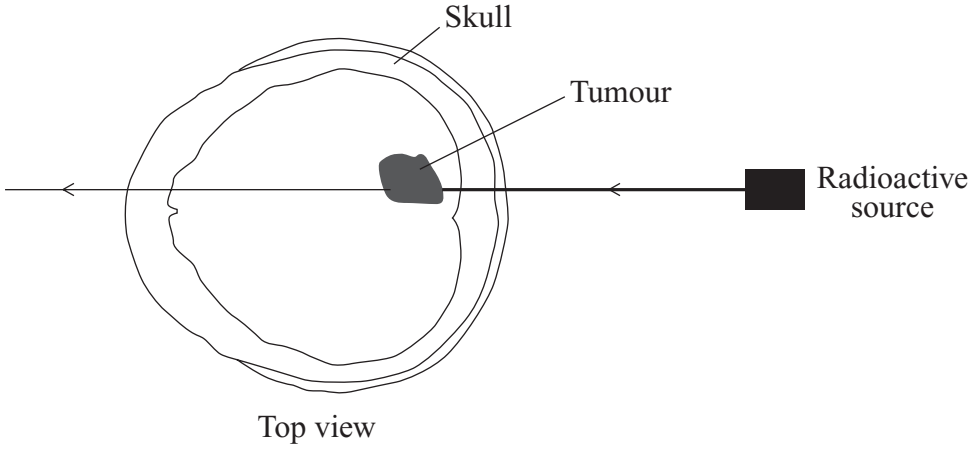
(iii) Describe how a neutral atom may be changed by a collision with a beta particle.

.....

.....

(1 mark)

(b) The diagram shows how radiation can be used to kill the cells of a brain tumour.



Why is a beta emitting radioactive source unsuitable for this purpose?

.....

.....

(1 mark)

4.4.1.1 The structure of an atom

Question 22 · continued

BLANK

(c) The table gives the average radiation dose which someone in the UK receives in one year from background radiation.

Source of radiation	Dose in millisieverts
the ground	0.30
radon gas	0.80
food	0.40
space	0.25
man-made sources	0.25

(i) What percentage of the background radiation comes from space?

.....

.....

(1 mark)

(ii) It is estimated that flying across the Atlantic exposes passengers to an additional radiation dose equivalent to one chest X-ray.

Suggest why flying increases radiation dose and give a possible effect this may have on the health of someone who flies a lot.

.....

.....

.....

.....

(2 marks)

7

4.4.1.1 The structure of an atom

Question 23

November 2006 | PHY1B | Original Q4 | Legacy

QUESTION FOUR

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.

4A 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.

4B 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

4.4.1.1 The structure of an atom

Question 23 · continued

4C 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.'

4D 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.

4.4.1.1 The structure of an atom

Question 24

November 2006 | PHY1B | Original Q5 | Legacy

QUESTION FIVE

Some substances give out radiation from the nuclei of their atoms.

5A A radioactive source emits alpha, beta and gamma radiation.

Which row in the table is correct?

	Deflected by a magnetic field?		
	Alpha	**Beta**	**Gamma**
1	no	no	yes
2	no	yes	no
3	yes	yes	no
4	yes	yes	yes

5B Americium oxide is used in smoke alarms. Atoms of americium can exist as different isotopes.

Which row in the table correctly describes the number of particles in the nucleus of an atom of each of two different isotopes of americium?

	Particles in each isotope	
1	different number of neutrons	different number of protons
2	different number of neutrons	same number of protons
3	same number of neutrons	different number of protons
4	same number of neutrons	same number of protons

4.4.1.1 The structure of an atom

Question 24 · continued

5C The radioactive americium oxide used in a smoke alarm emits alpha particles.

These particles . . .

1 add electrons to the air.

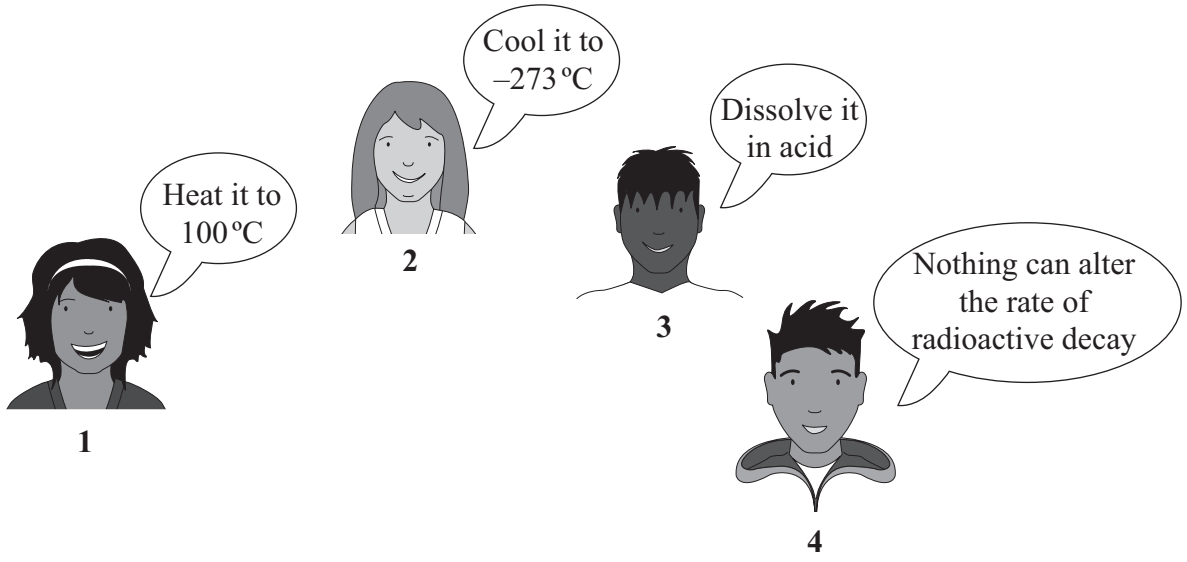
2 add neutrons to the air.

3 add protons to the air.

4 ionise particles in the air.

5D Four students discuss how to alter the rate of decay of a radioactive source.

Which student, **1**, **2**, **3** or **4**, is correct?



4.4.1.1 The structure of an atom

Question 25

March 2007 | PHY1A | Original Q2 | Legacy

QUESTION TWO

Thermal energy can be transferred in several ways.

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

A free electrons

B ions

C particles

D waves

Convection currents in liquids and gases are the result of expansion caused by . . . **1** . . . moving faster in hotter regions.

Thermal radiation is energy transfer by . . . **2** . . . .

The hotter a metal is, the greater the kinetic energy of the vibrating . . . **3** . . . in the metal structure.

Kinetic energy is transferred to cooler parts of the metal by . . . **4** . . . diffusing through it.

4.4.1.1 The structure of an atom

Question 26

June 2007 | PHY1B | Original Q4 | Legacy

QUESTION FOUR

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

4A 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

4B 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

4.4.1.1 The structure of an atom

Question 26 · 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.

4C 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

4D 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

4.4.1.1 The structure of an atom

Question 27

June 2007 | PHY1B | Original Q8 | Legacy

QUESTION EIGHT

Americium-241 has a half-life of 432 years. A smoke detector uses the radiation from about 0.0002 g of americium-241 oxide. This substance emits alpha radiation. The alpha radiation ionises molecules in the air inside the smoke detector and this allows an electric current to flow. However, particles of smoke will absorb the radiation. This stops the electric current and causes the alarm to switch on.

8A When used as intended, a smoke detector is **not** a health hazard to humans.

This is because . . .

1 alpha particles are harmless.

2 alpha particles are the least harmful type of radiation.

3 alpha particles do **not** travel beyond the smoke alarm.

4 americium-241 has a long half-life.

8B Alpha particle emission is the most effective type of radiation for use in smoke detectors because . . .

1 alpha particles are heavier than beta particles.

2 alpha particles travel only short distances.

3 it is cheap to produce.

4 it is the most ionising type of radiation.

8C When an americium-241 atom emits an alpha particle, the new atom which is formed will have . . .

1 fewer protons only.

2 fewer neutrons only.

3 fewer electrons only.

4 fewer protons and fewer neutrons.

4.4.1.1 The structure of an atom

Question 27 · continued

8D The table shows the properties of four radioactive isotopes.

Isotope	Type of radiation emitted	Half-life
Californium-241	alpha	4 minutes
Cobalt-60	gamma	5 years
Strontium-90	beta	28 years
Technetium-99	gamma	6 hours

Which isotope would be the best to use as a tracer in the human body?

1 californium-241

2 cobalt-60

3 strontium-90

4 technetium-99

4.4.1.1 The structure of an atom

Question 28

June 2007 | PHY1H | Original Q1 | Legacy

1 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)

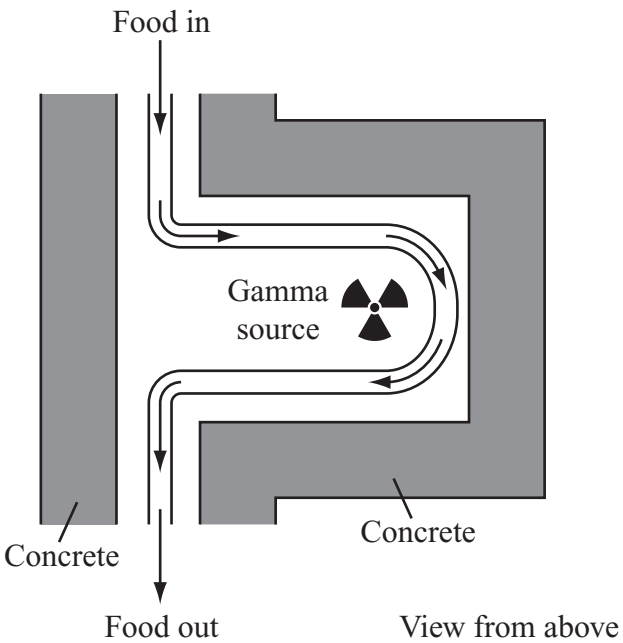
Question 1 continues on the next page

4.4.1.1 The structure of an atom

Question 28 · continued

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(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)

4.4.1.1 The structure of an atom

Question 28 · continued

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(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

4.4.1.1 The structure of an atom

Question 29

November 2007 | PHY1B | Original Q5 | Legacy

QUESTION FIVE

There are different types of electromagnetic radiation and nuclear radiation.

5A Which one of the following types of radiation is **not** used for communication?

1 infra red radiation

2 microwaves

3 visible light

4 X-rays

5B Which one of the following types of radiation has the longest wavelength?

1 infra red radiation

2 microwaves

3 visible light

4 X-rays

5C Which one of the following statements is **not** true of **both** ultraviolet radiation and infra red radiation?

1 They can be seen by the human eye.

2 They are members of the electromagnetic spectrum.

3 Each can have a range of different wavelengths and frequencies.

4 They travel at the same speed in a vacuum.

5D Which type of radiation is emitted by the nucleus of an atom of a radioactive isotope?

1 gamma radiation

2 X-rays

3 microwave radiation

4 ultraviolet radiation

4.4.1.1 The structure of an atom

Question 30

January 2008 | PHY1H | Original Q4 | Legacy

4 (a) A radioactive source emits alpha (α), beta (β) and gamma (γ) radiation.

(i) Which **two** types of radiation will pass through a sheet of card?

.....

(1 mark)

(ii) Which **two** types of radiation would be deflected by an electric field?

.....

(1 mark)

(iii) Which type of radiation has the greatest range in air?

.....

(1 mark)

(b) A student suggests that the radioactive source should be stored in a freezer at –20 °C. The student thinks that this would reduce the radiation emitted from the source.

Suggest why the student is wrong.

.....

.....

(1 mark)

Question 4 continues on the next page

Question 30 · continued

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(c) Phosphorus-32 is a radioactive isotope that emits beta radiation.

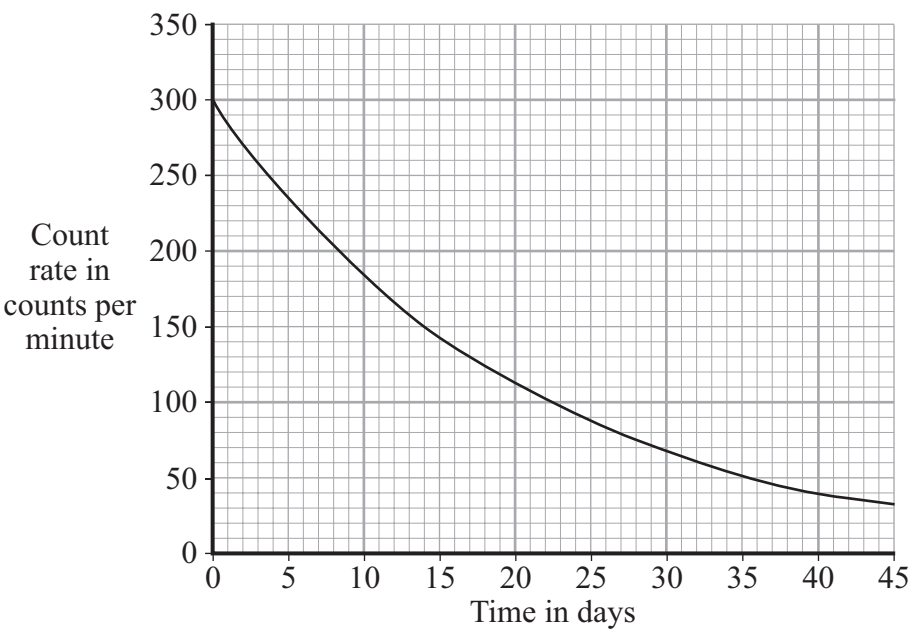
(i) How is an atom of phosphorus-32 different from an atom of the stable isotope phosphorus-31?

.....

.....

(1 mark)

(ii) The graph shows how the count rate of a sample of phosphorus-32 changes with time.



Use the graph to calculate the half-life of phosphorus-32.

Show clearly how you used the graph to obtain your answer.

.....

.....

Half-life = ... days

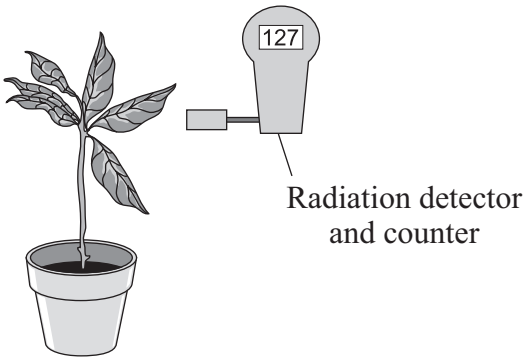
(2 marks)

4.4.1.1 The structure of an atom

Question 30 · continued

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(iii) Plants use phosphorus compounds to grow. Watering the root system of a plant with a solution containing a phosphorus-32 compound can help scientists to understand the growth process.



Explain why phosphorus-32 is suitable for use as a tracer in this situation.

.....

.....

.....

.....

(2 marks)

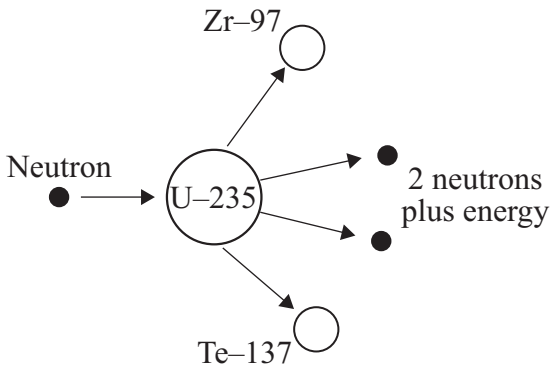
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4.4.1.1 The structure of an atom

Question 31

January 2008 | PHY2H | Original Q4 | Legacy

4 (a) The diagram shows what can happen when the nucleus of a uranium atom absorbs a neutron.



(i) What name is given to the process shown in the diagram?

.....

(1 mark)

(ii) Explain how this process could lead to a chain reaction.

You may wish to add further detail to the diagram to help your answer.

.....

.....

.....

.....

(2 marks)

(iii) How does the mass number of an atom change when its nucleus absorbs a neutron?

.....

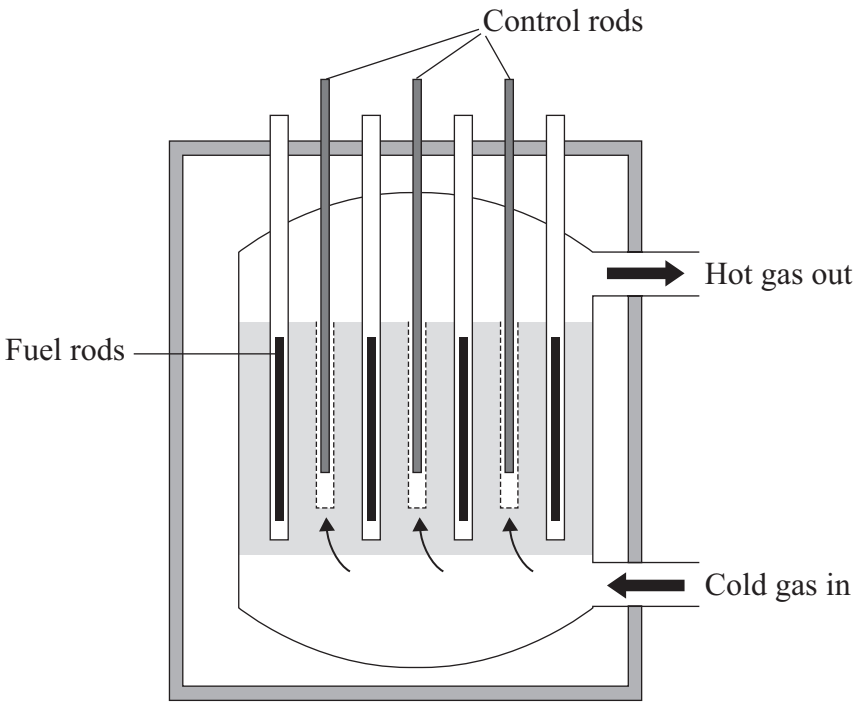
(1 mark)

4.4.1.1 The structure of an atom

Question 31 · continued

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(b) Uranium-235 is used as a fuel in some nuclear reactors.



The reactor contains control rods used to absorb neutrons.

Suggest what happens when the control rods are lowered into the reactor.

.....

.....

.....

.....

(2 marks)

6

4.4.1.1 The structure of an atom

Question 32

March 2008 | PHY1BP | Original Q5 | Legacy

QUESTION FIVE

This question is about the structure of atoms and radioactive decay.

5A Where is an electron found in the basic structure of an atom?

1 in orbit around the nucleus

2 on its own in the nucleus

3 with neutrons in the nucleus

4 with protons in the nucleus

5B Which type of radiation consists of helium nuclei?

1 alpha radiation

2 beta radiation

3 delta radiation

4 gamma radiation

5C Which one of the following statements is true for alpha radiation?

1 It is emitted by all radioactive substances.

2 It is identical to an electron.

3 It is **not** deflected by an electric field.

4 It is deflected by a magnetic field.

5D The table shows the half-lives of four radioactive sources which all emit the same type of radiation.

Which source is the most suitable for use as a medical tracer?

Source	Half-life
1	6 hours
2	6 weeks
3	6 months
4	6 years

4.4.1.1 The structure of an atom

Question 33

March 2008 | PHY1BP | Original Q8 | Legacy

QUESTION EIGHT

Carbon-14 is a radioactive isotope of carbon. It is a beta (β) particle emitter with a half-life of approximately 5750 years. Carbon-14 makes up a tiny proportion of all naturally occurring carbon on our planet.

When living things die the carbon-14 they contain continues to decay and is not replaced. So the approximate age of the object which was once part of a living plant or animal, can be calculated by measuring the proportion of carbon-14 which it now contains.

8A An organism has been dead for 17 000 years.

Approximately how many half-lives of carbon-14 have passed during this time?

1 2

2 3

3 4

4 5

8B A small sample of material taken from a plant contains 32 billion atoms of carbon-14.

Approximately how many of these atoms will it contain in 13 000 years time?

1 4 billion

2 7 billion

3 15 billion

4 30 billion

8C It is difficult to date samples more than 50 000 years old using carbon-14.

This is because . . .

1 all the carbon-14 will have decayed away.

2 carbon-14 did not exist more than 50 000 years ago.

3 so little carbon-14 remains that it is very difficult to detect and measure.

4 from the start there was no carbon-14 in samples of this age.

4.4.1.1 The structure of an atom

Question 33 · continued March 2008 | PHY1BP | Original Q8 | Legacy

8D Carbon-14 dating **cannot** be used for . . .

1 a cotton cloak.

2 a gold plate.

3 a paper scroll.

4 a wooden mast.

Turn over for the next question

4.4.1.1 The structure of an atom

Question 34

June 2008 | PHY1BP | Original Q4 | Legacy

QUESTION FOUR

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

4A Which isotope emits an electron from the nucleus?

1 **P**

2 **Q**

3 **R**

4 **S**

4B Which isotope emits radiation with the longest range in air?

1 **P**

2 **Q**

3 **R**

4 **S**

4C 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**

4.4.1.1 The structure of an atom

Question 34 · continued

4D Which isotope would be most suitable for monitoring the flow of blood through the heart?

1 **P**

2 **Q**

3 **R**

4 **S**

Turn over for the next question

4.4.1.1 The structure of an atom

Question 35

June 2008 | PHY1H | Original Q6 | Legacy

6 In 1986, a nuclear reactor exploded in a power station at Chernobyl in the Ukraine.

6 (a) The table gives information about some of the radioactive substances released into the air by the explosion.

Radioactive substance	Half-life	Type of radiation emitted
Iodine-131	8 days	beta and gamma
Caesium-134	2 years	beta
Caesium-137	30 years	beta

6 (a) (i) How is the structure of a caesium-134 atom different from the structure of a caesium-137 atom?

.....

(1 mark)

6 (a) (ii) What is a beta particle and from which part of an atom is a beta particle emitted?

.....

.....

(1 mark)

6 (a) (iii) Once a radioactive substance is dissolved in rainwater, it can enter the food chain.

Following the Chernobyl explosion, some milk supplies were found to be radioactive.

If one litre of milk contaminated with iodine-131 gives a count rate of 400 counts/second, how long will it take for the count rate to fall to 25 counts/second?

Show clearly how you work out your answer.

.....

.....

.....

Time taken = ... days

(2 marks)

4.4.1.1 The structure of an atom

Question 35 · continued

for mark

6 (a) (iv) After 20 years, the caesium-137 emitted into the atmosphere is a more serious problem than the iodine-131.

Explain why.

.....

.....

.....

.....

.....

(2 marks)

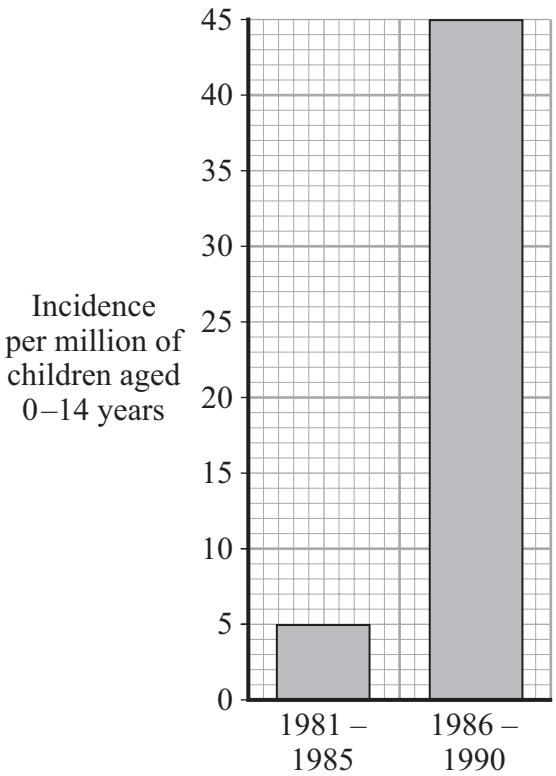
Question 6 continues on the next page

4.4.1.1 The structure of an atom

Question 35 · continued

for mark

6 (b) The bar chart compares the incidence of thyroid cancer in Ukrainian children, aged 0–14 years, before and after the Chernobyl explosion.



Of the children that developed thyroid cancer, 64% lived in the areas most contaminated by the radiation.

Considering this data, can you be certain that a child who developed thyroid cancer between 1986 and 1990 did so because of the Chernobyl explosion?

Explain the reason for your answer.

.....

.....

.....

.....

(2 marks)

4.4.1.1 The structure of an atom

Question 35 · continued

for mark

6 (c) In 1991, some scientists compared the health of two groups of people: a *control* group and a group that had been exposed to the radiation from Chernobyl.

What people would have been in the *control* group?

.....

(1 mark)

6 (d) Although there are some risks associated with nuclear power stations, it is likely that new ones will be built.

Give **two** reasons to justify the use of nuclear power.

1 .....

.....

2 .....

.....

(2 marks)

11

4.4.1.1 The structure of an atom

Question 36

June 2008 | PHY2H | Original Q2 | Legacy

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

mass number	222
atomic number	86
radiation emitted	alpha particle

2 (a) (i) Complete the following sentence.

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

..... inside an atom.

(2 marks)

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

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

..... *(1 mark)*

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

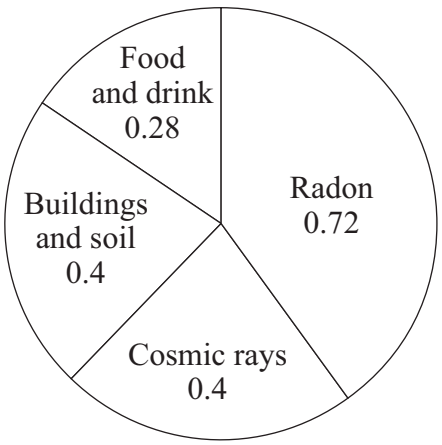
An alpha particle consists of 2 protons and 2 neutrons.

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)

2 (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).



4.4.1.1 The structure of an atom

Question 36 · continued

for mark

2 (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)

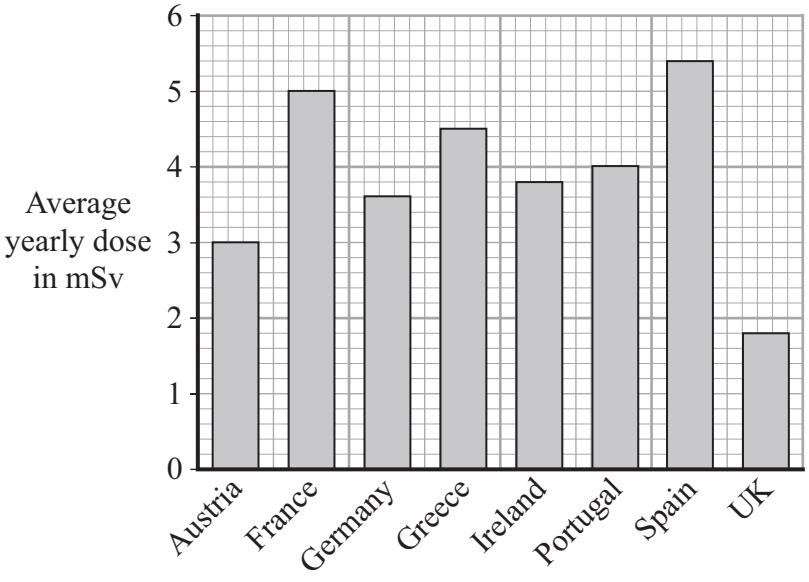
2 (b) (ii) Not all background radiation is from natural sources.

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

.....

(1 mark)

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



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

.....

(1 mark)

Question 2 continues on the next page

4.4.1.1 The structure of an atom

Question 36 · continued

for mark

2 (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

4.4.1.1 The structure of an atom

Question 37

November 2008 | PHY1BP | Original Q4 | Legacy

QUESTION FOUR

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

4A 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

4B How can the rate, at which a particular radioactive substance decays, be changed?

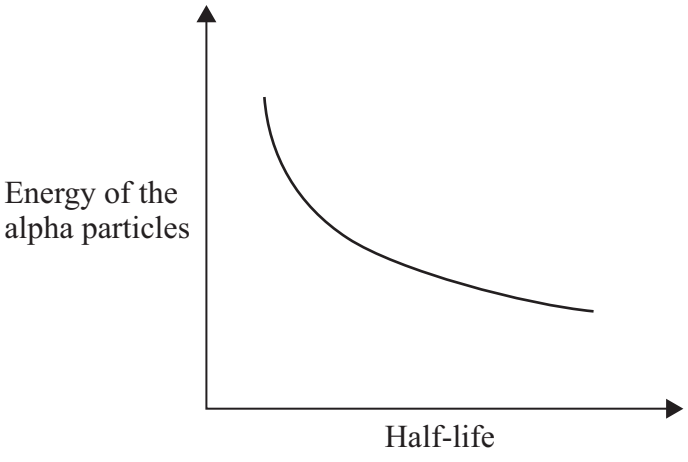
1 by changing the temperature of the nucleus

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.



4.4.1.1 The structure of an atom

4C 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.

4D 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

Turn over for the next question

4.4.1.1 The structure of an atom

Question 38

November 2008 | PHY1BP | Original Q6 | Legacy

QUESTION SIX

The tables show the types of radiation observed by different telescopes, and the types of radiation emitted by different parts of the universe.

Name of telescope	Type of radiation
Arecibo	Radio
COBE	Microwave
Hess	Gamma
Hopkins	Ultraviolet
Keck	Visible light
Spitzer	Infra red
XMM Newton	X-rays

Origin of radiation in universe	Main radiation emitted
Pulsars	Radio
Neutron stars	X-rays
Nebulae	Infra red
Stars	Visible light
Gamma ray bursts	Gamma
Big bang	Microwaves

6A Which telescope could be used to hunt for neutron stars in galaxies?

1 Arecibo

2 Spitzer

3 Hopkins

4 XMM Newton

6B Which telescope could be used to analyse the radiation of the universe left over from the 'big bang'?

1 COBE

2 Spitzer

3 Keck

4 Hopkins

4.4.1.1 The structure of an atom

Question 38 · continued

6C Which one of the following emits the longest wavelength radiation?

1 Gamma ray bursts

2 Neutron stars

3 Pulsars

4 Stars

6D Which one of the following emits radiation with the highest frequency?

1 Nebulae

2 Neutron stars

3 Pulsars

4 Stars

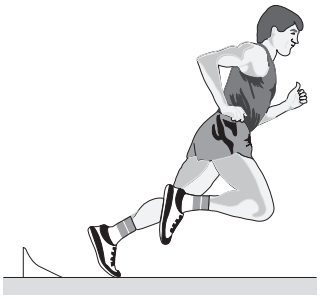
Turn over for the next question

4.4.1.1 The structure of an atom

Question 39

January 2009 | PHY2H | Original Q2 | Legacy

2 (a) The diagram shows an athlete at the start of a race. The race is along a straight track.



In the first 2 seconds, the athlete accelerates constantly and reaches a speed of 9 m/s.

2 (a) (i) Use the equation in the box to calculate the acceleration of the athlete.

$$\text{acceleration} = \frac{\text{change in velocity}}{\text{time taken for change}}$$

Show clearly how you work out your answer.

.....

.....

.....

Acceleration = ...

(2 marks)

2 (a) (ii) Which **one** of the following is the unit for acceleration?

Draw a ring around your answer.

J/s **m/s** **m/s^2** **Nm**

(1 mark)

4.4.1.1 The structure of an atom

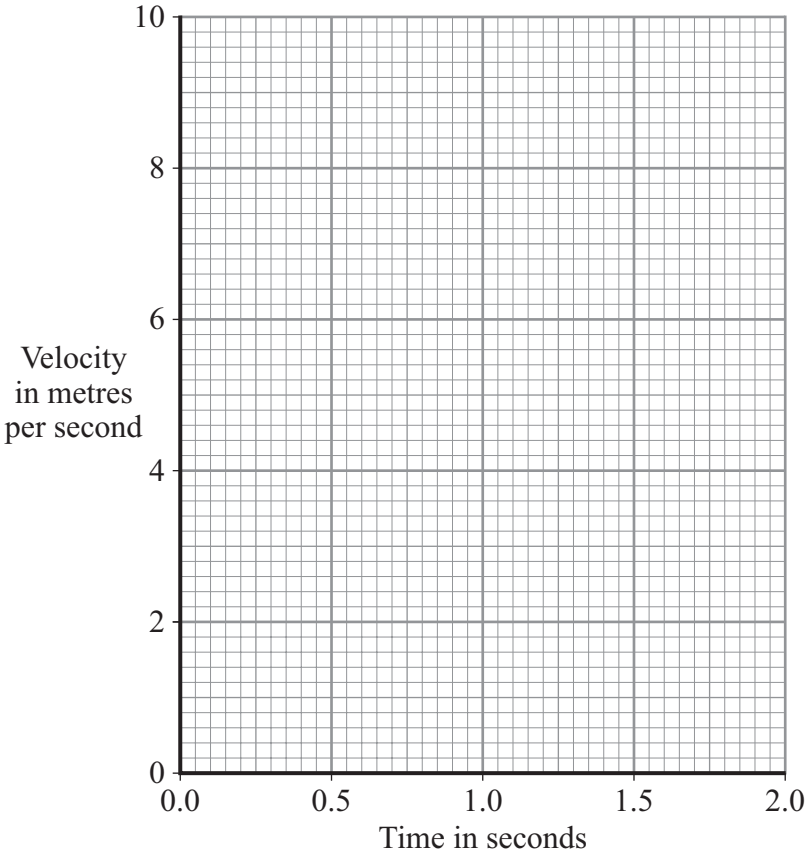
Question 39 · continued

for mark

2 (a) (iii) Complete the following sentence.

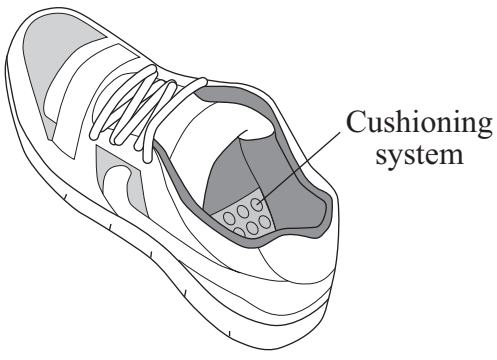
The velocity of the athlete is the ..... of the athlete in a given direction. *(1 mark)*

2 (a) (iv) Complete the graph to show how the velocity of the athlete changes during the first 2 seconds of the race.



(2 marks)

2 (b) Many running shoes have a cushioning system. This reduces the impact force on the athlete as the heel of the running shoe hits the ground.



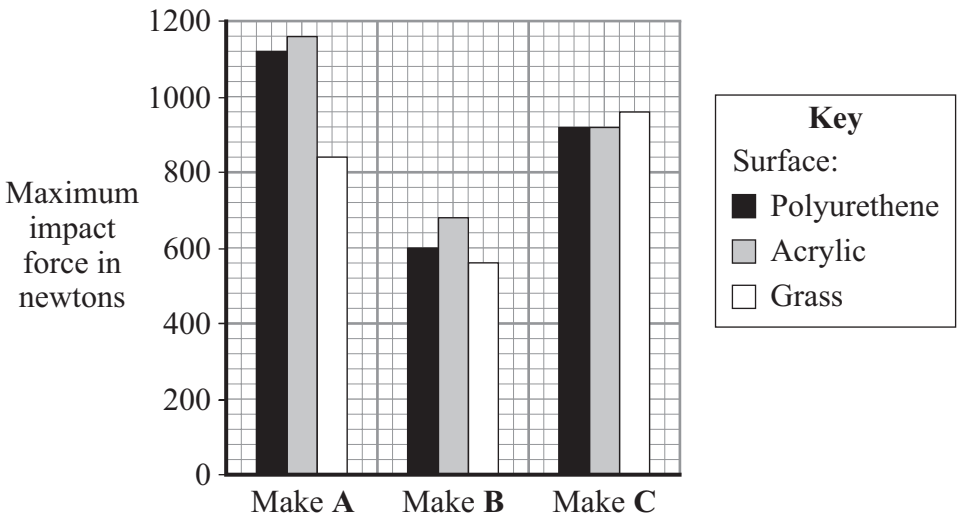
Question 2 continues on the next page

4.4.1.1 The structure of an atom

Question 39 · continued

for mark

The bar chart shows the maximum impact force for three different makes of running shoe used on three different types of surface.



2 (b) (i) Which **one** of the three makes of running shoe, **A**, **B** or **C**, has the best cushioning system?

.....

Explain the reason for your answer.

.....

.....

.....

.....

(3 marks)

2 (b) (ii) The data needed to draw the bar chart was obtained using a robotic athlete fitted with electronic sensors.

Why is this data likely to be more reliable than data obtained using human athletes?

.....

.....

(1 mark)

10

4.4.1.1 The structure of an atom

Question 40

January 2009 | PHY2H | Original Q6 | Legacy

6 (a) Complete the following table for an atom of uranium-238 ($^{238}_{92}U$).

mass number	238
number of protons	92
number of neutrons	

(1 mark)

6 (b) Complete the following sentence.

The name given to the number of protons in an atom is the proton number or the

..... .

(1 mark)

6 (c) An atom of uranium-238 ($^{238}_{92}U$) decays to form an atom of thorium-234 ($^{234}_{90}Th$).

6 (c) (i) What type of radiation, alpha, beta or gamma, is emitted by uranium-238?

.....

(1 mark)

6 (c) (ii) Why does an atom that decays by emitting alpha or beta radiation become an atom of a different element?

.....

.....

(1 mark)

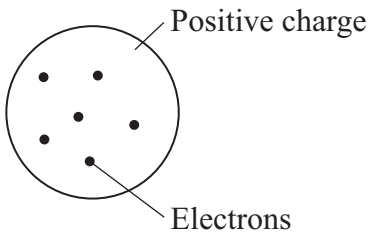
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4.4.1.1 The structure of an atom

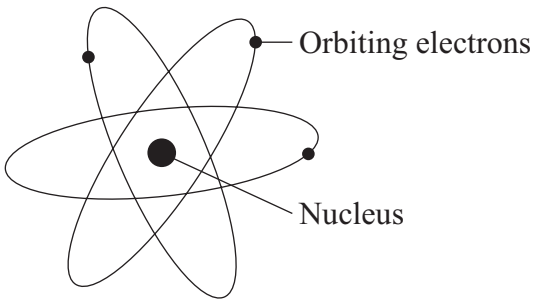
Question 41

January 2009 | PHY2H | Original Q7 | Legacy

7 In the early part of the 20th century, scientists used the 'plum pudding' model to explain the structure of the atom.



Following work by Rutherford and Marsden, a new model of the atom, called the 'nuclear' model, was suggested.



7 (a) Describe the differences between the two models of the atom.

.....

.....

.....

.....

.....

.....

.....

.....

(4 marks)

4.4.1.1 The structure of an atom

Question 41 · continued

for mark

7 (b) In their investigation, Rutherford and Marsden fired positively charged alpha particles at a very thin sheet of gold. Over a period of several months, the scientists made over 100 000 measurements. These measurements showed that:

- a very small number of alpha particles were deflected backwards from the gold foil.

Use the nuclear model to explain this experimental result.

.....

.....

.....

.....

(2 marks)

7 (c) Why did the work of Rutherford and Marsden convince many scientists that the 'plum pudding' model of the atom was incorrect?

.....

.....

.....

.....

(2 marks)

8

4.4.1.1 The structure of an atom

Question 42

January 2009 | PHY3H | Original Q1 | Legacy

1 (a) This information is from a science magazine.

> Electronic systems can be used to produce ultrasonic waves.
> These waves have a frequency higher than the upper limit for hearing in humans.

Complete the sentence by choosing the correct number from the box.

20	**2000**	**20 000**	**200 000**

The upper limit for hearing in humans is a frequency of ..... Hz.

(1 mark)

1 (b) An electronic system produces ultrasound with a frequency of 500 kHz.

What does the symbol kHz stand for?

.....

(1 mark)

1 (c) (i) State **one** industrial use for ultrasound.

.....

(1 mark)

1 (c) (ii) State **one** medical use for ultrasound.

.....

(1 mark)

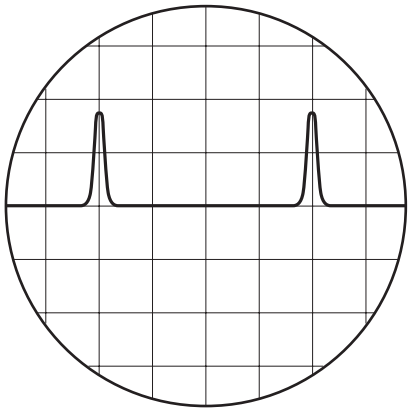
4.4.1.1 The structure of an atom

Question 42 · continued

for mark

1 (d) An ultrasound detector is connected to an oscilloscope.

The diagram shows centimetre squares on an oscilloscope screen.
Each horizontal division represents 2 microseconds.



Calculate the time, in microseconds, between one peak of one ultrasound pulse and the peak of the next.

.....

Time = ... microseconds
(1 mark)

1 (e) Ultrasounds are partially reflected when they reach a boundary between two different media.
The time taken for the reflection from the boundary to reach the detector can be seen from the screen.

What can be calculated from this time interval?

.....

.....
(2 marks)

1 (f) Explain what action scientists should take if they find evidence that ultrasonic waves may be harmful to human health.

.....

.....

.....
(2 marks)

9

4.4.1.1 The structure of an atom

Question 43

January 2009 | PHY3H | Original Q7 | Legacy

7 Read this statement from a website.

> Immediately after the 'big bang', at the start of the Universe, there were only atoms of the element hydrogen (H).
>
> Now the Universe contains atoms of over one hundred elements.

7 (a) Explain how atoms of the element helium (He) are formed in a star.

.....

.....

.....

.....

(2 marks)

7 (b) Explain how atoms of very heavy elements, such as gold (Au), were formed.

.....

.....

.....

.....

(2 marks)

7 (c) Explain how, and when, atoms of different elements may be distributed throughout the Universe.

.....

.....

.....

.....

(2 marks)

6

4.4.1.1 The structure of an atom

Question 44

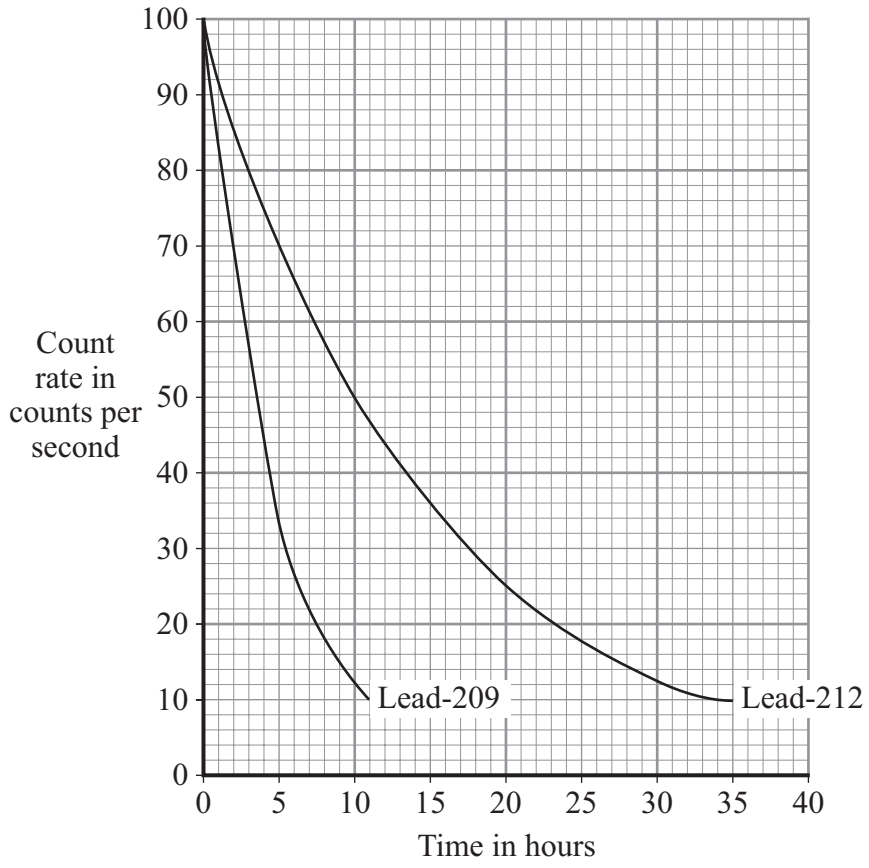
March 2009 | PHY1BP | Original Q1 | Legacy

QUESTION ONE

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.



4.4.1.1 The structure of an atom

Question 44 · continued

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.

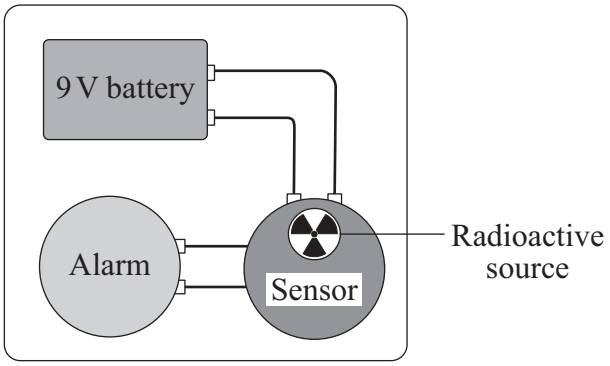
Lead-212 has . . . **4** . . . more neutrons than lead-209.

4.4.1.1 The structure of an atom

Question 45

June 2009 | PHY1H | Original Q6 | Legacy

6 (a) The diagram shows the parts of a smoke detector. The radioactive source emits alpha particles.



The alpha particles ionise the air inside the sensor which causes a small electric current. Any smoke getting into the sensor changes the current. The change in current sets the alarm off.

6 (a) (i) The smoke detector would **not** work if a radioactive source that emitted only gamma rays was used.

Why not?

.....

.....

(1 mark)

6 (a) (ii) Curium-242 is a radioactive isotope with a half-life of 160 days. It emits alpha particles.

Why is curium-242 **not** suitable for use inside smoke detectors?

.....

.....

(1 mark)

6 (a) (iii) Curium-242 and curium-244 are two of the isotopes of the element curium.

How is an atom of curium-242 different from an atom of curium-244?

.....

.....

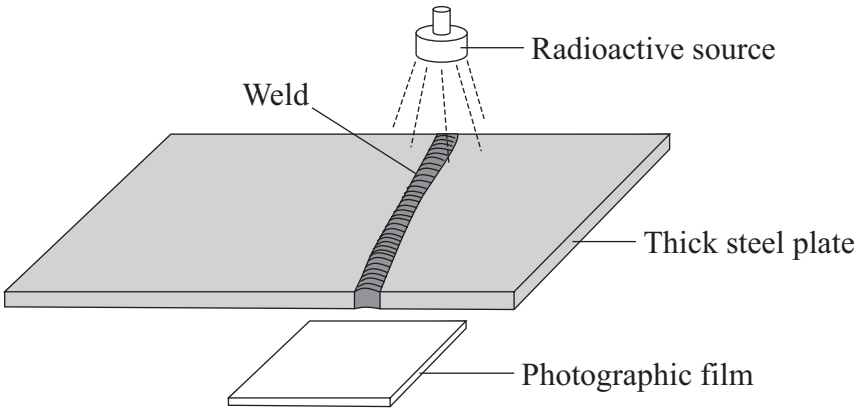
(1 mark)

4.4.1.1 The structure of an atom

Question 45 · continued

for mark

6 (b) Sections of steel are often joined by welding them together. The diagram shows how a radioactive source can be used to check for tiny cracks in the weld.



Cracks in the weld will be shown up on the photographic film below the thick steel plate.

6 (b) (i) Which type of source, alpha, beta or gamma, should be used to check the weld?

.....

(1 mark)

6 (b) (ii) Give a reason why the other two types of source **cannot** be used.

.....

.....

(1 mark)

Question 6 continues on the next page

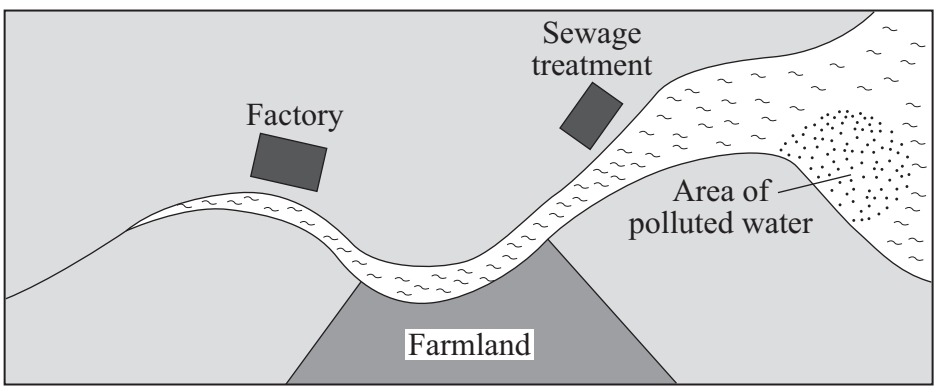
4.4.1.1 The structure of an atom

Question 45 · continued

for mark

6 (c) The diagram shows a map of a river and its estuary.

Environmental scientists have found that the water flowing into one part of the river estuary is polluted. To find where the pollution is coming from, the scientists use a radioactive isotope, gold-198.



6 (c) (i) Explain how the gold-198 is used to find where the pollution is coming from.

.....

.....

.....

.....

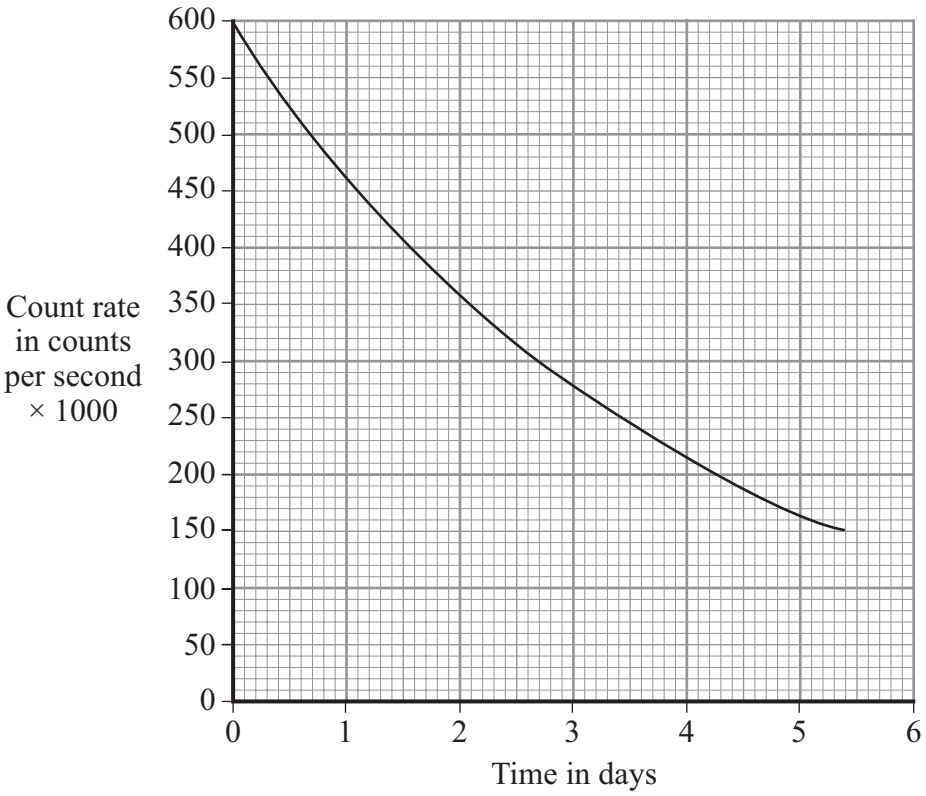
(2 marks)

4.4.1.1 The structure of an atom

Question 45 · continued

for mark

6 (c) (ii) The graph shows how the count rate from a sample of gold-198 changes with time.



Use the graph to calculate the half-life of gold-198.

Show clearly on the graph how you obtain your answer.

.....

.....

Half-life = ... days

(2 marks)

9

4.4.1.1 The structure of an atom

Question 46

June 2009 | PHY2H | Original Q1 | Legacy

1 The table gives information about the three types of particle that make up an atom.

Particle	Relative mass	Relative charge
Proton		+1
Neutron	1	
Electron	very small	–1

1 (a) Complete the table by adding the **two** missing values. *(2 marks)*

1 (b) Use the information in the table to explain why an atom has no overall electrical charge.

.....

.....

.....

.....

(2 marks)

1 (c) Uranium has two natural isotopes, uranium-235 and uranium-238.
Uranium-235 is used as a fuel inside a nuclear reactor.
Inside the reactor, atoms of uranium-235 are split and energy is released.

1 (c) (i) How is the structure of an atom of uranium-235 different from the structure of an atom of uranium-238?

.....

.....

(1 mark)

1 (c) (ii) The nucleus of a uranium-235 atom must absorb a particle before the atom is able to split.

What type of particle is absorbed?

.....

(1 mark)

4.4.1.1 The structure of an atom

Question 46 · continued

for mark

1 (c) (iii) The nucleus of an atom splits into smaller parts in a reactor.

What name is given to this process?

.....

(1 mark)

7

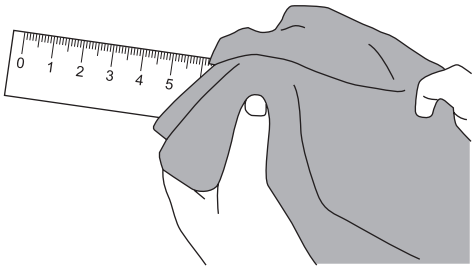
Turn over for the next question

4.4.1.1 The structure of an atom

Question 47

June 2009 | PHY2H | Original Q2 | Legacy

2 (a) A plastic ruler is rubbed with a cloth.



The ruler becomes negatively charged.

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

The ruler becomes negatively charged because it has

gained electrons
lost neutrons
lost protons

.

(1 mark)

2 (a) (ii) How could you show that the ruler is charged?

.....

.....

(1 mark)

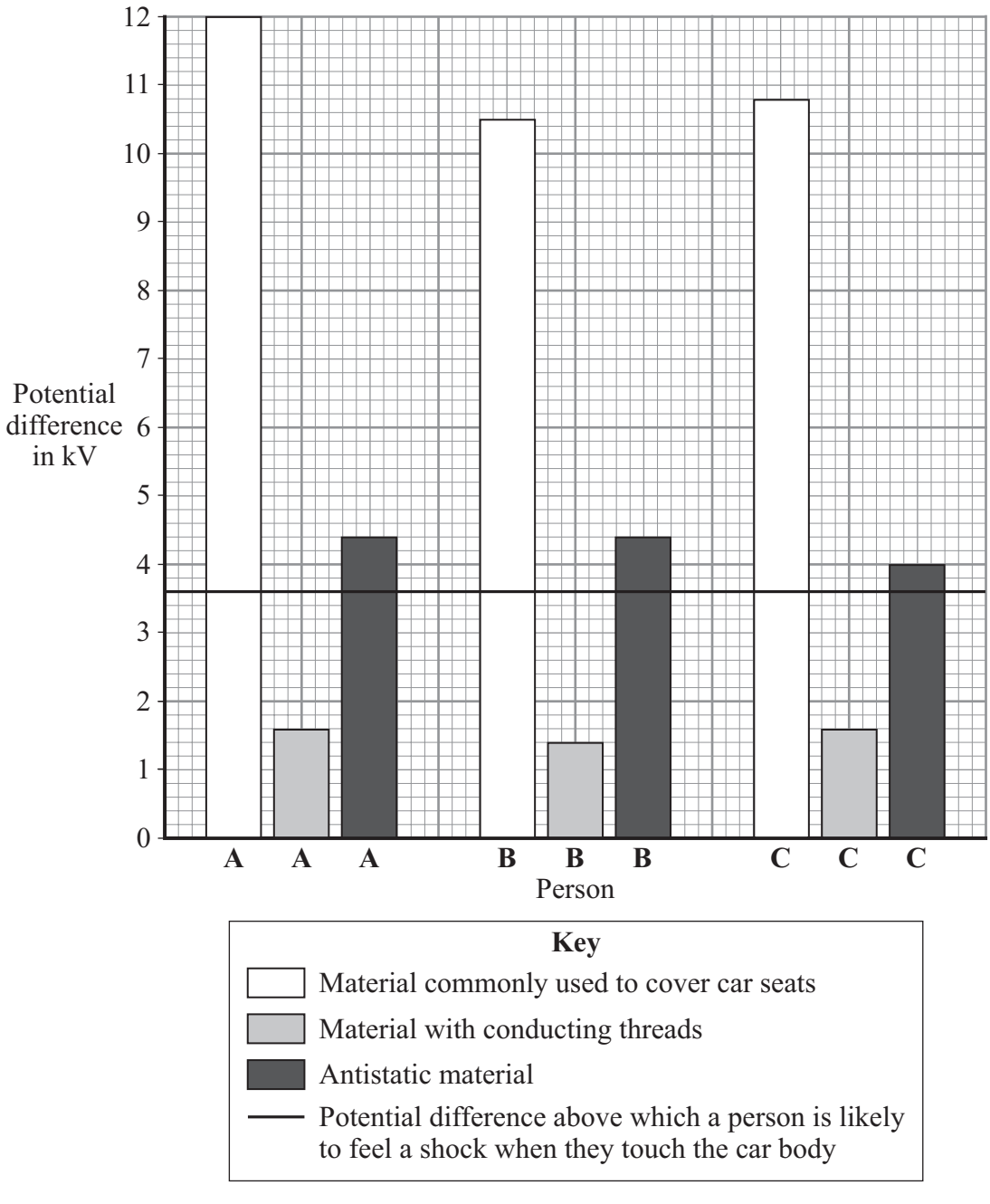
Question 47 · continued

for mark

2 (b) People often become electrostatically charged as they get out of a car.
This happens because their clothing rubs against the car seat.

A scientist was asked to find out whether the amount of charge on a person depended on the type of material which covered the car seat.
Three people, **A**, **B** and **C**, were used to test three different types of seat covering.

In each test, the person got out of the car and stood on a thick sheet of plastic.
The scientist then measured the potential difference between the person and the car body.
The results of the investigation are displayed in the bar chart.



Question 2 continues on the next page

4.4.1.1 The structure of an atom

Question 47 · continued

for mark

2 (b) (i) Explain why the measurement was made with the person standing on a thick sheet of plastic.

.....

.....

.....

.....

(2 marks)

2 (b) (ii) To make this a fair test, the three people, **A**, **B** and **C**, each wore the same type of clothing.

Suggest a reason why this was important.

.....

.....

(1 mark)

2 (b) (iii) The smallest scale division on the voltmeter was 0.1 kV.

Suggest why, from the data, it was **not** necessary to increase the precision of the potential difference measurements.

.....

.....

(1 mark)

2 (b) (iv) Explain why this investigation may cause a manufacturer to change the material used to cover car seats.

.....

.....

.....

.....

(2 marks)

8

4.4.1.1 The structure of an atom

Question 48

June 2009 | PHY3H | Original Q5 | Legacy

5 (a) The diagrams show oscilloscope traces for the same musical note played on two different instruments. The oscilloscope settings are not changed.

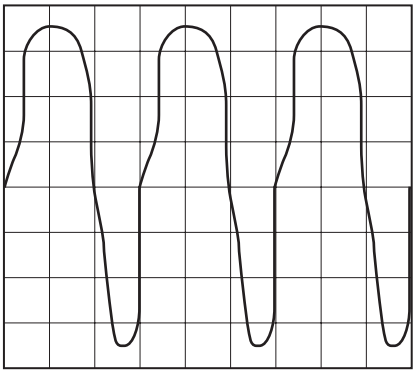


Diagram X

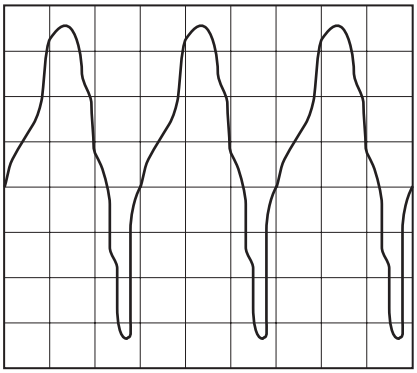


Diagram Y

5 (a) (i) How can you tell, from the diagrams, that it is the same musical note?

.....

.....

(1 mark)

5 (a) (ii) How can you tell, from the diagrams, that the musical note has been played on different instruments?

.....

.....

(1 mark)

4.4.1.1 The structure of an atom

Question 48 · continued

for mark

5 (b) This passage is from an electronics magazine.

> *Electronic systems can be used to produce ultrasound waves.*
> *These waves have a higher frequency than the upper limit for hearing in humans.*
> *Ultrasound waves are partially reflected when they meet a boundary between two different media.*

5 (b) (i) Approximately what is the highest frequency that humans can hear?
State the number and the unit.

.....

(1 mark)

5 (b) (ii) What does the word *media* mean when it is used in this passage?

.....

.....

(1 mark)

5 (b) (iii) What happens to the ultrasound which reaches the boundary between two different media and is **not** reflected?

.....

.....

.....

.....

(2 marks)

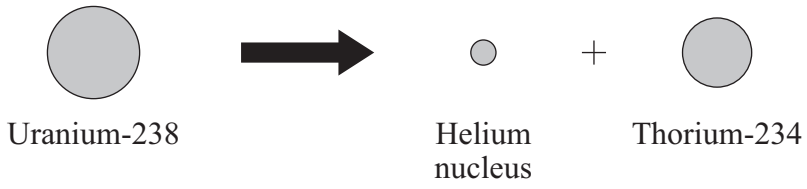
6

4.4.1.1 The structure of an atom

Question 49

January 2010 | PHY1H | Original Q4 | Legacy

4 (a) Some rocks inside the Earth contain uranium-238, a radioactive isotope of uranium. When an atom of uranium-238 decays, it gives out radiation and changes into a thorium-234 atom.



4 (a) (i) What type of radiation is emitted when a uranium-238 atom decays?

.....

(1 mark)

4 (a) (ii) From which part of a uranium-238 atom is the radiation emitted?

.....

(1 mark)

4 (a) (iii) Uranium-235 is another isotope of uranium.

How is an atom of uranium-235 similar to an atom of uranium-238?

.....

(1 mark)

4 (b) Uranium-238 has a half-life of 4500 million years.

4 (b) (i) When the Earth was formed, there was twice as much uranium-238 in the rocks as there is now.

What is the age of the Earth?

.....

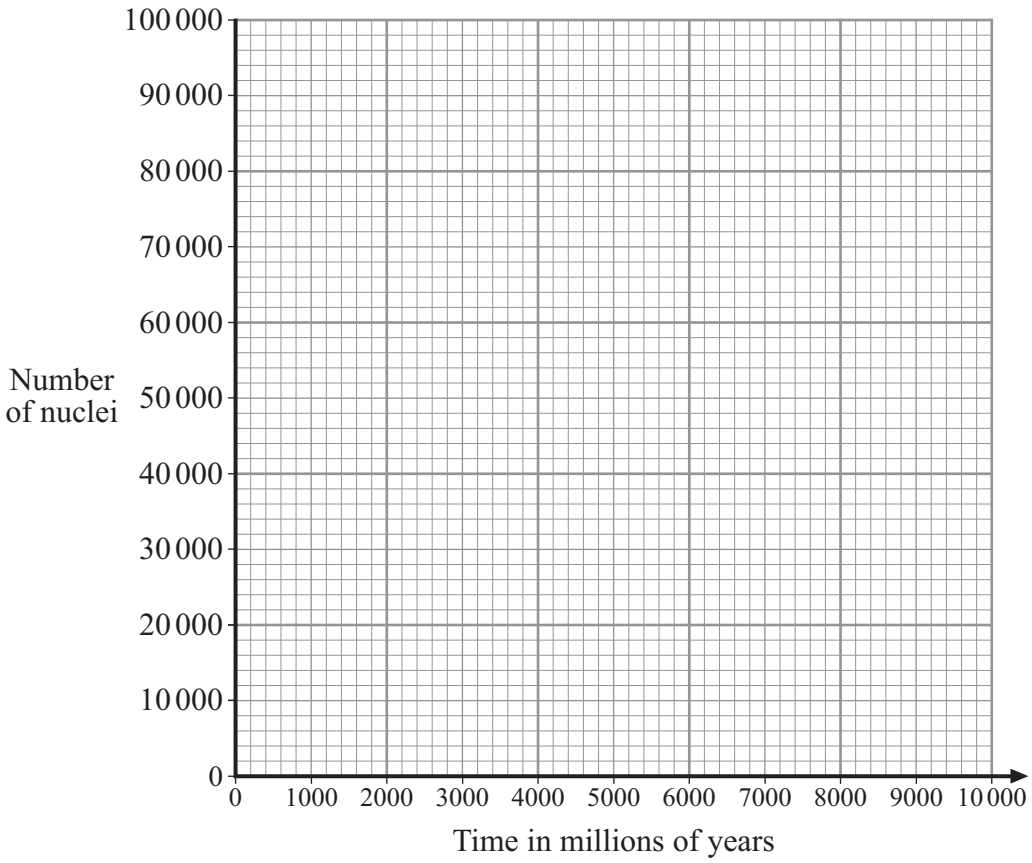
(1 mark)

4.4.1.1 The structure of an atom

Question 49 · continued

for mark

4 (b) (ii) Complete the graph to show how the number of nuclei in a sample of uranium-238 will change with time.
Initially, there were 100 000 nuclei in the sample.



(2 marks)

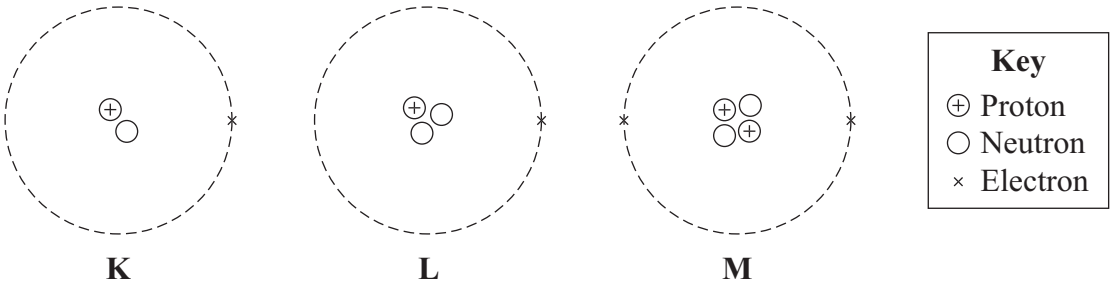
6

4.4.1.1 The structure of an atom

Question 50

January 2010 | PHY2H | Original Q3 | Legacy

3 (a) The diagram represents 3 atoms, **K**, **L** and **M**.



K **L** **M**

3 (a) (i) Which **two** of the atoms are isotopes of the same element?

..... and .....

(1 mark)

3 (a) (ii) Give a reason why the **two** atoms that you chose in part (a)(i) are:

(1) atoms of the same element .....

.....

(2) different isotopes of the same element. .....

.....

.....

(2 marks)

3 (b) The table gives some information about the radioactive isotope thorium-230.

mass number	230
atomic number	90

3 (b) (i) How many electrons are there in an atom of thorium-230?

.....

(1 mark)

3 (b) (ii) How many neutrons are there in an atom of thorium-230?

.....

(1 mark)

4.4.1.1 The structure of an atom

Question 50 · continued

for mark

3 (c) When a thorium-230 nucleus decays, it emits radiation and changes into radium-226.

$$^{230}_{90}\text{Th} \longrightarrow {}^{226}_{88}\text{Ra} + \boxed{\text{Radiation}}$$

What type of radiation, alpha, beta or gamma, is emitted by thorium-230?

.....

Explain the reason for your answer.

.....

.....

.....

.....

.....

(3 marks)

8

4.4.1.1 The structure of an atom

Question 51

January 2010 | PHY3H | Original Q3 | Legacy

3 (a) Explain what an ultrasound wave is.

.....

.....

.....

.....

(2 marks)

3 (b) Ultrasound waves can be used to clean jewellery.

One method is to put the jewellery in a bath of cleaning fluid which contains an electronic oscillator. The electronic oscillator generates ultrasound waves in the cleaning fluid.

Suggest how these waves clean the jewellery.

.....

.....

.....

.....

(2 marks)

3 (c) Ultrasound is used for pre-natal scanning. This is much safer than using X-rays. However, doctors were only sure it was safe after experiments on mice.

Explain whether or not you think that these experiments were justified.

.....

.....

.....

.....

(2 marks)

6

4.4.1.1 The structure of an atom

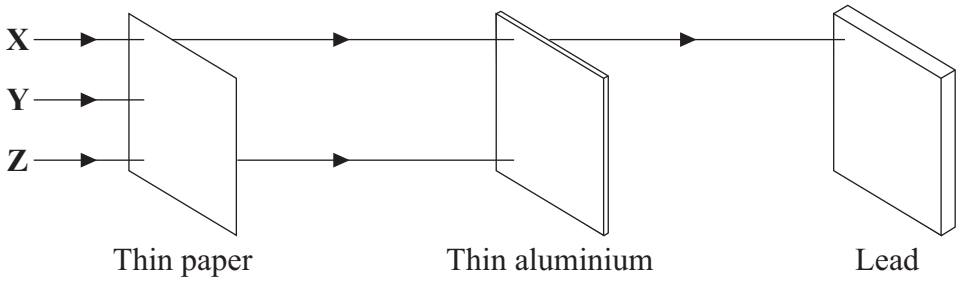
Question 52

March 2010 | PHY1BP | Original Q6 | Legacy

QUESTION SIX

This question is about radioactive substances and the radiation they emit.

The diagram shows how each type of radiation, **X**, **Y** and **Z**, is absorbed by different materials.



6A Which row in **Table 1** shows the correct radiation types?

Table 1

	X	Y	Z
1	beta	alpha	gamma
2	gamma	alpha	beta
3	beta	gamma	alpha
4	gamma	beta	alpha

6B When gamma radiation is absorbed, . . .

1 the absorber increases in mass.

2 the absorber shows a rise in temperature.

3 the radiation will become helium gas.

4 the radiation will transform into light.

4.4.1.1 The structure of an atom

Question 52 · continued

6C Which row in **Table 2** correctly describes the three types of radiation?

Table 2

	Alpha	Beta	Gamma
1	an electron from outside the nucleus	a helium nucleus	a short wavelength electromagnetic wave
2	a short wavelength electromagnetic wave	an electron from outside the nucleus	a helium nucleus
3	a helium nucleus	an electron from inside the nucleus	a high frequency electromagnetic wave
4	a helium nucleus	a short wavelength electromagnetic wave	an electron from inside the nucleus

6D The radioactive gas thoron, which has a half-life of 50 seconds, is used in an experiment. At the end of the experiment, the count rate had fallen to $\frac{1}{32}$ of the count rate at the beginning.

The time taken to carry out the experiment was . . .

1 200 seconds.

2 250 seconds.

3 300 seconds.

4 1600 seconds.

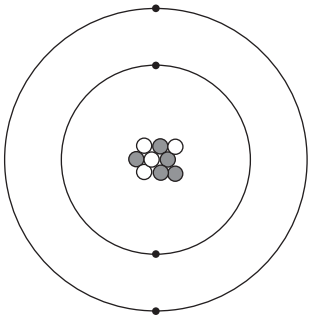
4.4.1.1 The structure of an atom

Question 53

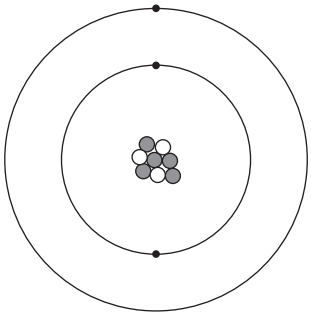
June 2010 | PHY1BP | Original Q1 | Legacy

QUESTION ONE

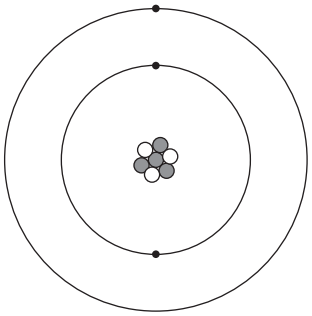
The diagram shows four atoms, **W**, **X**, **Y** and **Z**.



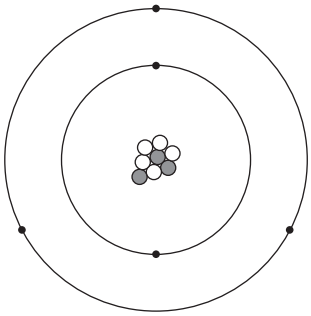
Atom **W**



Atom **X**



Atom **Y**



Atom **Z**

4.4.1.1 The structure of an atom

Question 53 · continued June 2010 | PHY1BP | Original Q1 | Legacy

Atoms **X** and **Y** are isotopes of the same element.

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

A three

B four

C five

D eight

Atom **W** contains . . . **1** . . . electrons.

Atom **X** contains . . . **2** . . . neutrons.

Atom **Y** contains . . . **3** . . . protons.

Atom **Z**'s nucleus contains . . . **4** . . . particles.

Turn over for the next question

4.4.1.1 The structure of an atom

Question 54 June 2010 | PHY1BP | Original Q9 | Legacy

QUESTION NINE

Thermal imaging cameras are used by rescue workers to search for people trapped under rubble after an earthquake. Like all warm objects, the living human body emits infra red radiation. The cameras detect this infra red radiation. Electronic circuits in the camera produce a colour image in which different colours correspond to different wavelengths of infra red radiation.

The table shows the image colour, infra red wavelength and the temperature of the object.

Image colour	Infra red wavelength in micrometres	Temperature of object in °C
Red	9.51	32
Red-orange	9.45	34
Orange	9.4	36
Orange-yellow	9.32	38
Yellow	9.26	40
Yellow-white	9.2	42

9A Two of the values of wavelength in the table show a lower . . .

1 calibration.

2 precision.

3 range.

4 reliability.

9B A scientist wanted to display this data as a line graph.

Which row in the table below shows the scales which would best display the data?

	x-axis (wavelength in micrometres)	y-axis (temperature in °C)
1	0 to 10	0 to 50
2	0 to 10	30 to 50
3	9 to 10	0 to 50
4	9 to 10	30 to 50

4.4.1.1 The structure of an atom

Question 54 · continued

9C A thermal image of a small boy is mainly orange.

Under identical conditions, the thermal image of a much larger man would be . . .

1 mainly yellow because the man's body has a greater mass.

2 mainly red because the man's body has a larger surface area.

3 a mixture of red, orange and yellow because the man's body has a larger mass and a larger surface area.

4 mainly orange because the man and the boy have approximately the same body temperature.

9D At night, police officers use thermal imaging cameras to track criminals running away from crime scenes.

These cameras work better at night than during the day because at night . . .

1 the criminals emit more infra red radiation.

2 the cooler surroundings emit less infra red radiation.

3 the cooler surroundings emit less visible light.

4 the criminals wear black clothes.

END OF TEST

4.4.1.1 The structure of an atom

Question 55

June 2010 | PHY2H | Original Q4 | Legacy

4 (a) Uranium atoms do not always have the same number of neutrons.
What are atoms of the same element that have different numbers of neutrons called?

.....

(1 mark)

4 (b) By emitting an alpha particle, an atom of uranium-235 decays into an atom of thorium.

An alpha particle, which is the same as a helium nucleus, is represented by the symbol $^{4}_{2}He$.

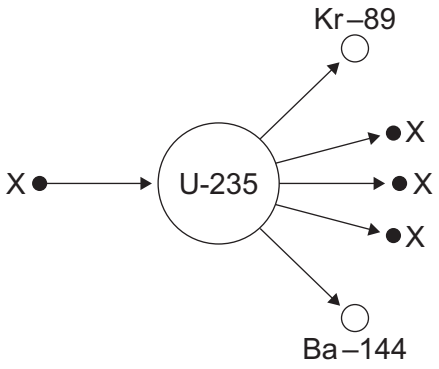
The decay can be represented by the equation below.

Complete the equation by writing the correct number in each of the two boxes.

$$^{235}_{92}U \longrightarrow \square \quad \square \; Th + {}^{4}_{2}He$$

(2 marks)

4 (c) The diagram shows an atom of uranium-235 being split into several pieces.



4 (c) (i) Name the process shown in the diagram.

.....

(1 mark)

4 (c) (ii) Name the particles labelled X.

.....

(1 mark)

4 (d) Uranium-235 is used as a fuel in some nuclear reactors.
Name another substance used as a fuel in some nuclear reactors.

.....

(1 mark)

6

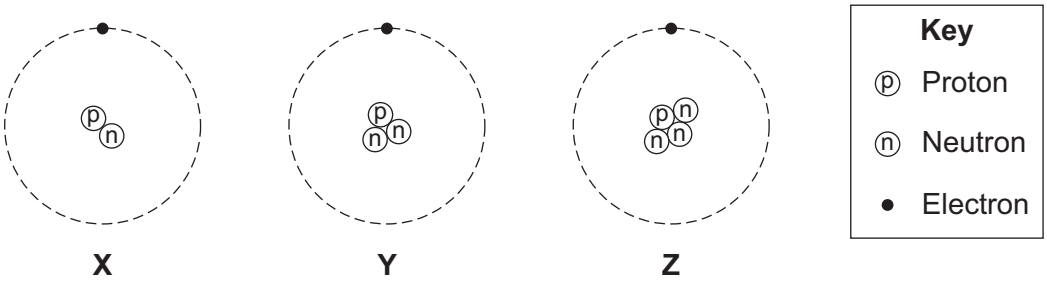
4.4.1.1 The structure of an atom

Question 56

November 2010 | PHY1BP | Original Q3 | Legacy

QUESTION THREE

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



3A 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

3B 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.

4.4.1.1 The structure of an atom

Question 56 · continued

3C 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

3D The warning label is from a smoke detector.

Warning!
This device contains a source that emits alpha radiation.
Do not take this device apart.

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.

4.4.1.1 The structure of an atom

Question 57

January 2011 | PHY2H | Original Q3 | Legacy

3 (a) Background radiation is all around us all the time.

3 (a) (i) Radon is a natural source of background radiation.

Name another natural source of background radiation.

.....

(1 mark)

3 (a) (ii) X-rays are an artificial source of background radiation.

Name another artificial source of background radiation.

.....

(1 mark)

3 (a) (iii) An atom of radon-222 decays by emitting an alpha particle.
The equation representing the decay is shown below.

$$^{222}_{86}\text{Rn} \longrightarrow {}^{218}_{84}\text{X} + \text{alpha particle}$$

How can you tell from the equation that 'X' is not an atom of radon?

.....

.....

(1 mark)

Question 3 continues on the next page

4.4.1.1 The structure of an atom

Question 57 · continued

3 (b) Having an X-ray taken increases your exposure to radiation.

The table gives:

- the radiation doses received for 6 different medical X-rays;
- the number of days' of exposure to natural background radiation each dose is equivalent to.

Medical X-ray	Radiation dose received (in arbitrary units)	Equivalent number of days of exposure to natural background radiation
Chest	2	2.4
Skull	7	8.4
Pelvis	22	26.4
Hip	44	52.8
Spine	140	
CT head scan	200	240

A hospital patient has an X-ray of the spine taken.
Calculate the number of days of exposure to natural background radiation that an X-ray of the spine is equivalent to.

Show how you work out your answer.

.....

.....

.....

Equivalent number of days = ...

(2 marks)

4.4.1.1 The structure of an atom

Question 57 · continued

3 (c) Scientists have shown that X-rays increase the risk of developing cancer.
The scientists came to this conclusion by studying the medical history of people placed in one of two groups, **A** or **B**.
The group into which people were put depended on their X-ray record.

3 (c) (i) Person **J** has been placed into group **A**.
Place each of the people, **K**, **L**, **M**, **N** and **O**, into the appropriate group, **A** or **B**.

Person	J 	K 	L 	M 	N 	O 
Medical X-ray record	3 arm	None	None	2 skull	None	4 leg

Group A	Group B
J	

(1 mark)

3 (c) (ii) To be able to make a fair comparison, what is important about the number of people in each of the two groups studied by the scientists?

.....

.....

(1 mark)

3 (c) (iii) What data would the scientists have compared in order to come to the conclusion that X-rays increase the risk of developing cancer?

.....

.....

(1 mark)

Question 3 continues on the next page

4.4.1.1 The structure of an atom

Question 57 · continued

3 (c) (iv) The chance of developing cancer due to a CT head scan is about 1 in 10 000.
The chance of developing cancer naturally is about 1 in 4.

A hospital patient is advised by a doctor that she needs to have a CT head scan.
The doctor explains to the patient the risks involved.

Do you think that the patient should give her permission for the CT scan to be taken?

Draw a ring around your answer.

Yes **No**

Give a reason for your answer.

.....

.....

(1 mark)

9

4.4.1.1 The structure of an atom

Question 58

March 2011 | PHY1BP | Original Q8 | Legacy

QUESTION EIGHT

An isotope, **X**, is radioactive and decays into isotope **Y**, which is not radioactive.

Rocks such as granite contain both of these isotopes.

The half-life of isotope **X** is 4 million years.

8A A sample of granite is found to contain one atom of **Y** for each atom of **X**.

The age of the rock is about . . .

1 1 million years.

2 2 million years.

3 4 million years.

4 6 million years.

8B Another sample of rock is known to be 8 million years old.

The ratio of the number of atoms of **X** to the number of atoms of **Y** would be . . .

1 1 : 2

2 1 : 3

3 1 : 4

4 2 : 1

8C A sample of rock contains atoms of isotope **X**, but no atoms of isotope **Y**.

This is because . . .

1 all the atoms of **Y** have decayed.

2 the atoms of **X** in this sample are not radioactive.

3 the half-life of atoms of **X** in this sample is greater than 4 million years.

4 the rock has only recently been formed.

4.4.1.1 The structure of an atom

Question 58 · continued

8D Isotope **X** decays by emitting alpha particles.

An alpha particle consists of . . .

1 2 electrons only.

2 2 protons and 2 neutrons.

3 2 neutrons only.

4 2 protons and 2 electrons.

Turn over for the next question

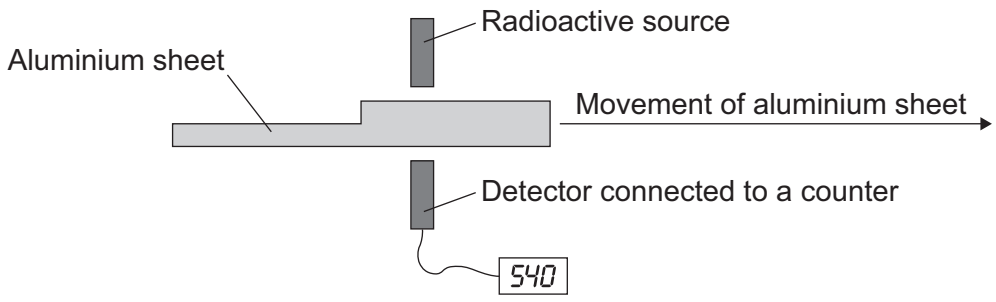
4.4.1.1 The structure of an atom

Question 59

June 2011 | PHY1BP | Original Q7 | Legacy

QUESTION SEVEN

A teacher demonstrates how radiation can be used in industry to monitor the thickness of aluminium sheets.



7A Which type of radioactive source should she choose?

1 an alpha emitter

2 a beta emitter

3 a gamma emitter

4 it does not matter

7B The teacher chose the isotope strontium-90 as the radioactive source. The most common isotope of strontium, strontium-88, contains 38 protons and 50 neutrons in its nucleus.

What particles are in the strontium-90 nucleus?

1 38 protons and 50 neutrons

2 38 protons and 52 neutrons

3 40 protons and 50 neutrons

4 42 protons and 48 neutrons

7C What happens to the count rate shown by the counter when a thinner part of the aluminium sheet passes the detector?

1 It increases.

2 It decreases.

3 It stays the same.

4 It falls to zero.

4.4.1.1 The structure of an atom

Question 59 · continued

7D Strontium-90 has a half-life of 28 years. The source contains 100 mg of strontium-90.

How long will it be before 75 mg of strontium-90 has decayed?

1 7 years

2 14 years

3 56 years

4 84 years

Turn over for the next question

4.4.1.1 The structure of an atom

Question 60

June 2011 | PHY1H | Original Q5 | Legacy

5 LOFAR is a new type of telescope designed to observe the lowest frequency radio waves. It consists of thousands of simple radio antennae linked to a super-computer. This combines all the signals to give a single output.

5 (a) (i) Give **one** reason, apart from its physical size, why a telescope such as LOFAR is positioned on the Earth and not on a satellite in space.

.....

.....

(1 mark)

5 (a) (ii) Why are the analogue signals from the antennae converted into digital signals before being sent to the computer?

.....

.....

(1 mark)

5 (b) One of the main purposes of the LOFAR telescope is to study the period of time a few hundred thousand years after the big bang. This is done by measuring the *red-shift* of the waves emitted by hydrogen atoms in very distant galaxies.

5 (b) (i) What is *red-shift*?

.....

.....

(1 mark)

5 (b) (ii) The LOFAR telescope has a sensitivity 20 times greater than other radio telescopes.

What does this statement mean?

.....

.....

(1 mark)

4.4.1.1 The structure of an atom

Question 60 · continued

June 2011 | PHY1H | Original Q5 | Legacy

5 (b) (iii) The Ancient Greeks believed that the Universe went on forever; it never changed and had no beginning. It had always existed.

How are the ideas put forward by the big bang theory different from the beliefs of the Ancient Greeks?

.....

.....

.....

.....

(2 marks)

5 (c) Some scientists are using the LOFAR super-computer for Earth based investigations. For example, to study the effect of natural gas extraction on ground levels in the Netherlands.

Suggest **one** positive benefit of developing technologies that can be used by many different groups of scientists.

.....

.....

(1 mark)

7

4.4.1.1 The structure of an atom

Question 61

June 2011 | PHY1H | Original Q6 | Legacy

6 (a) Carbon has three naturally occurring isotopes. The isotope, carbon-14, is radioactive. An atom of carbon-14 decays by emitting a beta particle.

6 (a) (i) Complete the following sentences.

The atoms of the three carbon isotopes are the same as each other because

..... .

The atoms of the three carbon isotopes are different from each other because

..... .

(2 marks)

6 (a) (ii) What is a beta particle and from what part of an atom is it emitted?

.....

.....

(1 mark)

6 (b) Carbon-14 is constantly being made in the atmosphere, yet for most of the last million years, the amount of carbon-14 in the atmosphere has not changed.

How is this possible?

.....

.....

(1 mark)

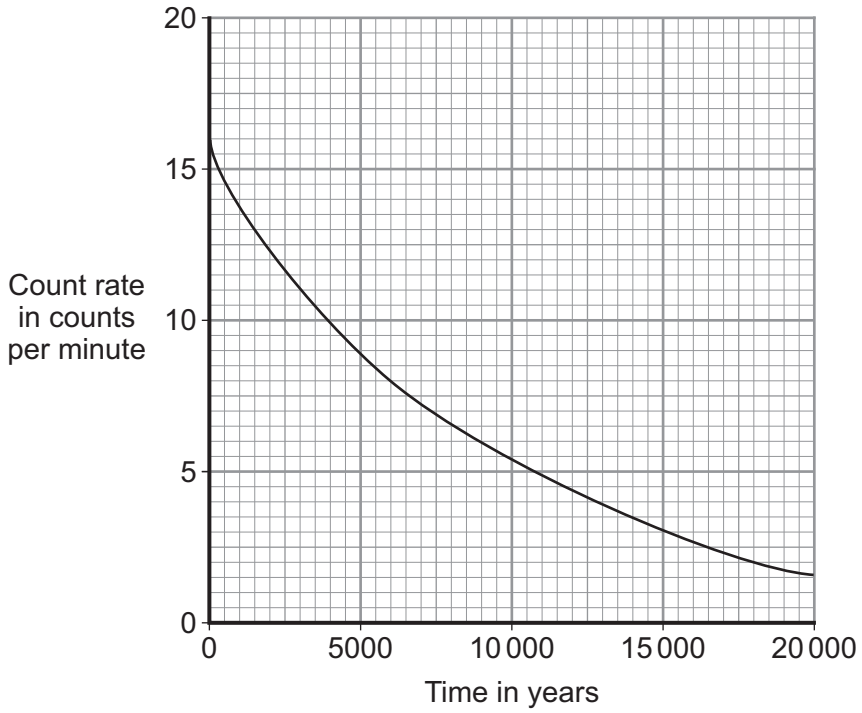
4.4.1.1 The structure of an atom

Question 61 · continued

6 (c) Trees take in carbon-12 and carbon-14 from the atmosphere. After the tree dies, the proportion of carbon-14 that the tree contains decreases.

Graph **A** shows the decay curve for carbon-14.

Graph **A**



6 (c) (i) Lake Cuicocha in Ecuador was formed after a volcanic eruption.
Carbon taken from a tree killed by the eruption was found to have a count rate of 10.5 counts per minute.
At the time of the eruption, the count rate would have been 16 counts per minute.

Use graph **A** to find the age of Lake Cuicocha.

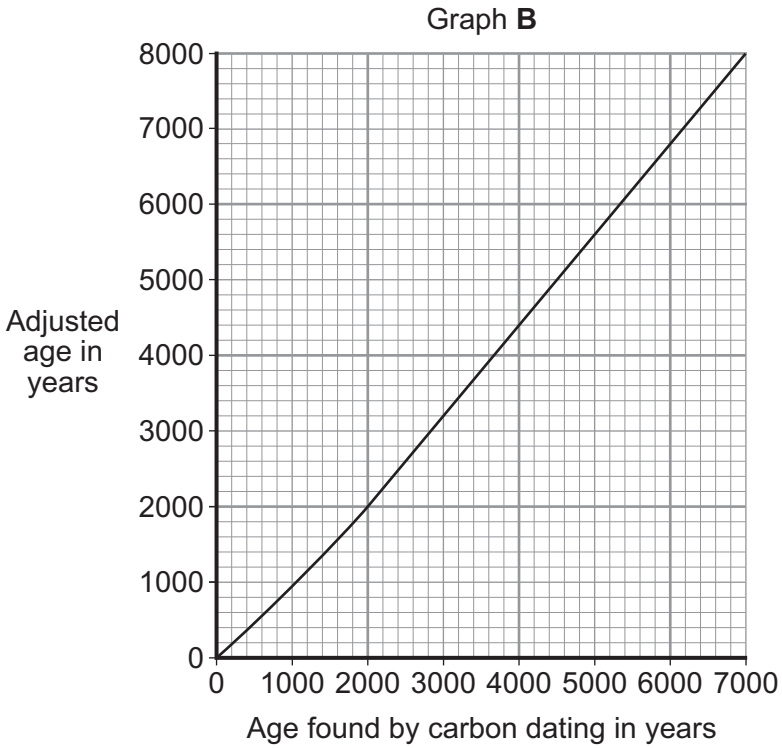
Age of Lake Cuicocha = ... years
(1 mark)

Question 6 continues on the next page

4.4.1.1 The structure of an atom

Question 61 · continued

6 (c) (ii) Finding the age of organic matter by measuring the proportion of carbon-14 that it contains is called carbon dating. This technique relies on the ratio of carbon-14 to carbon-12 in the atmosphere remaining constant. However, this ratio is not constant so the age found by carbon dating needs to be adjusted.



Graph **B** is used to adjust the age of an object found by carbon dating.
The value obtained from graph **B** will be no more than 50 years different to the true age of the object.

Use graph **B** and the information above to find the maximum age that Lake Cuicocha could be.

Show clearly how you obtain your answer.

.....

.....

Maximum age of Lake Cuicocha = ... years

(2 marks)

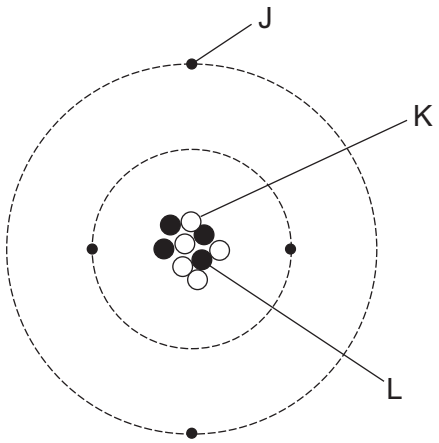
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4.4.1.1 The structure of an atom

Question 62

June 2011 | PHY2H | Original Q3 | Legacy

3 The diagram represents an atom of beryllium.



3 (a) Complete the following statements by writing one of the letters, **J**, **K** or **L**, in each box.

Each letter should be used only **once**.

The particle with a positive charge is ☐

The particle with the smallest mass is ☐

The particle with no charge is ☐

(2 marks)

3 (b) Give the reason why all atoms have a total charge of zero.

.....

.....

(1 mark)

3 (c) Complete the following sentence.

There are several isotopes of beryllium. Atoms of different beryllium isotopes will have different numbers of ..... .

(1 mark)

3 (d) What happens to the structure of an atom to change it into an ion?

.....

.....

(1 mark)

5

4.4.1.1 The structure of an atom

Question 63

June 2011 | PHY2H | Original Q4 | Legacy

4 When the nucleus of a radium-225 atom decays, it changes into a nucleus of actinium-225.

$$^{225}_{88}\text{Ra} \longrightarrow {}^{225}_{89}\text{Ac} + \boxed{\text{Radiation}}$$

What type of radiation is emitted by radium-225?

Draw a ring around your answer.

alpha **beta** **gamma**

Explain the reason for your answer.

.....

.....

.....

.....

.....

.....

(3 marks)

3

4.4.1.1 The structure of an atom

Question 64

June 2012 | PH2HP | Original Q6 | Legacy

6 (a) As part of its life cycle, a star changes from being a protostar to a main sequence star.

Explain the difference between a protostar and a main sequence star.

.....

.....

.....

.....

(2 marks)

6 (b) The early Universe contained only atoms of hydrogen. The Universe now contains atoms of over one hundred different elements.

Explain how the different elements now contained in the Universe were formed.

.....

.....

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.....

.....

(3 marks)

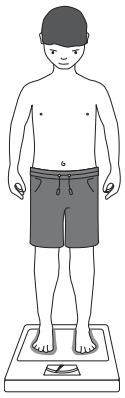
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4.4.1.1 The structure of an atom

Question 65

June 2012 | PH2HP | Original Q7 | Legacy

7 (a) The picture shows a person using a set of electronic 'Body Fat Scales'. When the person stands on the scales, a small, harmless, electric current passes through the person's body. The scales then calculate the resistance of the person's body and convert the resistance into a *prediction* of body fat content.



7 (a) (i) The scales contain two 3 V cells joined in series.

Calculate the resistance of a person's body, if when he stands on the scales, a current of 0.12 mA passes through his body.

1000 mA = 1 A

Use the correct equation from the Physics Equations Sheet.

Show clearly how you work out your answer and give the unit.

.....

.....

.....

Resistance = ...

(3 marks)

4.4.1.1 The structure of an atom

Question 65 · continued

7 (a) (ii) The scales can only produce a *prediction* of body fat content and not an accurate measurement.

Suggest why.

.....

.....

.....

(1 mark)

7 (a) (iii) It is recommended that the scales are **not** used immediately after a person has drunk a large amount of water.

Suggest why.

.....

.....

.....

.....

.....

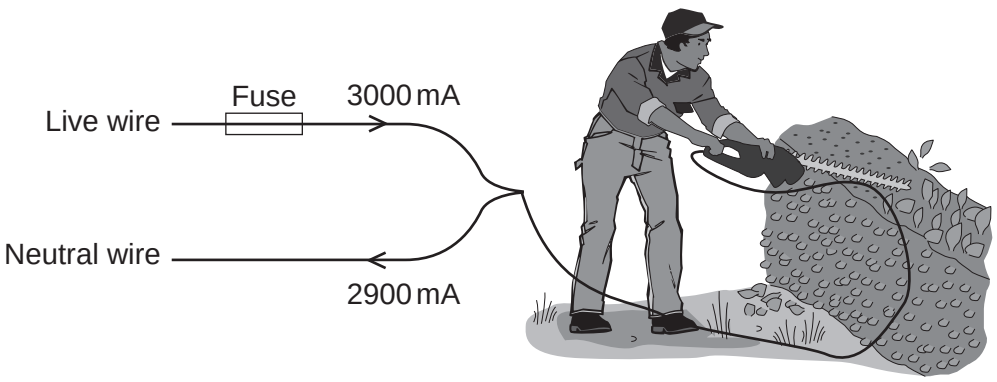
(2 marks)

Question 7 continues on the next page

4.4.1.1 The structure of an atom

Question 65 · continued

7 (b) The diagram shows how someone could get an electric shock from accidentally cutting into an electric cable. If this happens, and a Residual Current Circuit Breaker (RCCB) is being used, the circuit will switch off automatically.



7 (b) (i) A faulty appliance or circuit can be switched off by a RCCB or a fuse.

Compare the action of a RCCB with the action of a fuse.

.....

.....

.....

.....

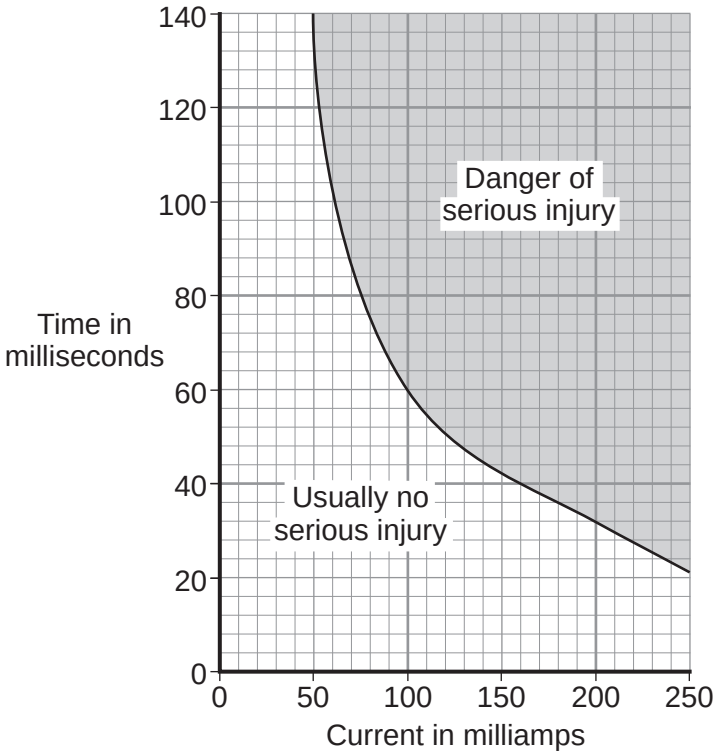
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(2 marks)

4.4.1.1 The structure of an atom

Question 65 · continued

7 (b) (ii) The graph shows how the severity of an electric shock depends on the size of the current and the time that the current flows through the body.



Using the RCCB helps prevent an electric shock seriously injuring the person using the hedge trimmers.

Using information from both the diagram and the graph explain how.

.....

.....

.....

.....

.....

(2 marks)

10

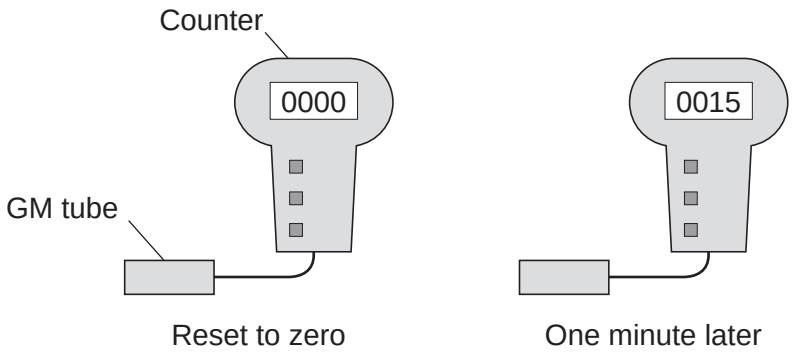
4.4.1.1 The structure of an atom

Question 66

January 2013 | PH2HP | Original Q2 | Legacy

2 (a) 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 the procedure two more times.



2 (a) (i) Background radiation can be either from natural sources or from man-made sources.

Name **one man-made** source of background radiation.

.....

(1 mark)

2 (a) (ii) The three readings taken by the teacher are given in the table.

Count after one minute
15
24
18

The readings given in the table are correct.

Why are the readings different?

.....

.....

(1 mark)

4.4.1.1 The structure of an atom

Question 66 · continued

2 (b) Some scientists say they have found evidence to show that people living in areas of high natural background radiation are less likely to develop cancer than people living in similar areas with lower background radiation.

The evidence these scientists found does not definitely mean that the level of background radiation determines whether a person will develop cancer.

Suggest a reason why.

.....

.....

(1 mark)

2 (c) An atom of the isotope radon-222 emits an alpha particle and decays into an atom of polonium.

An alpha particle is the same as a helium nucleus. The symbol below represents an alpha particle.

$$^{4}_{2}\text{He}$$

2 (c) (i) How many protons and how many neutrons are there in an alpha particle?

Number of protons = ...

Number of neutrons = ...

(2 marks)

2 (c) (ii) The decay of radon-222 can be represented by the equation below.

Complete the equation by writing the correct number in each of the **two** boxes.

$$^{222}_{86}\text{Rn} \longrightarrow \square \quad \square \quad \text{Po} + \text{alpha particle}$$

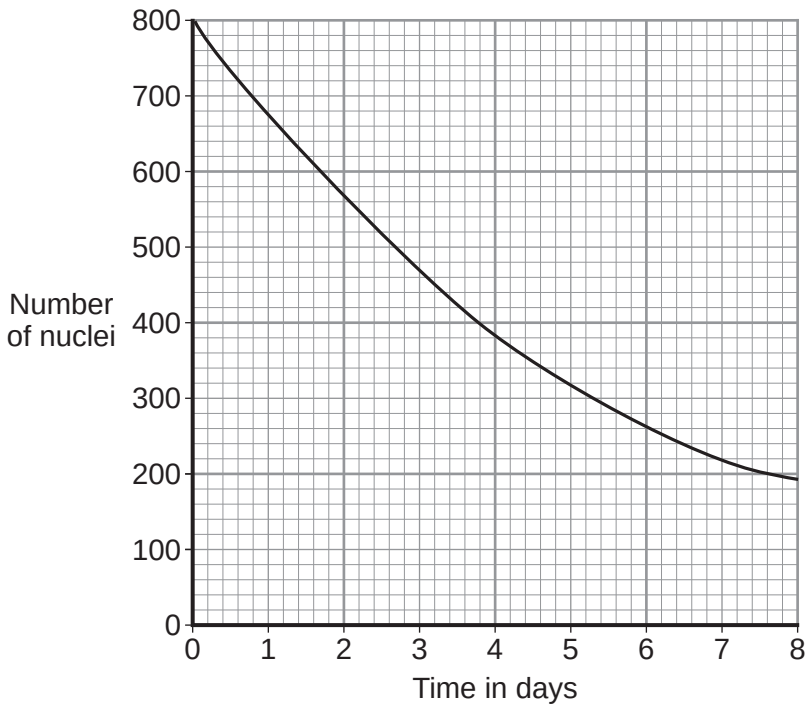
(2 marks)

Question 2 continues on the next page

4.4.1.1 The structure of an atom

Question 66 · continued

2 (d) The graph shows how, in a sample of air, the number of radon-222 nuclei changes with time.



Use the graph to find the half-life of radon-222.

Show clearly on the graph how you obtain your answer.

Half-life = ... days

(2 marks)

9

4.4.1.1 The structure of an atom

Question 67

June 2013 | PH2HP | Original Q3 | Legacy

3 (a) Nuclear power stations generate about 14% of the world's electricity.

3 (a) (i) Uranium-235 is used as a fuel in some nuclear reactors.

Name **one** other substance used as a fuel in some nuclear reactors.

.....

(1 mark)

3 (a) (ii) Energy is released from nuclear fuels by the process of nuclear fission.
This energy is used to generate electricity.

Describe how this energy is used to generate electricity.

Do **not** explain the nuclear fission process.

.....

.....

.....

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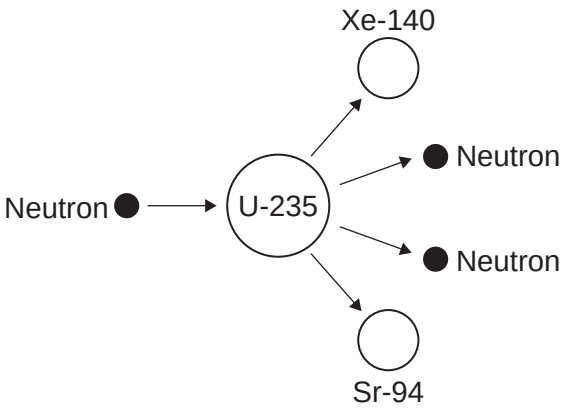
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.....

(3 marks)

3 (b) The diagram shows the nuclear fission process for an atom of uranium-235.

Complete the diagram to show how the fission process starts a chain reaction.

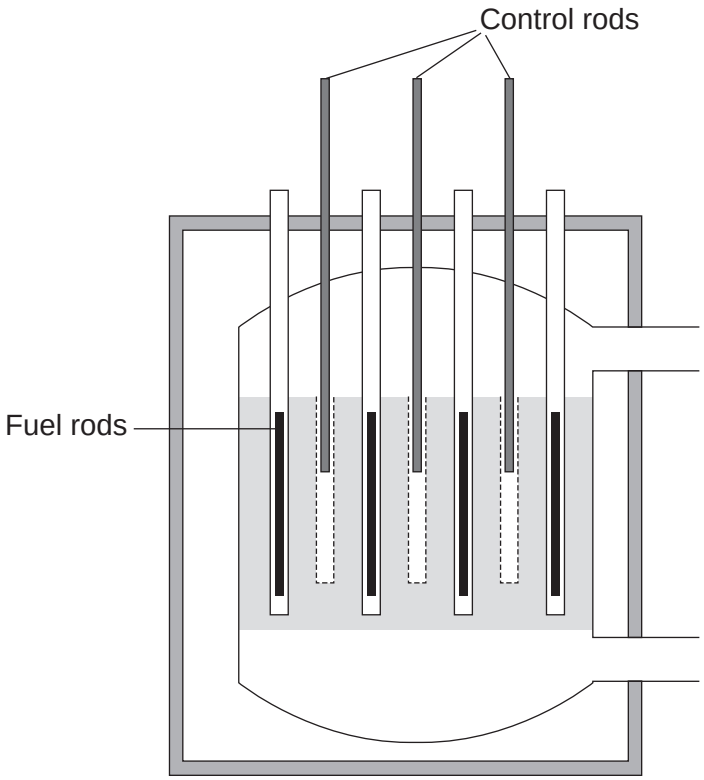


(2 marks)

4.4.1.1 The structure of an atom

Question 67 · continued

3 (c) The diagram shows the cross-section through a nuclear reactor.



The control rods, made from boron, are used to control the chain reaction. Boron atoms absorb neutrons without undergoing nuclear fission.

Why does lowering the control rods reduce the amount of energy released each second from the nuclear fuel?

.....

.....

.....

.....

(2 marks)

8

4.4.1.1 The structure of an atom

Question 68

June 2013 | PH2HP | Original Q5 | Legacy

5 In 2011 an earthquake caused severe damage to a nuclear power station in Japan. The damage led to the release of large amounts of radioactive iodine-131($^{131}_{53}I$) into the atmosphere.

5 (a) The table gives some information about an atom of iodine-131($^{131}_{53}I$).

Complete the table.

mass number	131
number of protons	53
number of neutrons	

(1 mark)

5 (b) Complete the sentence.

The number of protons in an atom is called the proton number or

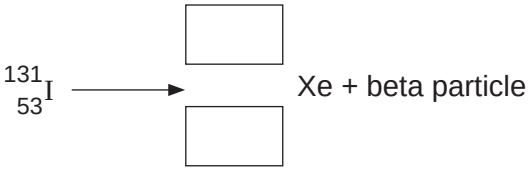
the ..... number.

(1 mark)

5 (c) An atom of iodine-131 decays into an atom of xenon (Xe) by emitting a beta particle.

5 (c) (i) The decay of iodine-131 can be represented by the equation below.

Complete the equation by writing the correct number in each of the **two** boxes.



(2 marks)

Question 5 continues on the next page

4.4.1.1 The structure of an atom

Question 68 · continued

5 (c) (ii) A sample of rainwater contaminated with iodine-131 gives a count rate of 1200 counts per second.

Calculate how many days it will take for the count rate from the sample of rainwater to fall to 75 counts per second.

Half-life of iodine-131 = 8 days

Show clearly how you work out your answer.

.....

.....

..... days
(2 marks)

5 (c) (iii) If people drink water contaminated with iodine-131, the iodine-131 builds up in the thyroid gland. This continues until the thyroid is saturated with iodine-131 and cannot absorb any more. The radiation emitted from the iodine-131 could cause cancer of the thyroid.

In Japan, people likely to be drinking water contaminated with iodine-131 were advised to take tablets containing a non-radioactive isotope of iodine.

Suggest why this advice was given.

.....

.....

.....

.....
(2 marks)

8

4.4.1.1 The structure of an atom

Question 69

June 2014 | PH2HP | Original Q6 | Legacy

6 (a) There are many isotopes of the element molybdenum (Mo).

What do the nuclei of different molybdenum isotopes have in common?

[1 mark]

.....

6 (b) The isotope molybdenum-99 is produced inside some nuclear power stations from the nuclear fission of uranium-235.

6 (b) (i) What happens during the process of nuclear fission?

[1 mark]

.....

.....

6 (b) (ii) Inside which part of a nuclear power station would molybdenum be produced?

[1 mark]

.....

6 (c) When the nucleus of a molybdenum-99 atom decays, it emits radiation and changes into a nucleus of technetium-99.

$$^{99}_{42}\text{Mo} \longrightarrow {}^{99}_{43}\text{Tc} + \text{Radiation}$$

What type of radiation is emitted by molybdenum-99?

[2 marks]

.....

Give a reason for your answer.

.....

.....

Question 6 continues on the next page

4.4.1.1 The structure of an atom

Question 69 · continued

6 (d) Technetium-99 has a short half-life and emits gamma radiation.

What is meant by the term 'half-life'?

[1 mark]

.....

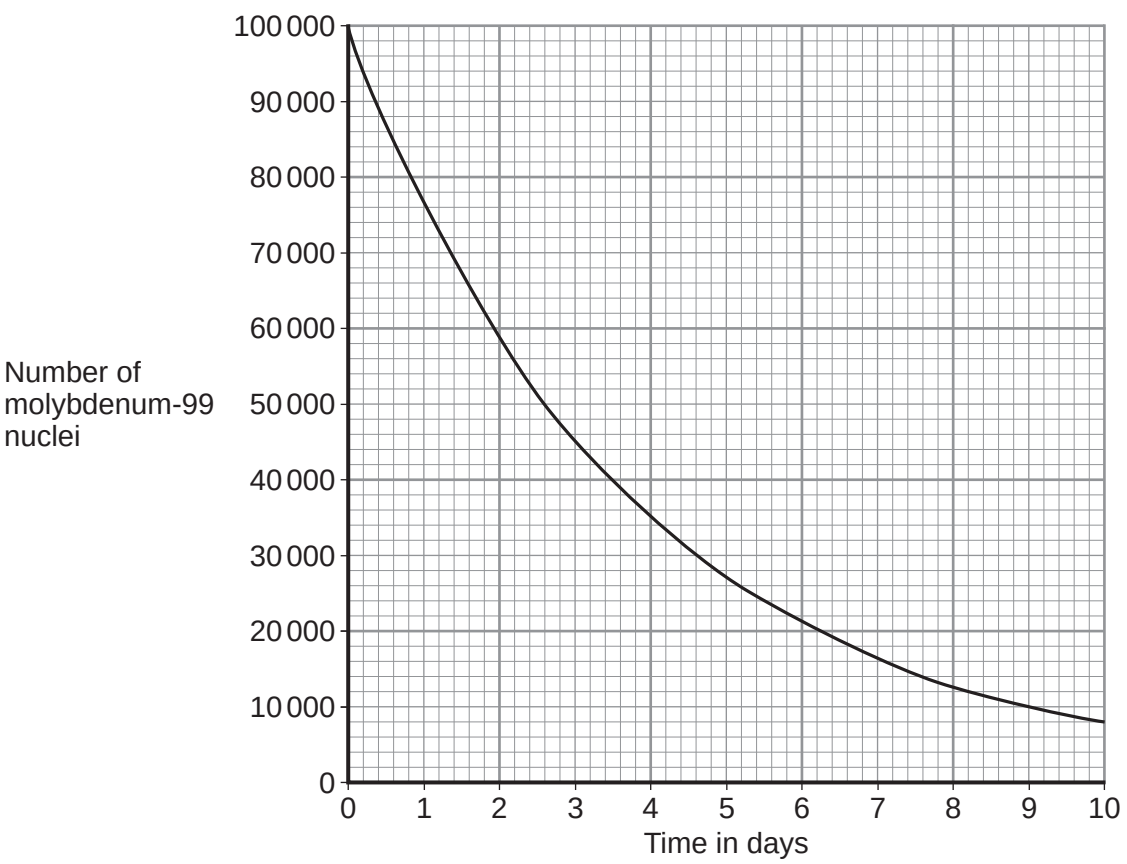
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6 (e) Technetium-99 is used by doctors as a medical tracer. In hospitals it is produced inside a technetium generator by the decay of molybdenum-99 nuclei.

6 (e) (i) **Figure 7** shows how the number of nuclei in a sample of molybdenum-99 changes with time as the nuclei decay.

Figure 7



4.4.1.1 The structure of an atom

Question 69 · continued

A technetium generator will continue to produce sufficient technetium-99 until 80% of the original molybdenum nuclei have decayed.

After how many days will a source of molybdenum-99 inside a technetium-99 generator need replacing?

Show clearly your calculation and how you use the graph to obtain your answer.

[2 marks]

.....

.....

.....

Number of days = ...

6 (e) (ii) Medical tracers are injected into a patient's body; this involves some risk to the patient's health.

Explain the risk to the patient of using a radioactive substance as a medical tracer.

[2 marks]

.....

.....

.....

.....

6 (e) (iii) Even though there may be a risk, doctors frequently use radioactive substances for medical diagnosis and treatments.

Suggest why.

[1 mark]

.....

.....

11

4.4.1.1 The structure of an atom

Question 70

June 2014 | PH3HP | Original Q1 | Legacy

1 (a) What is ultrasound?

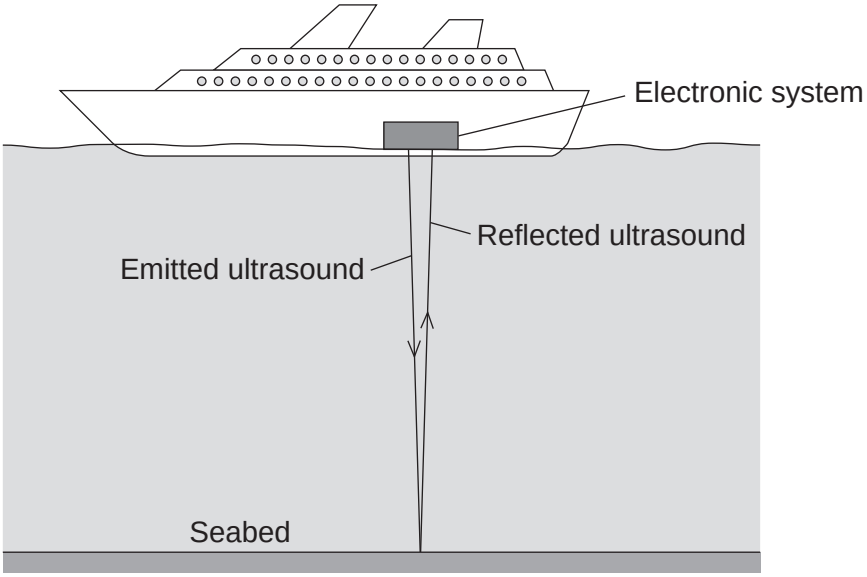
[1 mark]

.....

.....

1 (b) **Figure 1** shows how ultrasound is used to measure the depth of water below a ship.

Figure 1



A pulse of ultrasound is sent out from an electronic system on-board the ship.

It takes 0.80 seconds for the emitted ultrasound to be received back at the ship.

Calculate the depth of the water.

Speed of ultrasound in water = 1600 m/s

Use the correct equation from the Physics Equations Sheet.

[3 marks]

.....

.....

.....

.....

Depth of water = ... metres

4.4.1.1 The structure of an atom

Question 70 · continued

1 (c) Ultrasound can be used in medicine for scanning.

State **one** medical use of ultrasound scanning.

[1 mark]

.....

1 (d) Images of the inside of the human body can be made using a Computerised Tomography (CT) scanner. The CT scanner in **Figure 2** uses X-rays to produce these images.

Figure 2



State **one** advantage and **one** disadvantage of using a CT scanner, compared with ultrasound scanning, for forming images of the inside of the human body.

[2 marks]

Advantage of CT scanning .....

.....

.....

Disadvantage of CT scanning .....

.....

.....

7

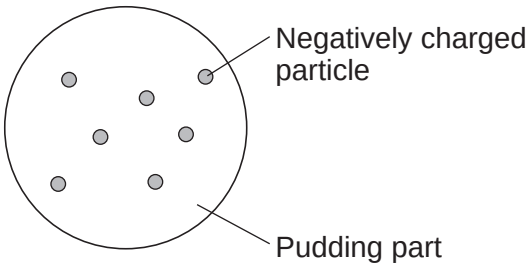
4.4.1.1 The structure of an atom

Question 71

June 2015 | PH2HP | Original Q2 | Legacy

2 (a) Over 100 years ago, scientists thought the atom was like a 'plum pudding'.
Figure 3 shows the plum pudding model of the atom.

Figure 3



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 2 continues on the next page

4.4.1.1 The structure of an atom

Question 71 · continued

2 (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.

2 (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]

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

[1 mark]

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4.4.1.1 The structure of an atom

Question 71 · continued

2 (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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4.4.1.1 The structure of an atom

Question 72

June 2015 | PH2HP | Original Q3 | Legacy

3 Many countries use nuclear power stations to generate electricity.
Nuclear power stations use the process of nuclear fission to release energy.

3 (a) (i) What is nuclear fission?

[1 mark]

.....

.....

3 (a) (ii) Plutonium-239 is one substance used as a fuel in a nuclear reactor. For nuclear fission to happen, the nucleus must absorb a particle.

What type of particle must be absorbed?

[1 mark]

.....

3 (b) Nuclear **fusion** also releases energy.
Nuclear fusion happens at very high temperatures. A high temperature is needed to overcome the repulsion force between the nuclei.

3 (b) (i) Why is there a repulsion force between the nuclei of atoms?

[1 mark]

.....

.....

3 (b) (ii) Where does nuclear fusion happen naturally?

[1 mark]

.....

4.4.1.1 The structure of an atom

Question 72 · continued

3 (c) In 1991, scientists produced the first controlled release of energy from an experimental nuclear **fusion** reactor. This was achieved by fusing the hydrogen isotopes, deuterium and tritium.

Deuterium is naturally occurring and can easily be extracted from seawater. Tritium can be produced from lithium. Lithium is also found in seawater.

Table 2 gives the energy released from 1 kg of fusion fuel and from 1 kg of fission fuel.

Table 2

Type of fuel	Energy released from 1 kg of fuel in joules
Fusion fuel	3.4×10^{14}
Fission fuel	8.8×10^{13}

3 (c) (i) Suggest **two** advantages of the fuel used in a fusion reactor compared with plutonium and the other substances used as fuel in a fission reactor.

[2 marks]

1 .....

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2 .....

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3 (c) (ii) Some scientists think that by the year 2050 a nuclear fusion power station capable of generating electricity on a large scale will have been developed.

Suggest **one** important consequence of developing nuclear fusion power stations to generate electricity.

[1 mark]

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.....

Question 3 continues on the next page

4.4.1.1 The structure of an atom

Question 72 · continued

3 (d) Tritium is radioactive.

After 36 years, only 10 g of tritium remains from an original sample of 80 g.

Calculate the half-life of tritium.

Show clearly how you work out your answer.

[2 marks]

.....

.....

Half-life = ... years

9

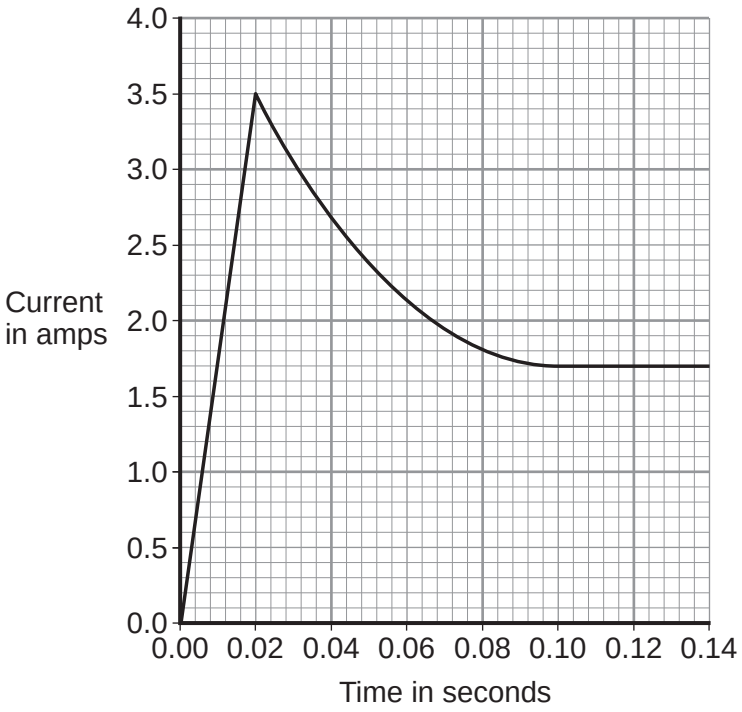
4.4.1.1 The structure of an atom

Question 73

June 2015 | PH2HP | Original Q5 | Legacy

5 A 12 V filament bulb is connected to a 12 V power supply.
Figure 6 shows how the current changes after the bulb is switched on.

Figure 6



5 (a) (i) After 0.10 seconds, the bulb works at its normal brightness.

What is the current through the bulb when it is working at normal brightness?

[1 mark]

Current = ... A

5 (a) (ii) The bulb works at normal brightness for 30 seconds before it is switched off.

Calculate the charge that flows through the bulb in the 30 seconds before it is switched off. Give the unit.

Use the correct equation from the Physics Equations Sheet.

[3 marks]

.....

.....

.....

Charge = ... unit .....

4.4.1.1 The structure of an atom

Question 73 · continued

5 (a) (iii) Calculate the energy transferred by the 12 V bulb when it is working at normal brightness for 30 seconds.

Use the correct equation from the Physics Equations Sheet.

[2 marks]

.....

.....

Energy transferred = ... J

5 (b) Between 0.02 seconds and 0.08 seconds, there is an increase in both the resistance and the temperature of the metal filament inside the bulb.

Explain, in terms of the electrons and ions inside the filament, why both the temperature and the resistance increase.

[2 marks]

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4.4.1.1 The structure of an atom

Question 74

June 2016 | PH2HP | Original Q2 | Legacy

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

2 (a) Describe the structure of an alpha particle.

[1 mark]

_____

_____

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

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

[1 mark]

Tick (✓) **one** box.

alpha particles ☐ beta particles ☐ gamma rays ☐

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

[1 mark]

_____

_____

2 (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]

_____

_____

4.4.1.1 The structure of an atom

Question 74 · continued

2 (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

4.4.1.1 The structure of an atom

Question 75

June 2017 | PH2HP | Original Q1 | Legacy

1 (a) Plutonium-239 is used as a fuel in some nuclear reactors.

Name the substance used as a fuel in most nuclear reactors.

[1 mark]

_____

1 (b) Energy is released from nuclear fuels by the process of nuclear fission.

1 (b) (i) Complete the following sentence.

[1 mark]

Nuclear fission occurs after the nucleus of a plutonium-239 atom has

absorbed a _____ .

1 (b) (ii) Describe what happens when the nucleus of an atom undergoes nuclear fission.

[2 marks]

_____

_____

_____

_____

4

4.4.1.1 The structure of an atom

Question 76

June 2017 | PH2HP | Original Q5 | Legacy

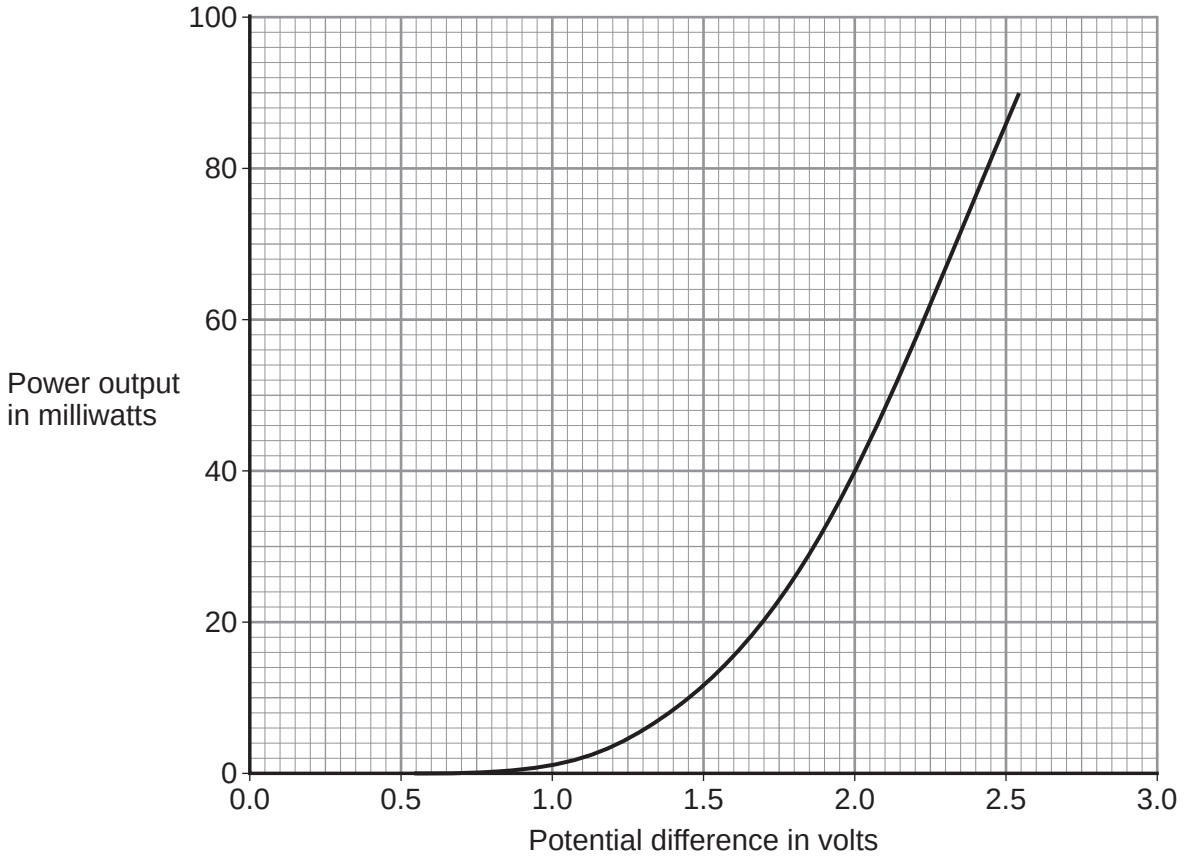
5 The lighting in a home may be provided by LED bulbs, filament bulbs or halogen bulbs.

5 (a) (i) In the box below, draw the circuit symbol for an LED.

[1 mark]

5 (a) (ii) **Figure 6** shows how the power output from one type of LED varies with the potential difference across the LED.

Figure 6



1 milliwatt = 0.001 W

4.4.1.1 The structure of an atom

Question 76 · continued

The LED is connected in series with a battery and resistor.
The potential difference across the LED is 2.0 V

Use data from **Figure 6** to calculate the energy transferred by the LED in 5 minutes.

Use the correct equation from the Physics Equations Sheet.

[3 marks]

Energy transferred = _____ J

5 (b) The resistance of a filament bulb increases as the temperature of the filament increases.

Explain, in terms of the electrons and ions inside the filament, why the resistance increases.

[2 marks]

5 (c) Why are LED bulbs cheaper to use than filament bulbs or halogen bulbs that produce the same brightness of light?

[1 mark]

7

4.4.1.1 The structure of an atom

Question 77

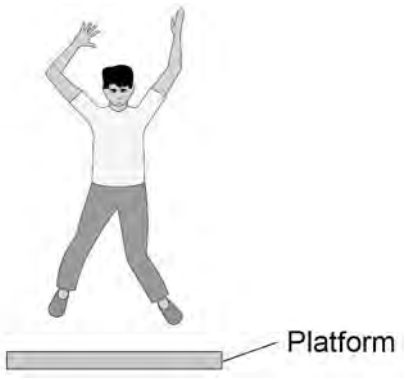
June 2019 | 8463/1H | Original Q3

0 3 A scientist investigated how the maximum muscle power of humans varies with age and gender.

The scientist asked volunteers to stand on a platform and to jump as high as they could.

Figure 4 shows a volunteer taking part in the experiment.

Figure 4



An electronic timer measured the time that the volunteer was in the air.

0 3 . 1 The muscle power in watts per kg is calculated using the following equation:

$$\text{muscle power} = \frac{9.8 \times \text{jump height}}{\text{time}}$$

One volunteer has a muscle power of 41 W/kg

He was in the air for 0.12 s

Calculate his jump height.

[3 marks]

Jump height = _____ m

Question 77 · continued

0 3 . 2 Write down the equation which links kinetic energy, mass and speed.

[1 mark]

0 3 . 3 One volunteer had a kinetic energy of 270 J and a speed of 3.0 m/s at the moment he left the ground.

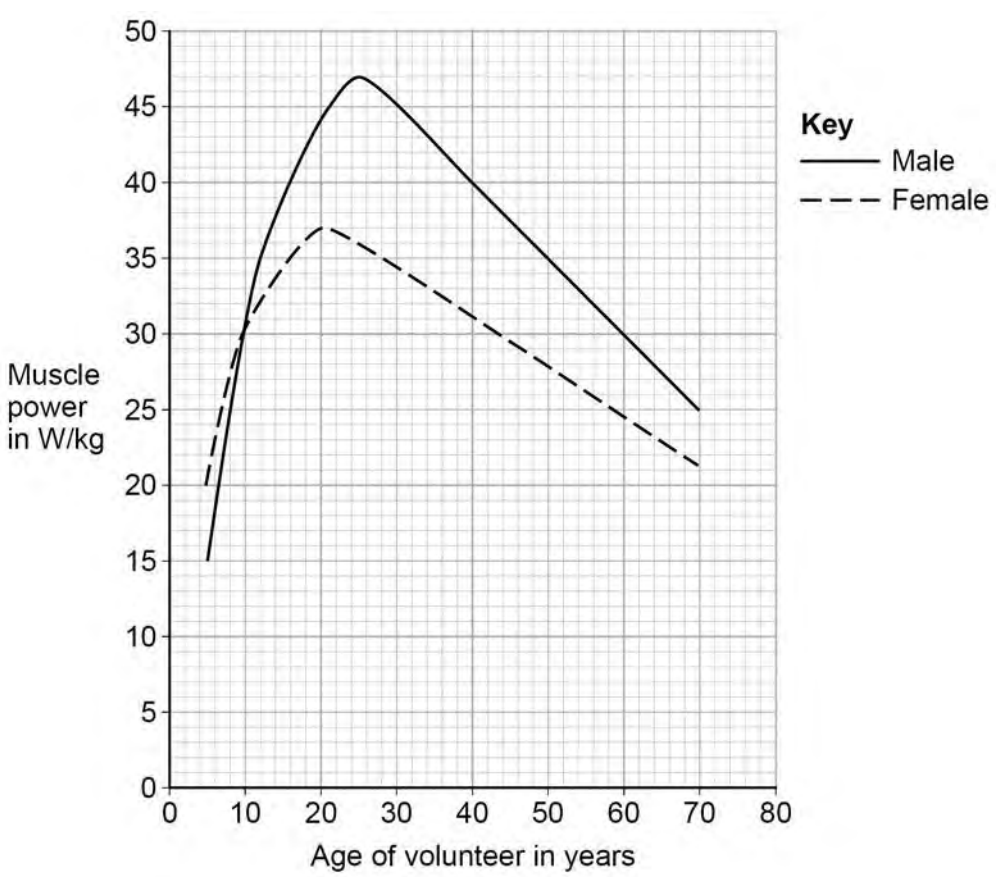
Calculate his mass.

[3 marks]

Mass = _____ kg

Figure 5 shows the scientist's results.

Figure 5



4.4.1.1 The structure of an atom

Question 77 · continued

0 3 . 4 Compare the muscle power of males with the muscle power of females.

Use data from **Figure 5** in your answer.

[4 marks]

0 3 . 5 The muscle power of each volunteer was measured five times.

The highest muscle power reading was recorded instead of calculating an average.

Suggest **one** reason why.

[1 mark]

12

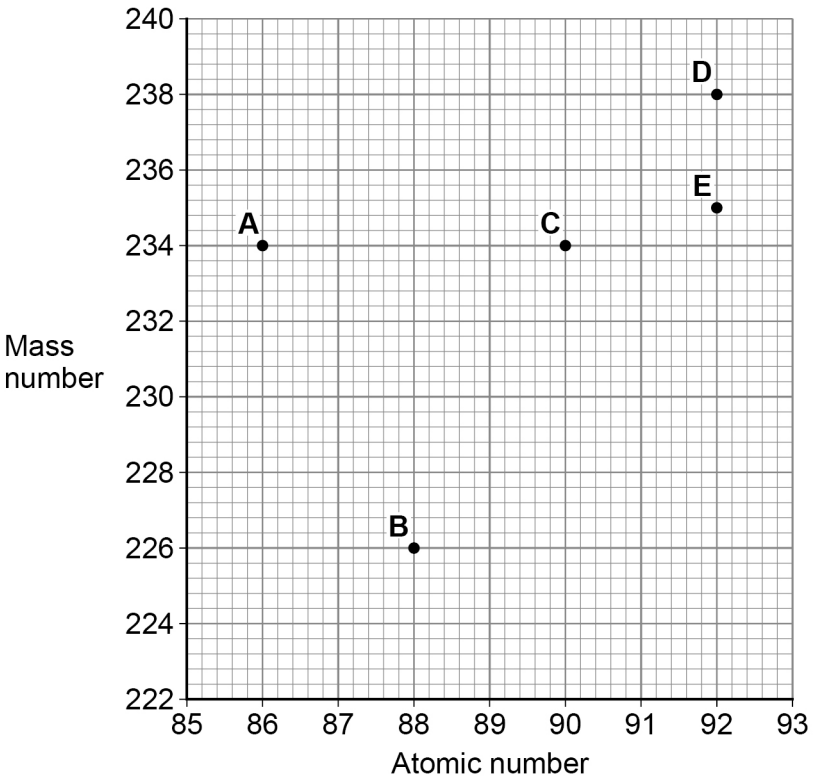
4.4.1.1 The structure of an atom

Question 78

November 2021 | 8463/1H | Original Q6

0 6 **Figure 6** shows the mass number and the atomic number for the nuclei of five different atoms.

Figure 6



0 6 . 1 How many neutrons are there in a nucleus of atom **A**?

[1 mark]

4.4.1.1 The structure of an atom

Question 78 · continued

0 6 . 2 Which **two** atoms in **Figure 6** are the same element?

[1 mark]

Tick (✓) **one** box.

A and **B** ☐

A and **C** ☐

C and **D** ☐

D and **E** ☐

Question 6 continues on the next page

4.4.1.1 The structure of an atom

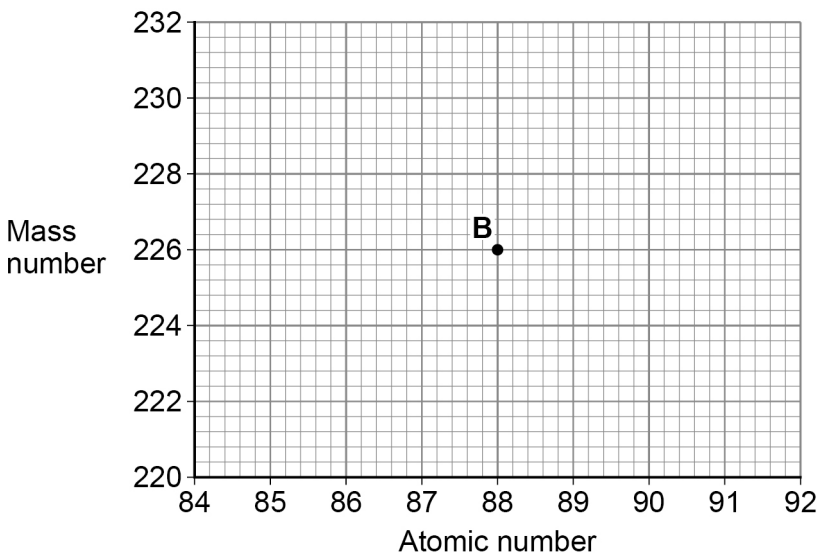
Question 78 · continued

0 6 . 3 Nucleus **B** decays by emitting an alpha particle.

Draw an arrow on **Figure 7** to represent the alpha decay.

[2 marks]

Figure 7



0 6 . 4 What is meant by the 'random nature of radioactive decay'?

[1 mark]

4.4.1.1 The structure of an atom

Question 78 · continued

0 6 . 5 A polonium (Po) nucleus decays by emitting an alpha particle and forming a lead (Pb) nucleus.

$$Po \rightarrow Pb + \alpha$$

The lead (Pb) nucleus then decays by emitting a beta particle and forms a bismuth (Bi) nucleus.

$$Pb \rightarrow Bi + \beta$$

The bismuth (Bi) nucleus then decays by emitting a beta particle and forms a polonium (Po) nucleus.

$$Bi \rightarrow Po + \beta$$

Explain how these three decays result in a nucleus of the original element, polonium.

[3 marks]

8

4.4.1.1 The structure of an atom

Question 79

June 2022 | 8463/1H | Original Q7

0 7 Alpha particles, beta particles and gamma rays are types of nuclear radiation.

0 7 . 1 What does an alpha particle consist of?

[1 mark]

0 7 . 2 A krypton (Kr) nucleus decays into a rubidium (Rb) nucleus by emitting a beta particle.

Complete the nuclear equation for this decay by writing the missing number in each box.

[2 marks]

$$\square_{36}\mathrm{Kr} \longrightarrow \square^{85}\mathrm{Rb} + {}^{0}_{-1}\mathrm{e}$$

0 7 . 3 Internal contamination of the human body means radioactive material is inside the human body.

Explain how the risk from internal contamination is different to the risk from external irradiation by a source of alpha radiation.

[5 marks]

8

4.4.1.1 The structure of an atom

Question 80

June 2023 | 8463/1H | Original Q5

0 5 Some isotopes emit nuclear radiation.

0 5 . 1 Carbon-14 and carbon-12 are isotopes of carbon.

Compare the structure of an atom of carbon-14 with the structure of an atom of carbon-12.

[3 marks]

0 5 . 2 Carbon-14 is a radioactive isotope.

Carbon-14 has a half-life of 5700 years.

What does 'a half-life of 5700 years' mean?

[1 mark]

Question 5 continues on the next page

Question 80 · continued

Table 1 gives the half-life of some other radioactive isotopes.

Table 1

Isotope	Half-life in seconds
Nitrogen-18	0.62
Nitrogen-17	4.17
Fluorine-17	64.37
Fluorine-18	6584.34

0 5 . 3 A sample of fluorine-17 has an activity that is one quarter of its original activity.

Calculate the age of the sample of fluorine-17.

[2 marks]

Age = _____ s

0 5 . 4 All of the isotopes in **Table 1** emit beta radiation.

Explain which isotope would cause the biggest risk to a person's health based only on the half-life of each isotope.

[3 marks]

4.4.1.1 The structure of an atom

Question 80 · continued

0 5 . 5 People who work in the nuclear power industry need to be aware of irradiation and contamination.

Describe the difference between irradiation and contamination.

[2 marks]

0 5 . 6 Give **one** health risk to a person working close to a source of nuclear radiation.

[1 mark]

0 5 . 7 Workers in nuclear power stations are monitored to check the radiation they emit.

A worker stands 1 cm away from a radiation detector.

The amount of radiation the worker emits is recorded.

Explain why the worker needs to stand close to the radiation detector.

[2 marks]

4.4.1.1 The structure of an atom

Question 80 · continued

0 5 . 8 Workers in the nuclear power industry are exposed to nuclear radiation.

Pilots on aircraft are exposed to cosmic radiation from space.

daily dose caused by working in a nuclear power station = 0.00050 mSv

hourly dose from cosmic rays to a pilot while flying = 0.0030 mSv

Calculate the number of days it takes for a nuclear power station worker to receive the same dose as a pilot flying for 24 hours.

[3 marks]

Number of days = _____

17

4.4.1.1 The structure of an atom

Question 81

June 2023 | 8463/1H | Original Q8

0 8 Scientists developed new models of the atom as new particles were discovered.

0 8 . 1 Draw **one** line from each particle to the year it was discovered.

[2 marks]

Particle	Year of discovery
Electron	1897
Neutron	1911
Nucleus	1920
Proton	1932

Question 8 continues on the next page

4.4.1.1 The structure of an atom

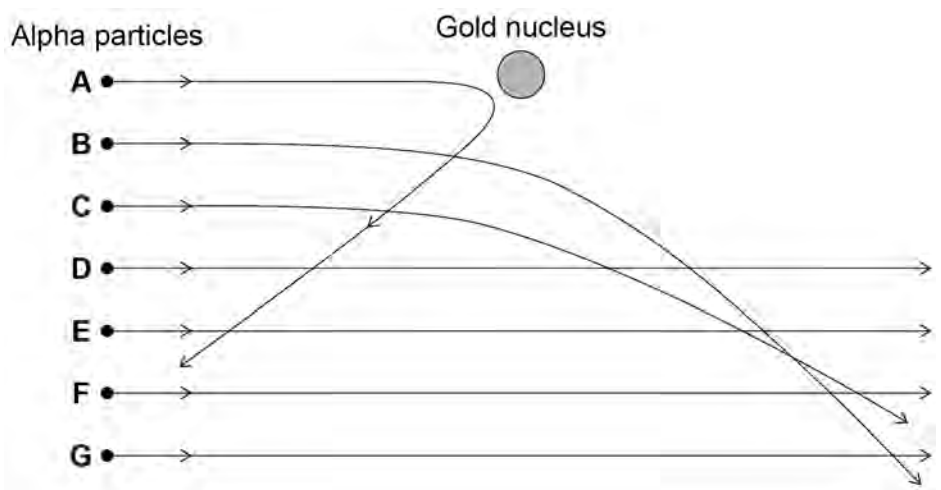
Question 81 · continued

The nucleus was discovered using an alpha particle scattering experiment.

Alpha particles were directed at a sheet of gold foil.

Figure 8 shows the paths taken by seven alpha particles, **A**, **B**, **C**, **D**, **E**, **F** and **G**.

Figure 8



0 8 . 2 Explain why alpha particle **A** takes the path shown in **Figure 8**.

[2 marks]

0 8 . 3 Explain why the path of alpha particle **B** is more tightly curved than the path of alpha particle **C**.

[2 marks]

4.4.1.1 The structure of an atom

Question 81 · continued

0 8 . 4 What can be deduced about the atom from the paths taken by alpha particles **D**, **E**, **F** and **G** in **Figure 8**?

[1 mark]

Tick (✓) **one** box.

The atom contains a nucleus. ☐

The atom contains protons, neutrons and electrons. ☐

The atom is mostly empty space. ☐

0 8 . 5 How is the Bohr model of the atom different from the nuclear model of the atom?

[1 mark]

0 8 . 6 Explain how an electron can move up and down between energy levels in an atom.

[2 marks]

10

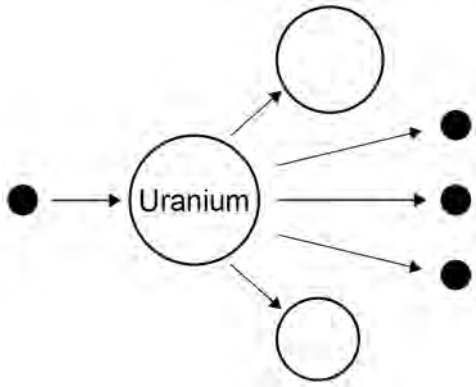
4.4.1.1 The structure of an atom

Question 82

0 2 The process of nuclear fission is used in nuclear power stations.

Figure 2 shows the process of nuclear fission.

Figure 2



0 2 . 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 2** splits into two parts and

releases three _____.

The process of nuclear fission releases electromagnetic radiation in the

form of _____.

4.4.1.1 The structure of an atom

Question 82 · continued

Use the Physics Equations Sheet to answer questions **02.2** and **02.3**.

0 2 . 2 Write down the equation which links energy (*E*), power (*P*) and time (*t*).

[1 mark]

0 2 . 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

0 2 . 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]

4.4.1.1 The structure of an atom

Question 82 · continued

0 2 . 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

4.4.1.1 The structure of an atom

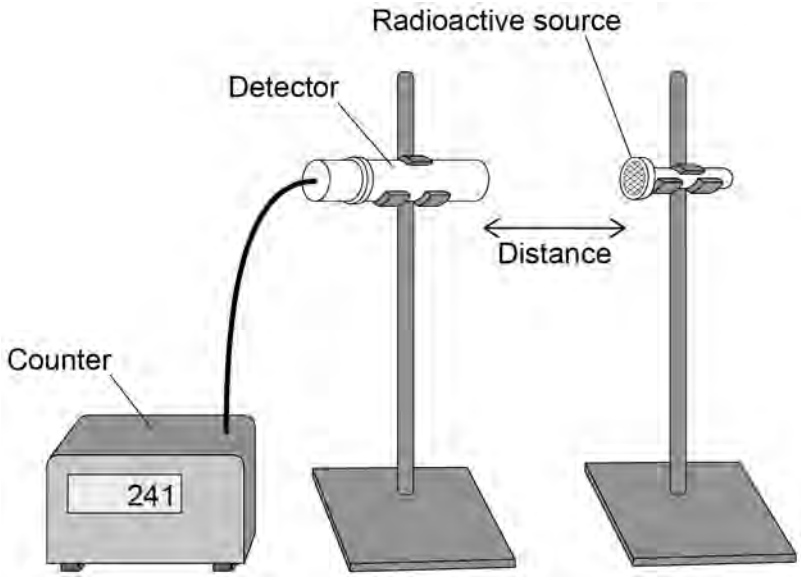
Question 83

June 2024 | 8463/1H | Original Q9

0 9 A teacher investigated the radiation emitted by two different radioactive sources, **A** and **B**.

Figure 14 shows a radiation detector positioned near one of the radioactive sources.

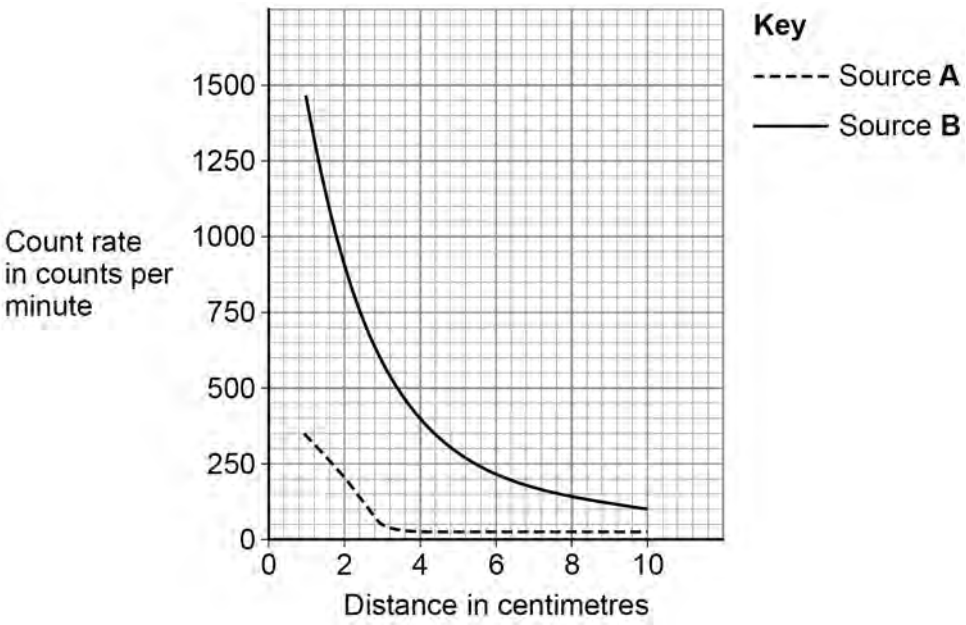
Figure 14



The teacher measured the count rate at different distances for each radioactive source.

Figure 15 shows the results.

Figure 15



4.4.1.1 The structure of an atom

Question 83 · continued

0 9 . 1 Explain how **Figure 15** shows that Source **A** only emits alpha radiation.

[3 marks]

0 9 . 2 **Figure 15** can **not** be used to determine if Source **B** emits beta radiation or gamma radiation.

Explain how an absorbing material could be used to show which type of radiation is emitted by Source **B**.

[2 marks]

Question 9 continues on the next page

4.4.1.1 The structure of an atom

Question 83 · continued

The teacher took safety precautions during the experiment.

0 9 . 3 Suggest **one** safety precaution the teacher would have taken to reduce the radiation dose the teacher received.

[1 mark]

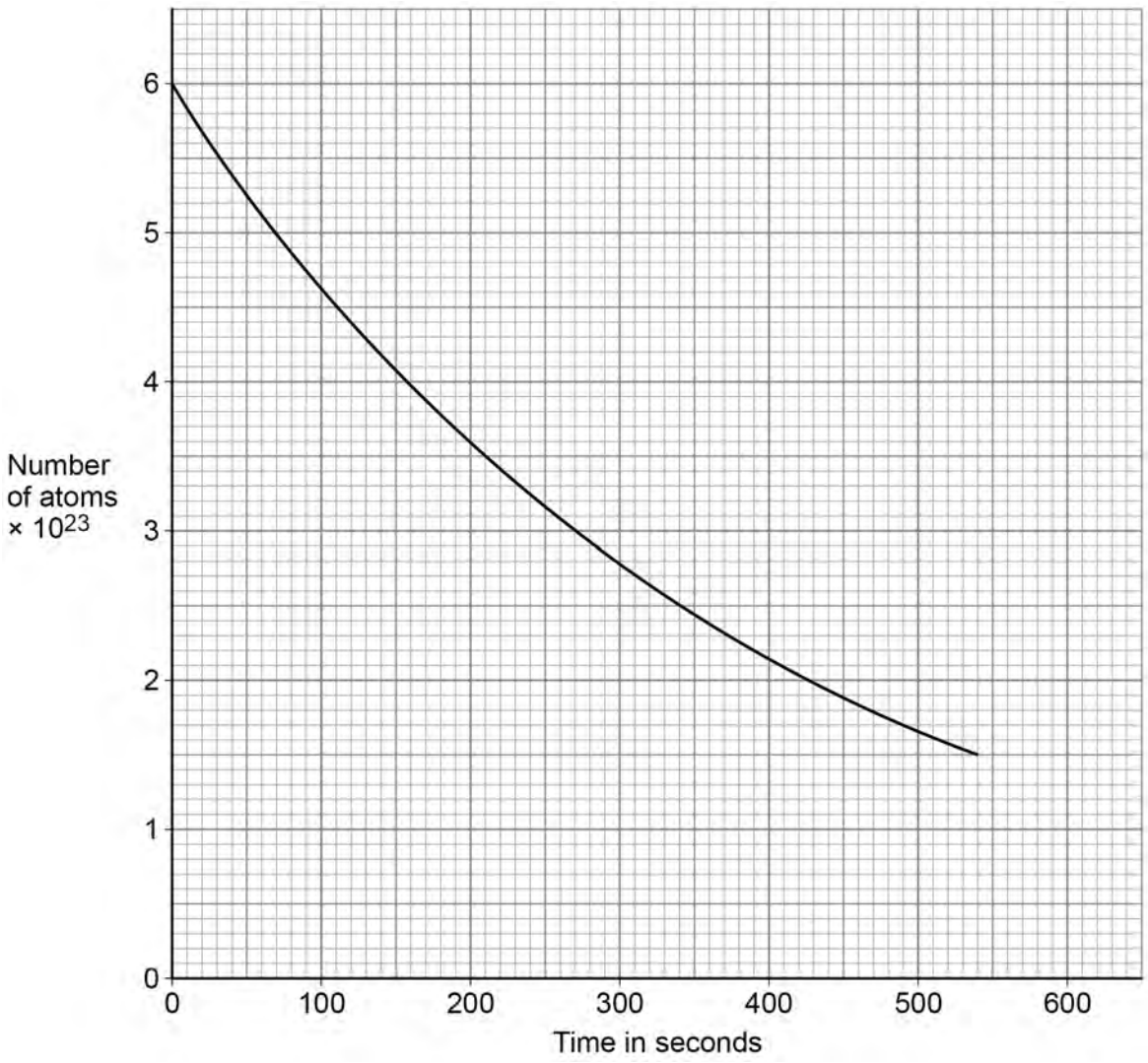
0 9 . 4 Suggest **one** safety precaution that the teacher would have taken to avoid becoming contaminated.

[1 mark]

Question 83 · continued

0 9 . 5 **Figure 16** shows how the number of atoms of a radioactive element in a sample varied with time.

Figure 16



Activity is the rate at which a source of unstable nuclei decays.

Determine the activity of the radioactive sample at 300 seconds.

Give the unit.

[4 marks]

Activity = _____ Unit _____

11

4.4.1.1 The structure of an atom

Question 84

June 2025 | 8463/1H | Original Q7

0 7 Some atoms emit radiation.

0 7 . 1 Why do scientists sometimes change the model used to describe the structure of the atom?

[1 mark]

Tick (✓) **one** box.

- Existing models use ideas that are old fashioned. ☐
- New evidence is discovered that existing models cannot explain. ☐
- Scientists need to develop new models every 100 years. ☐
- The public do not understand old models so new ones are created. ☐

0 7 . 2 When radioactivity was discovered, the dangers of radiation were not known.

Some scientists were irradiated and contaminated while working with the radioactive materials.

Describe the difference between irradiation and radioactive contamination.

[2 marks]

Question 7 continues on the next page

4.4.1.1 The structure of an atom

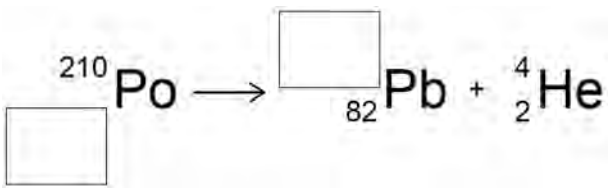
Question 84 · continued

0 7 . 3 Polonium-210 was one of the first radioactive elements to be discovered.

Polonium-210 (Po) decays into lead (Pb).

Complete the nuclear equation for polonium-210.

[2 marks]



0 7 . 4 Polonium-210 has a half-life of 138 days.

A sample of polonium contains 256 000 atoms.

Calculate the time taken for the number of polonium-210 atoms to reach 16 000.

[3 marks]

Time taken = _____ days

4.4.1.1 The structure of an atom

Question 84 · continued

0 7 . 5 A sample of polonium contains equal numbers of polonium-209 atoms and polonium-210 atoms.

Polonium-209 has a half-life of 125 **years**.

Polonium-210 has a half-life of 138 **days**.

Explain how the activity of polonium-209 compares with the activity of polonium-210 in this sample.

[2 marks]

10

Turn over for the next question