AQA GCSE Physics | 8463

SPECIFICATION POINT 4.4.1.1

The structure of an atom

Past-paper questions

Tier	**Foundation**
Question groups	**90**
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:** _____

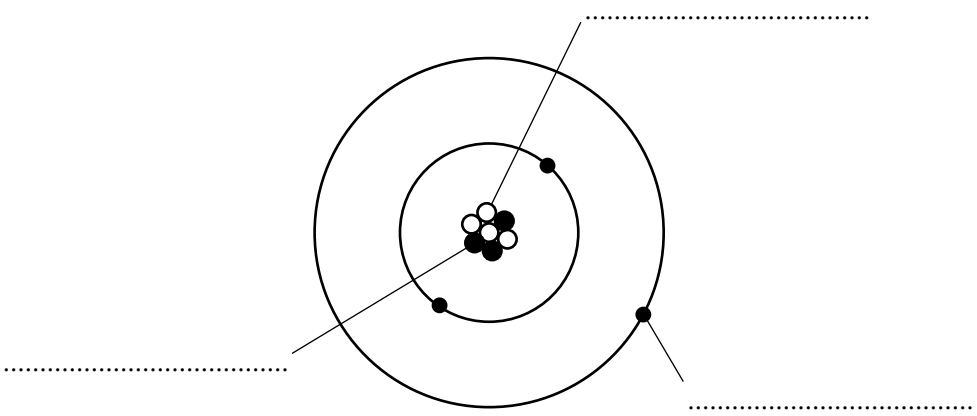
Whole questions are retained for context, so some parts assess other specification points. Current and legacy sources are labelled. Continue on extra paper if needed.

4.4.1.1 The structure of an atom

Question 01

June 2003 | 3451F | Original Q6 | Legacy

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



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

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

(3 marks)

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

.....

(1 mark)

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

.....

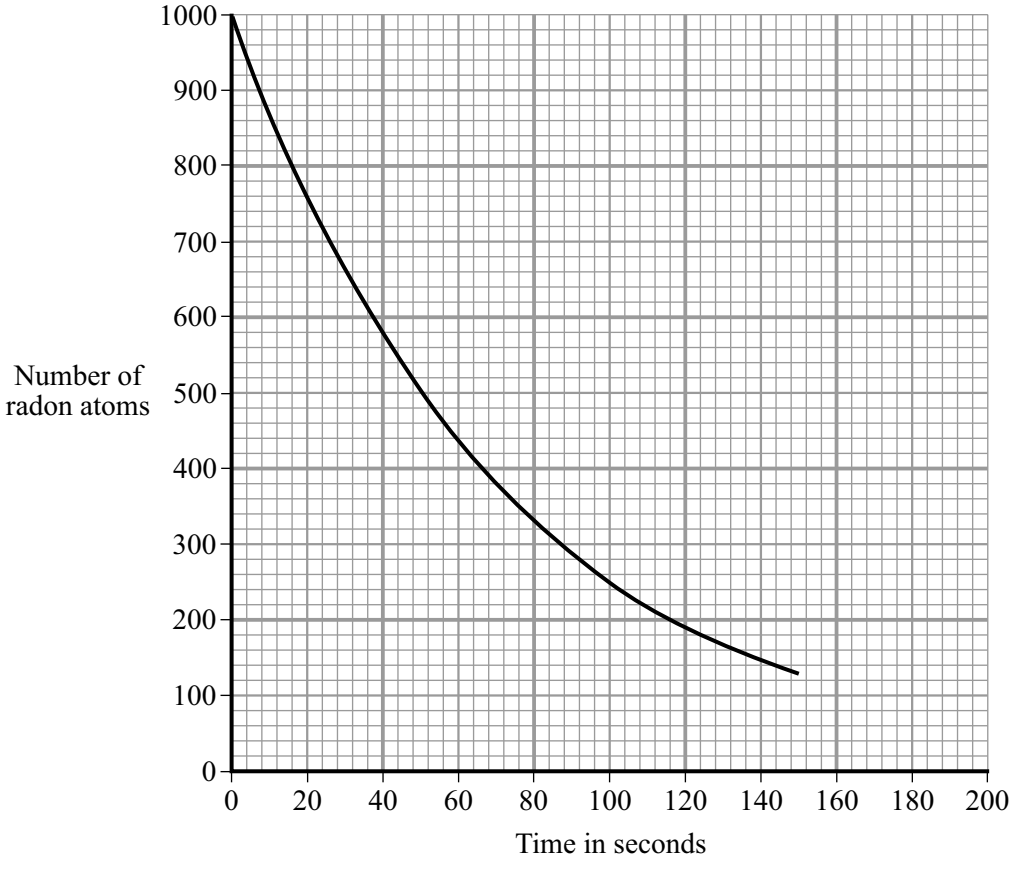
Give a reason for your choice.

.....

.....

(2 marks)

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



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

Time = ...seconds
(1 mark)

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

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

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

As a radioactive material gets older, it emits

less
a constant level of
more

radiation per second.

(1 mark)

9

4.4.1.1 The structure of an atom

Question 02

June 2003 | 3451F | Original Q12 | Legacy

12 (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 02 · continued

MARGIN BLANK

(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)

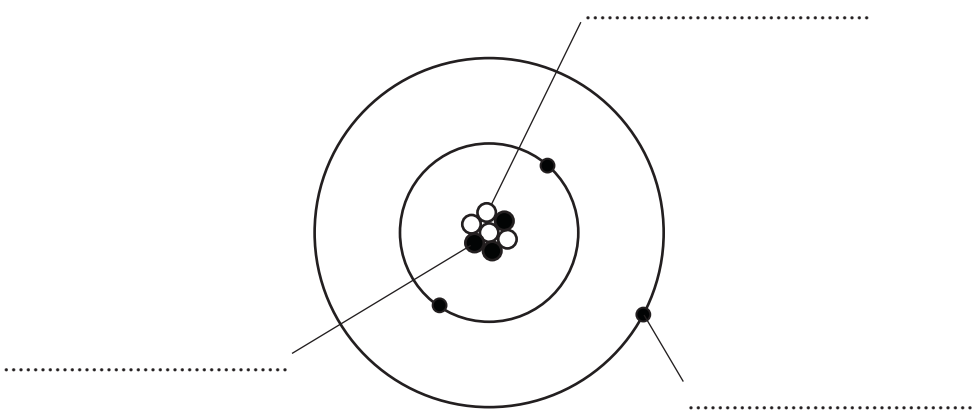
8

4.4.1.1 The structure of an atom

Question 03

June 2003 | 3462F3 | Original Q6 | Legacy

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



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

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

(3 marks)

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

.....

(1 mark)

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

.....

Give a reason for your choice.

.....

.....

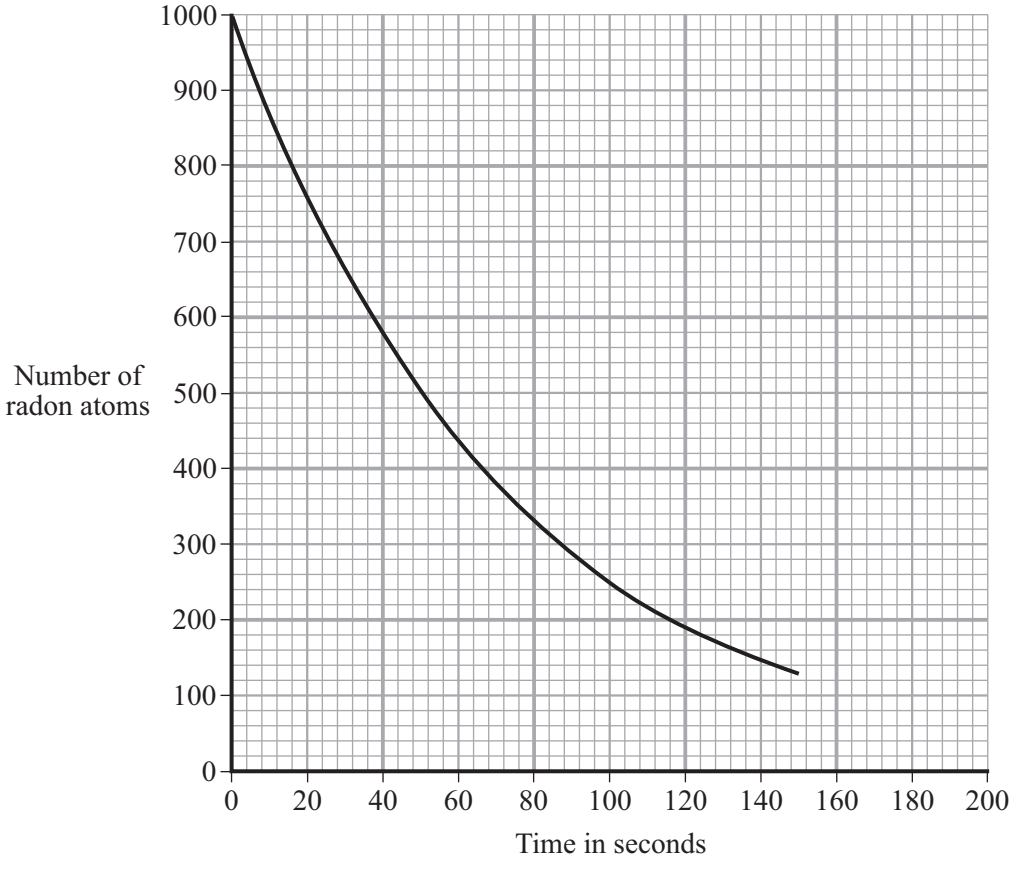
(2 marks)

4.4.1.1 The structure of an atom

Question 03 · continued

MARGIN BLANK

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



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

Time = ...seconds

(1 mark)

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

Half-life = ...seconds

(1 mark)

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

As a radioactive material gets older, it emits

less
a constant level of
more

radiation per second.

(1 mark)

9

4.4.1.1 The structure of an atom

Question 04

June 2003 | 3462F3 | Original Q10 | Legacy

10 (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 2004 | 3451F | Original Q2 | Legacy

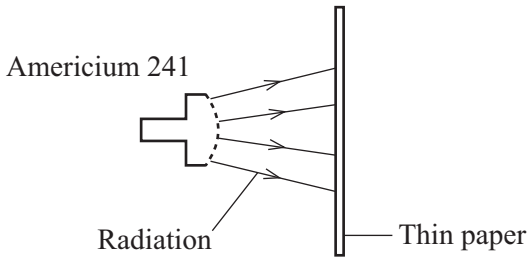
2 A smoke detector fitted inside a house contains a radioactive source, americium 241.

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

Number of neutrons	146
Number of protons	95
Number of electrons	

(1 mark)

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



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

.....

(1 mark)

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

.....

.....

.....

.....

(2 marks)

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

less than	**more than**	**the same as**

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

(1 mark)

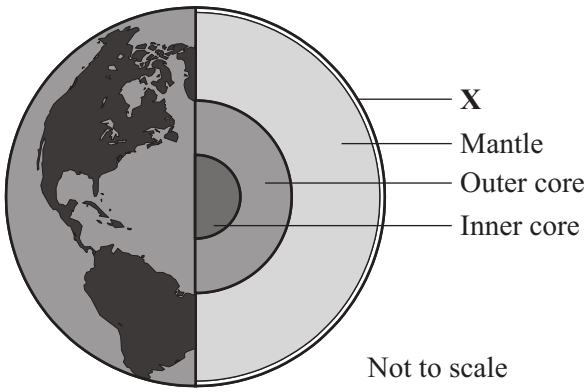
5

4.4.1.1 The structure of an atom

Question 06

June 2004 | 3451F | Original Q5 | Legacy

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



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

.....

(1 mark)

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

.....

.....

(2 marks)

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

Draw a ring around your answer.

barograph **seismograph** **tachograph**

(1 mark)

4.4.1.1 The structure of an atom

Question 06 · continued

MARGIN BLANK

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

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

.....

.....

.....

.....

(2 marks)

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

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

Draw a ring around your answer.

geometric **geostationary** **geothermal**

(1 mark)

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

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

.....

(1 mark)

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

.....

(1 mark)

9

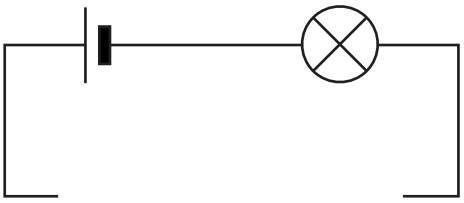
4.4.1.1 The structure of an atom

Question 07

June 2004 | 3451F | Original Q7 | Legacy

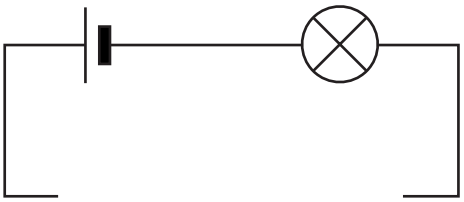
7 (a) Each diagram shows a cell connected to a lamp.

(i) Add **two** switches and connecting wires to the diagram below so that the lamp will light **only** when **both** switches are closed.



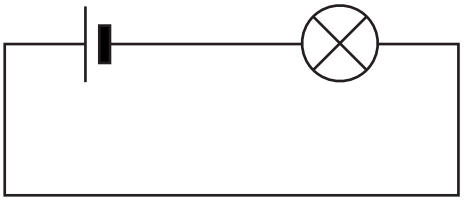
(1 mark)

(ii) Add **two** switches and connecting wires to the diagram below so that the lamp will light when either **one** or **both** switches are closed.



(1 mark)

(iii) Add **one** switch and connecting wires to the diagram below so that the lamp is **on** when the switch is **open** and the lamp is **off** when the switch is **closed**.



(1 mark)

(iv) Complete the table to name the type of logic gate represented by each circuit in parts (i), (ii) and (iii) above.

Circuit	Name of the logic gate
(a)(i)	.....
(a)(ii)	.....
(a)(iii)	.....

(3 marks)

4.4.1.1 The structure of an atom

Question 07 · continued

MARGIN
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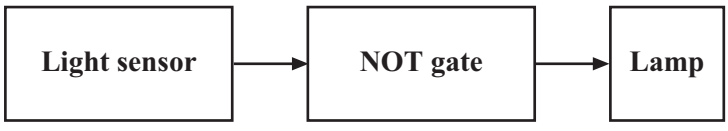
(b) The block diagram represents an electronic system.



(i) Describe how the system works.

.....

.....

.....

(2 marks)

(ii) Suggest a practical use for this system.

.....

.....

(1 mark)

(c) (i) Draw the symbol used in electronic circuits for a NOT gate.

(1 mark)

(ii) Use **0** and **1** to complete the table for a NOT gate.

Input	Output
.....	.....
.....	.....

(1 mark)

(iii) What is the name of the sort of table shown in part (c)(ii)?

.....

(1 mark)

4.4.1.1 The structure of an atom

Question 08

June 2004 | 3451F | Original Q14 | Legacy

14 (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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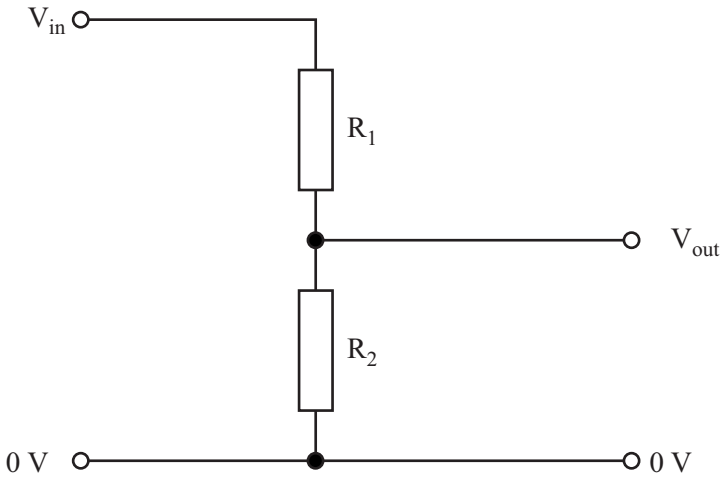
(c) The diagram shows part of an electronic circuit. This part is connected to the processor.



(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)

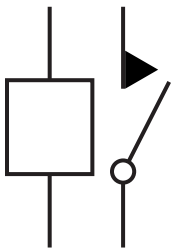
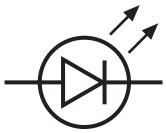
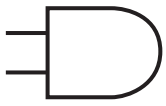
10

4.4.1.1 The structure of an atom

Question 09

June 2004 | 3451F | Original Q15 | Legacy

15 (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 09 · 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)

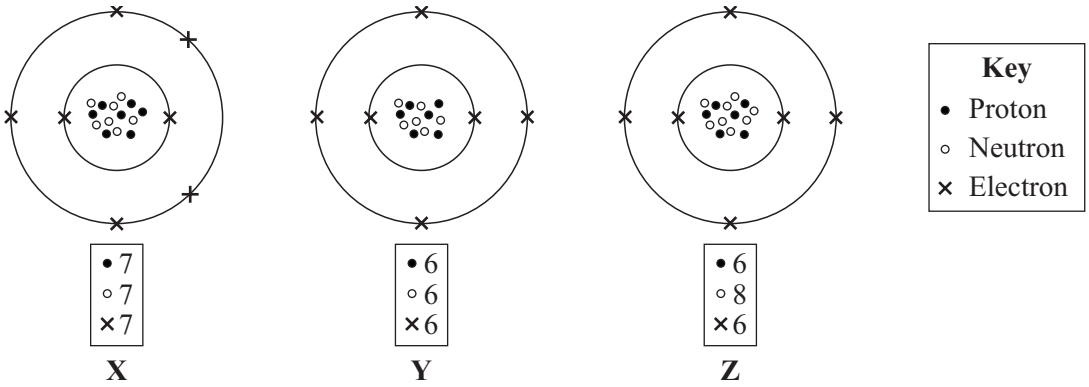
10

4.4.1.1 The structure of an atom

Question 10

June 2004 | 3451F | Original Q16 | Legacy

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



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

.....

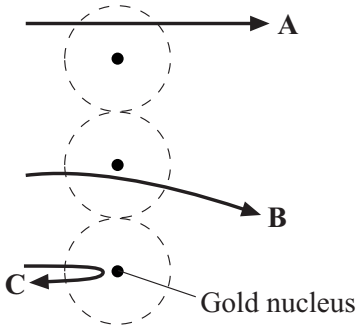
Give a reason for your answer.

.....

.....

(2 marks)

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



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

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

.....

.....

.....

.....

.....

(3 marks)

5

4.4.1.1 The structure of an atom

Question 11

June 2004 | 3462F3 | Original Q2 | Legacy

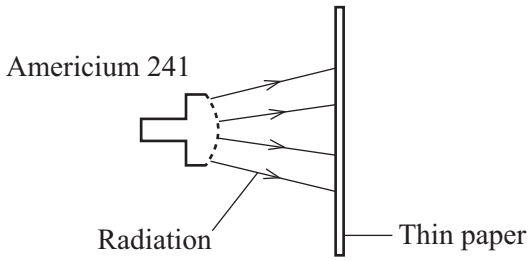
2 A smoke detector fitted inside a house contains a radioactive source, americium 241.

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

Number of neutrons	146
Number of protons	95
Number of electrons	

(1 mark)

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



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

.....

(1 mark)

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

.....

.....

.....

.....

(2 marks)

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

less than	**more than**	**the same as**

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

(1 mark)

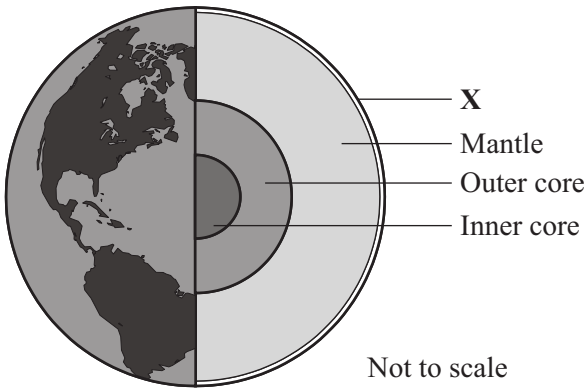
5

4.4.1.1 The structure of an atom

Question 12

June 2004 | 3462F3 | Original Q5 | Legacy

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



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

.....

(1 mark)

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

.....

.....

(2 marks)

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

Draw a ring around your answer.

barograph **seismograph** **tachograph**

(1 mark)

4.4.1.1 The structure of an atom

Question 12 · continued

MARGIN BLANK

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

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

.....

.....

.....

.....

(2 marks)

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

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

Draw a ring around your answer.

geometric **geostationary** **geothermal**

(1 mark)

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

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

.....

(1 mark)

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

.....

(1 mark)

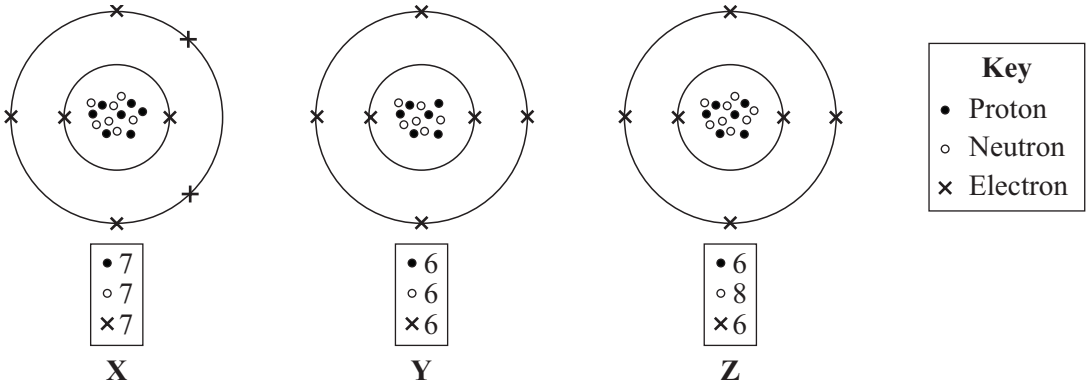
9

4.4.1.1 The structure of an atom

Question 13

June 2004 | 3462F3 | Original Q12 | Legacy

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



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

.....

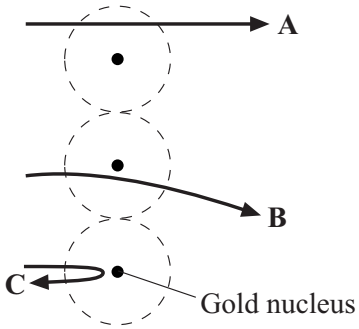
Give a reason for your answer.

.....

.....

(2 marks)

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



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

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

.....

.....

.....

.....

.....

(3 marks)

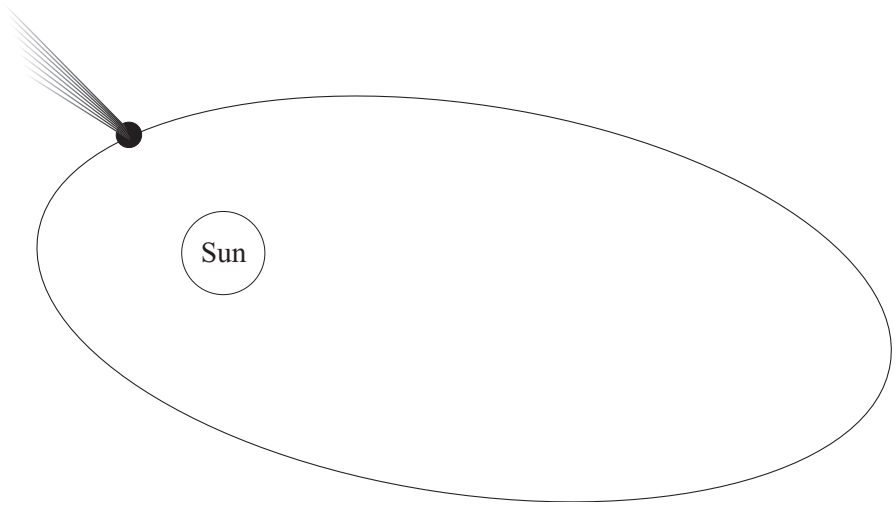
5

4.4.1.1 The structure of an atom

Question 14

June 2005 | 3451 | Original Q2 | Legacy

2 (a) The diagram shows an object in orbit around the Sun.



Which **one** of the following is the object most likely to be?

Draw a ring around your answer.

comet **moon** **planet** **star**

(1 mark)

(b) The Sun is part of the Milky Way galaxy.
What is a galaxy?

.....

(1 mark)

(c) Complete the following sentence by choosing the correct words from the box.
Each word may be used once or not at all.

dwarf	**giant**	**neutron**	**proton**	**supernova**

If a red ..... star is large enough, it may eventually blow up in an explosion called a ....., leaving behind a very dense ..... star.

(3 marks)

5

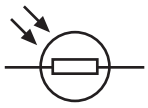
4.4.1.1 The structure of an atom

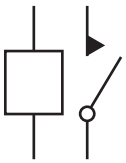
Question 15

June 2005 | 3451 | Original Q9 | Legacy

9 (a) Name each of the following circuit symbols.



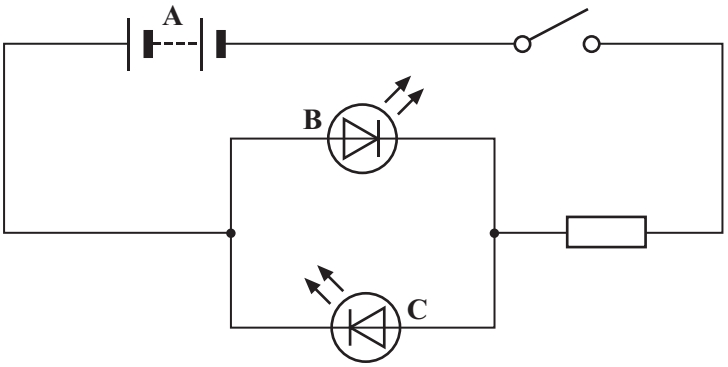




....

(3 marks)

(b) The diagram shows a circuit.



(i) Name part **A**.

.....

(1 mark)

(ii) Name part **B**.

.....

(1 mark)

(iii) What will you see happen when the switch is closed?

.....

.....

(1 mark)

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

.....

.....

(1 mark)

4.4.1.1 The structure of an atom

Question 15 · continued

1 /

MARGIN BLANK

(c) (i) Complete the table for an AND gate.

First input	Second input	Output
0	0	.....
1	0	.....
0	1	.....
1	1	.....

(1 mark)

(ii) What is this sort of table called?

.....

(1 mark)

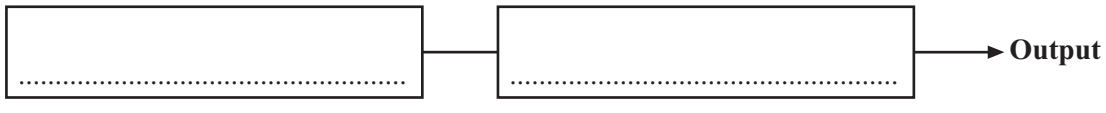
(iii) Draw the circuit symbol for an AND gate.

(1 mark)

(d) In another circuit, two electronic components are connected in series. The table shows the output from them when it is dark and when it is light.

Condition	Output
Dark	1
Light	0

Complete the boxes by adding the names of **two** suitable components in their correct order.



(2 marks)

12

4.4.1.1 The structure of an atom

Question 16

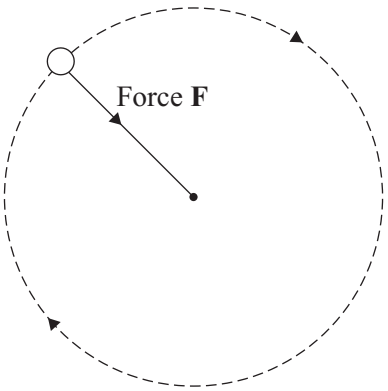
June 2005 | 3451 | Original Q15 | Legacy

15 (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 16 · 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

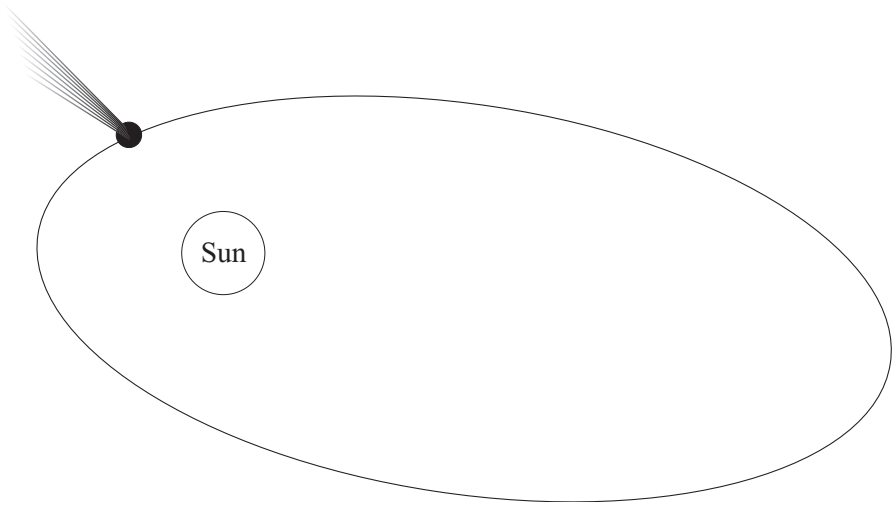
TURN OVER FOR THE NEXT QUESTION

4.4.1.1 The structure of an atom

Question 17

June 2005 | 3462 | Original Q2 | Legacy

2 (a) The diagram shows an object in orbit around the Sun.



Which **one** of the following is the object most likely to be?

Draw a ring around your answer.

comet **moon** **planet** **star**

(1 mark)

(b) The Sun is part of the Milky Way galaxy.
What is a galaxy?

.....

(1 mark)

(c) Complete the following sentence by choosing the correct words from the box.
Each word may be used once or not at all.

dwarf	**giant**	**neutron**	**proton**	**supernova**

If a red ..... star is large enough, it may eventually blow up in an explosion called a ....., leaving behind a very dense ..... star.

(3 marks)

5

4.4.1.1 The structure of an atom

Question 18

June 2006 | 3451 | Original Q4 | Legacy

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

Diagram A



2 protons ⊕
4 neutrons ○

Diagram B



3 protons ⊕
3 neutrons ○

Diagram C



2 protons ⊕
2 neutrons ○

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

..... and .....

(1 mark)

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

..... and .....

(1 mark)

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

.....

.....

(1 mark)

4.4.1.1 The structure of an atom

Question 18 · continued

BLANK

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

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

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

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

..... and .....

(1 mark)

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

..... and .....

(1 mark)

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

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

alpha
beta
gamma

radiation.

(1 mark)

6

4.4.1.1 The structure of an atom

Question 19

June 2006 | 3451 | Original Q10 | Legacy

10 (a) The diagram shows an electronic system.



Use a word from the box to fill in each space. Each word should be used only once.

buzzers	LDRs	LEDs	motors	switches	thermistors

Input sensors include:

- ..... which respond to changes in temperature;
- ..... which respond to changes in light;
- ..... which respond to changes in pressure.

Processors can be made using logic gates.

Output devices include:

- ..... which produce light;
- ..... which produce sound;
- ..... which produce movement.

(6 marks)

Question 19 · continued

BLANK

(b) Complete the truth tables by writing **1** or **0** in each space in the output column.

(i) AND gate

1st input	2nd input	Output
0	0	.....
1	0	.....
0	1	.....
1	1	1

(1 mark)

(ii) NOT gate

Input	Output
0	.....
1	.....

(1 mark)

(iii) OR gate

1st input	2nd input	Output
0	0	0
1	0	.....
0	1	.....
1	0	.....

(1 mark)

(c) Capacitors can be used as simple timers in electronic circuits.

(i) Draw a circuit symbol for a capacitor.

(1 mark)

(ii) Complete the sentence.

When a current flows to an uncharged capacitor, ... is stored and the potential difference across the capacitor ..... .

(2 marks)

12

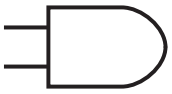
4.4.1.1 The structure of an atom

Question 20

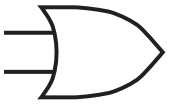
June 2006 | 3451 | Original Q18 | Legacy

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

Name the components with these symbols.



.....



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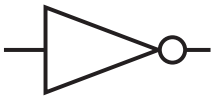

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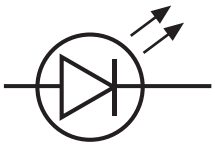
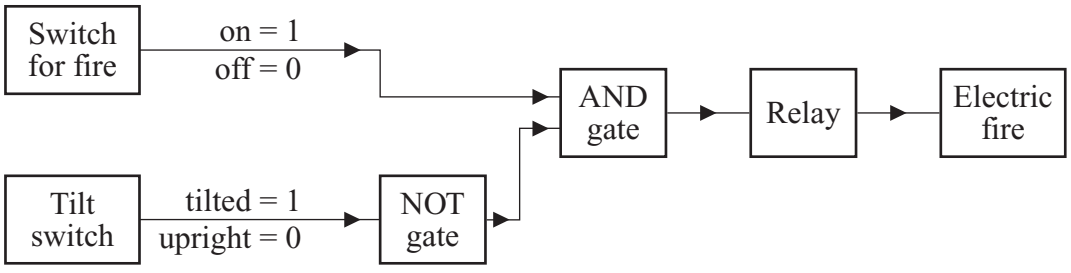


.....

(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.

.....

.....

.....

.....

.....

.....

.....

.....

(4 marks)

10

4.4.1.1 The structure of an atom

Question 21

June 2006 | 3462 | Original Q4 | Legacy

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

Diagram A



2 protons ⊕
4 neutrons ○

Diagram B



3 protons ⊕
3 neutrons ○

Diagram C



2 protons ⊕
2 neutrons ○

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

..... and .....

(1 mark)

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

..... and .....

(1 mark)

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

.....

.....

(1 mark)

4.4.1.1 The structure of an atom

Question 21 · continued

BLANK

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

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

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

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

..... and .....

(1 mark)

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

..... and .....

(1 mark)

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

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

alpha beta gamma

radiation.

(1 mark)

6

4.4.1.1 The structure of an atom

Question 22

November 2006 | PHY1B | Original Q7 | Legacy

QUESTION SEVEN

Hospital patients are sometimes injected with radioactive tracers.



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

1 to identify the patient's blood group.

2 to sedate the patient before an operation.

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

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

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

1 a gamma emitter with a long half-life

2 a gamma emitter with a short half-life

3 an alpha emitter with a long half-life

4 an alpha emitter with a short half-life

4.4.1.1 The structure of an atom

Question 22 · continued

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

1 It is a stream of electrons.

2 It is a stream of protons.

3 It is deflected by an electric field.

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

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

It is a group of . . .

1 electrons and neutrons.

2 electrons, neutrons and protons.

3 electrons and protons.

4 neutrons and protons.

4.4.1.1 The structure of an atom

Question 23

November 2006 | PHY1B | Original Q9 | Legacy

QUESTION NINE

Read this extract from a science magazine.

Stone Age campfire found in Norfolk

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

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

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

1 a copper coin.

2 a gold brooch.

3 a leather belt.

4 an iron horseshoe.

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

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

1 6 billion

2 12 billion

3 24 billion

4 48 billion

Question 23 · continued

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

Four students discuss this.

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

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

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

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

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

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

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

2 an electron from the outer part of the atom.

3 a helium nucleus.

4 a neutron.

END OF TEST

4.4.1.1 The structure of an atom

Question 24

March 2007 | PHY1B | Original Q2 | Legacy

QUESTION TWO

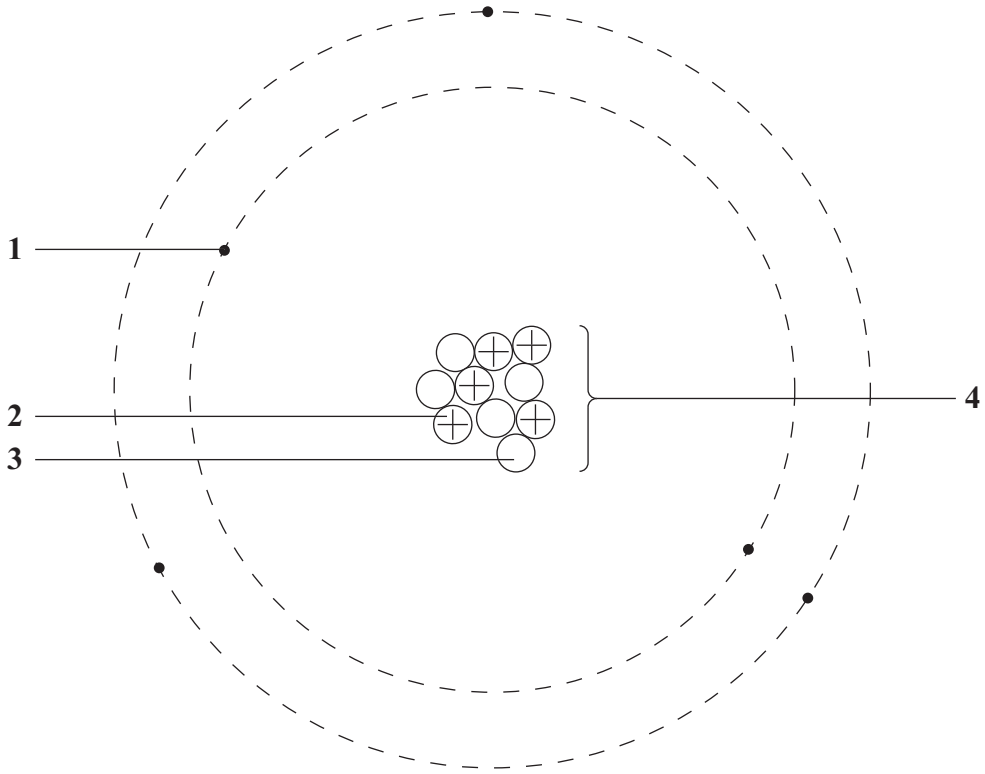
Match words, **A**, **B**, **C** and **D**, with the labels **1–4** on the diagram of an atom.

A electron

B nucleus

C neutron

D proton



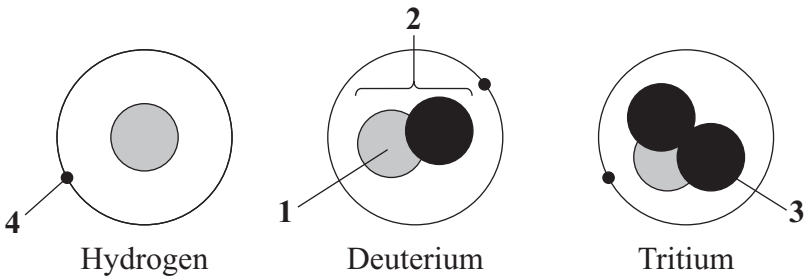
4.4.1.1 The structure of an atom

Question 25

June 2007 | PHY1B | Original Q3 | Legacy

QUESTION THREE

The diagrams show three isotopes of hydrogen.



Match the parts of atoms, **A**, **B**, **C** and **D**, with the labels **1–4** on the diagrams.

A electron

B neutron

C nucleus

D proton

4.4.1.1 The structure of an atom

Question 26

June 2007 | PHY1B | Original Q9 | Legacy

QUESTION NINE

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

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

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

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

1 2

2 3

3 79

4 82

9B A city in Ukraine has 200 000 children.

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

1 1

2 2

3 5

4 49

4.4.1.1 The structure of an atom

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

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

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

1 25

2 50

3 75

4 100

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

1 alpha radiation

2 beta radiation

3 gamma radiation

4 ultraviolet radiation

END OF TEST

4.4.1.1 The structure of an atom

Question 27

June 2007 | PHY1F | Original Q6 | Legacy

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

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

.....

(1 mark)

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

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

.....

.....

(1 mark)

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

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

electrons	**neutrons**	**protons**

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

(1 mark)

Question 6 continues on the next page

Question 27 · continued

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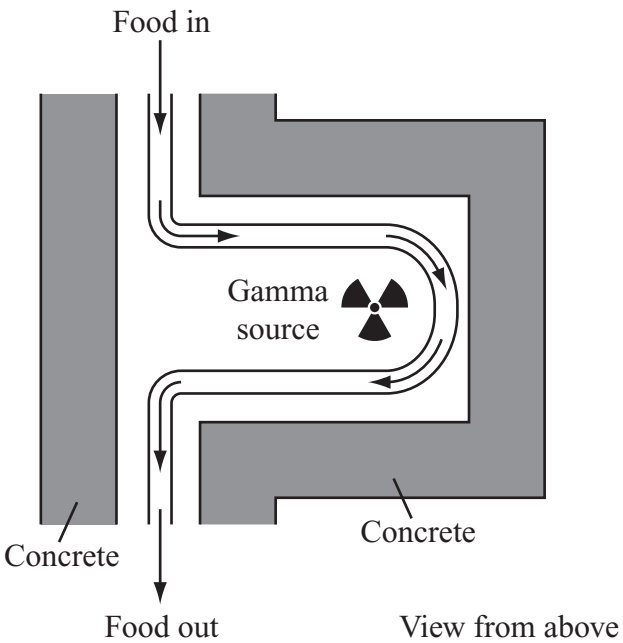
(b) The diagram shows how a conveyor belt can be used to move food past the radioactive source.



(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 27 · continued

BLANK

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

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

.....

.....

.....

.....

(2 marks)

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



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

.....

.....

(1 mark)

8

4.4.1.1 The structure of an atom

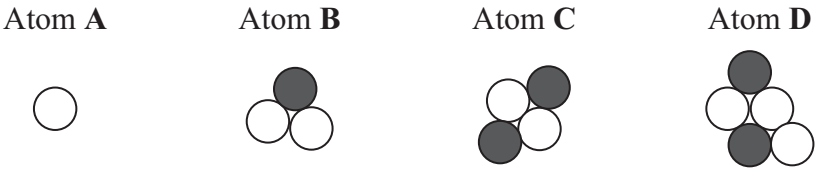
Question 28

November 2007 | PHY1B | Original Q4 | Legacy

QUESTION FOUR

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

Two of the atoms are isotopes of the same element.



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

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

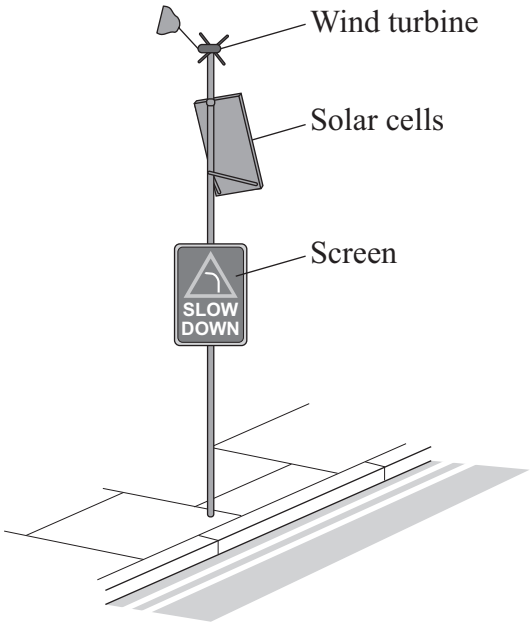
4.4.1.1 The structure of an atom

Question 29

March 2008 | PHY1AP | Original Q2 | Legacy

QUESTION TWO

The diagram shows an electronic road sign.



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

A electrical energy

B thermal energy

C light energy

D kinetic energy

The useful energy output from the screen is . . . **1** . . . .

The energy input to the wind turbine is . . . **2** . . . .

The useful energy output from the solar cells is . . . **3** . . . .

The wasted energy output from the road sign is . . . **4** . . . .

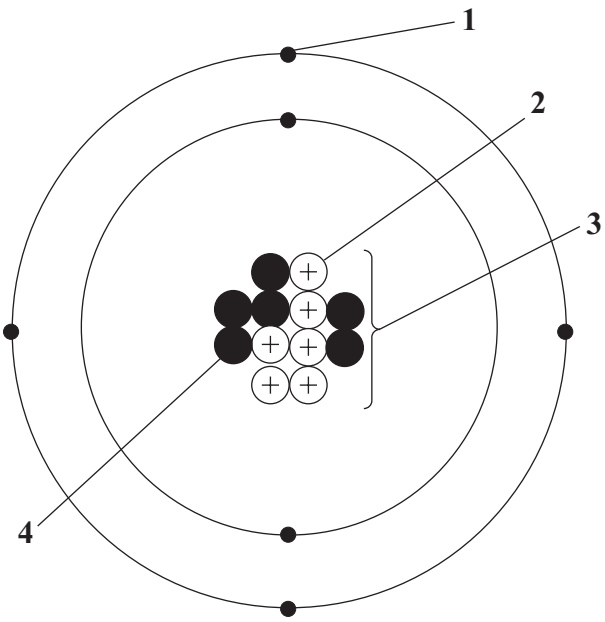
4.4.1.1 The structure of an atom

Question 30

March 2008 | PHY1BP | Original Q2 | Legacy

QUESTION TWO

The diagram shows an atom.



Match parts of the atom, **A**, **B**, **C** and **D**, with the labels **1–4** on the diagram.

A electron

B neutron

C nucleus

D proton

4.4.1.1 The structure of an atom

Question 31

June 2008 | PHY1BP | Original Q3 | Legacy

QUESTION THREE

This question is about the particles that make up an atom.

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

A electrons

B neutrons

C protons and electrons

D protons and neutrons

are outside the nucleus	**1**
are present in different numbers in isotopes of the same element	**2**
are the only particles in the nucleus	**3**
their numbers tell you to which element an atom belongs	**4**

4.4.1.1 The structure of an atom

Question 32

June 2008 | PHY1BP | Original Q9 | Legacy

QUESTION NINE

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

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

9A Which isotope emits an electron from the nucleus?

1 **P**

2 **Q**

3 **R**

4 **S**

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

1 **P**

2 **Q**

3 **R**

4 **S**

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

1 **P**

2 **Q**

3 **R**

4 **S**

4.4.1.1 The structure of an atom

Question 32 · continued

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

1 **P**

2 **Q**

3 **R**

4 **S**

END OF TEST

4.4.1.1 The structure of an atom

Question 33

June 2008 | PHY1F | Original Q3 | Legacy

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

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

List A Type of nuclear radiation	**List B** Property of radiation
	not deflected by an electric field
alpha	
	stopped by thin metal but not paper
beta	
	the most strongly ionising
gamma	
	will not harm living cells

(3 marks)

4.4.1.1 The structure of an atom

Question 33 · continued

for mark

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

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

(1 mark)

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

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

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

Give **two** reasons for your answer.

1 .....

.....

2 .....

.....

(3 marks)

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

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

.....

.....

(1 mark)

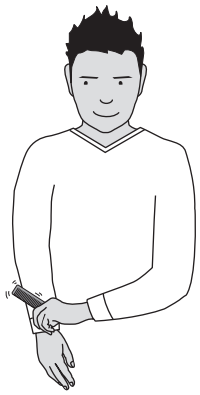
8

4.4.1.1 The structure of an atom

Question 34

June 2008 | PHY2F | Original Q2 | Legacy

2 (a) A student rubs a nylon comb on the sleeve of his jumper.



2 (a) (i) Use words from the box to complete the following sentence.

electrons	**hand**	**jumper**	**protons**

The comb becomes negatively charged because ..... move

from the student's ..... to the comb.

(2 marks)

2 (a) (ii) What type of charge is left on the jumper?

.....

(1 mark)

2 (a) (iii) The negatively charged comb is placed close to a charged plastic ruler. The comb and the ruler attract each other.

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

The ruler is

negatively charged
positively charged
uncharged

.

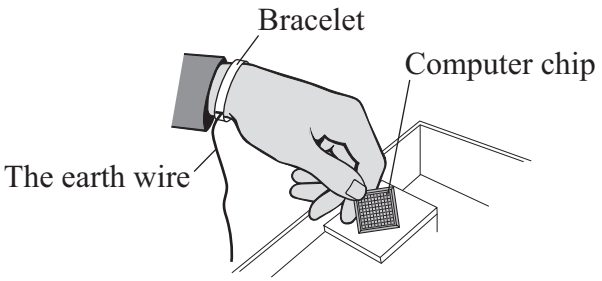
(1 mark)

4.4.1.1 The structure of an atom

Question 34 · continued

for mark

2 (b) Electrostatic charge can damage computer chips. People working with computer chips may wear a special bracelet, with a wire joining the bracelet to earth (the earth wire). Any negative charge on the person will flow through the wire to earth.



2 (b) (i) Which **one** of the following materials should the bracelet be made from?

Draw a ring around your answer.

copper **plastic** **rubber**

Give a reason for your answer.

.....

.....

(2 marks)

2 (b) (ii) Which **one** of the following words is used to describe the rate of flow of charge through a wire?

Draw a ring around your answer.

current **resistance** **voltage**

(1 mark)

7

4.4.1.1 The structure of an atom

Question 35

June 2008 | PHY2F | Original Q6 | Legacy

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

mass number	222
atomic number	86
radiation emitted	alpha particle

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

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

..... inside an atom.

(2 marks)

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

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

..... *(1 mark)*

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

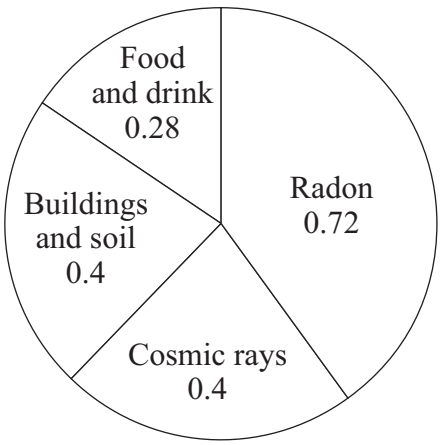
An alpha particle consists of 2 protons and 2 neutrons.

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

.....

(1 mark)

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



Question 35 · continued

for mark

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

.....

.....

Proportion of radon = ...

(2 marks)

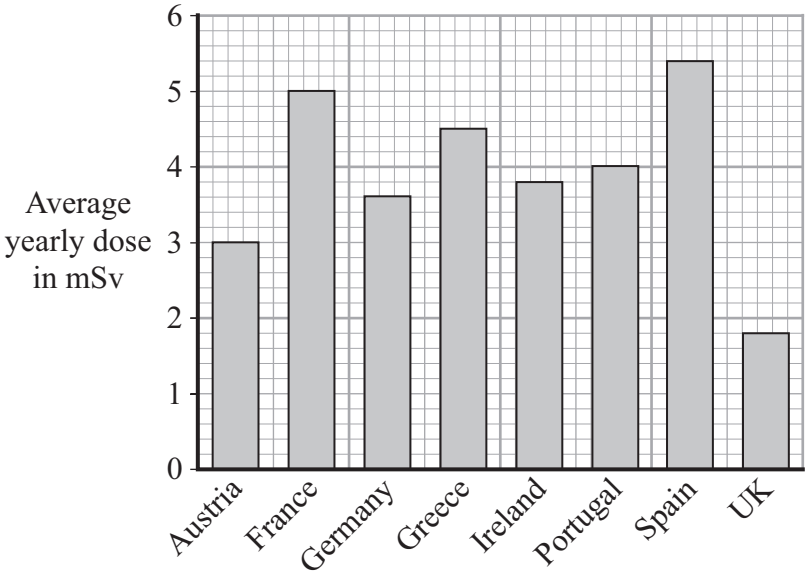
6 (b) (ii) Not all background radiation is from natural sources.

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

.....

(1 mark)

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



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

.....

(1 mark)

Question 6 continues on the next page

4.4.1.1 The structure of an atom

Question 35 · continued

for mark

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

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

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

Draw a ring around your answer.

Yes **No**

Explain your answer.

.....

.....

.....

.....

(2 marks)

10

4.4.1.1 The structure of an atom

Question 36

June 2008 | PHY3F | Original Q4 | Legacy

4 (a) Complete the **two** spaces in the sentence.

Stars form when enough ..... and gas from ..... are pulled together by gravitational attraction. *(2 marks)*

4 (b) How are stars able to give out energy for millions of years?

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

By atoms joining together ☐

By atoms splitting apart ☐

By burning gases ☐

(1 mark)

4 (c) There are many billions of stars in our galaxy. Our Sun is one of these stars. What is the name of our galaxy?

.....

(1 mark)

4 (d)

Why was the Universe created?

We cannot expect scientists to answer this question. What is the reason for this?

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

It will take too long to collect the scientific evidence. ☐

The answer depends on beliefs and opinions, not scientific evidence. ☐

There is not enough scientific evidence. ☐

(1 mark)

5

4.4.1.1 The structure of an atom

Question 37

November 2008 | PHY1BP | Original Q3 | Legacy

QUESTION THREE

Atoms are made up of different parts.

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

A electrons

B neutrons

C nuclei

D protons

All atoms of an element have the same number of positive particles called . . . **1** . . . .

These are located in their . . . **2** . . . .

The central part of an atom is surrounded by . . . **3** . . . .

The atoms of isotopes of the same element have a different number of . . . **4** . . . .

4.4.1.1 The structure of an atom

Question 38

November 2008 | PHY1BP | Original Q9 | Legacy

QUESTION NINE

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

9A What is an alpha particle?

1 an electron from outside the nucleus

2 an electron from inside the nucleus

3 a helium nucleus

4 a proton from inside the nucleus

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

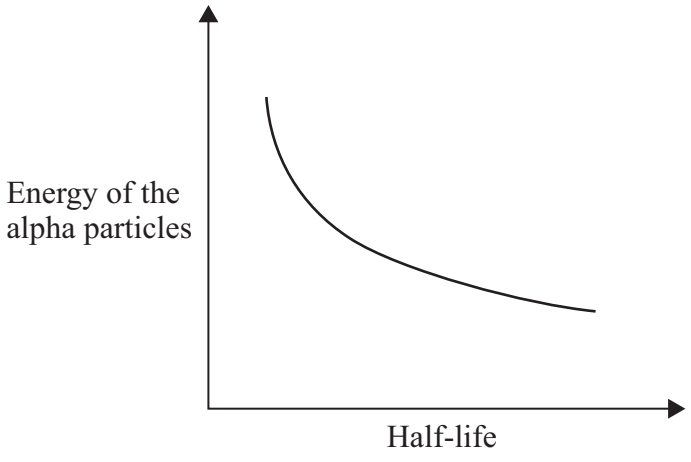
1 by changing the temperature of the nucleus

2 by changing the atmospheric pressure

3 by changing the amount of humidity

4 The rate cannot be changed.

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



4.4.1.1 The structure of an atom

Question 38 · continued

9C What relationship does the graph show?

1 Alpha particles always have the same amount of energy.

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

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

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

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

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

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

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

4 the time taken for one atom to split in half

END OF TEST

4.4.1.1 The structure of an atom

Question 39

January 2009 | PHY2F | Original Q1 | Legacy

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

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

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

(4 marks)

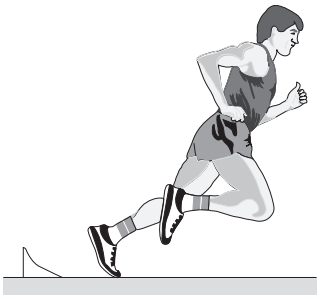
4

4.4.1.1 The structure of an atom

Question 40

January 2009 | PHY2F | Original Q8 | Legacy

8 (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.

8 (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)

8 (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)

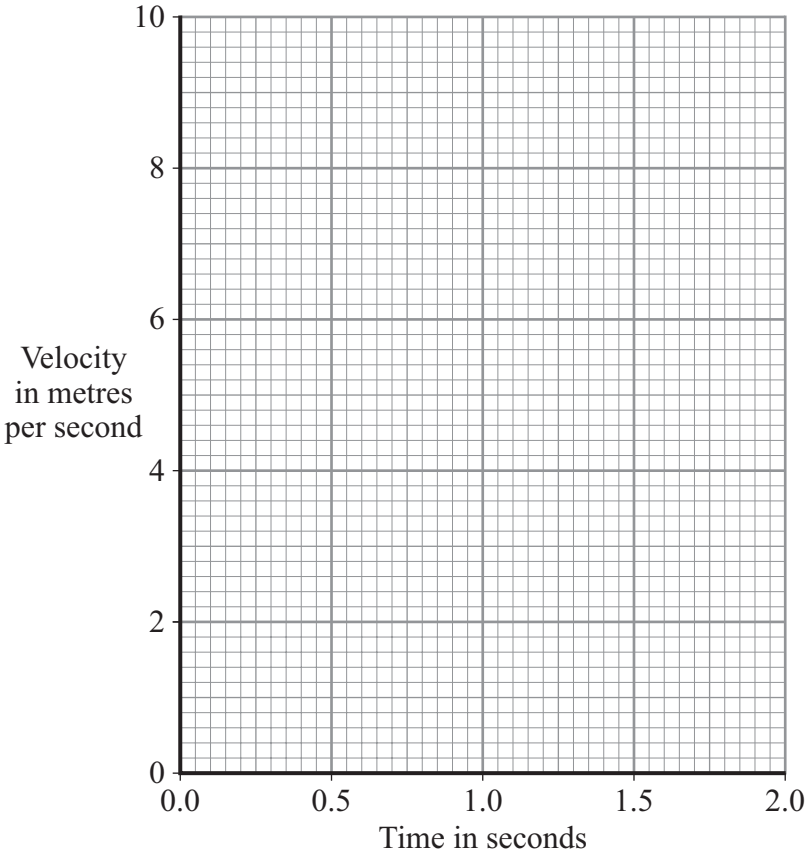
Question 40 · continued

for mark

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

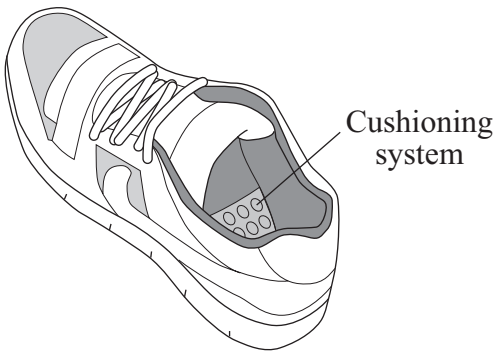
The velocity of the athlete is the ..... of the athlete in a given direction. *(1 mark)*

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



(2 marks)

8 (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.



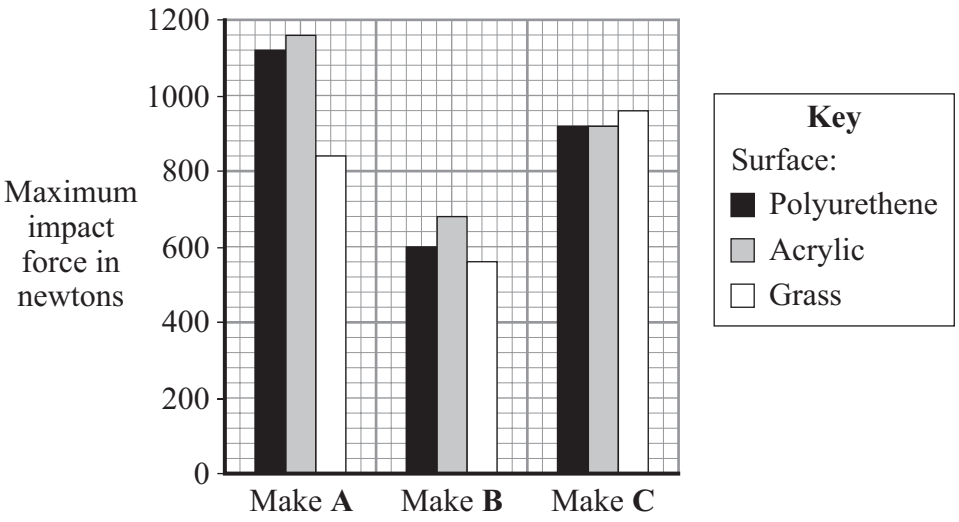
Question 8 continues on the next page

4.4.1.1 The structure of an atom

Question 40 · 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.



8 (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)

8 (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 41

January 2009 | PHY3F | Original Q7 | Legacy

7 (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)

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

What does the symbol kHz stand for?

.....

(1 mark)

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

.....

(1 mark)

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

.....

(1 mark)

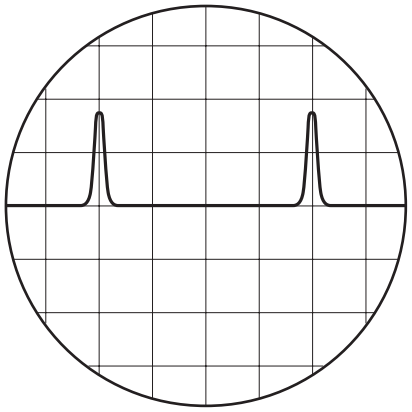
4.4.1.1 The structure of an atom

Question 41 · continued

for mark

7 (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)

7 (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)

7 (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 42

March 2009 | PHY1BP | Original Q2 | Legacy

QUESTION TWO

A radioactive material gives out radiation all the time.

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

A alpha

B beta

C electron

D gamma

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

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

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

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

Question 43

March 2009 | PHY1BP | Original Q4 | Legacy

QUESTION FOUR

This question is about the structure of the atom.

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

A electrons

B neutrons

C nuclei

D protons

The central part of the atom is surrounded by a number of . . . **1** . . . .

In the central part of the atom, there are positive particles called . . . **2** . . . .

The central parts of atoms are called . . . **3** . . . .

Isotopes of the same element contain different numbers of . . . **4** . . . .

4.4.1.1 The structure of an atom

Question 44

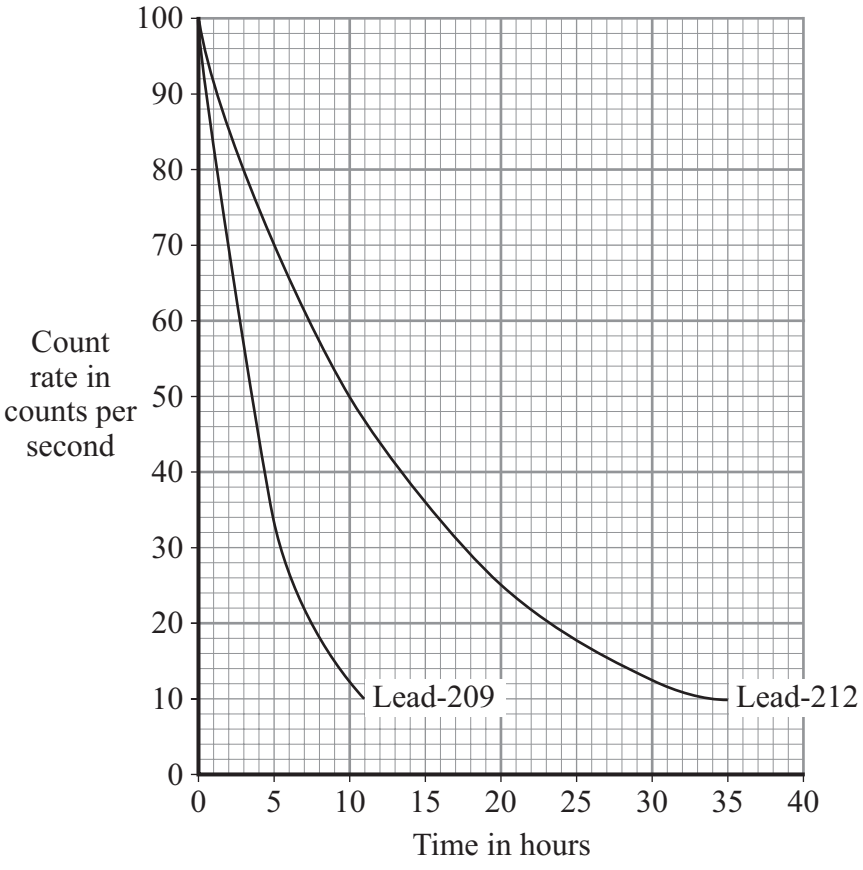
March 2009 | PHY1BP | Original Q5 | Legacy

QUESTION FIVE

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

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

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



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

A 3

B 10

C 12

D 60

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

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

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

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

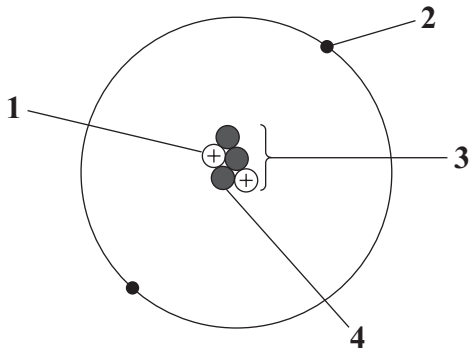
4.4.1.1 The structure of an atom

Question 45

June 2009 | PHY1BP | Original Q2 | Legacy

QUESTION TWO

The diagram shows an atom.



Match parts of the atom, **A**, **B**, **C** and **D**, with the labels **1**–**4** on the diagram.

A electron

B neutron

C nucleus

D proton

4.4.1.1 The structure of an atom

Question 46

June 2009 | PHY1BP | Original Q6 | Legacy

QUESTION SIX

The radioactive isotope phosphorus-32 emits beta particles.

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

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

1 radio waves all the time.

2 nuclear radiation all the time.

3 radio waves when heated.

4 nuclear radiation when heated.

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

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

1 electrons.

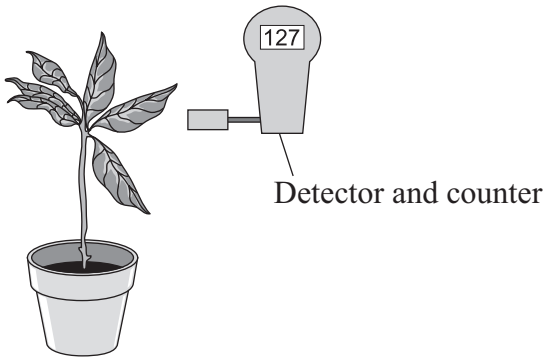
2 neutrons.

3 nuclei.

4 protons.

4.4.1.1 The structure of an atom

Question 46 · continued



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

1 beta particles.

2 phosphorus atoms.

3 phosphorus nuclei.

4 ultraviolet radiation.

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

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

1 fall to zero in 14 days.

2 halve in 14 days.

3 double in 14 days.

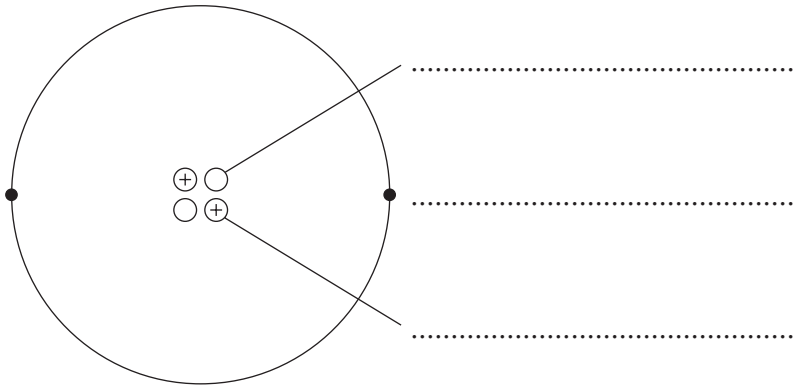
4 be unchanged in 14 days.

4.4.1.1 The structure of an atom

Question 47

June 2009 | PHY1F | Original Q3 | Legacy

3 The diagram shows a helium atom.



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

electron	**neutron**	**proton**

(2 marks)

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

How is an alpha particle different from a helium atom?

.....

.....

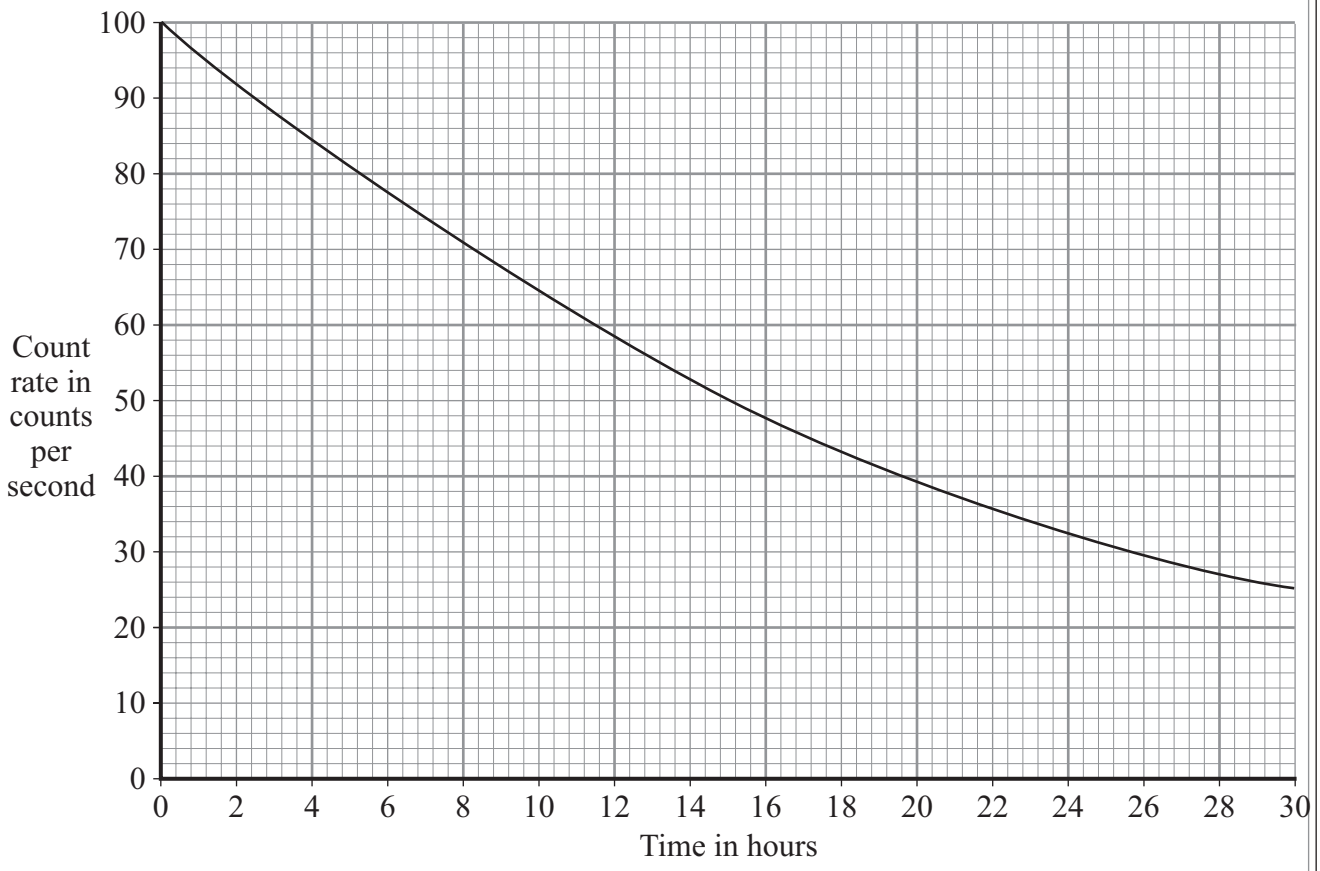
(1 mark)

4.4.1.1 The structure of an atom

Question 47 · continued

for mark

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



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

Time = ... hours
(1 mark)

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

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

Question 3 continues on the next page

4.4.1.1 The structure of an atom

Question 47 · continued

for mark

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

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

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

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

The alpha particles have a low energy. ☐

People replace smoke detectors every few years. ☐

Americium-241 has a long half-life. ☐

(1 mark)

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



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

.....

.....

(1 mark)

7

4.4.1.1 The structure of an atom

Question 48

June 2009 | PHY2F | Original Q7 | Legacy

7 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

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

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

.....

.....

.....

.....

(2 marks)

7 (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.

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

.....

.....

(1 mark)

7 (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)

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

What name is given to this process?

.....

(1 mark)

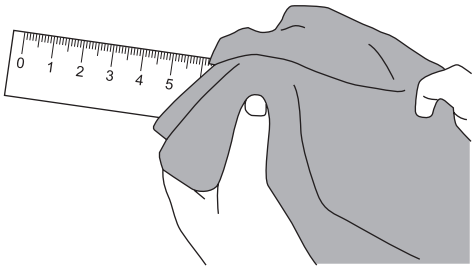
7

4.4.1.1 The structure of an atom

Question 49

June 2009 | PHY2F | Original Q8 | Legacy

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



The ruler becomes negatively charged.

8 (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)

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

.....

.....

(1 mark)

Question 8 continues on the next page

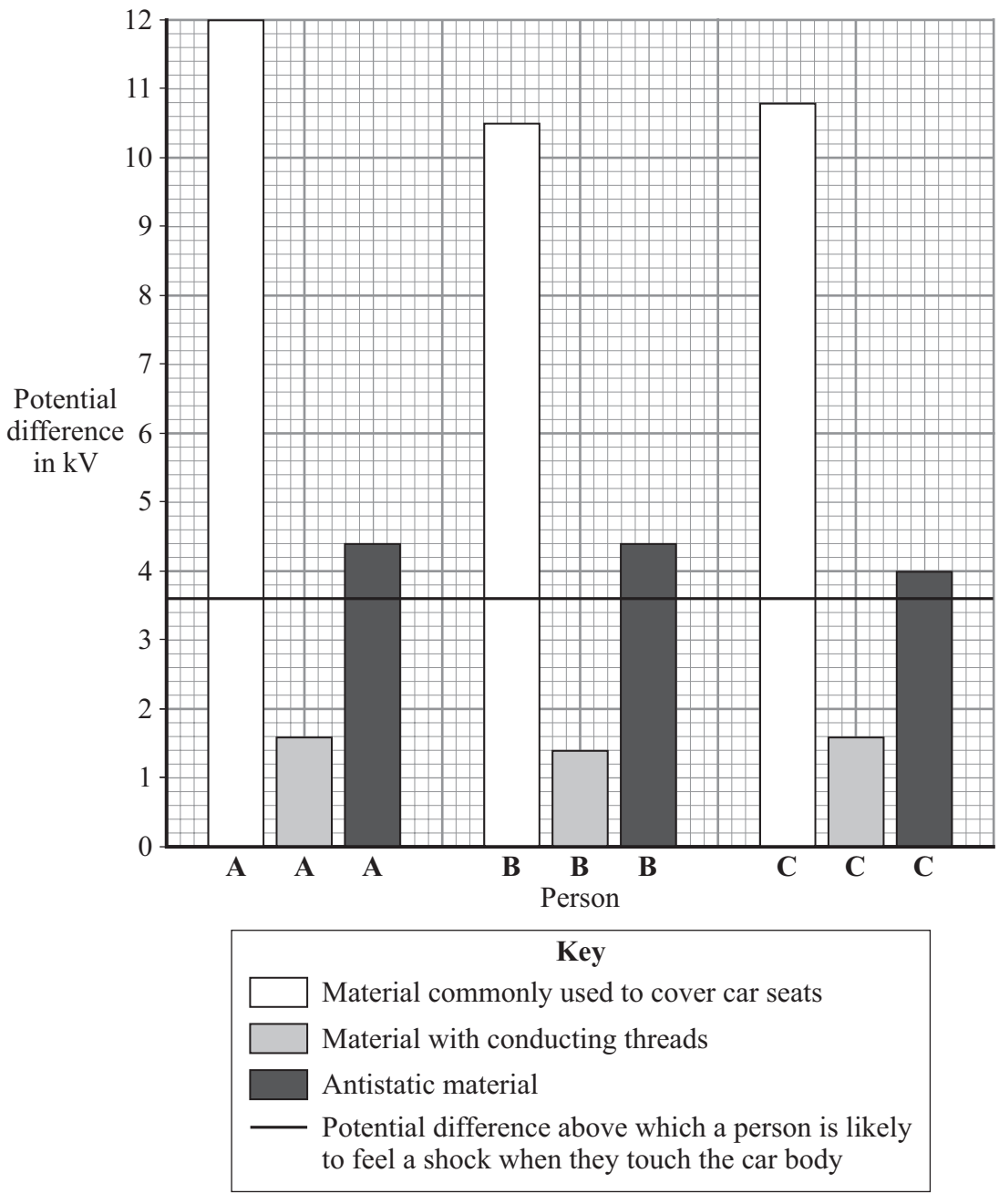
Question 49 · continued

for mark

8 (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.



4.4.1.1 The structure of an atom

Question 49 · continued

for mark

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

.....

.....

.....

.....

(2 marks)

8 (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)

8 (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)

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

.....

.....

.....

.....

(2 marks)

8

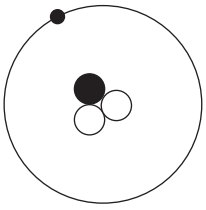
4.4.1.1 The structure of an atom

Question 50

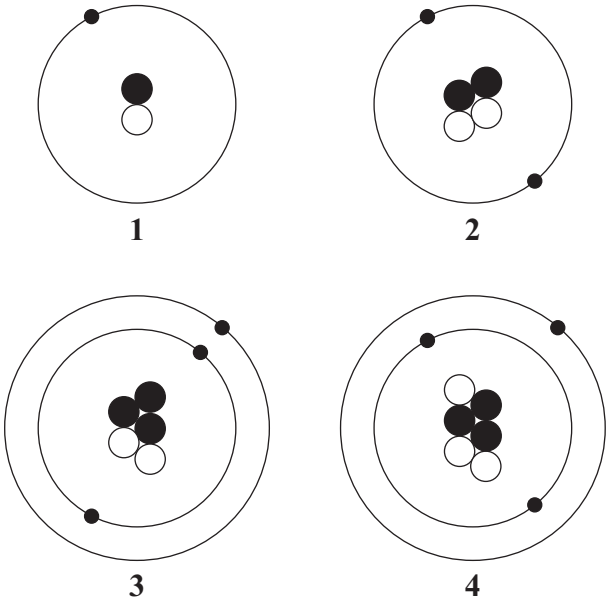
November 2009 | PHY1BP | Original Q4 | Legacy

QUESTION FOUR

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



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



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

A contains 5 particles in its nucleus

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

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

D is a different isotope of hydrogen

4.4.1.1 The structure of an atom

Question 51

January 2019 | PHY1F | Original Q4 | Legacy

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

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

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

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

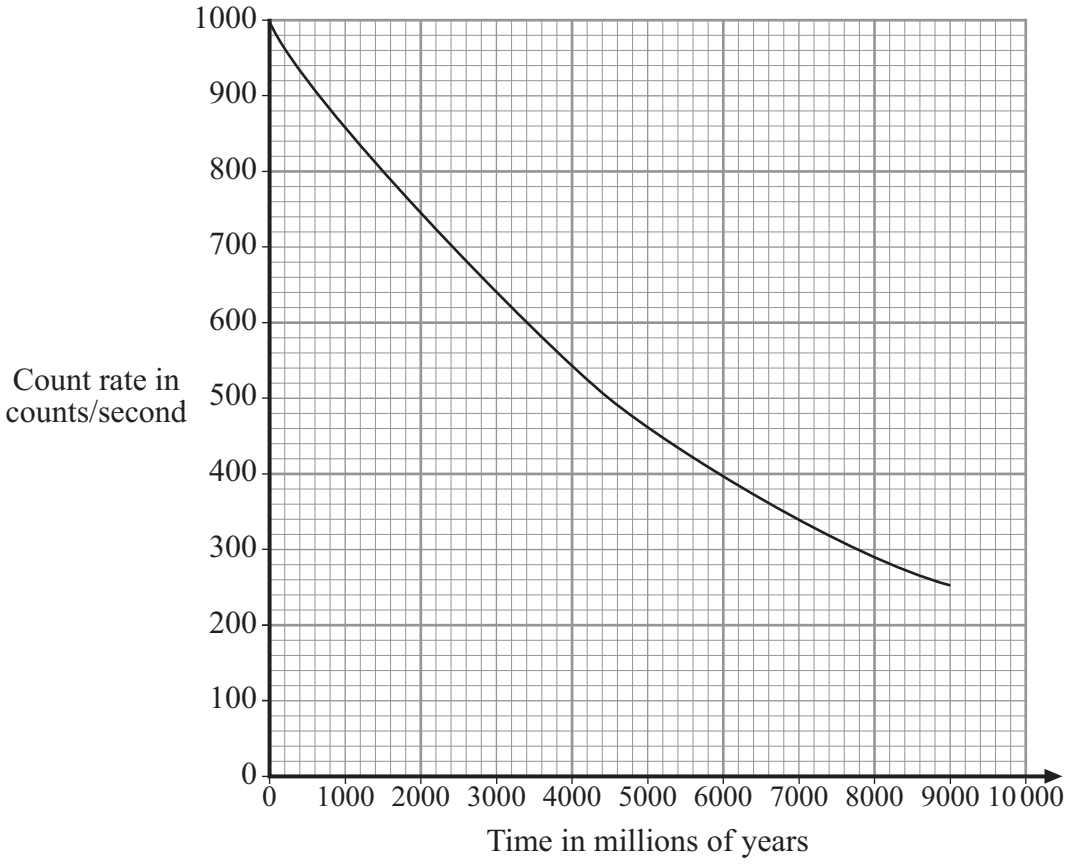
Write down your **new** statement.

.....

.....

(1 mark)

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



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

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

(1 mark)

4.4.1.1 The structure of an atom

Question 51 · continued

for mark

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

How old is the Earth?

Draw a ring around your answer.

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

(1 mark)

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

Explain why.

.....

.....

.....

.....

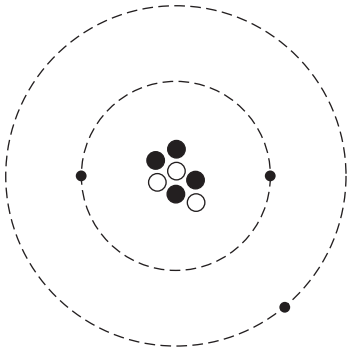
(2 marks)

5

4.4.1.1 The structure of an atom

Question 52

4 The diagram represents an atom of lithium.



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

Number of protons	
Number of electrons	
Number of neutrons	

(2 marks)

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

Draw a ring around your answer.

3	**4**	**7**	**10**

Give a reason for your answer.

.....

.....

(2 marks)

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

An atom that has lost an electron is called

an ion
an isotope
a positive atom

.

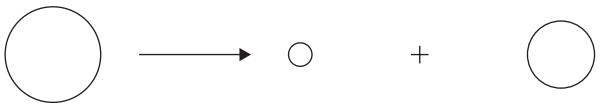
(1 mark)

4.4.1.1 The structure of an atom

Question 52 · continued

for mark

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



Radon — Alpha particle — Polonium

Not to scale

An alpha particle consists of 2 protons and 2 neutrons.

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

The mass of a polonium atom is

greater than
the same as
smaller than

the mass of a radon atom.

(1 mark)

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

.....

.....

(1 mark)

7

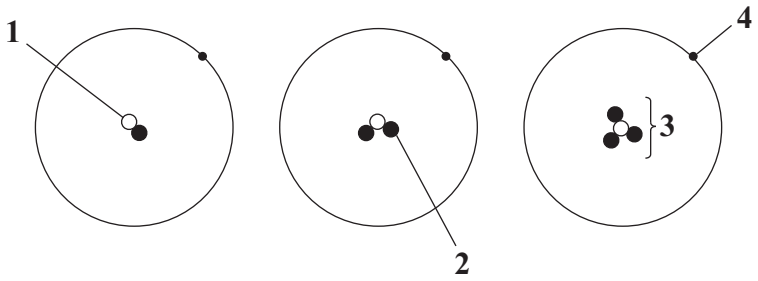
4.4.1.1 The structure of an atom

Question 53

March 2010 | PHY1BP | Original Q3 | Legacy

QUESTION THREE

The diagrams show three isotopes of hydrogen.



Match words, **A**, **B**, **C** and **D**, with the labels **1–4** on the diagrams.

A electron

B neutron

C nucleus

D proton

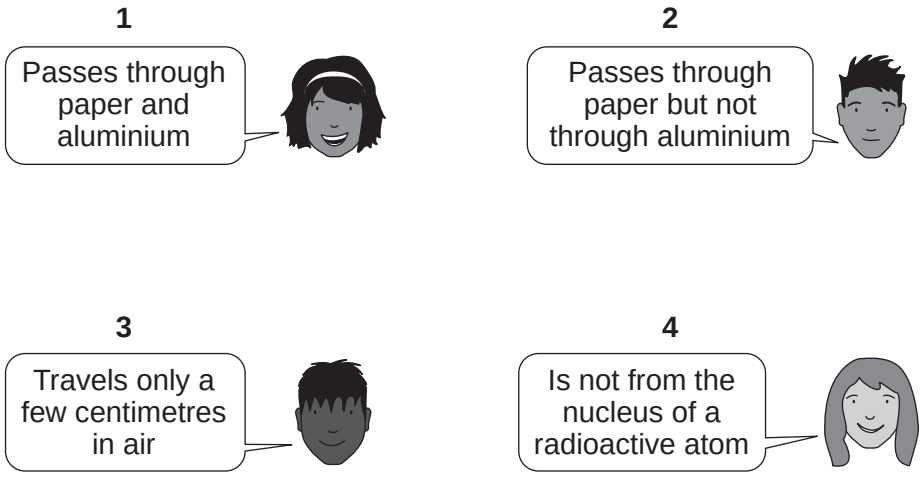
4.4.1.1 The structure of an atom

Question 54

June 2010 | PHY1BP | Original Q2 | Legacy

QUESTION TWO

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



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

A alpha

B beta

C gamma

D X-rays

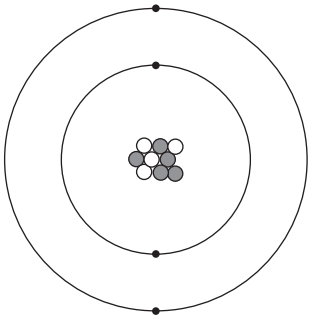
4.4.1.1 The structure of an atom

Question 55

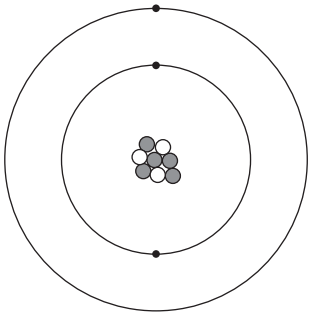
June 2010 | PHY1BP | Original Q5 | Legacy

QUESTION FIVE

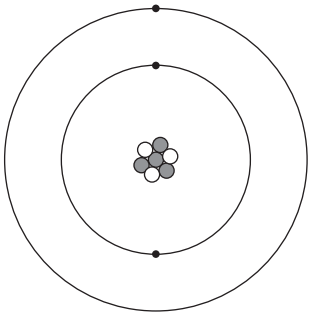
The diagram shows four atoms, **W**, **X**, **Y** and **Z**.



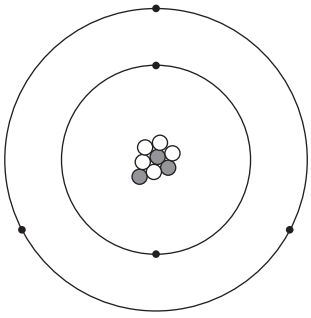
Atom **W**



Atom **X**



Atom **Y**



Atom **Z**

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.

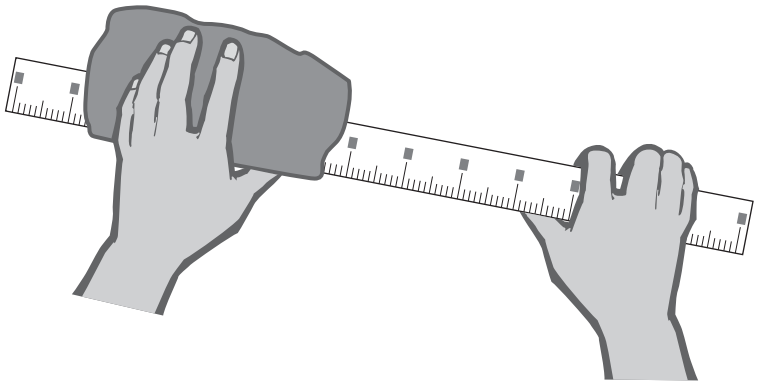
Atom **Z**'s nucleus contains . . . **4** . . . particles.

4.4.1.1 The structure of an atom

Question 56

June 2010 | PHY2F | Original Q4 | Legacy

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



Some electrons move from the cloth onto the ruler.

4 (a) (i) What type of charge does the ruler gain?

.....

(1 mark)

4 (a) (ii) What type of charge is left on the cloth?

.....

(1 mark)

4 (b) The following statement is **false**.

> Objects carrying the same type of charge attract each other.

Change **one** word in this statement to make it **true**.

Write down your new statement.

.....

.....

(1 mark)

4.4.1.1 The structure of an atom

Question 56 · continued

4 (c) Many devices use electrostatic charge to work.
The following sentences describe how a photocopier uses electrostatic charge to produce a photocopy.

Use words from the box to complete the sentences.

attracts	charge	insulating	light	photoconducting	repels

1 A roller coated with ..... material is given a charge.

2 A strong light is used to form an image of the page to be copied onto the roller.

3 Where light hits the roller, the ..... flows to earth.

4 The charge left on the roller ..... particles of black toner powder.

5 The toner powder sticks to a sheet of paper, producing the photocopy.

(3 marks)

4 (d) Give **one** other use for electrostatic charge.

.....

.....

(1 mark)

7

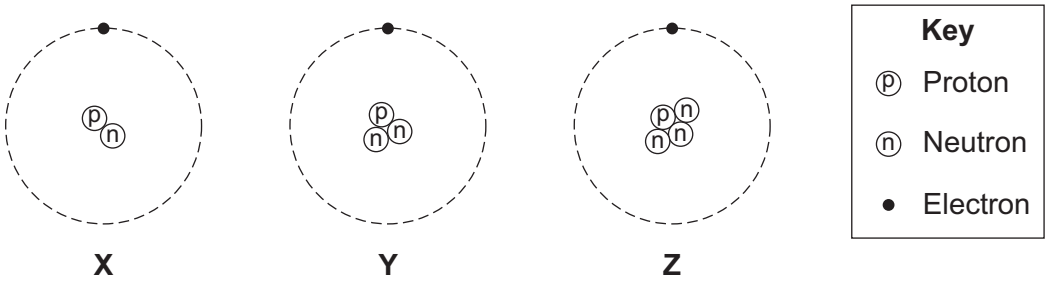
4.4.1.1 The structure of an atom

Question 57

November 2010 | PHY1BP | Original Q8 | Legacy

QUESTION EIGHT

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



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

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

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

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

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

8B Some substances are radioactive.

What does this mean?

1 Radio signals make these substances emit radiation.

2 These substances can take part in chemical reactions.

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

4 These substances glow in the dark.

8C Some substances emit beta radiation.

What is beta radiation?

1 a helium nucleus

2 an electron from outside the nucleus

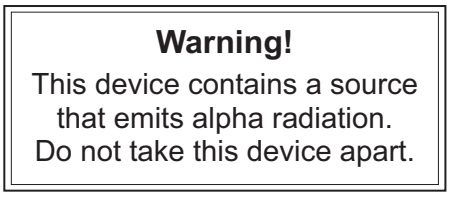
3 an electron from inside the nucleus

4 an electromagnetic wave

4.4.1.1 The structure of an atom

Question 57 · continued

8D The warning label is from a smoke detector.



What is the reason for this warning?

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

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

3 Alpha radiation has the longest half-life.

4 Alpha radiation is the most penetrating of all radiations.

Turn over for the next question

4.4.1.1 The structure of an atom

Question 58

January 2011 | PHY1F | Original Q3 | Legacy

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

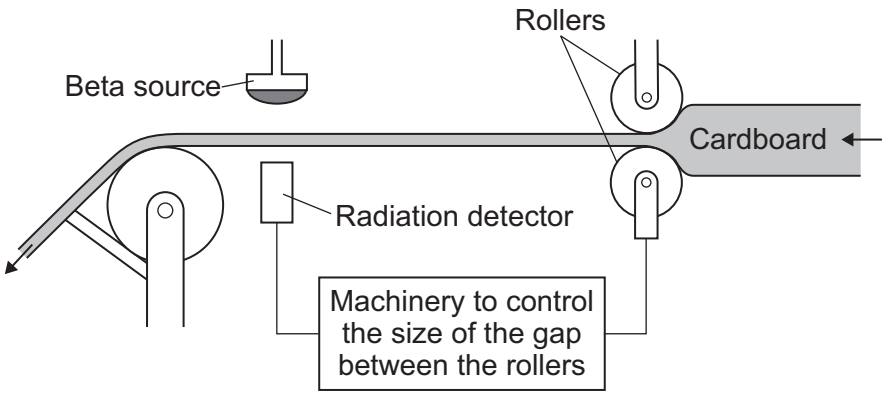
Draw a straight line to link each type of radiation in **List A** to its correct property in **List B**.

Draw only **three** lines.

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

(3 marks)

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



4.4.1.1 The structure of an atom

Question 58 · continued

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

The table gives the detector readings over 1 hour.

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

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

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

.....

.....

.....

.....

(2 marks)

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

Draw a ring around your answer.

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

(1 mark)

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

Why not?

.....

.....

(1 mark)

7

4.4.1.1 The structure of an atom

Question 59

January 2011 | PHY2F | Original Q1 | Legacy

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

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

Draw only **three** lines.

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

(3 marks)

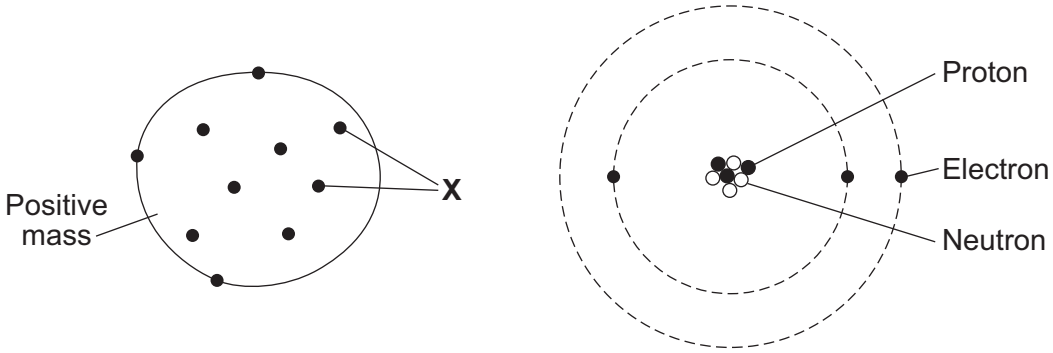
3

4.4.1.1 The structure of an atom

Question 60

January 2011 | PHY2F | Original Q6 | Legacy

6 The diagrams show two different models of an atom.



'Plum pudding' model **Model used today**

6 (a) The particles labelled '**X**' in the plum pudding model are also included in the model of the atom used today.

What are the particles labelled '**X**'?

.....

(1 mark)

6 (b) Scientists decided that the 'plum pudding' model was wrong and needed replacing.

Which **one** of the following statements gives a reason for deciding that a scientific model needs replacing?

Tick (✓) **one** box.

The model is too simple. ☐

The model has been used by scientists for a long time. ☐

The model cannot explain the results from a new experiment. ☐

(1 mark)

4.4.1.1 The structure of an atom

Question 60 · continued

6 (c) The table gives information about the three types of particle that are in the model of the atom used today.

Particle	Relative mass	Relative charge
	1	+1
	very small	–1
	1	0

Complete the table by adding the names of the particles.

(2 marks)

4

Turn over for the next question

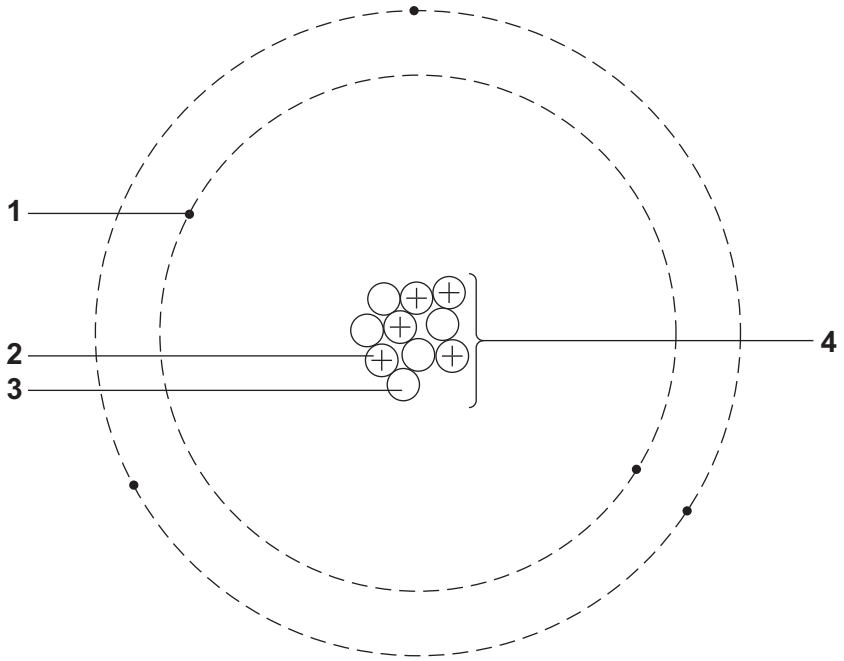
4.4.1.1 The structure of an atom

Question 61

June 2011 | PHY1BP | Original Q4 | Legacy

QUESTION FOUR

The diagram shows the different parts of an atom.



Match words, **A**, **B**, **C** and **D**, with the labels **1**–**4** on the diagram.

A electron

B neutron

C nucleus

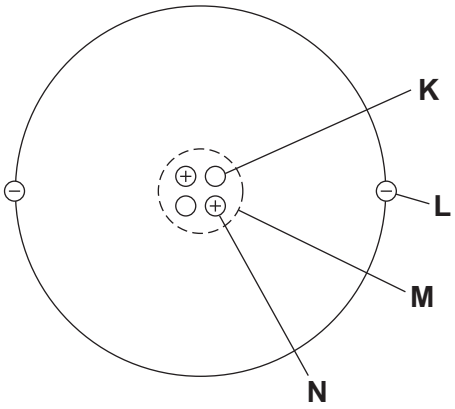
D proton

4.4.1.1 The structure of an atom

Question 62

June 2011 | PHY1F | Original Q1 | Legacy

1 (a) The diagram represents a helium atom.



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

Part ☐

(1 mark)

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

Part ☐

(1 mark)

1 (b) A radioactive source emits alpha particles.

What might this source be used for?

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

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

to make a smoke detector work ☐

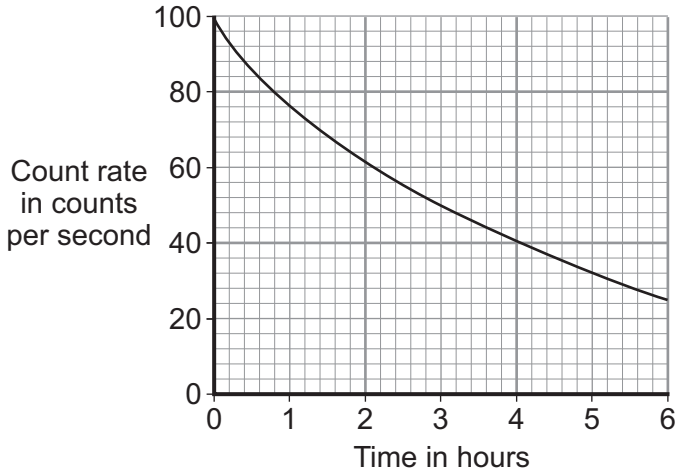
to inject into a person as a medical tracer ☐

(1 mark)

4.4.1.1 The structure of an atom

Question 62 · continued

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



What is the count rate after 4 hours?

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

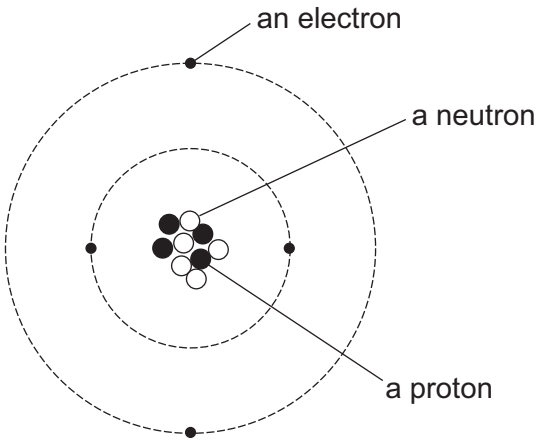
4

4.4.1.1 The structure of an atom

Question 63

June 2011 | PHY2F | Original Q2 | Legacy

2 The diagram represents an atom of beryllium. The three types of particle that make up the atom have been labelled.



2 (a) Use the labels from the diagram to complete the following statements.

Each label should be used once.

The particle with a positive charge is ..... .

The particle with the smallest mass is ..... .

The particle with no charge is ..... .

(2 marks)

2 (b) What is the atomic number of a beryllium atom?

Draw a ring around your answer.

4	5	9	13

Give a reason for your answer.

.....

.....

(2 marks)

4.4.1.1 The structure of an atom

Question 63 · continued

2 (c) Which **one** of the following statements describes what can happen to an atom to change it into an ion?

Tick (✓) **one** box.

The atom loses a neutron. ☐

The atom loses an electron. ☐

The atom loses a proton. ☐

(1 mark)

5

Turn over for the next question

4.4.1.1 The structure of an atom

Question 64

November 2011 | PHY1BP | Original Q2 | Legacy

QUESTION TWO

This question is about nuclear and electromagnetic radiation.

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

A alpha particle

B beta particle

C gamma ray

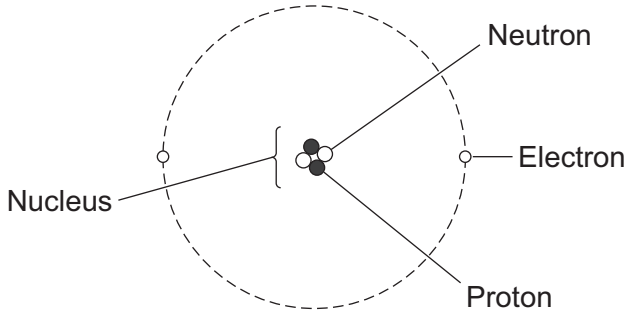
D X-rays

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

4.4.1.1 The structure of an atom

Question 65

7 The diagram shows the structure of an atom.



Not drawn to scale

7 (a) In 1931 scientists thought that atoms contained **only** protons and electrons.

Suggest what happened in 1932 to change the idea that atoms contained only protons and electrons.

.....

.....

(1 mark)

7 (b) The table gives information about the particles in an atom.

Complete the table by adding the names of the particles.

Particle	Relative Mass	Relative Charge
	1	0
	very small	–1
	1	+1

(2 marks)

3

4.4.1.1 The structure of an atom

Question 66

June 2013 | PH2FP | Original Q1 | Legacy

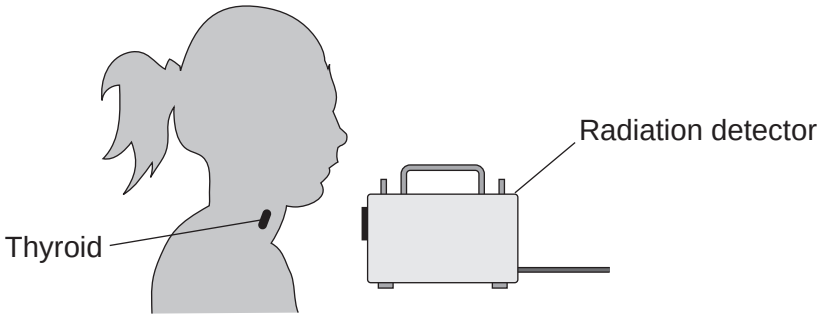
1 (a) The names of three types of radiation are given in **List A**. Some properties of these three types of radiation are given in **List B.**

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

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

(3 marks)

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



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

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

Tick (✓) **one** box.

Gamma radiation will pass through the body. ☐

Gamma radiation is not deflected by a magnet. ☐

Gamma radiation has a long range in air. ☐

(1 mark)

4.4.1.1 The structure of an atom

Question 66 · continued

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

Use a word from the box to complete the sentence.

all	half	most

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

(1 mark)

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

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

The nucleus of an iodine-123 atom has the same number of

electrons
neutrons
protons

as the

nucleus of an iodine-131 atom.

(1 mark)

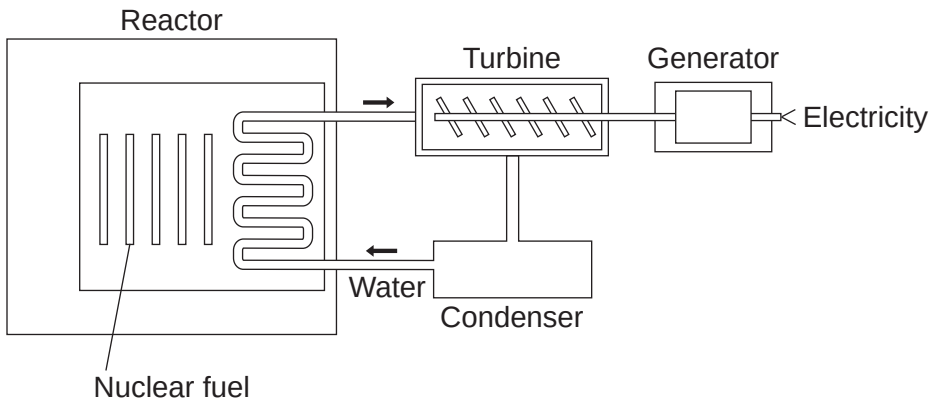
6

4.4.1.1 The structure of an atom

Question 67

June 2013 | PH2FP | Original Q5 | Legacy

5 Nuclear power stations use the energy released from nuclear fuels to generate electricity.



5 (a) Which substance do the majority of nuclear reactors use as fuel?

Draw a ring around your answer.

plutonium-239 **thorium-232** **uranium-235**

(1 mark)

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

Describe what happens to the nucleus of an atom during nuclear fission.

.....

.....

.....

.....

(2 marks)

5 (c) Use words from the box to complete each sentence.

condenser	**gas**	**generator**	**reactor**	**steam**	**turbine**

The energy released from the nuclear fuel is used to heat water. The water turns into

..... and this is used to drive a ..... .

This turns a ..... to produce electricity.

(3 marks)

6

4.4.1.1 The structure of an atom

Question 68

June 2014 | PH2FP | Original Q1 | Legacy

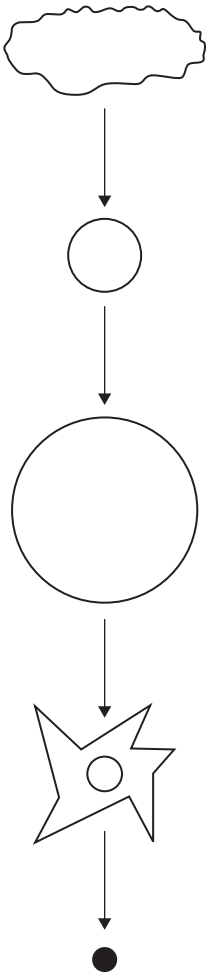
1 (a) **Figure 1** shows the life cycle of a very large star.

Use the correct answers from the box to complete the sentences in **Figure 1**.

[2 marks]

main sequence star	**neutron star**	**supernova**	**white dwarf**

Figure 1



Gas and dust join together to become a protostar.

The star is stable as a ..... .

The star expands to become a red super giant.

The outer layers of the star explode as a ..... .

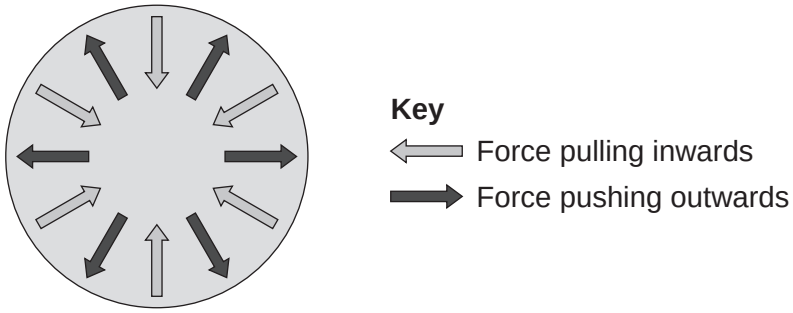
The core of the star shrinks and a black hole is formed.

4.4.1.1 The structure of an atom

Question 68 · continued

1 (b) **Figure 2** shows the forces acting on a star when the star is stable.

Figure 2



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

[1 mark]

When a star is stable, the forces pushing outwards are

bigger than

smaller than

balanced by

the forces pulling inwards.

3

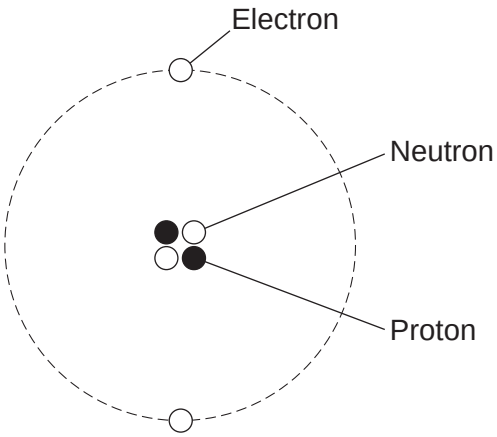
4.4.1.1 The structure of an atom

Question 69

June 2014 | PH2FP | Original Q5 | Legacy

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

Figure 9



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

Draw a ring around the correct answer.

[1 mark]

electron **neutron** **proton**

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

[1 mark]

..... and .....

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

Draw a ring around the correct answer.

[2 marks]

2 **4** **6**

Give a reason for your answer.

.....

.....

4.4.1.1 The structure of an atom

Question 69 · continued

June 2014 | PH2FP | Original Q5 | Legacy

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

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

[1 mark]

.....

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

[1 mark]

electrons	**neutrons**	**protons**

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

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

Tick (✓) **one** box.

[1 mark]

Have a long range in air ☐

Are highly ionising ☐

Will pass through metals ☐

Question 5 continues on the next page

4.4.1.1 The structure of an atom

Question 69 · continued

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

Treating an illness with radiation may also harm a patient.

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

[1 mark]

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

..... healthy body cells.

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

[1 mark]

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

radiation is

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

the possible benefit of having the treatment.

9

4.4.1.1 The structure of an atom

Question 70

June 2014 | PH3FP | Original Q7 | Legacy

7 (a) What is ultrasound?

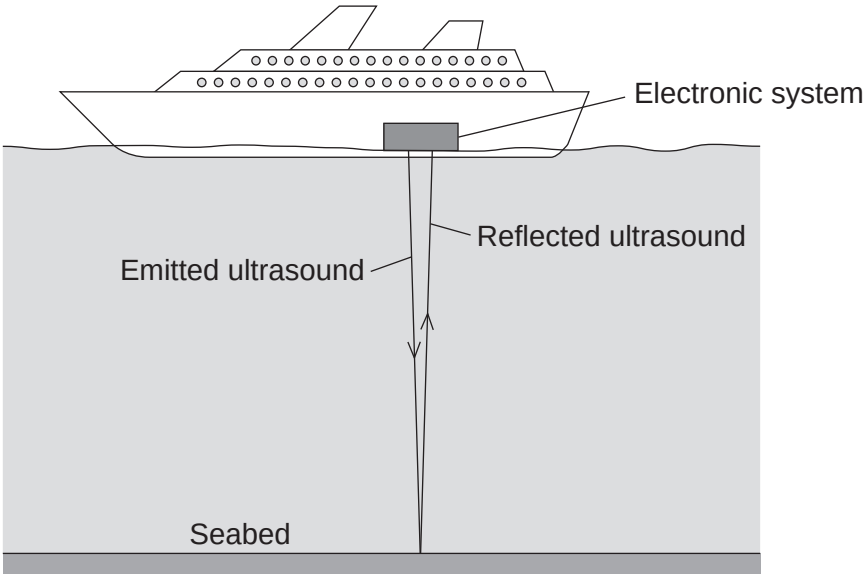
[1 mark]

.....

.....

7 (b) **Figure 12** shows how ultrasound is used to measure the depth of water below a ship.

Figure 12



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

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

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

[1 mark]

.....

7 (d) Images of the inside of the human body can be made using a Computerised Tomography (CT) scanner. The CT scanner in **Figure 13** uses X-rays to produce these images.

Figure 13



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 | PH2FP | Original Q2 | Legacy

2 The equation below shows the process by which two atomic nuclei join to form a different nucleus.

$$^{1}_{1}H + ^{2}_{1}H \rightarrow ^{3}_{2}He$$

2 (a) Where does the process shown by the equation above happen naturally?

[1 mark]

Tick (✓) **one** box.

Inside the Earth ☐

Inside a nuclear power station ☐

Inside the Sun ☐

2 (b) Use the correct answer from the box to complete the sentence.

[1 mark]

fission	**force**	**fusion**

The process of joining two atomic nuclei to form a different nucleus is called

nuclear ..... .

2 (c) What is released during this process?

[1 mark]

Draw a ring around the correct answer.

charge **energy** **force**

3

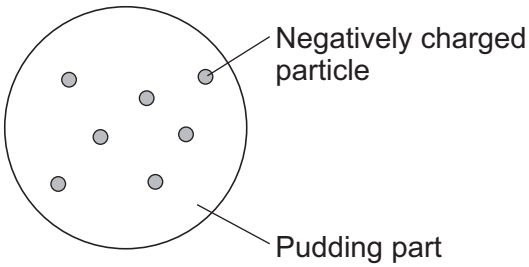
4.4.1.1 The structure of an atom

Question 72

June 2015 | PH2FP | Original Q8 | Legacy

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

Figure 11



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

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

.....

.....

Question 8 continues on the next page

4.4.1.1 The structure of an atom

Question 72 · continued

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

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

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

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

Explain why.

[2 marks]

.....

.....

.....

.....

.....

.....

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

[1 mark]

.....

.....

.....

4.4.1.1 The structure of an atom

Question 72 · continued

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

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

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

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

[6 marks]

.....

.....

.....

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.....

Extra space .....

.....

.....

.....

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10

4.4.1.1 The structure of an atom

Question 73

June 2016 | PH2FP | Original Q4 | Legacy

4 (a) Uranium has two natural isotopes, uranium-235 and uranium-238.

Use the correct answer from the box to complete the sentence.

[1 mark]

electrons	neutrons	protons

The nucleus of a uranium-238 atom has three more _____ than the nucleus of a uranium-235 atom.

4 (b) Uranium-235 is used as a fuel inside a nuclear reactor.
Energy is released from nuclear fuels by the process of nuclear fission.

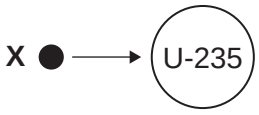
What is the energy released from nuclear fuels inside a nuclear reactor used for?

[1 mark]

_____

4 (c) **Figure 6** shows the nucleus of an atom of uranium-235 (U-235) about to undergo nuclear fission.

Figure 6



4 (c) (i) Before nuclear fission can happen the nucleus of a uranium atom has to absorb the particle labelled **X**.

What is particle **X**?

[1 mark]

Tick (✓) **one** box.

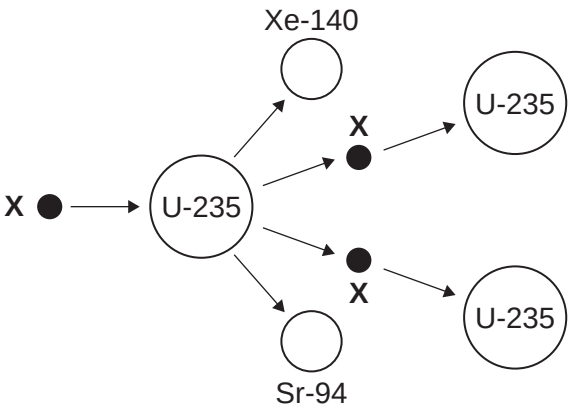
an electron ☐ a neutron ☐ a proton ☐

4.4.1.1 The structure of an atom

Question 73 · continued

4 (c) (ii) The process of nuclear fission, shown in **Figure 7**, causes the nucleus of the uranium-235 (U-235) atom to split apart and release two of the particles **X**.

Figure 7



Complete **Figure 7** to show how the particles **X start** a chain reaction.

[2 marks]

5

4.4.1.1 The structure of an atom

Question 74

June 2016 | PH2FP | Original Q9 | Legacy

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

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

[1 mark]

_____

_____

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

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

[1 mark]

Tick (✓) **one** box.

alpha particles ☐ beta particles ☐ gamma rays ☐

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

[1 mark]

_____

_____

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

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

[1 mark]

_____

_____

4.4.1.1 The structure of an atom

Question 74 · continued

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

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

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

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

[6 marks]

Extra space

10

4.4.1.1 The structure of an atom

Question 75

June 2016 | PH3FP | Original Q2 | Legacy

2 **Figure 2** shows an X-ray of an arm with a broken bone.

Figure 2



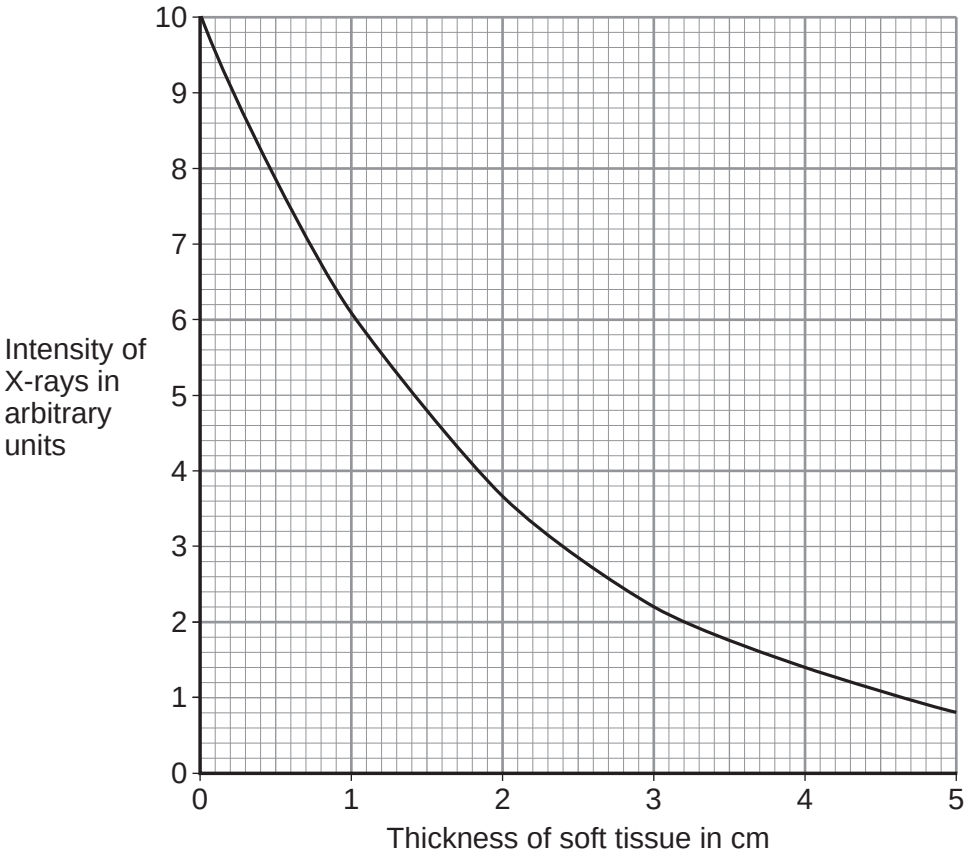
2 (a) Complete the following sentence.

[1 mark]

X-rays are part of the _____ spectrum.

2 (b) **Figure 3** shows how the intensity of the X-rays changes as they pass through soft tissue and reach a detector.

Figure 3



4.4.1.1 The structure of an atom

Question 75 · continued

2 (b) (i) Use **Figure 3** to determine the intensity of X-rays reaching the detector for a 3 cm thickness of soft tissue.

[1 mark]

Intensity of X-rays = _____ arbitrary units

2 (b) (ii) Describe how the thickness of soft tissue affects the intensity of the X-rays.

[2 marks]

_____

_____

_____

_____

2 (b) (iii) The data in **Figure 3** are shown as a line graph and not as a bar chart.

Choose the reason why.

[1 mark]

Tick (✓) **one** box.

Both variables are categoric ☐

Both variables are continuous ☐

One variable is continuous and one is categoric ☐

2 (c) What happens to X-rays when they enter a bone?

[1 mark]

_____

_____

Question 2 continues on the next page

4.4.1.1 The structure of an atom

Question 75 · continued

2 (d) How are images formed electronically in a modern X-ray machine?

[1 mark]

Tick (✓) **one** box.

With a charge-coupled device (CCD) ☐

With an oscilloscope ☐

With photographic film ☐

2 (e) Radiographers who take X-ray photographs may be exposed to X-rays.

2 (e) (i) X-rays can increase the risk of the radiographer getting cancer.

Why can X-rays increase the risk of getting cancer?

[1 mark]

Tick (✓) **one** box.

X-rays travel at the speed of light ☐

X-rays can travel through a vacuum ☐

X-rays are ionising ☐

2 (e) (ii) What should the radiographer do to reduce the risk from X-rays?

[1 mark]

_____

_____

9

4.4.1.1 The structure of an atom

Question 76

June 2017 | PH2FP | Original Q1 | Legacy

1 (a) A student rubs a rubber balloon against the sleeve of her woollen jumper. The balloon becomes negatively charged.

1 (a) (i) Use the correct answer from the box to complete the sentence.

[1 mark]

electrons	neutrons	protons

The balloon becomes negatively charged because it gains _____ from the jumper.

1 (a) (ii) After charging the balloon, what is the overall charge left on the jumper?

[1 mark]

Tick (✓) **one** box.

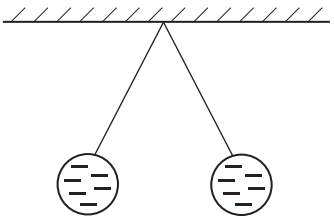
negative ☐

neutral ☐

positive ☐

1 (b) **Figure 1** shows two identically charged balloons hanging close together.

Figure 1



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

[1 mark]

The balloons carry the same type of charge and so _____ each other.

1 (b) (ii) From **Figure 1**, what can you conclude about the sizes of the **forces** acting on the balloons?

[1 mark]

_____

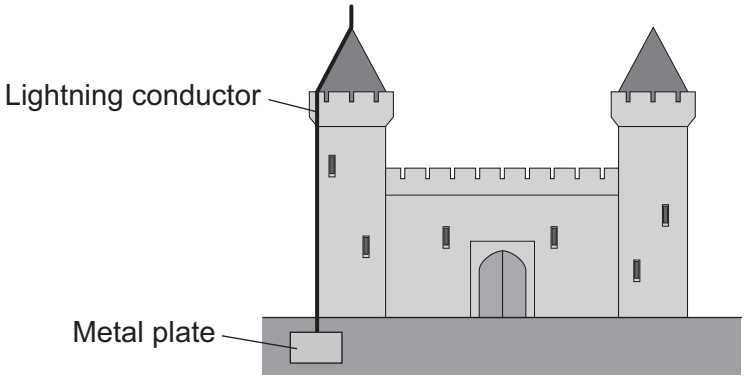
_____

4.4.1.1 The structure of an atom

Question 76 · continued

1 (c) A lightning conductor attached to the outside of a building reduces the risk of damage being caused to the building by a lightning strike.

Figure 2



If the building is struck by lightning the electrical charge flows through the lightning conductor to earth.

1 (c) (i) Through which one of the following materials can electrical charge flow easily?

Draw a ring around the correct answer.

[1 mark]

copper **plastic** **rubber**

1 (c) (ii) What happens to the temperature of a lightning conductor when electrical charge flows through it?

[1 mark]

Tick (✓) **one** box.

the temperature decreases ☐

the temperature does not change ☐

the temperature increases ☐

1 (c) (iii) During a lightning strike, 4 coulombs of charge flow through a lightning conductor in 0.002 seconds.

Calculate the current in the lightning conductor.

Use the correct equation from the Physics Equations Sheet.

[2 marks]

_____

_____

Current = _____ A

8

4.4.1.1 The structure of an atom

Question 77

June 2018 | 8463/1F | Original Q5

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

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

[2 marks]

Table 1

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

Isotope _____

Give a reason for your answer.

_____

_____

_____

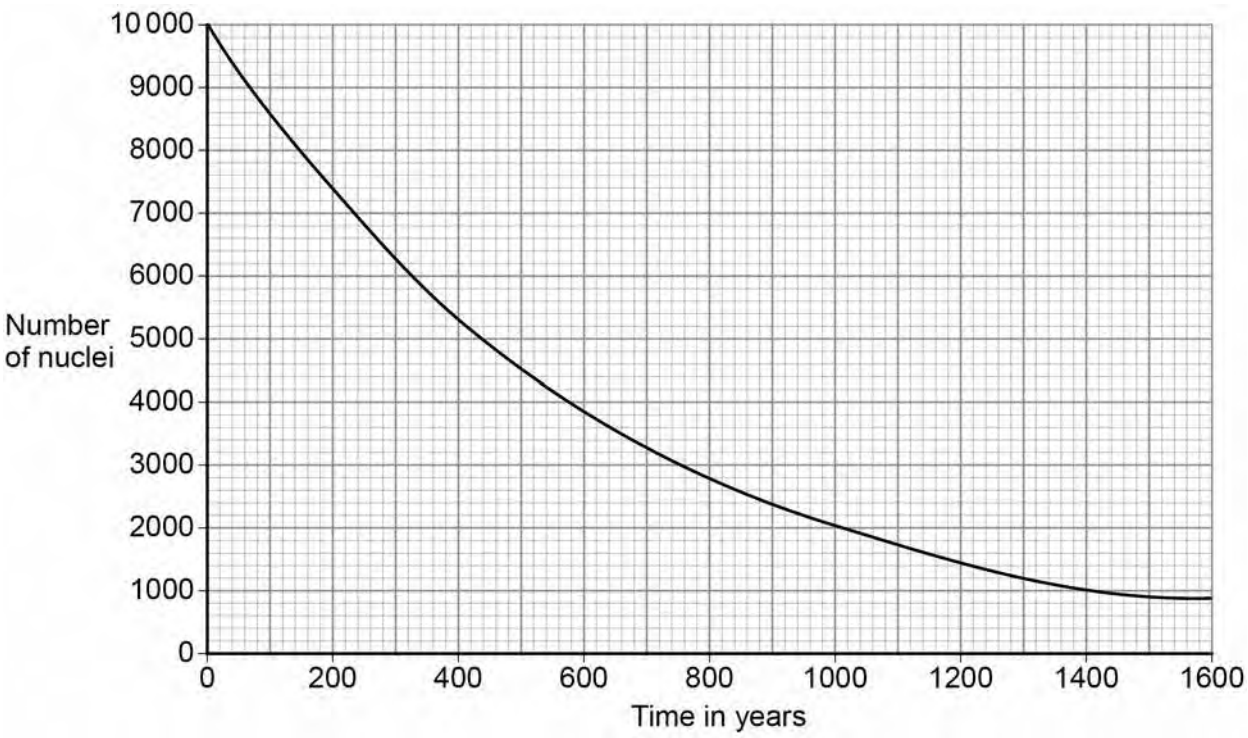
Question 5 continues on the next page

4.4.1.1 The structure of an atom

Question 77 · continued

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

Figure 5



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

[1 mark]

Time = _____ years

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

[1 mark]

Half-life = _____ years

4

4.4.1.1 The structure of an atom

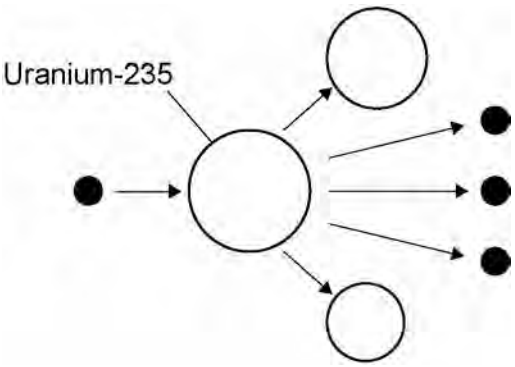
Question 78

June 2018 | 8463/1F | Original Q6

0 6 Nuclear power can be used to generate electricity through nuclear fission.

Figure 6 shows the process of nuclear fission.

Figure 6



0 6 . 1 Complete the sentences.

Choose answers from the box.

[3 marks]

gamma rays	**light rays**	**proton**	**neutron**	**nucleus**	**X-rays**

During the process of nuclear fission a uranium _____

absorbs a _____ .

Electromagnetic radiation is released in the form of _____ .

0 6 . 2 The UK needs at least 25 000 000 kW of electrical power at any time.

A nuclear power station has an electrical power output of 2 400 000 kW

Calculate how many nuclear power stations are needed to provide 25 000 000 kW of electrical power.

[2 marks]

Number of nuclear power stations = _____

4.4.1.1 The structure of an atom

Question 78 · continued

0 6 . 3 State **two** environmental issues caused by generating electricity using nuclear power stations.

[2 marks]

1 _____

_____

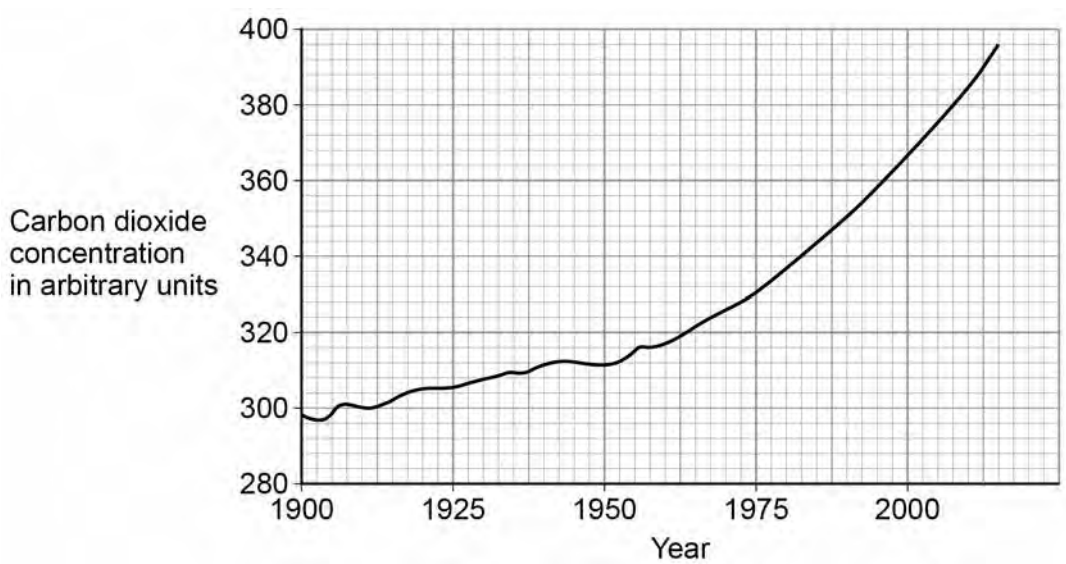
2 _____

_____

0 6 . 4 The UK currently generates a lot of electricity by burning natural gas. This process releases carbon dioxide into the atmosphere.

Figure 7 shows how the concentration of carbon dioxide in the atmosphere has changed over the past 115 years.

Figure 7

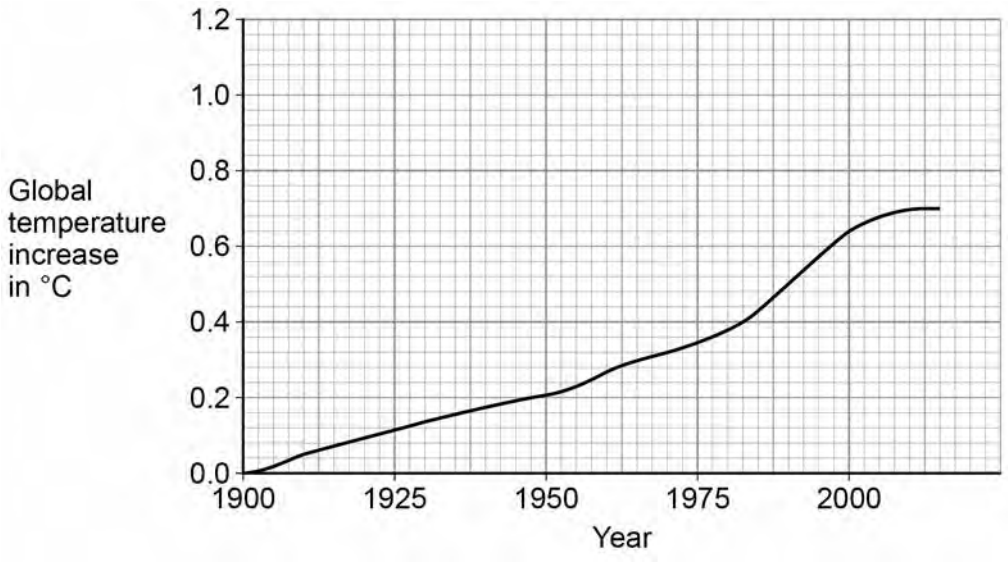


4.4.1.1 The structure of an atom

Question 78 · continued

Figure 8 shows how the global temperature has changed over the past 115 years.

Figure 8



Give **one** similarity and **one** difference between the data in **Figure 7** and **Figure 8**.

[2 marks]

Similarity _____

_____

_____

Difference _____

_____

_____

9

4.4.1.1 The structure of an atom

Question 79

June 2019 | 8463/1F | Original Q2

0 2 Polonium-210 $\left({}^{210}_{84}\mathrm{Po}\right)$ is a radioactive isotope that decays by emitting alpha radiation.

0 2 . 1 Which is the correct decay equation for polonium-210?

[1 mark]

Tick (✓) **one** box.

$^{210}_{84}\mathrm{Po} \rightarrow {}^{214}_{86}\mathrm{X} + {}^{4}_{2}\mathrm{He}$ ☐

$^{210}_{84}\mathrm{Po} \rightarrow {}^{206}_{86}\mathrm{X} + {}^{4}_{2}\mathrm{He}$ ☐

$^{210}_{84}\mathrm{Po} \rightarrow {}^{206}_{82}\mathrm{X} + {}^{4}_{2}\mathrm{He}$ ☐

0 2 . 2 Why is alpha radiation dangerous inside the human body?

[1 mark]

Tick (✓) **one** box.

Alpha radiation is electromagnetic radiation. ☐

Alpha radiation is highly ionising. ☐

Alpha radiation is very penetrating. ☐

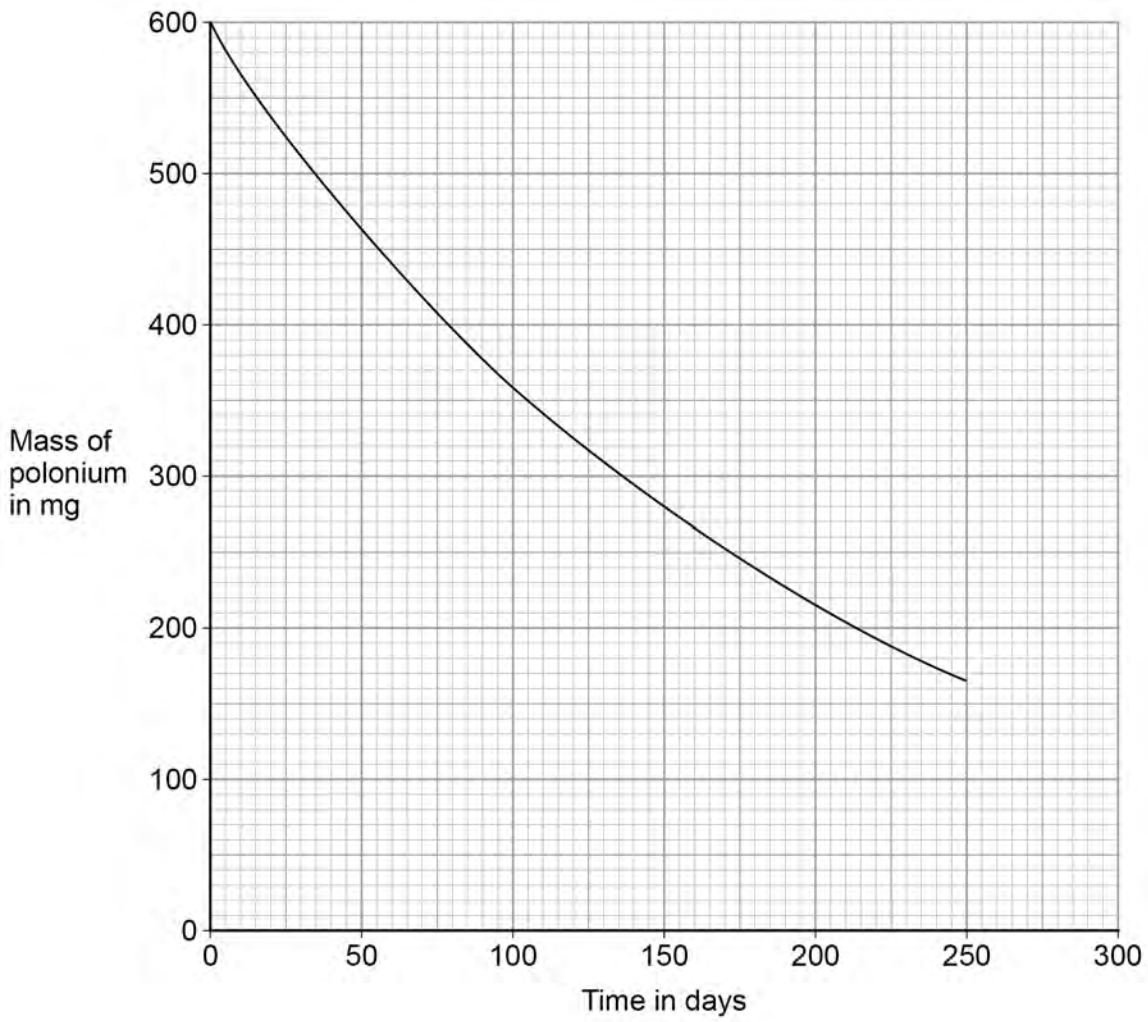
Question 2 continues on the next page

4.4.1.1 The structure of an atom

Question 79 · continued

Figure 3 shows how the mass of a sample of polonium-210 changes with time.

Figure 3



0 2 . 3 Determine the change in mass of the sample of polonium-210 between 50 and 150 days.

[2 marks]

Change in mass = _____ mg

4.4.1.1 The structure of an atom

Question 79 · continued

0 2 . 4 Estimate the mass of polonium-210 remaining after 300 days.

[1 mark]

Mass = _____ mg

0 2 . 5 Nuclear radiation can cause ionisation.

Complete the sentences.

Choose answers from the box.

[2 marks]

a negative	**an electron**	**a neutron**	**a positive**	**a proton**	**a zero**

An atom becomes an ion when it loses _____.

The resulting ion has _____ charge.

7

4.4.1.1 The structure of an atom

Question 80

June 2019 | 8463/1F | Original Q4

0 4 The ancient Greeks thought that atoms were tiny spheres that could not be divided into anything smaller.

Since then, different discoveries have led to the model of the atom changing.

Some of the discoveries are given in **Table 1**.

Table 1

The mass of an atom is concentrated in the nucleus.	**A**
Electrons orbit the nucleus at specific distances.	**B**
The nucleus contains neutrons.	**C**
The nucleus contains positively charged protons.	**D**

0 4 . 1 Which discovery was the earliest?

[1 mark]

Tick (✓) **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐

0 4 . 2 Which discovery was the most recent?

[1 mark]

Tick (✓) **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐

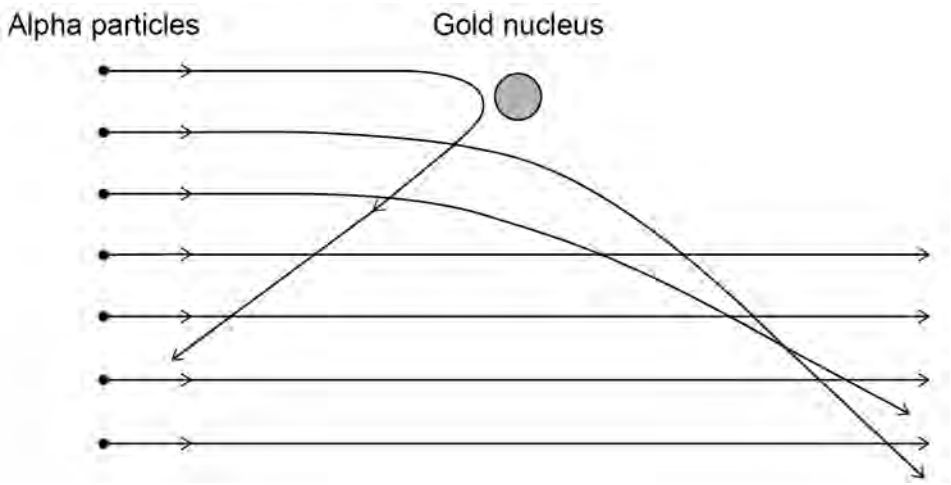
4.4.1.1 The structure of an atom

Question 80 · continued

0 4 . 3 The alpha particle scattering experiment led to the nuclear model of the atom.

Figure 5 shows the paths of alpha particles travelling close to a gold nucleus.

Figure 5



Complete the sentences.

Choose answers from the box.

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

[3 marks]

attracts	**decreases**	**does not change**
increases	**reflects**	**repels**

Alpha particles and gold nuclei are both positively charged.

The gold nucleus _____ the alpha particles.

As the alpha particle approaches the gold nucleus, the electric field strength experienced by the alpha particle _____ .

As an alpha particle approaches the gold nucleus, the force experienced by the alpha particle _____ .

4.4.1.1 The structure of an atom

Question 80 · continued

0 4 . 4 The results of the alpha particle scattering experiment were reproducible.

What does reproducible mean?

[1 mark]

Tick (✓) **one** box.

- Another scientist repeats the experiment and gets the same results. ☐
- Another scientist repeats the experiment and gets different results. ☐
- The same scientist repeats the experiment and gets the same results. ☐
- The same scientist repeats the experiment and gets different results. ☐

6

4.4.1.1 The structure of an atom

Question 81

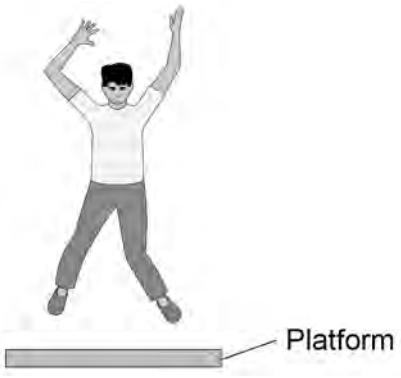
June 2019 | 8463/1F | Original Q11

1 1 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 18 shows a volunteer taking part in the experiment.

Figure 18



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

1 1 . 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 81 · continued

1 1 . 2 Write down the equation which links kinetic energy, mass and speed.

[1 mark]

1 1 . 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.

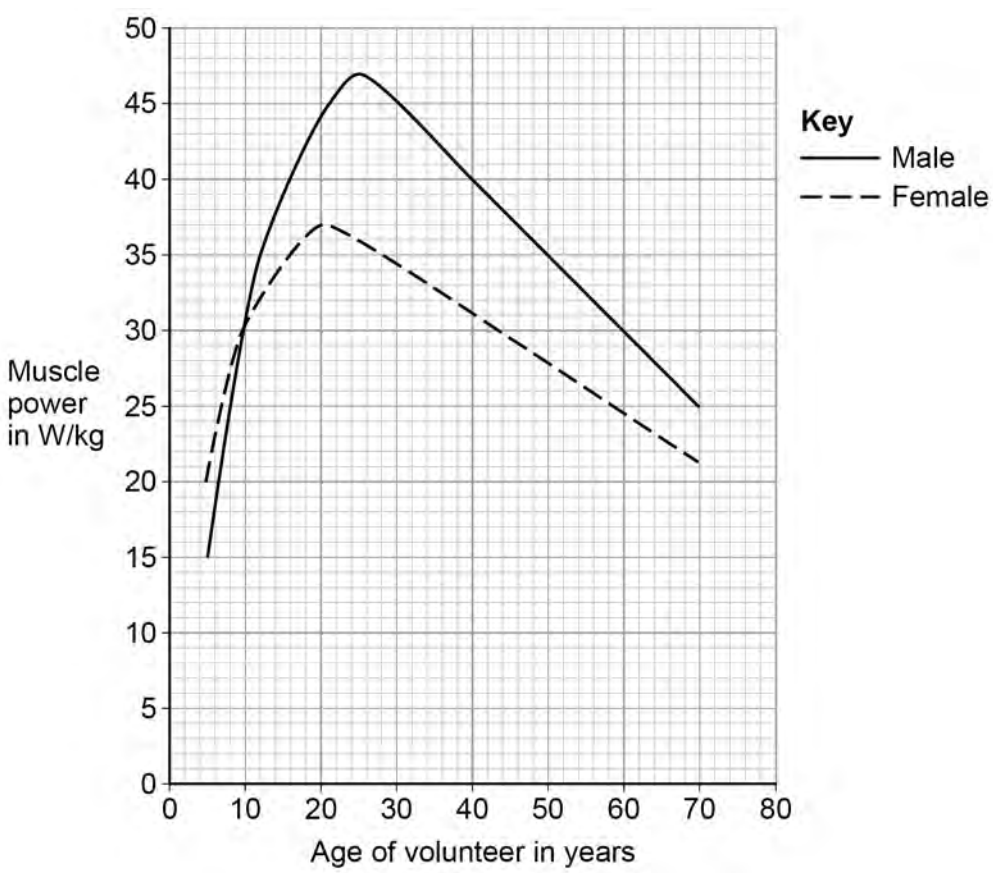
Calculate his mass.

[3 marks]

Mass = _____ kg

Figure 19 shows the scientist's results.

Figure 19



4.4.1.1 The structure of an atom

Question 81 · continued

1 1 . 4 Compare the muscle power of males with the muscle power of females.

Use data from **Figure 19** in your answer.

[4 marks]

1 1 . 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]

1

4.4.1.1 The structure of an atom

Question 82

November 2020 | 8463/1F | Original Q5

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

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

[1 mark]

Tick (✓) **one** box.

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

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

Complete the sentences to describe the process of nuclear fission.

Choose answers from the box.

[3 marks]

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

An unstable nucleus absorbs _____ and splits into two parts.

Two or three neutrons are released, as well as _____

and _____ .

4.4.1.1 The structure of an atom

Question 82 · continued

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

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

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

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

[1 mark]

Tick (✓) **one** box.

An alpha particle contains 92 protons. ☐

An alpha particle has a mass number of 235. ☐

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

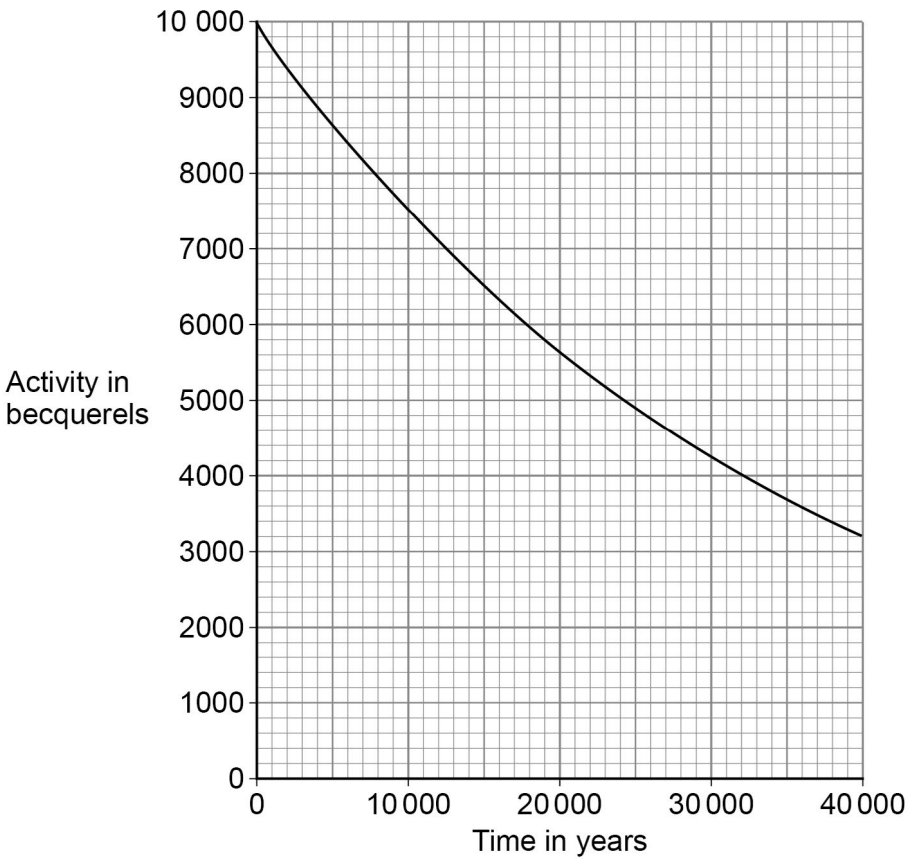
Question 5 continues on the next page

4.4.1.1 The structure of an atom

Question 82 · continued

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

Figure 8



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

[1 mark]

Time = _____ years

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

[1 mark]

Half-life = _____ years

4.4.1.1 The structure of an atom

Question 82 · continued

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

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

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

[1 mark]

8

Turn over for the next question

4.4.1.1 The structure of an atom

Question 83

November 2021 | 8463/1F | Original Q5

0 5 Atoms of different elements have different properties.

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

[1 mark]

Tick (✓) **one** box.

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

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

[1 mark]

Tick (✓) **one** box.

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

Question 5 continues on the next page

4.4.1.1 The structure of an atom

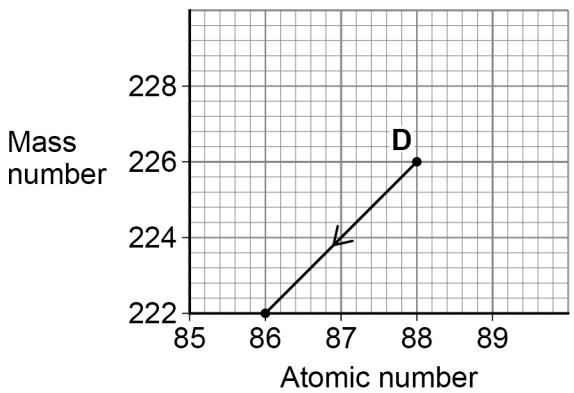
Question 83 · continued

0 5 . 3 A nucleus emits radiation.

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

The nucleus is labelled **D**.

Figure 7



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

[1 mark]

Tick (✓) **one** box.

Alpha ☐

Beta ☐

Neutron ☐

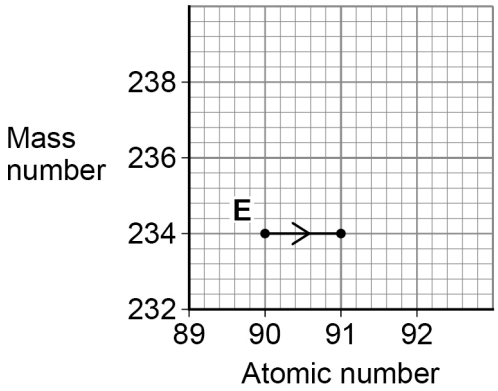
4.4.1.1 The structure of an atom

Question 83 · continued

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

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

Figure 8



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

[1 mark]

Tick (✓) **one** box.

Alpha ☐

Beta ☐

Neutron ☐

Question 5 continues on the next page

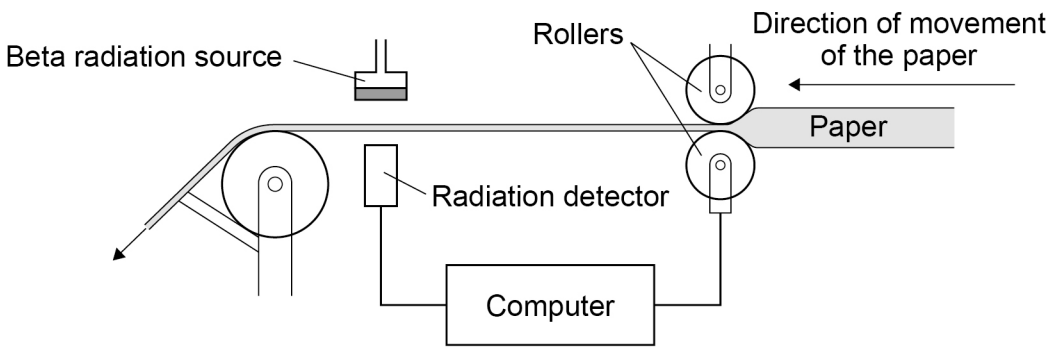
4.4.1.1 The structure of an atom

Question 83 · continued

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

Figure 9 shows how the radiation is used.

Figure 9



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

0 5 . 5 Complete the sentences.

Choose answers from the box.

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

decrease	**stay the same**	**increase**

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

[2 marks]

The reading on the detector will _____.

This is because the amount of radiation absorbed by the paper

will _____.

4.4.1.1 The structure of an atom

Question 83 · continued

November 2021 | 8463/1F | Original Q5

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

What is meant by 'half-life'?

[1 mark]

Tick (✓) **one** box.

The time it takes for all the nuclei in a radioactive sample to split in half. ☐

The time it takes for the count rate of a radioactive sample to halve. ☐

The time it takes for the radiation to travel half of its range in air. ☐

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

[1 mark]

Tick (✓) **one** box.

So the activity of the source is approximately constant. ☐

So the amount of radiation decreases quickly. ☐

So the radiation has a long range in air. ☐

8

4.4.1.1 The structure of an atom

Question 84

November 2021 | 8463/2F | Original Q6

0 6 The Sun is the closest star to the Earth.

0 6 . 1 A 2.5 kg mass would have a weight of 750 N at the surface of the Sun.

Calculate the gravitational field strength at the surface of the Sun.

Use the equation:

$$\text{gravitational field strength} = \frac{\text{weight}}{\text{mass}}$$

[2 marks]

Gravitational field strength = _____ N/kg

0 6 . 2 Gravity is a non-contact force.

Which of the following is also a non-contact force?

[1 mark]

Tick (✓) **one** box.

- Air resistance ☐
- Electrostatic ☐
- Friction ☐
- Tension ☐

4.4.1.1 The structure of an atom

Question 84 · continued

0 6 . 3 All stars have a life cycle.

Figure 15 shows part of the life cycle of a star that becomes a black dwarf.

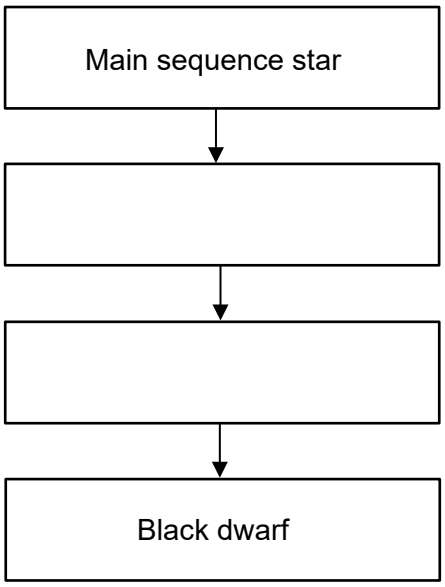
Complete **Figure 15**.

Choose answers from the box.

[2 marks]

Black hole		**Neutron star**
Red giant	**Supernova**	**White dwarf**

Figure 15



Question 6 continues on the next page

4.4.1.1 The structure of an atom

Question 84 · continued

Table 3 gives the mass of three stars compared to the mass of the Sun.

Table 3

Star	Mass compared to the mass of the Sun
X	× 25.0
Y	× 15.0
Z	× 0.9

0 6 . 4 Which letter represents the star most likely to become a black dwarf?

Give a reason for your answer.

[2 marks]

Tick (✓) **one** box.

X ☐ **Y** ☐ **Z** ☐

Reason _____

_____

_____

0 6 . 5 In which stage of the life cycle of a star are elements heavier than iron produced?

[1 mark]

Tick (✓) **one** box.

Nebula ☐

Protostar ☐

Supernova ☐

8

4.4.1.1 The structure of an atom

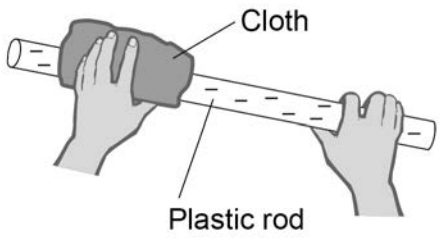
Question 85

June 2022 | 8463/1F | Original Q3

0 3 **Figure 3** shows a plastic rod being rubbed with a cloth.

The plastic rod becomes negatively charged.

Figure 3



0 3 . 1 Complete the sentences.

Choose answers from the box.

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

[2 marks]

electrons	**neutrons**	**protons**

The plastic rod becomes charged because it gains _____ .

The cloth also becomes charged because it loses _____ .

0 3 . 2 What charge is left on the cloth?

[1 mark]

Tick (✓) **one** box.

A negative charge ☐

A neutral charge ☐

A positive charge ☐

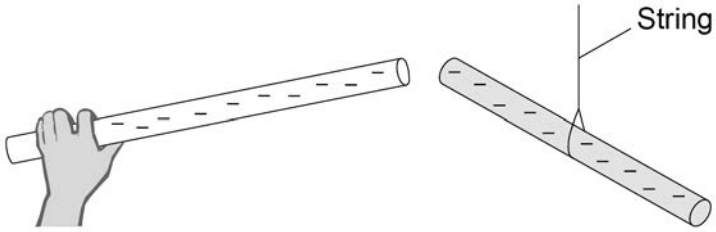
4.4.1.1 The structure of an atom

Question 85 · continued

0 3 . 3 The negatively charged plastic rod is put near another negatively charged plastic rod that is hanging from a string.

Figure 4 shows the two rods.

Figure 4



What force is exerted on the two rods?

Tick (✓) **one** box.

Give a reason for your answer.

[2 marks]

A force of attraction ☐

A force of repulsion ☐

There is no force ☐

Reason _____

_____

_____

Question 3 continues on the next page

4.4.1.1 The structure of an atom

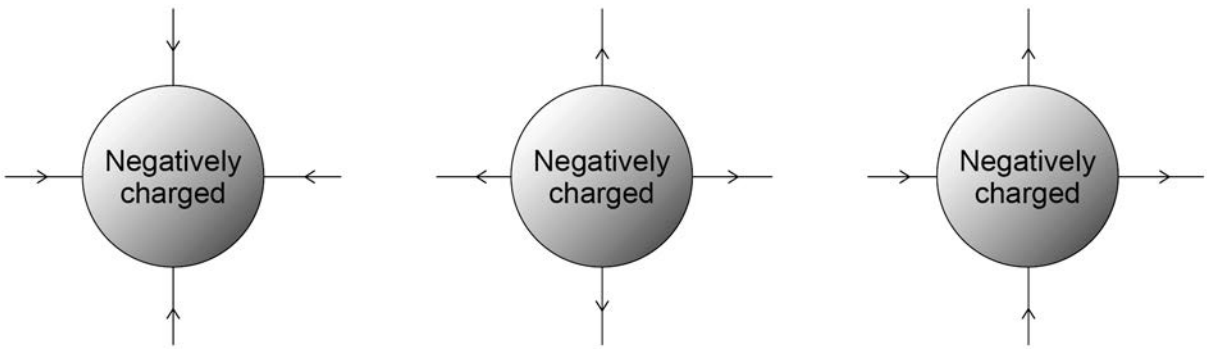
Question 85 · continued

0 3 . 4 There is an electric field around any charged object.

Which diagram shows the electric field pattern around a negatively charged sphere?

[1 mark]

Tick (✓) **one** box.

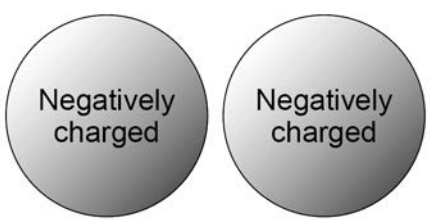


☐ ☐ ☐

0 3 . 5 In which position do two charged spheres experience the greatest electrostatic force?

[1 mark]

Tick (✓) **one** box.

A 

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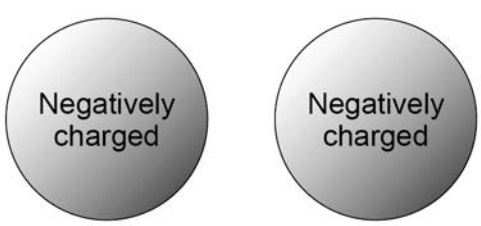
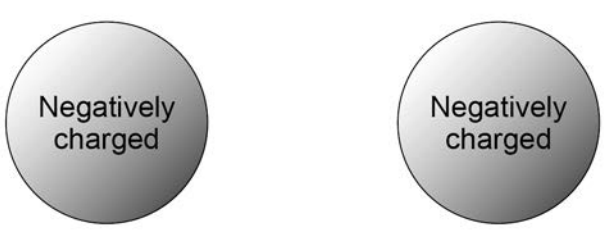
B 

☐

C 

☐

7

4.4.1.1 The structure of an atom

Question 86

June 2022 | 8463/1F | Original Q4

0 4 Radioactive isotopes emit different types of nuclear radiation.

0 4 . 1 What does an alpha particle consist of?

[1 mark]

Tick (✓) **one** box.

- 2 protons and 2 electrons ☐
- 2 protons and 2 neutrons ☐
- 4 protons ☐
- 4 neutrons ☐

0 4 . 2 What is a beta particle?

[1 mark]

Tick (✓) **one** box.

- An electron ☐
- A neutron ☐
- Electromagnetic radiation ☐

0 4 . 3 A krypton (Kr) nucleus decays into a rubidium (Rb) nucleus by emitting a beta particle.

What is the correct equation for this decay?

[1 mark]

Tick (✓) **one** box.

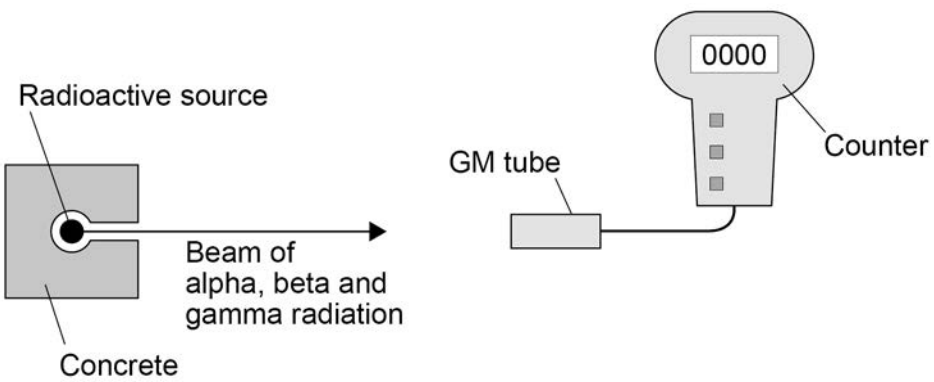
- $^{85}_{36}Kr + {}^{0}_{-1}e \longrightarrow {}^{85}_{37}Rb$ ☐
- $^{85}_{36}Kr \longrightarrow {}^{85}_{37}Rb + {}^{0}_{-1}e$ ☐
- $^{85}_{37}Rb \longrightarrow {}^{85}_{36}Kr + {}^{0}_{-1}e$ ☐

Question 86 · continued

0 4 . 4 **Figure 5** shows an experiment to demonstrate how alpha, beta and gamma radiation penetrate different materials.

The experiment takes place in a vacuum.

Figure 5



Three different materials are used:

- a sheet of paper
- a 0.5 cm thick sheet of aluminium
- a 10 cm block of lead.

Each material is placed one at a time between the radioactive source and the GM tube.

The GM tube and counter show whether the material has stopped the radiation.

Complete **Table 1** to show how alpha, beta and gamma radiation penetrate the materials in **Figure 5**.

Use the words **Yes** and **No**.

Part of **Table 1** has been completed for you.

[3 marks]

Table 1

Type of radiation	Most radiation is stopped by:		
	the sheet of paper	the sheet of aluminium	the block of lead
Alpha			Yes
Beta	No		
Gamma		No	

Question 86 · continued

0 4 . 5 Alpha, beta and gamma radiation have different ionising powers.

Draw **one** line from each radiation type to the correct ionising power.

[3 marks]

Radiation type	Ionising power
Alpha	Zero
Beta	Low
Gamma	Medium
	High

0 4 . 6 Some sources of background radiation are natural and other sources are man-made.

Which of the following is a man-made source of background radiation?

[1 mark]

Tick (✓) **one** box.

Cosmic rays ☐

Nuclear accidents ☐

Rocks ☐

0 4 . 7 The average background radiation dose per year in the UK is 2.0 millisieverts.

A dental X-ray gives a patient a radiation dose of 0.005 millisieverts.

Calculate how many dental X-rays would be the same as the average background radiation dose per year.

[2 marks]

Number of dental X-rays = _____

12

4.4.1.1 The structure of an atom

Question 87

June 2023 | 8463/1F | Original Q2

0 2 Scientists developed different models of the atom as new discoveries were made.

0 2 . 1 Which particle in the atom was discovered first?

[1 mark]

Tick (✓) **one** box.

Electron ☐

Neutron ☐

Proton ☐

Question 2 continues on the next page

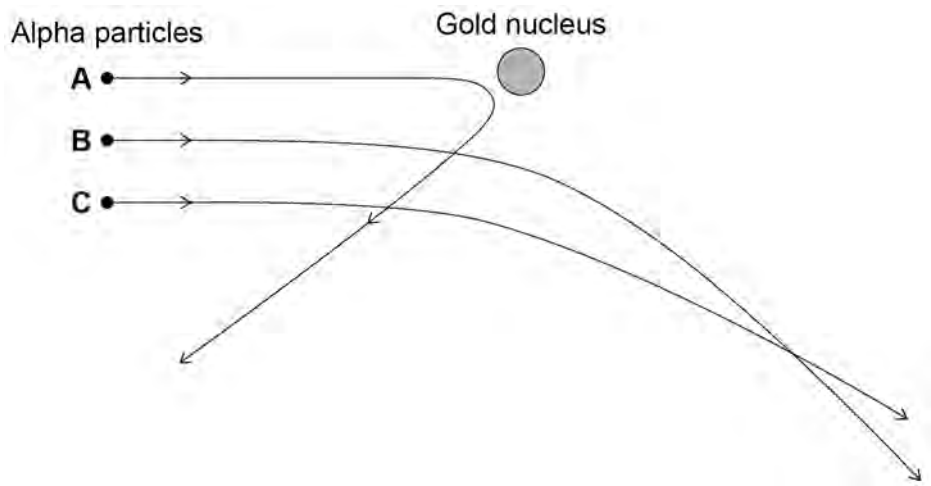
4.4.1.1 The structure of an atom

Question 87 · continued

In an experiment that led to the nuclear model of the atom, alpha particles were directed at a sheet of gold foil.

Figure 3 shows the path of three alpha particles passing close to a gold nucleus.

Figure 3



0 2 . 2 An alpha particle has a radius of 1.7 femtometres.

The radius of a gold nucleus is 4.2 times larger than the radius of an alpha particle.

Calculate the radius of a gold nucleus in femtometres.

[2 marks]

Radius of a gold nucleus = _____ femtometres

4.4.1.1 The structure of an atom

Question 87 · continued

0 2 . 3 Alpha particles are deflected by the gold nucleus.

What are the charges on an alpha particle and a gold nucleus?

[1 mark]

Tick (✓) **one** box.

An alpha particle and a gold nucleus are both neutral. ☐

An alpha particle and a gold nucleus are both positively charged. ☐

An alpha particle is positively charged and a gold nucleus is neutral. ☐

0 2 . 4 Which statement describes the force between the alpha particle and the gold nucleus?

[1 mark]

Tick (✓) **one** box.

A contact force ☐

A force of attraction ☐

A force of repulsion ☐

There is no force ☐

0 2 . 5 Which alpha particle in **Figure 3** experiences the largest force from the gold nucleus?

[1 mark]

Tick (✓) **one** box.

A ☐ **B** ☐ **C** ☐

4.4.1.1 The structure of an atom

Question 87 · continued

Table 1 lists different models of the atom in alphabetical order.

Table 1

Model
Bohr
Nuclear
Plum pudding
Tiny spheres that cannot be divided

0 2 . 6 Which model in **Table 1** was developed first?

[1 mark]

0 2 . 7 Which model in **Table 1** was developed last?

[1 mark]

8

4.4.1.1 The structure of an atom

Question 88

June 2023 | 8463/1F | Original Q3

0 3 Some isotopes emit nuclear radiation.

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

Complete the sentences.

Choose answers from the box.

[2 marks]

alpha particles	**electrons**	**neutrons**	**protons**

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

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

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

What does 'half-life' mean?

[1 mark]

Tick (✓) **one** box.

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

Question 3 continues on the next page

Question 88 · continued

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

Table 2

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

Which isotope is the least stable?

[1 mark]

Tick (✓) **one** box.

Carbon-15 ☐

Carbon-16 ☐

Carbon-17 ☐

Carbon-18 ☐

4.4.1.1 The structure of an atom

Question 88 · continued

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

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

[2 marks]

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

Question 3 continues on the next page

Question 88 · continued

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

[1 mark]

Tick (✓) **one** box.

To remove alpha particles from their shoes. ☐

To remove gamma radiation from their shoes. ☐

To remove radioactive dust from their shoes. ☐

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

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

Table 3

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

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

[2 marks]

Number of days = _____

4.4.1.1 The structure of an atom

Question 88 · continued

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

The process of nuclear fusion takes place in the Sun.

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

[2 marks]

Process	Fuel
	Hydrogen
Nuclear fission	Iron
Nuclear fusion	Lead
	Uranium

11

4.4.1.1 The structure of an atom

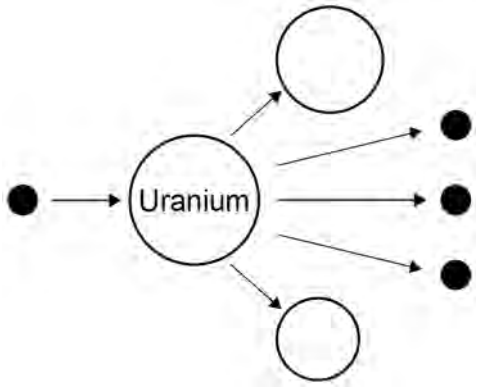
Question 89

June 2024 | 8463/1F | Original Q10

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

Figure 17 shows the process of nuclear fission.

Figure 17



1 0 . 1 Complete the sentences.

Choose answers from the box.

[3 marks]

electrons	**gamma rays**	**neutrons**	**nuclei**	**protons**

In nuclear power stations, energy is released from

uranium _____.

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

releases three _____.

The process of nuclear fission releases electromagnetic radiation in the

form of _____.

4.4.1.1 The structure of an atom

Question 89 · continued

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

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

[1 mark]

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

Calculate the energy output in 3600 s.

Give your answer in J.

[3 marks]

Energy output = _____ J

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

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

[1 mark]

4.4.1.1 The structure of an atom

Question 89 · continued

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

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

one year = 365 days

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

[2 marks]

Number of days = _____

10

Turn over for the next question

4.4.1.1 The structure of an atom

Question 90

June 2025 | 8463/1F | Original Q3

0 3 Different radioactive isotopes emit different types of radiation.

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

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

[1 mark]

Tick (✓) **one** box.

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

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

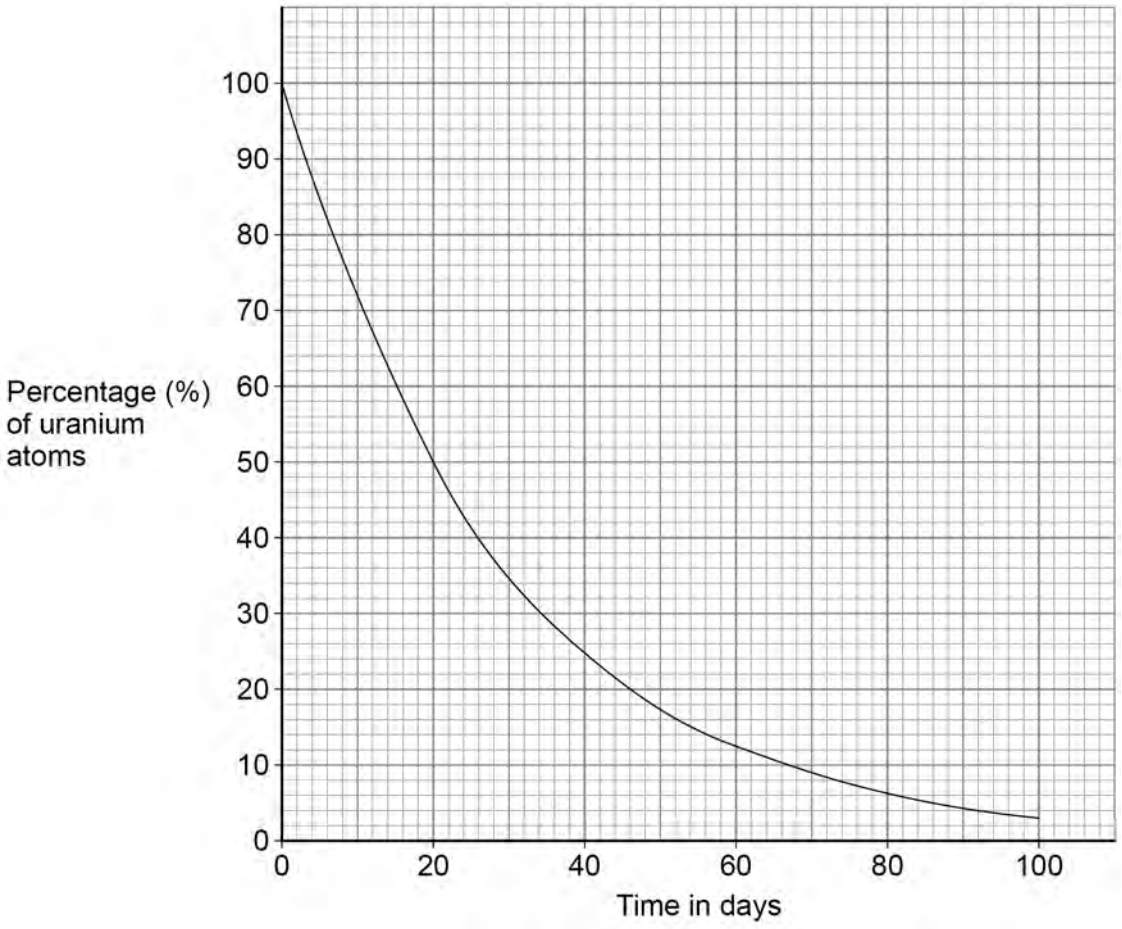
$^{230}_{92}U + {}^{226}_{90}Th \rightarrow {}^{4}_{2}He$ ☐

4.4.1.1 The structure of an atom

Question 90 · continued

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

Figure 4



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

Use **Figure 4**.

[1 mark]

Time taken = _____ days

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

[1 mark]

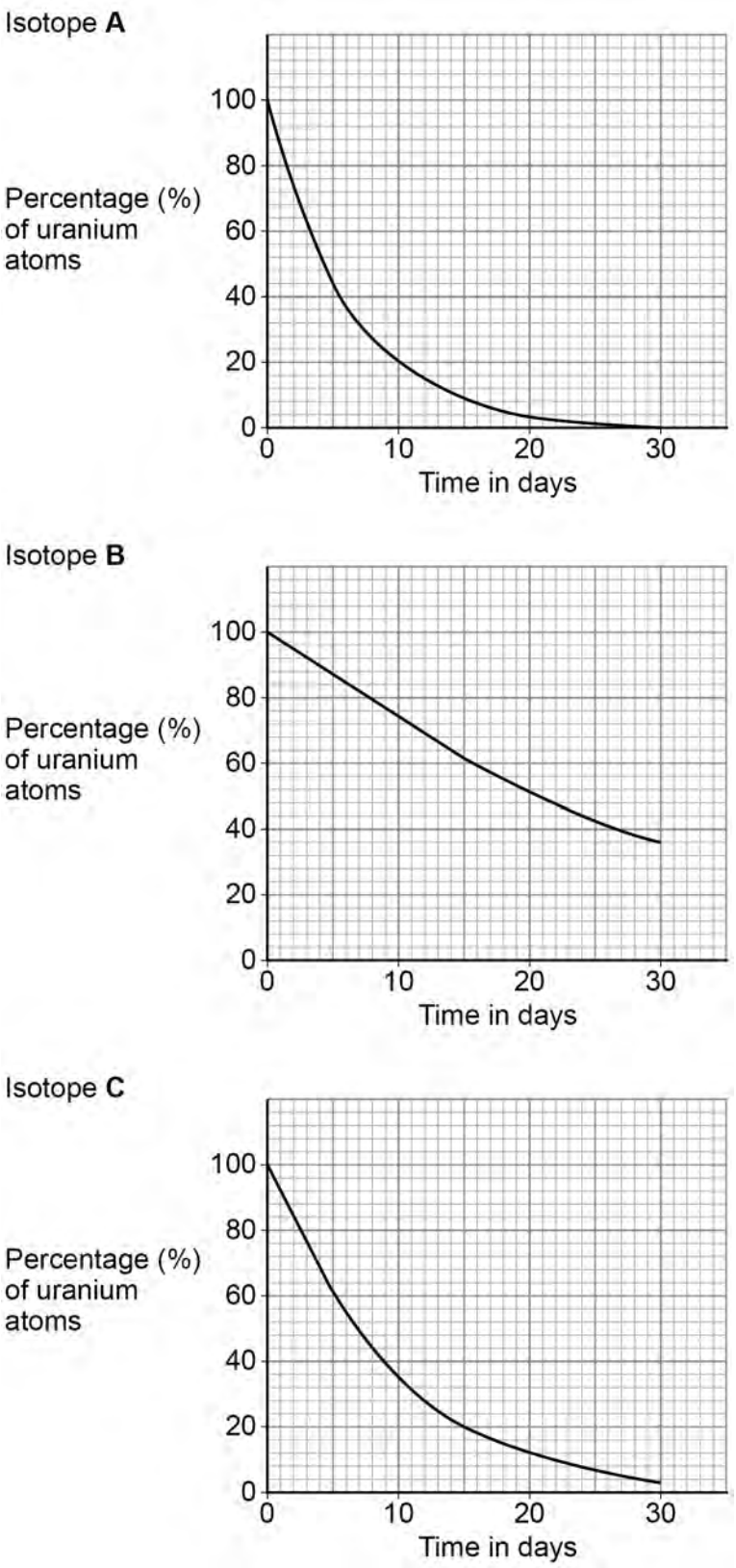
Half-life = _____ days

4.4.1.1 The structure of an atom

Question 90 · continued

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

Figure 5



4.4.1.1 The structure of an atom

Question 90 · continued

Which isotope is the most unstable?

Give a reason for your answer.

[2 marks]

Tick (✓) **one** box.

Isotope **A** ☐

Isotope **B** ☐

Isotope **C** ☐

Reason _____

_____

_____

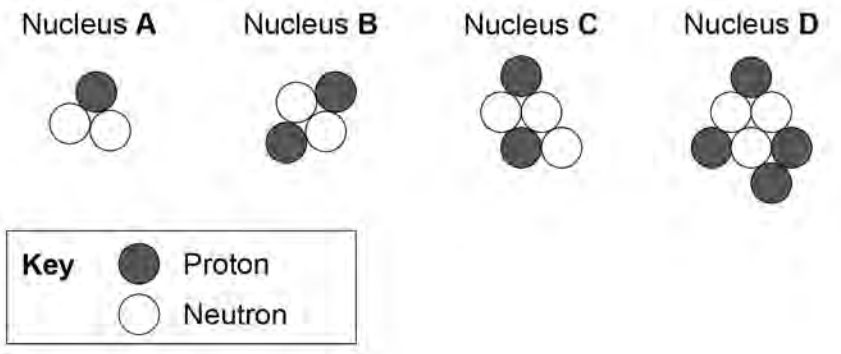
Question 3 continues on the next page

4.4.1.1 The structure of an atom

Question 90 · continued

Figure 6 shows the nuclei of four different atoms.

Figure 6



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

[1 mark]

Tick (✓) **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐

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

[1 mark]

Tick (✓) **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐

4.4.1.1 The structure of an atom

Question 90 · continued

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

Give a reason for your answer.

[2 marks]

Nucleus ☐ and nucleus ☐

Reason _____

_____

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

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

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

[1 mark]

Tick (✓) **one** box.

Bohr model ☐

Plum pudding model ☐

Tiny spheres that cannot be divided ☐

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

[1 mark]

Tick (✓) **one** box.

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

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

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

11