AQA GCSE Physics | 8463

SPECIFICATION POINT 4.4.1.3

The development of the model of the atom (common content with chemistry)

Past-paper questions

Tier	**Higher**
Question groups	**8**
Available paper years	**2005–2025**

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:** _____

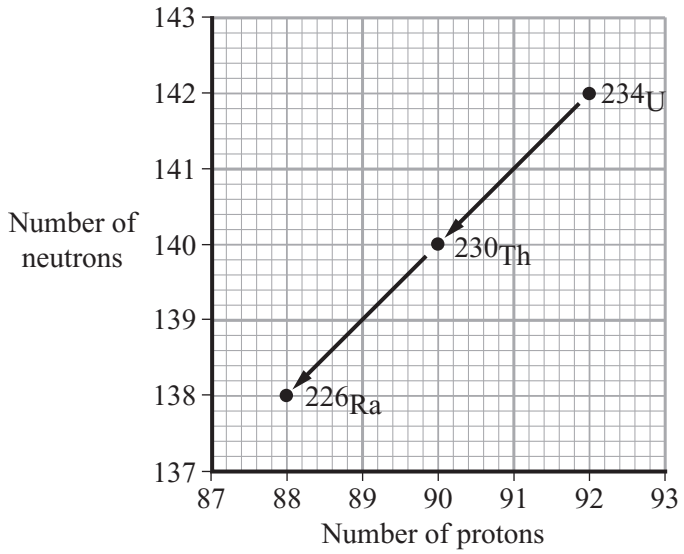
Whole questions are retained for context, so some parts assess other specification points. Current and legacy sources are labelled. Continue on extra paper if needed.

4.4.1.3 The development of the model of the atom (common content with chemistry)

Question 01

June 2005 | 3451 | Original Q9 | Legacy

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



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

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(1 mark)

(ii) What makes uranium and thorium different elements?

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(1 mark)

(iii) Radioactive decay may also produce gamma radiation.

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

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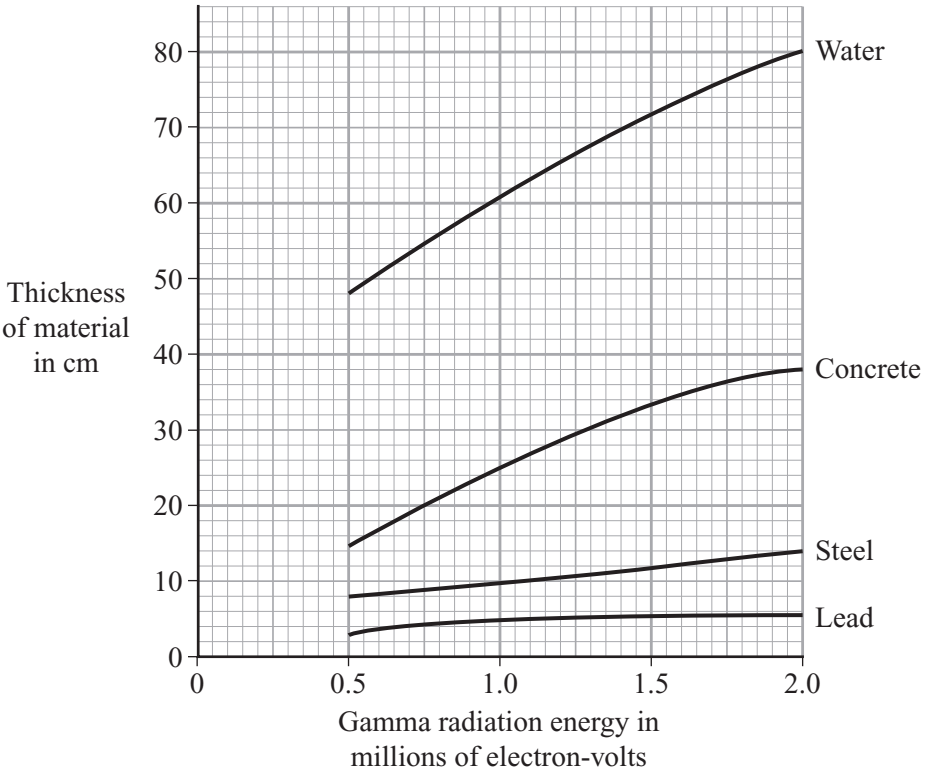
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(1 mark)

4.4.1.3 The development of the model of the atom (common content with chemistry)

Question 01 · continued

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



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

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(1 mark)

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

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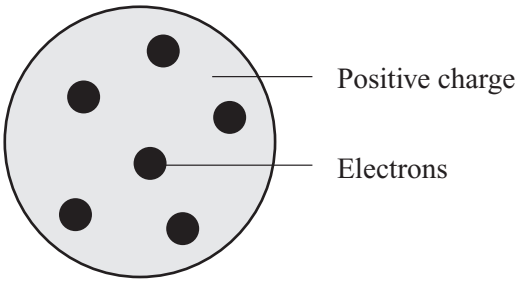
(2 marks)

QUESTION 9 CONTINUES ON THE NEXT PAGE

4.4.1.3 The development of the model of the atom (common content with chemistry)

Question 01 · continued

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



Plum pudding model

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

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(3 marks)

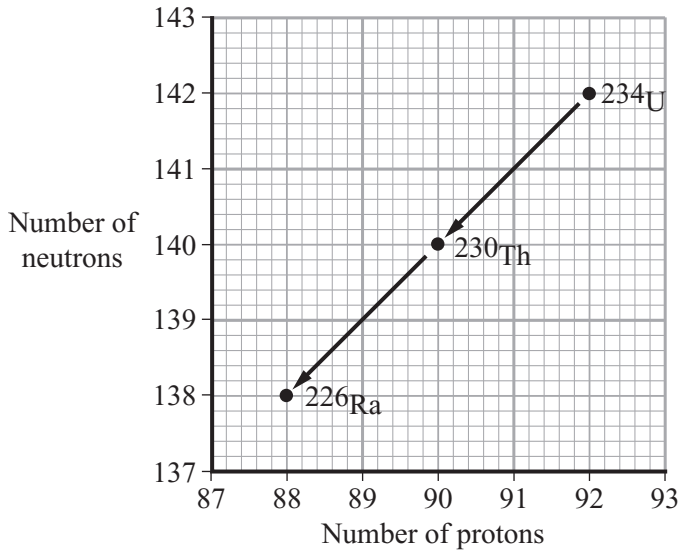
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4.4.1.3 The development of the model of the atom (common content with chemistry)

Question 02

June 2005 | 3462 | Original Q7 | Legacy

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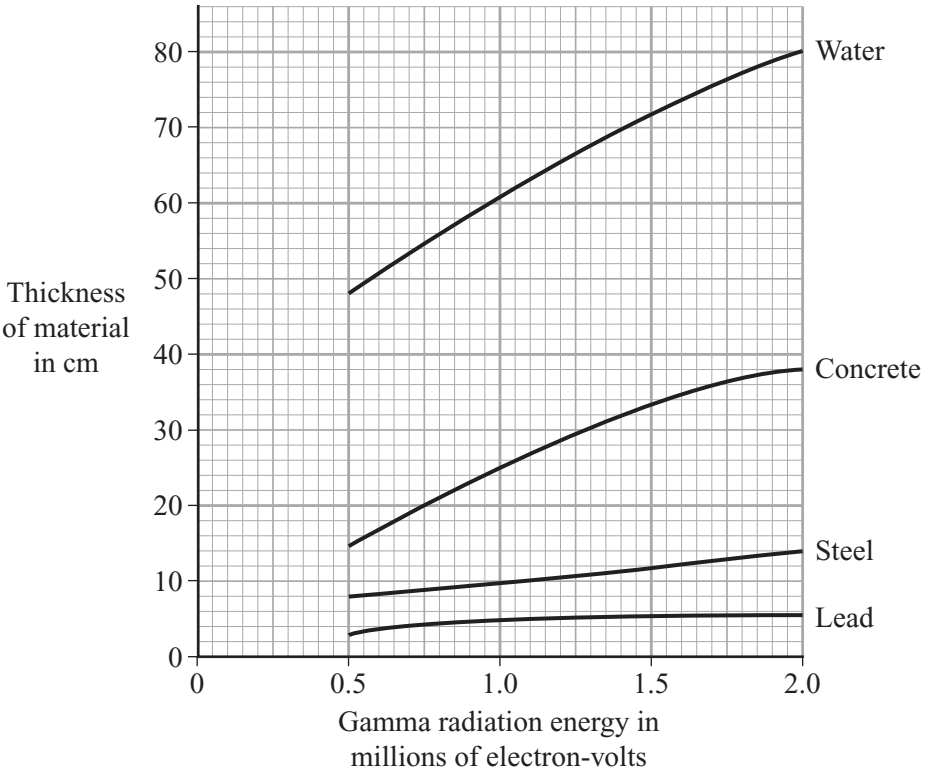
(1 mark)

4.4.1.3 The development of the model of the atom (common content with chemistry)

Question 02 · continued

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



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

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(2 marks)

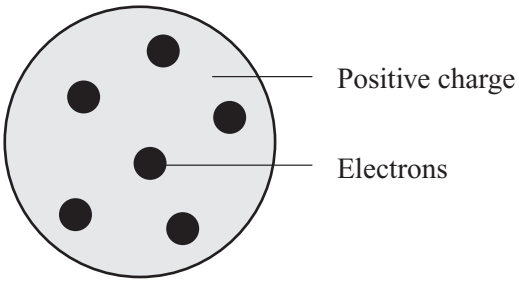
QUESTION 7 CONTINUES ON THE NEXT PAGE

4.4.1.3 The development of the model of the atom (common content with chemistry)

Question 02 · continued

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



Plum pudding model

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

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(3 marks)

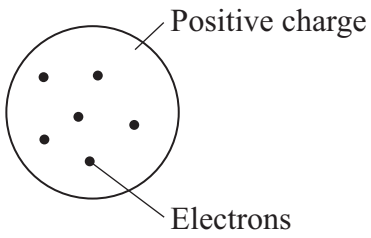
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4.4.1.3 The development of the model of the atom (common content with chemistry)

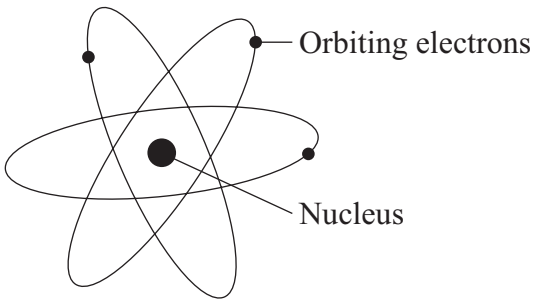
Question 03

January 2009 | PHY2H | Original Q7 | Legacy

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



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



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

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(4 marks)

4.4.1.3 The development of the model of the atom (common content with chemistry)

Question 03 · continued

for mark

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

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

Use the nuclear model to explain this experimental result.

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(2 marks)

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

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(2 marks)

8

4.4.1.3 The development of the model of the atom (common content with chemistry)

Question 04

June 2010 | PHY1BP | Original Q7 | Legacy

QUESTION SEVEN

In 1896, Henri Becquerel was doing an experiment with uranium. He first thought that uranium absorbed energy from the Sun and then re-emitted the energy as X-rays. Then, on a cloudy day, he found that the uranium emitted radiation even when the uranium sample was wrapped in black paper.

7A This suggests that . . .

1 his original theory was wrong and further investigation was needed.

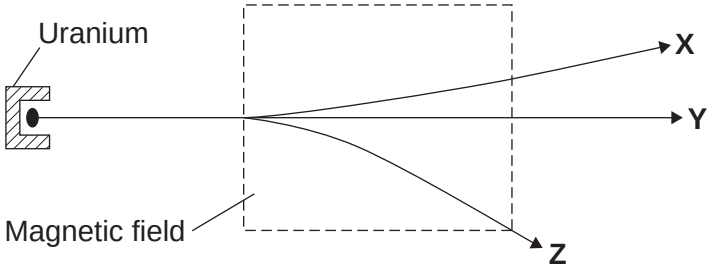
2 his test was fair but more variables needed to be controlled.

3 his original theory was correct and further investigation was needed.

4 his test was not fair and more variables needed to be controlled.

7B Becquerel passed the radiation emitted by uranium through a magnetic field. He found that there were three different types of radiation.

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



Later, Ernest Rutherford called the three types of radiation alpha, beta and gamma.

Which is the correct row in the table?

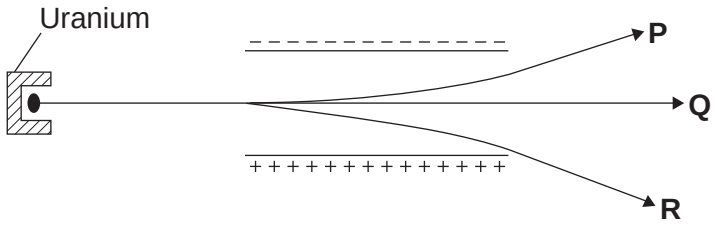
	X	Y	Z
1	alpha	beta	gamma
2	alpha	gamma	beta
3	beta	alpha	gamma
4	beta	gamma	alpha

4.4.1.3 The development of the model of the atom (common content with chemistry)

Question 04 · continued

7C The radiation emitted by uranium can also be deflected in an electric field between two charged plates.

The diagram shows the paths taken by the three types of radiation, **P**, **Q** and **R**, in an electric field.



The explanation for the different paths is that . . .

1 **P** and **R** have the same electric charge and **Q** is uncharged.

2 **P** and **R** are oppositely charged and **P** has a larger mass than **R**.

3 **P** and **R** are oppositely charged and **R** has a larger charge than **P**.

4 **Q** is uncharged and has a larger mass than both **P** and **R**.

7D Rutherford measured the range in air of the three types of radiation.

Which row of the table gives the correct order of range?

	Shortest range ⟶ **Longest range**		
1	alpha	beta	gamma
2	alpha	gamma	beta
3	beta	alpha	gamma
4	beta	gamma	alpha

4.4.1.3 The development of the model of the atom (common content with chemistry)

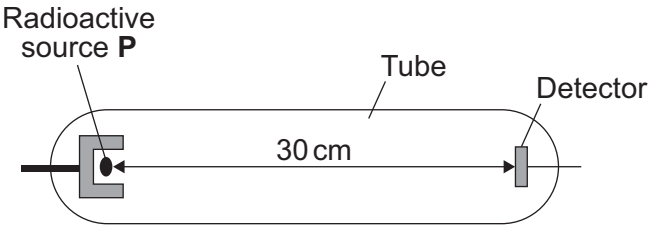
Question 05

June 2011 | PHY1BP | Original Q6 | Legacy

QUESTION SIX

Ernest Rutherford did many experiments in studying the properties of radioactive sources. He gave names to the three types of radiation emitted by radioactive sources.

One experiment used apparatus similar to that shown.



6A Rutherford found that when the air in the tube was removed, the radiation from **P** was detected. When the air was returned to the tube, no radiation was detected.

The radioactive source **P** emitted . . .

1 alpha particles.

2 beta particles.

3 gamma rays.

4 X-rays.

6B Another radioactive source, **Q**, was used. When a magnetic field was applied across the tube with no air inside, it made no difference to the radiation detected.

This shows that **Q** emits . . .

1 alpha and beta particles.

2 alpha particles and gamma rays.

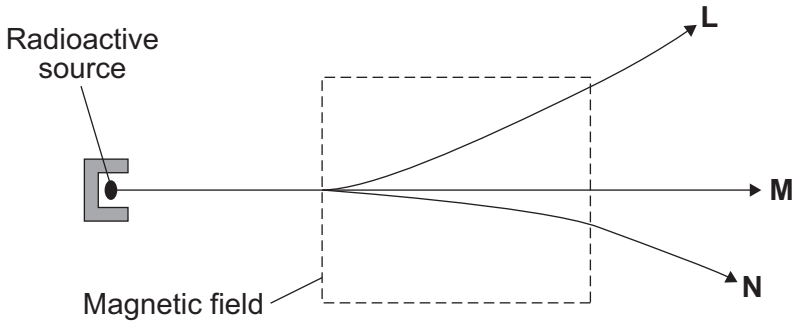
3 beta particles only.

4 gamma rays only.

4.4.1.3 The development of the model of the atom (common content with chemistry)

Question 05 · continued June 2011 | PHY1BP | Original Q6 | Legacy

6C The diagram shows three types of radiation, **L**, **M** and **N**, from a radioactive source. They are passing through a magnetic field.



Radiation **N** is deflected less than radiation **L** and in the opposite direction.

This is because radiation **N** consists of particles which . . .

1 have a smaller mass than **L** and the same charge.

2 have a bigger mass than **L** and the same charge.

3 have a smaller mass than **L** and the opposite charge.

4 have a bigger mass than **L** and the opposite charge.

6D Which row in the table correctly identifies the three types of radiation emitted by radioactive materials?

	Alpha	Beta	Gamma
1	an electron	a helium nucleus	an electromagnetic wave
2	a helium nucleus	an electromagnetic wave	an electron
3	a helium nucleus	an electron	an electromagnetic wave
4	an electron	an electromagnetic wave	an electron

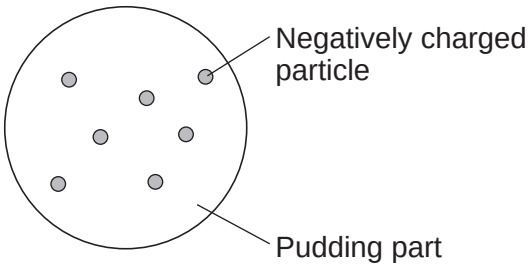
4.4.1.3 The development of the model of the atom (common content with chemistry)

Question 06

June 2015 | PH2HP | Original Q2 | Legacy

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

Figure 3



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

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

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Question 2 continues on the next page

4.4.1.3 The development of the model of the atom (common content with chemistry)

Question 06 · continued

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

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

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

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

Explain why.

[2 marks]

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

[1 mark]

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4.4.1.3 The development of the model of the atom (common content with chemistry)

Question 06 · continued

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

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

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

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

[6 marks]

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4.4.1.3 The development of the model of the atom (common content with chemistry)

Question 07

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

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

[2 marks]

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

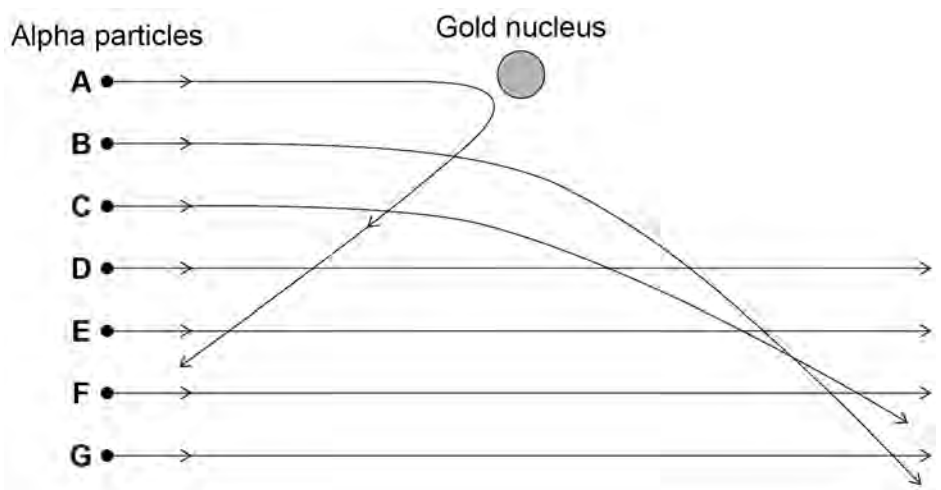
Question 8 continues on the next page

The nucleus was discovered using an alpha particle scattering experiment.

Alpha particles were directed at a sheet of gold foil.

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

Figure 8



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

[2 marks]

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

[2 marks]

4.4.1.3 The development of the model of the atom (common content with chemistry)

Question 07 · continued

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

[1 mark]

Tick (✓) **one** box.

The atom contains a nucleus. ☐

The atom contains protons, neutrons and electrons. ☐

The atom is mostly empty space. ☐

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

[1 mark]

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

[2 marks]

10

4.4.1.3 The development of the model of the atom (common content with chemistry)

Question 08

0 7 Some atoms emit radiation.

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

[1 mark]

Tick (✓) **one** box.

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

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

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

Describe the difference between irradiation and radioactive contamination.

[2 marks]

Question 7 continues on the next page

4.4.1.3 The development of the model of the atom (common content with chemistry)

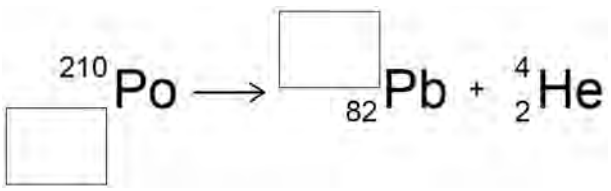
Question 08 · continued

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

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

Complete the nuclear equation for polonium-210.

[2 marks]



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

A sample of polonium contains 256 000 atoms.

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

[3 marks]

Time taken = _____ days

4.4.1.3 The development of the model of the atom (common content with chemistry)

Question 08 · continued

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

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

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

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

[2 marks]

10

Turn over for the next question