AQA GCSE Combined Science - Trilogy | 8464

SPECIFICATION POINT 6.4.1.3

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

Mark schemes and examiner comments

Tier	**Higher**
Question groups	**2**
Available paper years	**2018–2024**

Using this booklet

1. Booklet answer numbers match the question booklet.
2. Use the original question number within marking tables.
3. Examiner comments are included where available.

Name: _____ **Date:** _____

Where a precise marking extract is unavailable, the full source document is included in an appendix. Any missing mark scheme is explicitly identified.

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

Answer 01 · Mark scheme

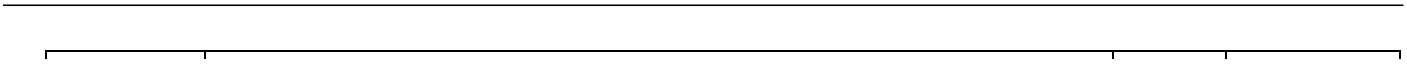
June 2018 | 8464/P/1H | Original Q1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.1	electron		1	AO1 6.4.1.3
	atom		1	5.1.1.3
	nucleus		1	
	orbit		1	
01.2	positive charge is provided by protons		1	AO1 6.4.1.2 6.4.1.3
	(every atom of the same element contain the) same number of protons	do **not** accept same number of protons and neutrons ignore reference to electrons	1	
01.3		an answer of 21 000 000 scores **2** marks		AO2 6.4.1.3
	$v = 300\ 00\ 000 \times \left(\frac{7}{100}\right)$	allow any correct method of determining 7% of 300 000 000	1	
	v = 21 000 000 (m/s)	allow 2.1×10^7 (m/s)	1	
01.4		an answer in the range 1.4×10^{-10} to 1.6×10^{-10} scores **2** marks		AO2 6.4.1.1
	$r = 6 \times 2.5 \times 10^{-11}$	allow a ratio in the range of 5.7–6.3 or measurements that would give this range, correctly substituted	1	
	$r = 1.5 \times 10^{-10}$ (m)	allow 1.4×10^{-10} to 1.6×10^{-10} their ratio $\times 2.5 \times 10^{-11}$ correctly calculated scores **1** mark	1	
Total			**10**	

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

Answer 01 · Mark scheme

June 2018 | 8464/P/1H | Original Q1



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

Answer 02 · Mark scheme

June 2024 | 8464/P/1H | Original Q2

Question 2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.1	2 protons and 2 neutrons	ignore helium nucleus	1	AO1 6.4.2.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.2	118		1	AO1 6.4.1.2

Question	Answers	Mark	AO / Spec. Ref.
02.3	**Level 2:** Scientifically relevant facts, events or processes are identified and given in detail to form an accurate account.	4–6	AO1 AO3 6.4.1.3
	Level 1: Facts, events or processes are identified and simply stated but their relevance is not clear.	1–3	
	No relevant content	0	
	Indicative content Plum pudding model • the atom is a ball of positive charge • electrons are embedded in the ball Reasons why the plum pudding model was replaced • the results were not correctly predicted by the plum pudding model • the plum pudding model did not predict that some particles would be deflected • the large angle deflections suggest that the atom contains a nucleus • all deflections suggest that the nucleus is charged • most alpha particles were not deflected suggesting that atoms are mostly empty space Nuclear model • mass is concentrated in the nucleus • the nucleus is charged • the atom is mostly empty space • electrons orbit the nucleus in the nuclear model		

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

Answer 02 · Mark scheme

June 2024 | 8464/P/1H | Original Q2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.4	James Chadwick		1	AO1 6.4.1.3

Total Question 2	**9**

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

Answer 01 · Examiner comments June 2018 | 8464/P/1H | Original Q1

Question 1 (Standard demand)

01.1 This question required students to label diagrams with given labels and the majority gained all 4 marks.

01.2 59% of students scored zero on this item. Of the students who gained 1 mark, this was usually for identifying that a proton has a positive charge. Many answers were ambiguous.

01.3 Students were required to calculate 7 per cent of the speed of light and many students managed to do this from either multiplying by 0.07, by 7/100, or by finding 10%, 5% and 1% or similar and adding appropriately. Occasionally the latter method led to a wrong answer because adding large numbers with plenty of zeros it was possible to slip a zero somewhere and so only the method mark was gained.

The most common mistake arose when students simply multiplied 300,000,000 by 7. Problems arose when students either used a totally incorrect method, struggled with the arithmetic, or then went on to calculate 93% instead. A fifth of students scored zero marks.

01.4 Nearly 40% of students scored a mark on this question with 27% scoring two marks.

The range of values acceptable for full marks ensured that most students who knew what to do gained the two marks.

A few students obtained an incorrect ratio these could gain one mark if they then calculated correctly with their ratio value. Some students assumed that they needed to measure radii, these students were more likely to get an incorrect ratio with smaller measurements and the centre not clearly defined. Some chose a number to multiply by with no evidence of a ratio attempt, or substituted the 2.5 from the hydrogen radius with a measurement of 7.5 or similar from the magnesium diagram.

Powers of 10 were confusing for weaker students – some changed the 10^{-11} by multiplying, adding or subtracting this power

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

Answer 02 · Examiner comments

June 2024 | 8464/P/1H | Original Q2

Question 2 (standard demand)

02.1 Most students were unable to accurately recall the structure of an alpha particle, with about 40% giving a full description.

02.2 The number of neutrons was correctly determined by nearly 85% of students.

02.3 Most students were able to make a good attempt at this question. The majority recalled a reasonable level of detail of at least one of the two atomic models, and many students gave some account of how the evidence led to the replacement of the plum pudding model with the nuclear model.

Some students used diagrams of the two models as part of their answers. Clearly labelled diagrams could help students to gain credit, but many diagrams were not labelled at all. However, many answers which included unlabelled diagrams had then gone on to describe features of each model, and the diagrams may have helped these students to recall the relevant details and to structure their answers.

A number of students described the ionising and penetrating properties of alpha particles, which did not prevent credit from being awarded, but was not relevant to answering the question.

There were a few misconceptions, which were demonstrated by a number of students. Descriptions of the plum pudding model as a proton with embedded electrons was common. A small proportion of answers alluded to positive electrons and negative electrons being present in atoms. A similar proportion referred to atoms being neutral because they contain neutrons.

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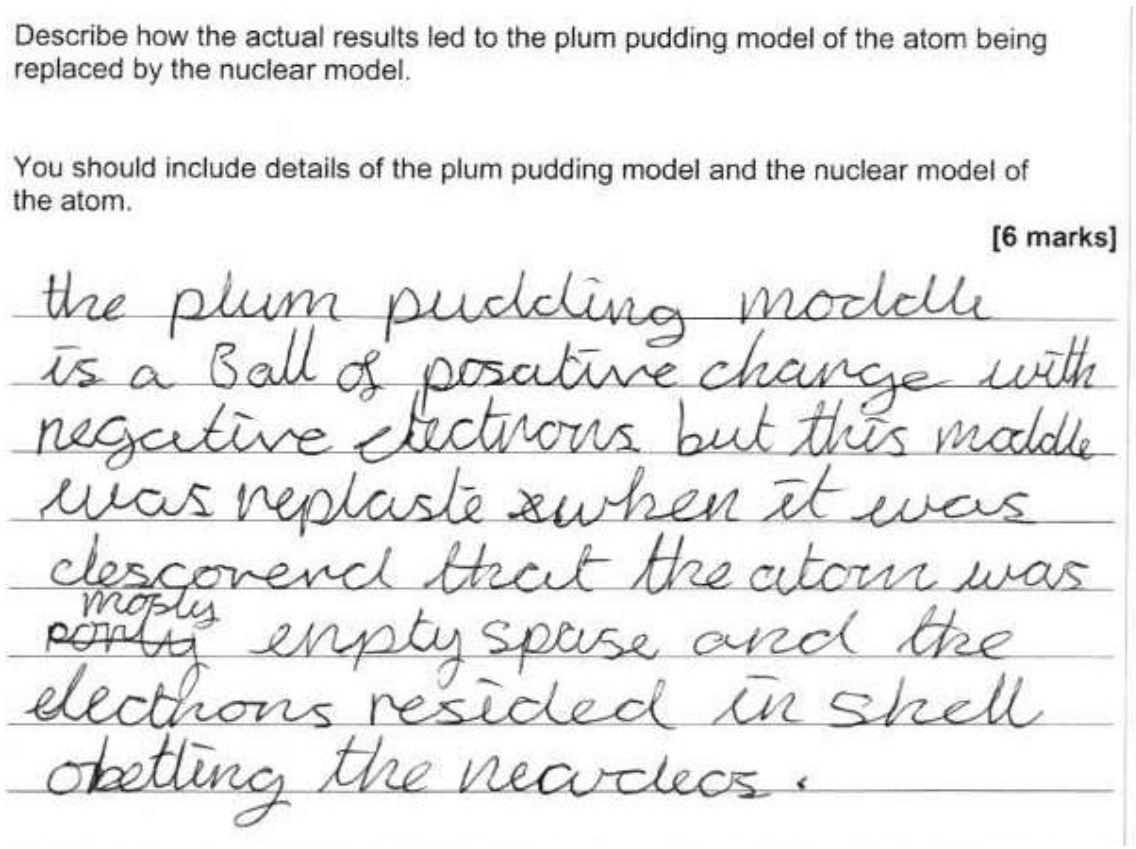
6.4.1.3 The development of the model of the atom (common content with chemistry)

Answer 02 · Examiner comments June 2024 | 8464/P/1H | Original Q2

Describe how the actual results led to the plum pudding model of the atom being replaced by the nuclear model.

You should include details of the plum pudding model and the nuclear model of the atom.

[6 marks]



This Foundation tier response is at the top of Level 1, gaining 3 marks. There is a description of the plum pudding model, but the description of the nuclear model lacks any detail about the massive and charged nature of the nucleus. Had the answer also included some detail about the nucleus, or referred to how the actual results led to the rejection of the plum pudding model, the answer would have been in Level 2.

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Describe how the actual results led to the plum pudding model of the atom being replaced by the nuclear model.

You should include details of the plum pudding model and the nuclear model of the atom.

[6 marks]

- The ~~plum~~ plum pudding model was a solid sphere of positive charge, with negatively charged electrons throughout.
- Some alpha particles passed straight through, showing it is mainly empty space, not a solid ball.
- Some were slightly deflected showing there are the electrons circling the positive charge in the middle.
- Some completely ~~deflected~~ deflected back as they were repelled by the positive charge at the centre of the atom.
- The nuclear model was made to show these findings. It had a positive nucleus in the centre, a cloud of electrons orbitting it and the rest is mainly empty space.

In order to achieve the top mark on 'extended response' type questions, answers do not have to be completely correct, and neither do they need to address every single point in the indicative content on the mark scheme.

This response (from a Higher tier paper) gives a complete description of the plum pudding model. It describes how the evidence led to an understanding both that the atom is mostly empty space and that the nucleus is positively charged. However the statement that some alpha particles were deflected by electrons is incorrect, and there is no mention of the nucleus being massive.

However, taken as a whole, there is a reasonably detailed description of the plum pudding model, relevant points made about how the evidence led to the nuclear model, and a reasonably detailed description of the nuclear model, which was enough to allow this student to gain the maximum mark of 6 on this question.

02.4 About 55% of students correctly identified the scientist who provided evidence for the existence of neutrons.

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