AQA GCSE Combined Science - Trilogy | 8464

SPECIFICATION POINT 6.4.1.1

The structure of an atom

Mark schemes and examiner comments

Tier	**Higher**
Question groups	**9**
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.

6.4.1.1 The structure of an atom

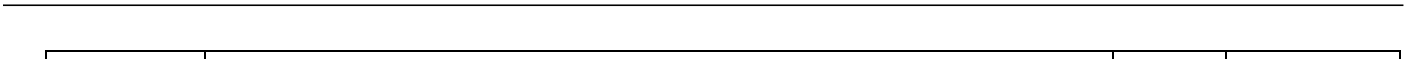
Answer 01 · Mark scheme June 2018 | 8464/P/1H | Original Q1

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**	

6.4.1.1 The structure of an atom

Answer 01 · Mark scheme

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



6.4.1.1 The structure of an atom

Answer 02 · Mark scheme June 2019 | 8464/P/1H | Original Q6

Question	Answers	Extra information	Mark	AO / Spec. Ref.	ID
06.1	mass number stays the same, charge stays the same		1	AO1.1 6.4.2.2	A
06.2	gamma radiation is only weakly ionising **or** most gamma radiation will pass through any detector	allow gamma radiation is very penetrating	1	AO1.1 6.4.2.1	E
06.3	any two from • the radiation spreads out in all directions • only some of the radiation goes into the G-M tube • only some of the radiation passing into the GM tube is detected	allow **2** marks for only some of the radiation passing into the GM tube is detected because gamma is weakly ionising	2	AO1.1 6.4.2.4	E
06.4	to reduce the amount of radiation received because radiation increases the risk of cancer or (genetic) mutation	allow to reduce irradiation (of the teacher) allow causes cancer or (genetic) mutation ignore references to contamination	1 1	AO1.1 6.4.2.1 WS 1.4	E

6.4.1.1 The structure of an atom

Answer 02 · Mark scheme

June 2019 | 8464/P/1H | Original Q6

06.5	a calculation of the product of thickness and count rate a second calculation of the product of thickness and count rate a comparison of the calculated values and a recognition that they are different **OR** A calculation of half the count rate (1) A comparison with the count rate for double that thickness (1) A recognition that the values are different (1)	examples of calculations 0.5 × 110 = 55 1.0 × 60 = 60 1.5 × 33 = 50 2.0 × 18 = 36 2.5 × 10 = 25 e.g. $\frac{110}{2}$ = 55 the first two marks may be scored for a count rate divided by 3, 4 or 5 compared with the corresponding count rate for 3, 4 or 5 times the thickness e.g. 55 ≠ 60	1 1 1	AO3.1b 6.4.2.1	E
06.6	$^{140}_{57}La \longrightarrow {}^{0}_{-1}e + {}^{140}_{58}Ce$	allow **1** mark for correct numbers on electron allow **1** mark for correct numbers on Ce	2	AO1.1 AO1 in isolation AO1.2 6.4.2.2	E

Answer 02 · Mark scheme

June 2019 | 8464/P/1H | Original Q6

06.7		an answer of $\frac{1}{32}$ or equivalent scores **4** marks		AO3.1a 6.4.2.3	E
	half-life = 50 seconds	this may be indicated on Figure 7	1		
	250 seconds difference in age = 5 half lives	allow 100 seconds = 2 half lives **and** 350 seconds = 7 half lives	1		
	ratio = $\left(\frac{1}{2}\right)^5$ **or** ratio = $\frac{1}{2}\times\frac{1}{2}\times\frac{1}{2}\times\frac{1}{2}\times\frac{1}{2}$	allow this mark if they have halved 1.25(× 10^{23}) five times to get 0.0390625(× 10^{23}) for example 1.25(× 10^{23}) → 0.625(× 10^{23})→ 0.3125(× 10^{23})→ 0.15625(× 10^{23}) → 0.078125(× 10^{23})→0.0390625(× 10^{23})	1		
	ratio = $\frac{1}{32}$ **or** ratio = 1:32	allow ratio = 0.031 allow 32:1 **or** 32	1		
06.8	tangent drawn on graph	do not allow a line drawn that crosses the graph line	1	AO2.2 6.4.2.1	E
	use of gradient = $\frac{(\Delta \text{ no. of atoms})}{\Delta \text{ time}}$	values must be taken from their tangent drawn at 20 seconds	1		
	gradient = 5.3 (× 10^{21}) (Bq)	allow gradient = 0.053 (× 10^{23}) (Bq) allow a range between 4.7 (× 10^{21}) (Bq) and 5.9 (× 10^{21}) (Bq)	1		

Total			**18**

6.4.1.1 The structure of an atom

Answer 03 · Mark scheme

November 2020 | 8464/P/1H | Original Q2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.1	A = 206		1	AO2 6.4.2.2
02.2	Z = 82		1	AO2 6.4.2.2
02.3	89 39	numbers must be in this order	1 1	AO2 6.4.2.2
02.4	electromagnetic waves		1	AO1 6.4.2.1

6.4.1.1 The structure of an atom

Answer 03 · Mark scheme

November 2020 | 8464/P/1H | Original Q2

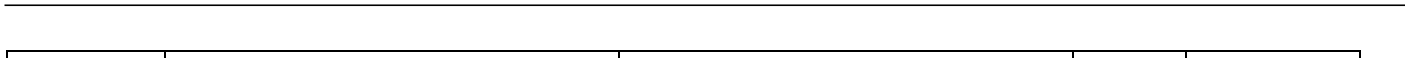
Question	Answers	Mark	AO / Spec. Ref.
02.5	**Level 3:** Relevant points (reasons/causes) are identified, given in detail and logically linked to form a clear account.	5–6	AO1 6.4.1.2 6.4.2.1 6.4.2.2
	Level 2: Relevant points (reasons/causes) are identified, and there are attempts at logical linking. The resulting account is not fully clear.	3–4	
	Level 1: Points are identified and stated simply, but their relevance is not clear and there is no attempt at logical linking.	1–2	
	No relevant content	0	
	Indicative content <u>alpha radiation</u> • an alpha particle is the same as a helium nucleus • alpha is the least penetrating • alpha is stopped by paper or skin • alpha has the shortest range in air • alpha will travel a few cm in air • because alpha is most ionising • because alpha has a charge of +2 <u>beta radiation</u> • a beta particle is an electron (emitted from the nucleus) • beta penetrates less than gamma and more than alpha • beta is stopped by a thin sheet of aluminium • beta has a shorter range than gamma • beta will travel up to 1m in air • because beta is more ionising that gamma and less ionising than alpha • because beta has a charge of -1 <u>gamma radiation</u> • gamma radiation is an electromagnetic wave • gamma is the most penetrating • gamma is reduced/stopped by several cm of lead or thick concrete • gamma has the largest range in air • gamma will travel very large distances in air • because gamma is least ionising • because is uncharged to access level 3 the answer should compare alpha, beta and gamma radiation and provide some explanation of their properties		

Total			11

6.4.1.1 The structure of an atom

Answer 03 · Mark scheme

November 2020 | 8464/P/1H | Original Q2



6.4.1.1 The structure of an atom

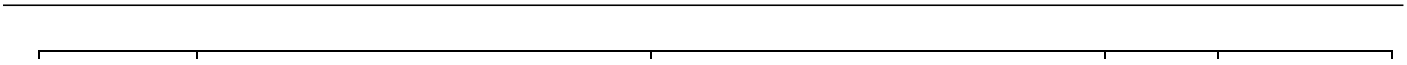
Answer 04 · Mark scheme November 2021 | 8464/P/1H | Original Q1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.1	$V = I R$		1	AO1 6.2.1.3
01.2	$3.9 = 0.12 \times R$ $R = \frac{3.9}{0.12}$ $R = 32.5\ (\Omega)$	 allow R = 33 (Ω)	1 1 1	AO2 6.2.1.3
01.3	energy = power × time **or** E = P t		1	AO1 6.2.4.2
01.4	time = 150 000s energy = 0.46 × 150 000 energy = 69 000 (J)	 allow a substitution using an incorrectly/not converted value of time allow a correct calculation using an incorrectly/not converted value of time	1 1 1	AO2 6.2.4.2
01.5	thermistor		1	AO1 6.2.1.1
01.6	the current will increase (because) the resistance decreases		1 1	AO1 6.2.1.4
Total			**11**	

6.4.1.1 The structure of an atom

Answer 04 · Mark scheme

November 2021 | 8464/P/1H | Original Q1



6.4.1.1 The structure of an atom

Answer 05 · Mark scheme

November 2021 | 8464/P/1H | Original Q2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.1	more than 10 000 times bigger		1	AO1 6.4.1.1
02.2	the atom becomes a positive ion the atom loses an electron		1 1	AO1 6.4.1.2
02.3	beta radiation is only weakly ionising		1	AO3 6.4.2.1

6.4.1.1 The structure of an atom

Answer 05 · Mark scheme

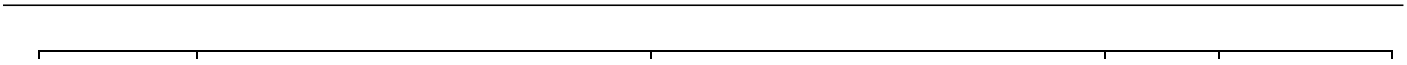
November 2021 | 8464/P/1H | Original Q2

Question	Answers	Mark	AO / Spec. Ref.
02.4	**Level 3:** The method would lead to the production of a valid outcome. The key steps are identified and logically sequenced.	5–6	AO3 6.4.2.1
	Level 2: The method would not necessarily lead to a valid outcome. Most steps are identified, but the method is not fully logically sequenced.	3–4	
	Level 1: The method would not lead to a valid outcome. Some relevant steps are identified, but links are not made clear.	1–2	
	No relevant content	0	
	Indicative content • move the detector very close to the source • record the count rate • position the paper between the source and the detector • record the new count rate • alpha radiation will not penetrate through paper • if the count rate with the paper is (significantly) less than without then the source emits alpha radiation • remove the paper and position the aluminium between the source and the detector • record the new count rate • (alpha and) beta radiation will not penetrate through the aluminium • if the count rate has (significantly) reduced compared with using paper then beta radiation is present • if radiation penetrates through the aluminium then gamma radiation is present • the experiment should be repeated and mean results calculated because radioactivity is a random process To access level 3, the candidate must use the paper sheet, the aluminium sheet and no sheet, and describe how the results would indicate the presence of alpha, beta or gamma radiation.		
Total		**10**	

6.4.1.1 The structure of an atom

Answer 05 · Mark scheme

November 2021 | 8464/P/1H | Original Q2



6.4.1.1 The structure of an atom

Answer 06 · Mark scheme November 2021 | 8464/P/2H | Original Q5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1	different temperatures emit different intensities of infrared which are represented (on the infrared camera) as different shades / colours	 allow wavelength / frequency / amount for intensity throughout	1 1	AO1 AO3 6.6.2.4
05.2	visible light		1	AO3 6.6.2.1
05.3	both ionising radiation so some risk of cancer the whole body is irradiated by gamma rays when an X-ray is taken only part of the body is exposed exposure time for gamma rays is longer		1 1 1 1	AO1 AO3 AO3 AO3 6.6.2.3
05.4	$1.2 \times 10^{-13} = F \times 0.015$ $F = \frac{1.2 \times 10^{-13}}{0.015}$ $F = 8.0 \times 10^{-12}$ N	 allow a correct rearrangement using an incorrectly / not converted value of s allow 8×10^{-12} allow a correct calculation using an incorrectly / not converted value of s	1 1 1	AO2 6.5.2

6.4.1.1 The structure of an atom

Answer 06 · Mark scheme

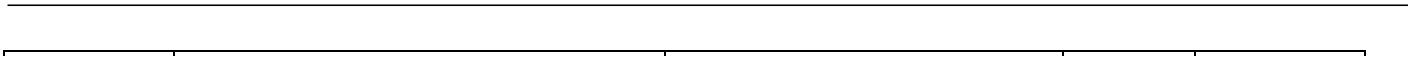
November 2021 | 8464/P/2H | Original Q5

05.5	some of the energy of the electrons causes heating (therefore) increasing the temperature (so using tungsten) allows more electrons to be collided per second than using any other metal	 allow (so using tungsten) enables more energy per second to be transferred than using any other metal	1 1 1	AO1 AO3 AO3 6.5.2
Total			**13**	

6.4.1.1 The structure of an atom

Answer 06 · Mark scheme

November 2021 | 8464/P/2H | Original Q5



6.4.1.1 The structure of an atom

Answer 07 · Mark scheme

June 2022 | 8464/P/1H | Original Q5

Question 5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1	reverse the connections to the LED / battery	allow reverse the potential difference across the LED / diode	1	AO3 6.2.1.4
	because an LED / diode only allows current through in one direction	allow because an LED / diode has a large resistance in the reverse direction	1	

6.4.1.1 The structure of an atom

Answer 07 · Mark scheme

June 2022 | 8464/P/1H | Original Q5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.2	290 mA = 0.29 A		1	AO2 6.2.4.1
	$0.98 = V \times 0.29$ **or** $R = \frac{0.98}{0.29^2}$	allow a correct substitution of an incorrectly / not converted current allow R = 11.652… ignore $0.98 = (0.29)^2 \times R$	1	
	$V = \frac{0.98}{0.29}$	allow $V = 11.65 \times 0.29$ allow a correct substitution of an incorrectly / not converted current	1	
	V = 3.379…	allow a correct rearrangement using an incorrectly / not converted current	1	
	V = 3.4 (V)	allow a correct calculation using an incorrectly / not converted current allow a correctly rounded answer to 2 sig figs consistent with their calculated value of V using numbers from the question	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.3	electrons in the atom fall to a lower energy level		1	AO1 6.4.1.1

6.4.1.1 The structure of an atom

Answer 07 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.4	$1.4 = Q \times 200$		1	AO2 6.2.4.2 6.2.1.2
	$Q = \frac{1.4}{200}$		1	
	$Q = 0.0070$ (C)		1	
	$0.0070 = I \times 2.8 \times 10^{-4}$	allow a correct substitution of their calculated value of Q	1	
	$I = \frac{0.0070}{2.8\times10^{-4}}$	allow a correct re-arrangement using their value of Q	1	
	$I = 25$ (A)	allow an answer consistent with their value of Q	1	
	OR			
	$1.4 = P \times 2.8 \times 10^{-4}$ (1)			
	$P = \frac{1.4}{2.8\times10^{-4}}$ (1)			
	$P = 5000$ (W) (1)			
	$5000 = 200 \times I$ (1)	allow a correct substitution of their calculated value of P		
	$I = \frac{5000}{200}$ (1)	allow a correct re-arrangement using their value of P		
	$I = 25$ (A) (1)	allow an answer consistent with their value of P		

Total Question 5		**14**

6.4.1.1 The structure of an atom

Answer 08 · Mark scheme

June 2022 | 8464/P/1H | Original Q6

Question 6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.1	beta radiation is more penetrating (than alpha radiation)	allow beta radiation can pass through the case (but alpha radiation cannot) allow beta radiation can travel further (in air than alpha radiation) do **not** allow beta radiation is more ionising	1	AO1 6.4.2.1 6.4.2.4
	so beta radiation could irradiate people passing near the smoke detector	allow beta radiation can pass through skin	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.2	A = 227 Z = 89		1 1	AO1 AO2 6.4.2.2 6.4.2.1 6.4.1.2

6.4.1.1 The structure of an atom

Answer 08 · Mark scheme

June 2022 | 8464/P/1H | Original Q6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.3	(some) radiation is stopped by paper		1	AO3 6.4.2.1
	so the source emits alpha radiation	MP2 dependent on MP1	1	
	and (some) radiation passes through paper but is stopped by aluminium		1	
	so the source emits beta radiation (but does not emit gamma)	MP4 dependent on MP3	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.4	D B A C	all four letters must be in the correct order explanation only scores if correct order given	1	AO3 6.4.2.1 6.4.2.3
	explanation			
	a substance with a longer half-life has more stable nuclei	allow the more stable a nucleus, the less likely it is to decay (in a given time)	1	
	so answers are in order of increasing half-life		1	

Total Question 6		11

6.4.1.1 The structure of an atom

Answer 09 · 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		

6.4.1.1 The structure of an atom

Answer 09 · 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**

6.4.1.1 The structure of an atom

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

6.4.1.1 The structure of an atom

Answer 02 · Examiner comments

June 2019 | 8464/P/1H | Original Q6

Question 6 (High demand)

06.1 Just under half of students gained this mark.

06.2 Slightly less than 30% of students gained this mark for identifying that gamma radiation is weakly ionising or very penetrating.

06.3 Around 10% of students gained marks on this question. There was a very common apparent misunderstanding about what is meant by the term count-rate, with many students stating that the count-rate is the total number of decays that have happened since the radioactive source was created. It was also quite common to see answers about the random nature of decay making the count-rate unpredictable.

06.4 While about a quarter of all students gained at least 1 mark on this question, very few gained both marks. The most common reason for gaining a mark was mentioning a cancer risk. Many students stated that standing away from the source would prevent irradiation completely, rather than reducing the level of irradiation and therefore reducing the risk. A common misconception was that if the teacher stood closer to the experiment then this would affect the results.

06.5 The concept of inverse proportion was not understood well. Many students incorrectly described inverse proportion as being a straight line with a negative gradient and illustrating that this was not the trend shown by pointing out that the count-rate decreased by different amounts each time an extra half centimetre of lead was introduced. Around 13% of students gained marks for their response to this question.

06.6 Around 40% of students could recall the atomic and mass numbers which go with an electron, and around a quarter of all students gained both marks on this question.

06.7 This question was aimed at the highest-attaining students, and required a high level of logical thought to arrive at the correct answer. Over a fifth of students managed to gain at least 1 mark, with just under 6% of students scoring all four marks.

06.8 This question was also aimed at the highest-attaining students and tested some of the maths content of the new science specifications at GCSE. Just under 6% of students attempted to draw a tangent on the graph, and therefore gained some credit. Many of

6.4.1.1 The structure of an atom

Answer 02 · Examiner comments June 2019 | 8464/P/1H | Original Q6

those who attempted to calculate the gradient of the tangent divided the change in x by the change in y, giving an incorrect answer.

6.4.1.1 The structure of an atom

Answer 02 · Examiner comments

Use of statistics

Statistics used in this report may be taken from incomplete processing data. However, this data still gives a true account on how students have performed for each question.

Mark Ranges and Award of Grades

Grade boundaries and cumulative percentage grades are available on the Results Statistics page of the AQA Website.

6.4.1.1 The structure of an atom

Answer 04 · Examiner comments — November 2021 | 8464/P/1H | Original Q1

Question 01 (Standard demand)

01.1 Slightly over two thirds of students selected the correct equation.

01.2 Full marks were gained by over 60% of the students, with about 35% failing to gain any credit.

01.3 This equation was correctly recalled by around 70% of students.

01.4 Most students did not attempt to convert 2500 minutes into seconds. Nearly a quarter of students gained all 3 marks, with just over half of students gaining 2 marks.

01.5 Slightly less than 40% of higher tier students were able to correctly identify the symbol for a thermistor.

Answer 04 · Examiner comments — November 2021 | 8464/P/1H | Original Q1

01.6 Most students failed to recognise that the resistance of the thermistor would decrease as temperature increased, with many students stating that because the potential different across the thermistor was constant, the current in the thermistor must also be constant. Another misconception demonstrated in a number of responses was that the current would increase because the increased temperature gives the current more energy. Roughly one in ten students gained 2 marks, with just over a third gaining 1 mark.

6.4.1.1 The structure of an atom

Answer 05 · Examiner comments — November 2021 | 8464/P/1H | Original Q2

Question 02 (Standard demand)

02.1 This question was answered correctly by roughly 40% of students.

02.2 Around a third of students gained both marks, with approximately half gaining one mark.

02.3 Many students gave answers which were too vague, such as “beta radiation is not strong enough”, or stated that beta radiation is not ionising, which is incorrect. The mark was gained by just under a fifth of students.

02.4 Most students struggled to answer this question, with many struggling to write answers containing any relevant content. Many answers suggested placing the piece of paper or aluminium into the radioactive source holder, for example. A fair proportion of students did not read the question carefully, and suggested changing the radioactive source to test the equipment using one source of just alpha radiation, one of just beta, and one that emits just gamma radiation, although it was still possible to gain full credit if they did this. Some students recalled that paper stops alpha radiation, that aluminium stops beta radiation, and that gamma would penetrate both, but didn’t describe how to set up the equipment. Others described how to set up the equipment, but not how to use any measurements to draw conclusions.
Nearly one in ten students did not attempt to answer the question, and most answers did not give enough information to move out of level 1.

Answer 06 · Examiner comments — November 2021 | 8464/P/2H | Original Q5

Question 5 (standard/high demand and high demand)

05.1 Only 10% of students scored marks on this question. At high demand it is expected that where a question follows a figure, students should use information from the figure. Very few students linked the amount of infra-red radiation to temperature, or stated that different temperatures are displayed at different colours, despite that information being given in Figure 8.

05.2 This was a demanding question - students had to compare wavelengths given in nm and mm and in standard form. They then had to use their understanding of the electromagnetic spectrum. Less than 30% of students answered this question correctly.

05.3 The vast majority of the 40% of students that scored marks on this question only scored 1 mark, and that was mostly for saying that there is some risk of cancer with both.

05.4 This question performed as expected with 30% of students scoring 2 marks. Only 8% of students included the conversion to gain full marks.

6.4.1.1 The structure of an atom

Answer 06 · Examiner comments November 2021 | 8464/P/2H | Original Q5

05.5 20% of students gained at least 1 mark. Most of those stated that the energy from the electrons would cause heating and increase the temperature. Some went on to say that tungsten could be heated to a higher temperature than any other metal. No student scored full marks for explaining this meant that more electrons could be collided.

Answer 07 · Examiner comments June 2022 | 8464/P/1H | Original Q5

Question 05 (Standard/high and high demand)

05.1 Most students were unable to answer this question correctly, with only about 10% of students gaining any marks, and less than 5% gaining both marks.

Common suggestions which would not work included moving the LED closer to the battery, swapping the voltmeter and ammeter, moving the resistor, removing the resistor, reducing the resistance of the resistor, or placing the resistor after the LED.

05.2 Around a fifth of students gained full marks on this question, with a third of students gaining 4 marks.

Although the simplest way to calculate the answer was to use $P = VI$, a significant minority of students decided that a 5-mark calculation needed two equations to arrive at the correct answer. This was possible, by using $P = I^2R$ and then $V = IR$, an approach which could gain full marks. However, most students who attempted this alternative route neglected to convert mA to A.

05.3 Around 15% of students chose the correct description.

05.4 This extended calculation was answered well, with around 45% of students gaining all 6 marks. Just under 10% of students gained 3 marks, and about 35% gaining no marks.

6.4.1.1 The structure of an atom

Answer 08 · Examiner comments

June 2022 | 8464/P/1H | Original Q6

Question 06 (Standard/high and high demand)

06.1 Nearly two thirds of students gained some credit on this question, but only about one in ten students scored both marks.

Most students correctly contrasted the penetrating ability of alpha and beta radiation. There was some confusion evident between contamination and radiation in many answers. Some students suggested that beta radiation would have a chemical reaction with smoke, causing the smoke detector not to work.

06.2 Just over 40% of students gained both marks for determining the nucleon and proton numbers.

06.3 Approximately 50% of students gained some marks on this question, with most of them gaining 2 marks. Very few students gained 3 or 4 marks.

The concept of there being two different types of radiation being emitted by the same source proved to be very difficult for students. Most answers which gained two marks identified that some of the radiation passed through paper, and it was all stopped by aluminium, and therefore beta radiation must be present. It was far less common for students to recognise that most of the radiation was stopped by paper, and to then suggest that alpha radiation must be present.

A fair number of students suggested that the radiation that was transmitted through the paper and stopped by aluminium would be alpha radiation. These students still gained marking point 3, despite drawing an incorrect conclusion from the data.

Many student responses recited facts that students had learned about the different types of nuclear radiation, but failed to apply it to this situation. Stating that alpha radiation is stopped by paper, beta by aluminium, and gamma stopped by lead, for example, was not sufficient to gain any marks.

Some students demonstrated confusion about nuclear radiation, with statements that paper was emitted by alpha radiation, or that alpha radiation was emitted by paper, being suggested by a small proportion of students.

06.4 Just under 10% of students gained some credit on this question, with about half of these gaining more than one mark.

Most students did not attempt to determine the half lives of the four isotopes, and answers based on gradients of each line, the change in activity of each isotope or comparisons of the initial activity of each sample led to incorrect orders of stability, so gained no marks.

6.4.1.1 The structure of an atom

Answer 08 · Examiner comments

Mark Ranges and Award of Grades

Grade boundaries and cumulative percentage grades are available on the Results Statistics page of the AQA Website.

6.4.1.1 The structure of an atom

Answer 09 · Examiner comments

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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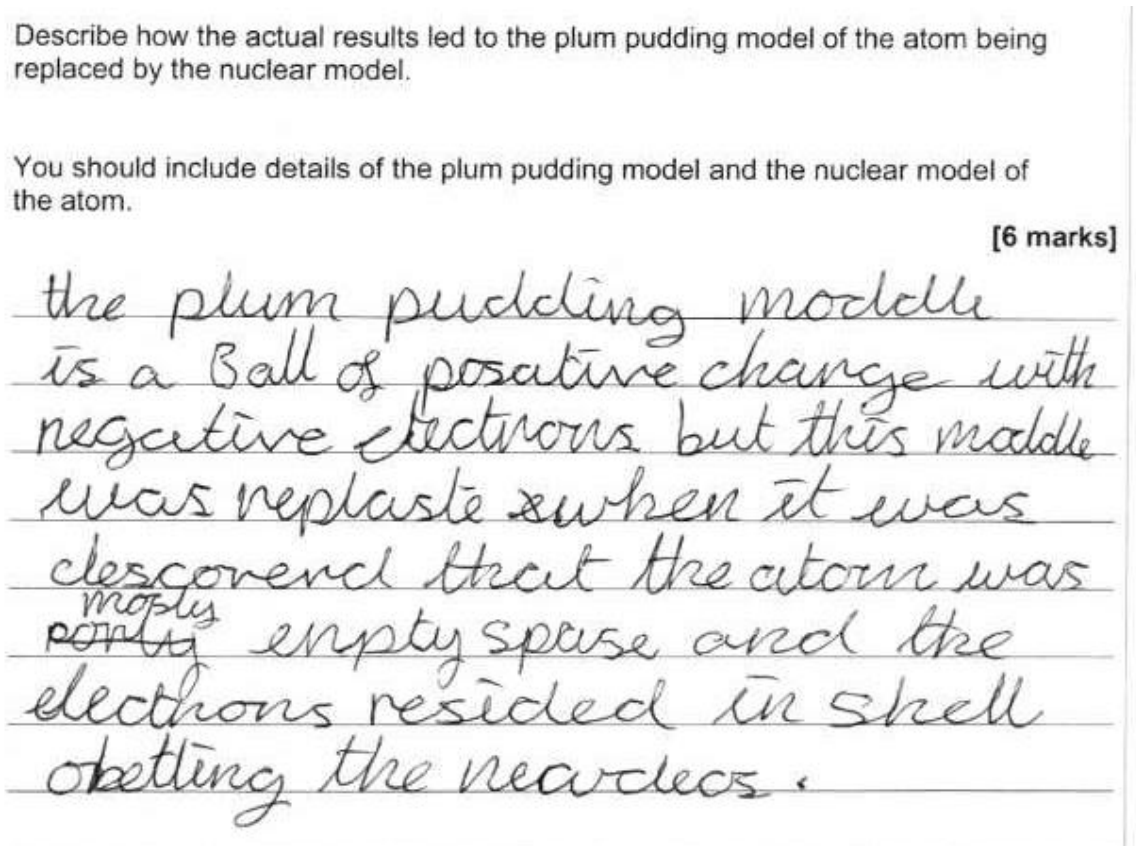
6.4.1.1 The structure of an atom

Answer 09 · 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]

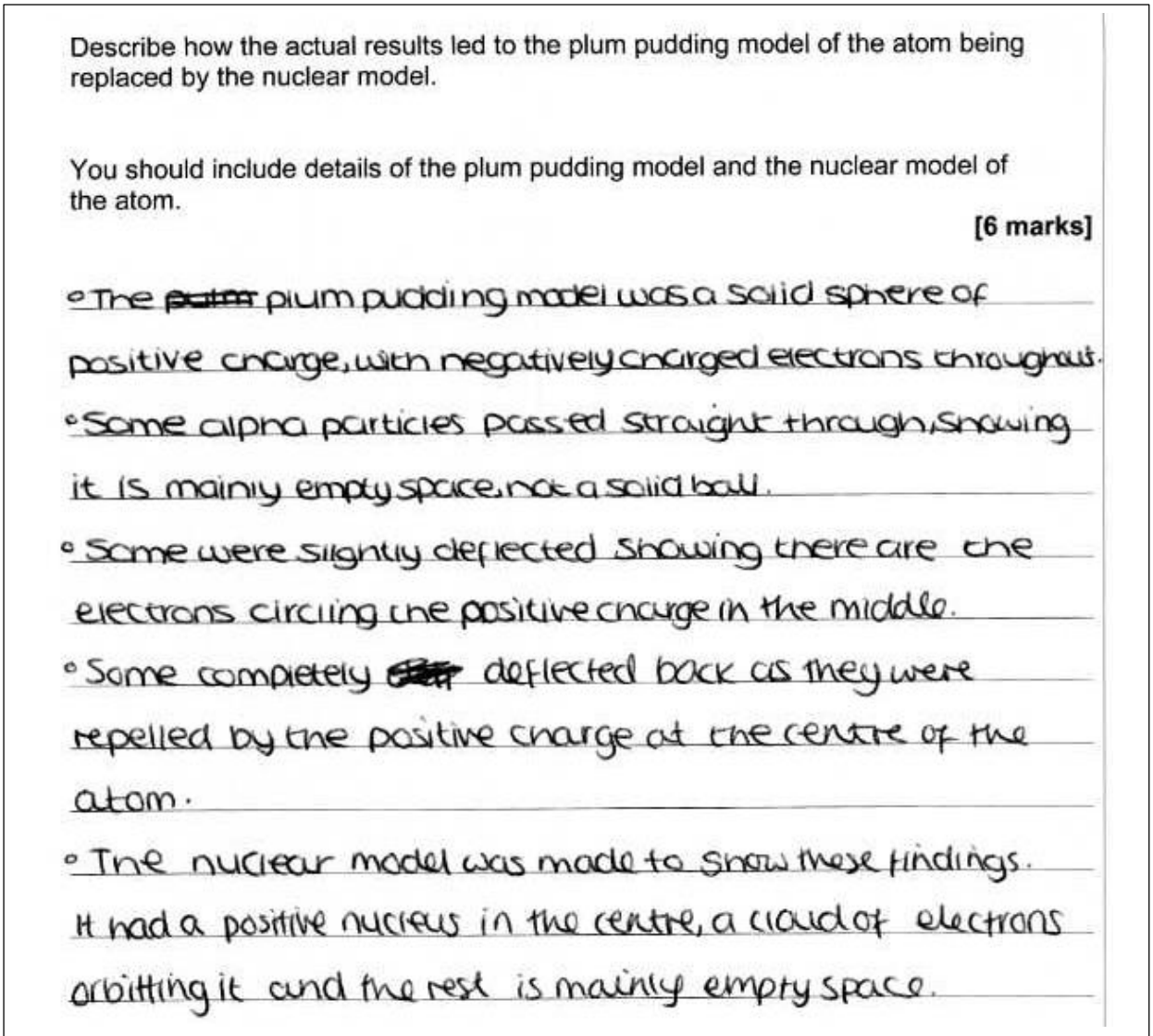


This Foundation tier response is at the top of Level 1, gaining 3 marks. There is a description of the plum pudding model, but the description of the nuclear model lacks any detail about the massive and charged nature of the nucleus. Had the answer also included some detail about the nucleus, or referred 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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6.4.1.1 The structure of an atom

Answer 09 · 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]

- The ~~pudd~~ 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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