AQA GCSE Combined Science - Trilogy | 8464

SPECIFICATION POINT 6.4.2.2

Nuclear equations

Mark schemes and examiner comments

Tier	**Foundation**
Question groups	**3**
Available paper years	**2020–2023**

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.

6.4.2.2 Nuclear equations

Answer 01 · Mark scheme

November 2020 | 8464/P/1F | Original Q6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.1	A = 206		1	AO2 6.4.2.2
06.2	Z = 82		1	AO2 6.4.2.2
06.3	89 39	numbers must be in this order	1 1	AO2 6.4.2.2
06.4	electromagnetic waves		1	AO1 6.4.2.1

6.4.2.2 Nuclear equations

Answer 01 · Mark scheme November 2020 | 8464/P/1F | Original Q6

Question	Answers	Mark	AO / Spec. Ref.
06.5	**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

6.4.2.2 Nuclear equations

Answer 02 · Mark scheme

June 2022 | 8464/P/1F | Original Q3

Question 3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	$^{241}_{95}Am \longrightarrow {}^{237}_{93}Np + {}^{4}_{2}He$	first box ticked	1	AO2 6.4.2.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.2	a few centimetres		1	AO1 6.4.2.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.3	paper stops alpha radiation		1	AO1 6.4.2.1

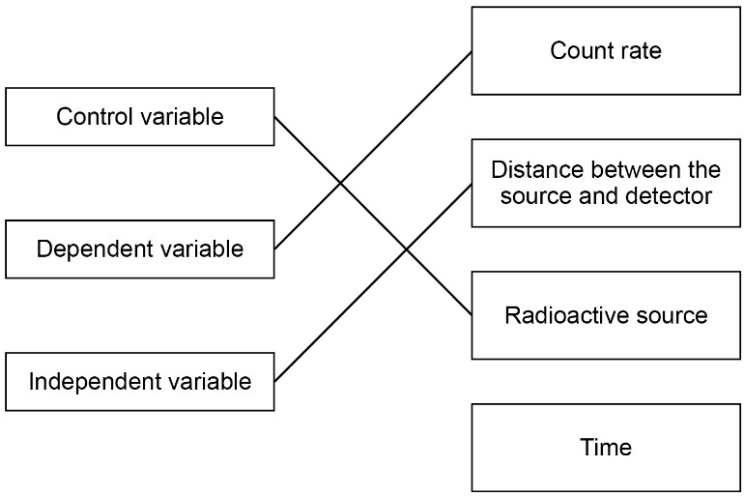
Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.4	$^{0}_{-1}e$		1	AO1 6.4.2.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.5	112		1	AO2 6.4.2.1

6.4.2.2 Nuclear equations

Answer 02 · Mark scheme

June 2022 | 8464/P/1F | Original Q3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.6	 do **not** accept more than one line from a box on the left		1 1 1	AO3 6.4.2.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.7	as distance increases the count rate decreases (between 40 cm and 50 cm) the count rate becomes zero		1 1	AO3 6.4.2.1

Total Question 3		10

6.4.2.2 Nuclear equations

Answer 03 · Mark scheme June 2023 | 8464/P/1F | Original Q1

Question 1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.1	alpha		1	AO1 6.4.2.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.2	2		1	AO1 6.4.2.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.3	82		1	AO2 6.4.2.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.4	50		1	AO1 6.4.2.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.5	$\frac{1500}{30}$ 50 (counts per second)		1 1	AO2 6.4.2.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.6	the count-rate decreased because (gamma) radiation is absorbed by lead	allow decreased to (almost) zero allow (gamma) radiation cannot penetrate (thick) lead	1 1	AO1 6.4.2.1

6.4.2.2 Nuclear equations

Answer 03 · Mark scheme

June 2023 | 8464/P/1F | Original Q1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.7	the lead was exposed to gamma radiation		1	AO1 6.4.2.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.8	electromagnetic waves		1	AO1 6.4.2.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.9	any one from: • (longer tongs give) a greater distance between the scientist and the radioactive source • (longer tongs) reduce the amount of radiation the scientist is exposed to • (longer tongs) reduce the risk of cell mutation	allow (longer tongs) reduce the risk of cancer	1	AO1 6.4.2.4

Total Question 1	11

6.4.2.2 Nuclear equations

Answer 02 · Examiner comments

June 2022 | 8464/P/1F | Original Q3

Question 03 (Low demand and standard demand)

03.1 Just under half of all students were able to identify the correct nuclear equation.

03.2 Slightly less than 45% of students recalled that alpha radiation can travel a few centimetres in air.

03.3 Nearly three quarters of the students knew that paper stops alpha radiation.

03.4 Only about 40% of students identified the symbol for a beta particle.

03.5 Approximately a quarter of students gained the mark for this calculation.

Many students added 7 to 119, while a large number of students appeared not to understand the symbol ±, and divided or multiplied the two numbers.

03.6 Only about 5% of students correctly identified all three variables, with about 10% giving two correct answers. Approximately 55% of students gained at least one mark.

03.7 Nearly 60% of students gained at least one mark on this question, with the vast majority of these describing the decreasing count rate with increased distance from the source.

Some students incorrectly identified this as an inversely proportional relationship. The range in air of nuclear radiation helps to distinguish between alpha, beta, and gamma radiation, but very few students commented on the maximum distance travelled.

6.4.2.2 Nuclear equations

Answer 03 · Examiner comments June 2023 | 8464/P/1F | Original Q1

Question 01 (Low demand)

01.1 Approximately half of all students identified the type of radiation.

01.2 Slightly more than 40% of students recognised that an alpha particle has 2 protons.

01.3 About two-thirds of students chose the correct value for X.

01.4 Just under two thirds of students chose the correct activity.

01.5 Nearly 80% of students scored full marks in this simple calculation, with the majority of the remaining students gaining no credit. Common mistakes were losing a zero somewhere in the working, multiplying the two numbers together rather than dividing.

01.6 Nearly 50% of students gained some credit on this question, although only about a fifth of students scored both marks.

Many students did not state the effect of the lead on the count-rate, with a fair proportion writing that there were fewer counts and making no reference to rate or a time-frame. A small minority of students stated that the lead stopped the gamma from being emitted by the source, which is incorrect and gained no credit.

It appeared that some students misread the question and described the effect of the radiation on the lead, giving a description of the lead being irradiated rather than describing the effect on the count-rate.

01.7 Around 40% of students knew that the lead was exposed to gamma radiation, with the remaining students being split more or less equally between the other two options.

01.8 Just over 40% of students identified that gamma radiation consists of electromagnetic waves.

Answer 03 · Examiner comments June 2023 | 8464/P/1F | Original Q1

01.9 Roughly a third of students gave a correct answer. It was very common for students to state that using the long tongs made it less likely for the radioactive source to touch the skin. Many students stated that the radioactivity could travel through the tongs. It was reasonably common for students to think that it was being held by tongs so that it could be safely held above a bunsen burner. A small, but noticeable, proportion of students gave statements indicating that they thought the radioactive source was hot, or could electrocute you, or could explode, which was why the tongs were needed.
There was some confusion from a small proportion of students about the difference between radiation and radioactivity. These students tended to give answers describing longer tongs reducing the exposure of the scientist to radioactivity, rather than to radiation, which was not creditworthy.