AQA GCSE Combined Science - Trilogy | 8464

SPECIFICATION POINT 6.6.2.3

Properties of electromagnetic waves 2

Mark schemes and examiner comments

Tier	**Higher**
Question groups	**5**
Available paper years	**2018–2021**

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.

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Answer 01 · Mark scheme June 2018 | 8464/P/1H | Original Q4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1	2 charged particles and 2 neutral particles		1	AO1 6.4.2.1
04.2	it is the type of radiation with a negative charge		1	AO1 6.4.2.1
04.3	it has a very long range in air		1	AO1 6.4.2.1
04.4	risk / activity associated with iodine-131 has decreased by a large amount		1	AO3 6.4.2.3
	because of short half-life	allow many half-lives have passed allow half-life is only 8 days 2nd marking point dependent on 1st marking point	1	
	risk / activity associated with caesium-137 will not have decreased by much	allow activity has halved	1	
	because of long half-life	allow only one half-life has passed 4th marking point dependent on 3rd marking point	1	
04.5		an answer of 2136 scores **3** marks		AO2 6.4.2.3
	5 half-lives	allow any correct method eg ½ × ½ × ½ × ½ × ½ = 1/32	1	
	5 × 30 = 150		1	
	1986 + 150 = 2136	any calculation using a value of 137 scores zero	1	
Total			**10**	

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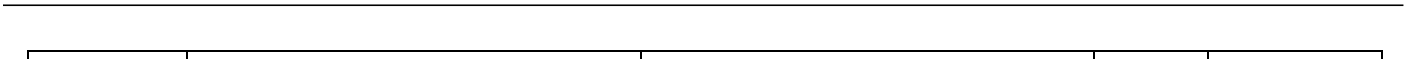
Answer 01 · Mark scheme

June 2018 | 8464/P/1H | Original Q4



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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

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Answer 02 · Mark scheme

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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

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Answer 02 · Mark scheme

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 $1.25(\times 10^{23})$ five times to get $0.0390625(\times 10^{23})$ for example $1.25(\times 10^{23})$ → $0.625(\times 10^{23})$ → $0.3125(\times 10^{23})$ → $0.15625(\times 10^{23})$ → $0.078125(\times 10^{23})$ → $0.0390625(\times 10^{23})$	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 $(\times 10^{21})$ (Bq)	allow gradient = 0.053 $(\times 10^{23})$ (Bq) allow a range between 4.7 $(\times 10^{21})$ (Bq) and 5.9 $(\times 10^{21})$ (Bq)	1		
Total			**18**		

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Answer 03 · Mark scheme

November 2020 | 8464/P/2H | Original Q5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1	X-rays are absorbed by bone		1	AO1 6.6.2.4
	but can pass through flesh	ignore skin	1	
05.2	taking lots of X-rays would give a large dose		1	AO3 6.6.2.3
	which would increase the radiographer's risk		1	
	the screen absorbs some of the X-rays	allow screen reduces the risk/dose received by the radiographer	1	
05.3	electrical current / oscillations in the transmitter producing radio waves		1	AO1 6.6.2.3
	radio waves are absorbed by the receiver inducing electrical current / oscillations in the receiver		1	
	at the same frequency	if no other mark is awarded, allow **1** mark for radio waves transfer information/energy through the air	1	
Total			**8**	

Answer 03 · Mark scheme

November 2020 | 8464/P/2H | Original Q5

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Answer 04 · 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

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Answer 04 · 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**	

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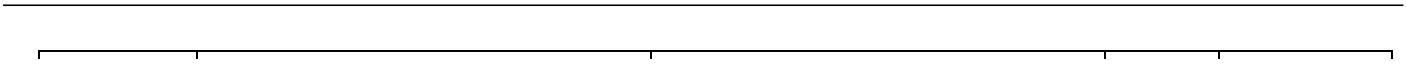
Answer 04 · Mark scheme

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



6.6.2.3 Properties of electromagnetic waves 2

Answer 05 · 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

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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**	

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Answer 05 · Mark scheme November 2021 | 8464/P/2H | Original Q5

Answer 01 · Examiner comments June 2018 | 8464/P/1H | Original Q4

Question 4 (Standard/high demand)

04.1 51% of students knew what an alpha particle consists of.

04.2 70% of students knew that a particle of beta radiation has a negative charge.

04.3 63% of students knew that gamma radiation has a very long range in air.

04.4 45% of students scored marks on this question. Students who failed to score often understood there is a risk associated with nuclear radiation but were unable to relate that to the changing levels of radiation with time. There were lots of misconceptions about half-life, the most common being that iodine-131 would not emit any radiation after two half-lives.

6.6.2.3 Properties of electromagnetic waves 2

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

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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.

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Answer 02 · Examiner comments

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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.

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Answer 04 · 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 05 · 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.

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Answer 05 · 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.