AQA GCSE Combined Science - Trilogy | 8464

SPECIFICATION POINT 6.6.2.4

Uses and applications of electromagnetic waves

Mark schemes and examiner comments

Tier	**Foundation**
Question groups	**13**
Available paper years	**2018–2025**

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.

6.6.2.4 Uses and applications of electromagnetic waves

Answer 01 · Mark scheme

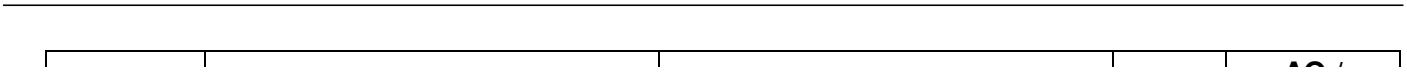
June 2018 | 8464/P/1F | Original Q5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1	gamma		1	AO1 6.4.2.1
05.2	alpha		1	AO1 6.4.2.1
05.3	gamma		1	AO1 6.4.2.1
05.4	<table><tr><th>isotope</th><th>number of neutrons</th><th>number of protons</th></tr><tr><td>uranium-238</td><td>146</td><td>**92**</td></tr><tr><td>thorium-234</td><td>**144**</td><td>90</td></tr></table>		1 1	AO2 6.4.1.2
05.5	$\Delta\theta = 80\ ^\circ C$ $E = 150 \times 4200 \times 80$ $E = 50\ 400\ 000$ (J)	an answer of 50 400 000 scores **3** marks allow 50 000 000 (J) allow **max 2** marks for correct calculation using incorrect value of $\Delta\theta$ allow **1** mark for correct calculation using $\theta = 20$ **or** $\theta = 100$	 1 1 1	AO2 6.3.2.2
Total			**8**	

6.6.2.4 Uses and applications of electromagnetic waves

Answer 01 · Mark scheme

June 2018 | 8464/P/1F | Original Q5



6.6.2.4 Uses and applications of electromagnetic waves

Answer 02 · Mark scheme

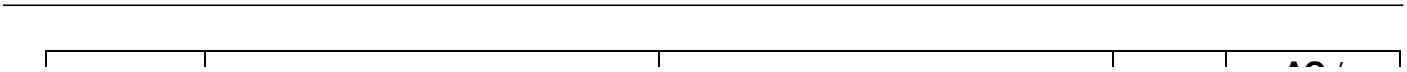
June 2018 | 8464/P/2F | Original Q4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1	R		1	AO1 6.6.2.1
04.2	they have the same wave speed as visible light they have a lower frequency than gamma rays		1 1	AO1 6.6.2.1
04.3	any **two** from: • ageing of the skin • skin cancer • eye damage	 allow sunburn burn unqualified is insufficient cancer is insufficient allow mutation of genes in skin cells allow blindness	2	AO1 6.6.2.3
04.4	any **two** from: • gamma (rays) • X-rays • ultraviolet		2	AO1 6.6.2.4
Total			**7**	

6.6.2.4 Uses and applications of electromagnetic waves

Answer 02 · Mark scheme

June 2018 | 8464/P/2F | Original Q4



6.6.2.4 Uses and applications of electromagnetic waves

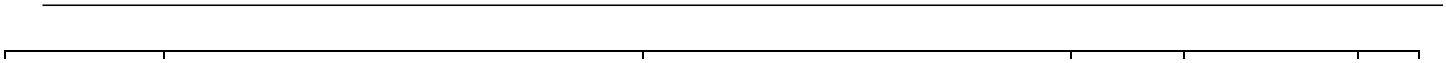
Answer 03 · Mark scheme June 2019 | 8464/P/2F | Original Q5

Question	Answers	Extra information	Mark	AO / Spec. Ref.	ID
05.1	velocity frequency wavelength		1 1 1	AO1 6.6.2.3	G
05.2	so people are not exposed to (as much) gamma radiation because gamma radiation can damage human tissue	allow less gamma radiation reaches the Earth's surface allow increases the risk of cancer or (cell) mutation allow gamma rays are ionising ignore any reference to temperature / heating of the atmosphere	1 1	AO1 6.6.2.3	E
05.3	(microwaves) are used in (satellite) communications	ignore any reference to temperature / heating of the atmosphere	1	AO2 6.6.2.4	E
05.4	can cause skin cancer / premature ageing	allow sunburn allow eye / skin damage cancer on its own is insufficient	1	AO1 6.6.2.3	E
05.5	risk from UV radiation is highest in July / summer two correct readings from the bar chart which support their comparison	allow any sensible comparison of named months / seasons if no other mark scored, two correct readings from the graph scores **1** mark	1 1	AO3 6.6.2.3	E
Total			**9**		

6.6.2.4 Uses and applications of electromagnetic waves

Answer 03 · Mark scheme

June 2019 | 8464/P/2F | Original Q5



6.6.2.4 Uses and applications of electromagnetic waves

Answer 04 · 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

6.6.2.4 Uses and applications of electromagnetic waves

Answer 04 · 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

6.6.2.4 Uses and applications of electromagnetic waves

Answer 05 · Mark scheme

November 2020 | 8464/P/2F | Original Q3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	skin		1	AO1 6.6.2.4
03.2	dose is much lower than even slight increased risk of cancer dose	allow much less than 100 mSv	1	AO3 6.6.2.3
03.3	to reduce the dose of radiation (they are exposed to)	allow reduce the risk	1	AO3 6.6.2.3
03.4	sterilising medical equipment		1	AO1 6.6.2.3
03.5	they are ionising		1	AO1 6.6.2.3
03.6	**microwaves** data is transmitted / detected by (mobile) phone / WiFi / satellite **visible light** example of device / system description of how light is used	 allow signal / information for data allow bluetooth e.g. the internet transfers information via visible light in fibre optics e.g. image produced / seen on a TV / mobile phone	 1 1 1 1	AO1 6.6.2.4

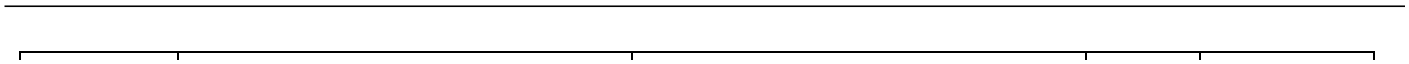
6.6.2.4 Uses and applications of electromagnetic waves

		allow any sensible suggestion for visible light, but the two marks must be linked		
Total			**9**	

6.6.2.4 Uses and applications of electromagnetic waves

Answer 05 · Mark scheme

November 2020 | 8464/P/2F | Original Q3



6.6.2.4 Uses and applications of electromagnetic waves

Answer 06 · Mark scheme

November 2021 | 8464/P/1F | Original Q6

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

Answer 06 · Mark scheme

Question	Answers	Mark	AO / Spec. Ref.
06.4	**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**	

6.6.2.4 Uses and applications of electromagnetic waves

Answer 07 · Mark scheme

June 2022 | 8464/P/2F | Original Q1

Question 1

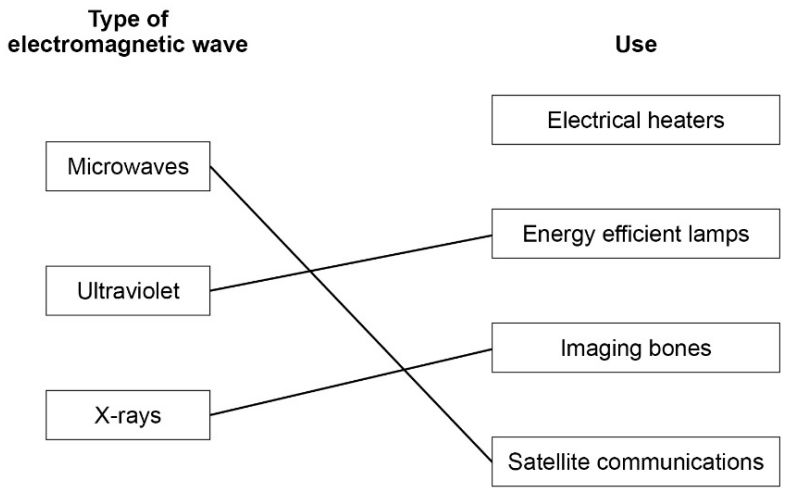
Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.1	energy		1	AO1 6.6.2.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.2	frequency wavelength	either order	1 1	AO1 6.6.2.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.3	**A** = visible light **B** = gamma (rays / waves / radiation)	allow visible allow light	1 1	AO1 6.6.2.1

6.6.2.4 Uses and applications of electromagnetic waves

Answer 07 · Mark scheme June 2022 | 8464/P/2F | Original Q1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.4	 additional line from a box on the left negates the mark for that box		1 1 1	AO1 6.6.2.4

Total Question 1		8

6.6.2.4 Uses and applications of electromagnetic waves

Answer 08 · Mark scheme

June 2022 | 8464/P/2F | Original Q2

Question 2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.1	any **one** from: • stand up • use a funnel • pour water slowly • pour at arms-length • wear heat-proof gloves	gloves on its own is insufficient allow do not touch hot objects (with bare hands)	1	AO3 6.6.2

Question	Answers	Mark	AO / Spec. Ref.
02.2	**Level 2:** The method would lead to the production of a valid outcome. All key steps are identified and logically sequenced.	3–4	AO1 6.6.2.2
	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 • use the kettle to heat the water • use measuring cylinder to measure volume of water • same volume of water in each flask • use the thermometer to measure temperature of the water • ensure temperature is the same in each flask • infrared detector the same distance from each flask • use the infrared detector to measure the power of infrared radiation from each flask and compare results		

6.6.2.4 Uses and applications of electromagnetic waves

Answer 08 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.3	as time increases the power decreases the change (in power) each 60s decreases as the time increases	 allow rate of decrease of power decreases	1 1	AO3 6.2.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.4	4.4 W		1	AO3 6.2.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.5	any **one** from: • all surfaces will be at the same temperature • temperature of the water does not need to be measured • more surfaces can be tested • the procedure only needs to be done once • volume of water does not need to be measured	 allow different surfaces can be tested at the same time	1	AO3 6.2.2

6.6.2.4 Uses and applications of electromagnetic waves

Answer 08 · Mark scheme

June 2022 | 8464/P/2F | Original Q2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.6	measurements can be taken at the same time results will be more accurate	allow no need to move the detectors / cube	1 1	AO3 6.2.2

Total Question 2		11

6.6.2.4 Uses and applications of electromagnetic waves

Answer 09 · 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

6.6.2.4 Uses and applications of electromagnetic waves

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

6.6.2.4 Uses and applications of electromagnetic waves

Answer 10 · Mark scheme

June 2023 | 8464/P/2F | Original Q6

Question 6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.1	**A** radio waves **B** microwaves **C** X-rays	allow **1** mark if 2 correct	2	AO1 6.6.2.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.2	**Similarity** any **one** from: • same speed (in a vacuum) • both transfer energy • both transverse **Difference** any **one** from: • gamma has a higher frequency • gamma has a shorter wavelength • gamma is more ionising • gamma is more penetrating	allow both can travel through a vacuum allow both are ionising allow both can harm living tissue allow both can be used for medical treatment / imaging allow gamma has more energy	1 1	AO1 6.6.2.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.3	refraction		1	AO1 6.6.2.2

6.6.2.4 Uses and applications of electromagnetic waves

Answer 10 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.4	wave speed = frequency × wavelength **or** $v = f\lambda$		1	AO1 6.6.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.5	$3.0 \times 10^{8} = f \times 5.0 \times 10^{-7}$ $f = \dfrac{3.0 \times 10^{8}}{5.0 \times 10^{-7}}$ $f = 6 \times 10^{14}$ (Hz)	 allow a correct rearrangement using incorrect powers of 10 allow a correct calculation of f using incorrect powers of 10 allow 6.0×10^{14} (Hz)	1 1 1	AO2 6.6.1.2

Total Question 6	9

6.6.2.4 Uses and applications of electromagnetic waves

Answer 11 · Mark scheme

June 2025 | 8464/P/1F | Original Q1

Question 1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.1	the number of neutrons		1	AO1 6.4.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.2	lead-210 has unstable nuclei		1	AO1 6.4.2.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.3	high speed electrons ejected from nuclei		1	AO1 6.4.2.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.4	50 (kBq)	allow an answer in the range 49 (kBq) to 50 (kBq)	1	AO2 6.4.2.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.5	25 (kBq)	allow ecf from question **01.4**	1	AO2 6.4.2.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.6	age = 50 (years)		1	AO3 6.4.2.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.7	the estimated age would be lower		1	AO3 6.4.2.1 6.4.2.3

6.6.2.4 Uses and applications of electromagnetic waves

Answer 11 · Mark scheme

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

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.9	alpha		1	AO1 6.4.2.1

Total Question 1	**9**

Answer 12 · Mark scheme

June 2025 | 8464/P/2F | Original Q2

Question 2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.1	colour of water		1	AO1 6.6.2.2 RPA 21

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.2	initial temperature of water		1	AO1 6.6.2.2 RPA 21

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.3	measuring cylinder		1	AO1 6.6.2.2 RPA 21

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.4	$\frac{80.0 - 65.0}{5.0}$ = 3 (°C / minute)	allow $\frac{65.0 - 80.0}{5.0}$ allow $\frac{15.0}{5.0}$ allow – 3 (°C / minute)	1 1	AO2 6.6.2.2 RPA 21

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.5	*y*-axis labelled rate of change of temperature in °C / minute *y*-axis scale of 1.0 °C / minute per cm bars plotted correctly	unit must be present allow a tolerance of ± ½ small square ignore width of bars	1 1 1	AO2 6.6.2.2 RPA 21

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.6	answer between 5.0 and 6.1 (°C / minute)	do **not** accept 5.0 (°C / minute) do **not** accept 6.1 (°C / minute)	1	AO3 6.6.2.2 RPA 21

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.7	infrared		1	AO1 6.6.2.2 6.6.2.4 RPA 21

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.8	energy		1	AO1 6.6.2.2 RPA 21

Total Question 2	**11**

Question 5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1	microwaves		1	AO1 6.6.2.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.2	gamma rays		1	AO1 6.6.2.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.3	the time taken for one wave to pass a fixed point		1	AO1 6.6.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.4	48 GHz = 48 000 000 000 Hz	allow 48 GHz = 48×10^9 Hz subsequent marks may be awarded if an incorrectly / not converted value of f is used	1	AO2
	$T = \frac{1}{48\ 000\ 000\ 000}$		1	AO2
	$T = 2.08\ldots \times 10^{-11}$	allow 0.000 000 000 0208… allow 0.000 000 000 021 allow 2.1×10^{-11}	1	AO2
	s	allow seconds	1	AO1 6.6.1.2

6.6.2.4 Uses and applications of electromagnetic waves

Answer 13 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.5	any **one** from: • speed (in a vacuum / air) • they can travel through a vacuum • they transfer energy • they are transverse		1	AO1 6.6.2.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.6	cables may not go to remote areas **or** it is expensive to lay cables	allow satellites may give faster data transfer	1	AO3 6.6.2.4

Total Question 5	**9**

6.6.2.4 Uses and applications of electromagnetic waves

Answer 06 · Examiner comments November 2021 | 8464/P/1F | Original Q6

Question 06 (Standard demand)

06.1 This question was answered correctly by roughly one in three students.

06.2 Around 15% of students gained both marks, with slightly over half gaining just one mark.

06.3 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. Very few students answered correctly.

6.6.2.4 Uses and applications of electromagnetic waves

Answer 06 · Examiner comments November 2021 | 8464/P/1F | Original Q6

06.4 Most students struggled to answer this question, with many unable 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 a quarter of students did not attempt to answer the question.

Mark Ranges and Award of Grades

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

6.6.2.4 Uses and applications of electromagnetic waves

Answer 07 · Examiner comments June 2022 | 8464/P/2F | Original Q1

Question 1 (Low demand)

01.1 A little over 70% of students knew that waves transfer energy.

01.2 Nearly all students scored a mark on this question comparing electromagnetic waves, with approximately two thirds scoring both marks.

01.3 50% of students could name either visible light or gamma - of those that did only score one mark, gamma was the most common correct answer. Less than 25% of students scored 2 marks.

01.4 Over 95% of students scored at least one mark on this question. 65% scored two marks, with most that did failing to identify the correct use of microwaves. Approximately 15% of students scored all three marks.

6.6.2.4 Uses and applications of electromagnetic waves

Answer 08 · Examiner comments

June 2022 | 8464/P/2F | Original Q2

Question 2 (Low demand)

02.1 Approximately 40% of students were able to suggest a way to reduce the risk of burning. Many incorrect answers suggested wearing gloves – unqualified, this is insufficient, as some gloves would not offer any protection. Other incorrect answers were impractical, such as full insulation suits.

02.2 This question on describing a practical was reasonably well answered. Over two thirds of students wrote answers that contained relevant content and scored marks. The answers that failed to make it into level two did not describe the use of all the equipment, or were vague, suggesting using measuring the temperature, but not stating that this is done using the thermometer. Many answers failed to include the use of the measuring cylinder. 25% of students' answers were judged to be in level two, so their methods would have led to a valid outcome

02.3 Over 75% of students were able to describe the power decreasing as the time increased. Very few students were able to describe the amount power decreased each minute getting less, as only approximately 5% of students were awarded 2 marks.

02.4 Approximately 50% of students were able to interpret the data and identify the most likely value for the power.

02.5 Only 20% of students were able to give an advantage of the Leslie Cube. Most answers were very vague with simple statements like 'it's easier'.

02.6 Approximately 45% of students scored at least one mark on this question. The most common correct answer was 'more accurate'. 5% of students scored two marks on this question.

6.6.2.4 Uses and applications of electromagnetic waves

Answer 09 · 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 09 · 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.

6.6.2.4 Uses and applications of electromagnetic waves

Answer 10 · Examiner comments — June 2023 | 8464/P/2F | Original Q6

Question 6 (standard demand)

06.1 Fewer than 25% of students could identify all the missing parts of the spectrum. 70% of students either scored zero marks or did not attempt the question. A significant number of students wrote answers that were nothing to do with the electromagnetic spectrum.

06.2 Only 2% of students we able to give a similarity and a difference. The similarity was more accessible and was how the majority of the 15% that scored one mark got the mark. Many

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identified that they are both transverse. For the difference, most students did not refer to a property of electromagnetic waves. A little over 15% of students did not attempt the question.

06.3 Approximately 20% of students knew that the process is refraction. A little over 15% of students did not attempt the question.

06.4 This question was well answered with over 90% of students getting the mark. Students were given the equation sheet, which will have contributed to the overall performance on this question.

06.5 25% of students were able to substitute correctly and give the correct answer to the question to the correct order of magnitude. Approximately 20% of students correctly rearranged and substituted but did not use their calculator to evaluate the numbers in standard form, so scored 2 marks.

6.6.2.4 Uses and applications of electromagnetic waves

Answer 11 · Examiner comments

June 2025 | 8464/P/1F | Original Q1

Question 1 (Low demand)

01.1 Approximately one third of students knew the difference between the atoms of different isotopes of lead.

01.2 Approximately two thirds of students knew what is meant by 'lead-210 is radioactive'.

01.3 Approximately one third of students knew what beta radiation is.

01.4 80% of students were able to read the initial activity correctly from the graph.

01.5 Just under 20% of students answered this question correctly. There was a very wide range of incorrect answers indicating that many students struggled to understand how to answer the question.

01.6 This question was well answered with a little over 50% giving the correct age of the painting.

01.7 Half of the students knew that the estimated age would be lower if the other radioactive substances were not removed.

01.8 60% of students correctly selected gamma as the type of radiation with the greatest range in air.

01.9 80% of students correctly selected alpha as the type of radiation that is the least penetrating.

6.6.2.4 Uses and applications of electromagnetic waves

Answer 12 · Examiner comments June 2025 | 8464/P/2F | Original Q2

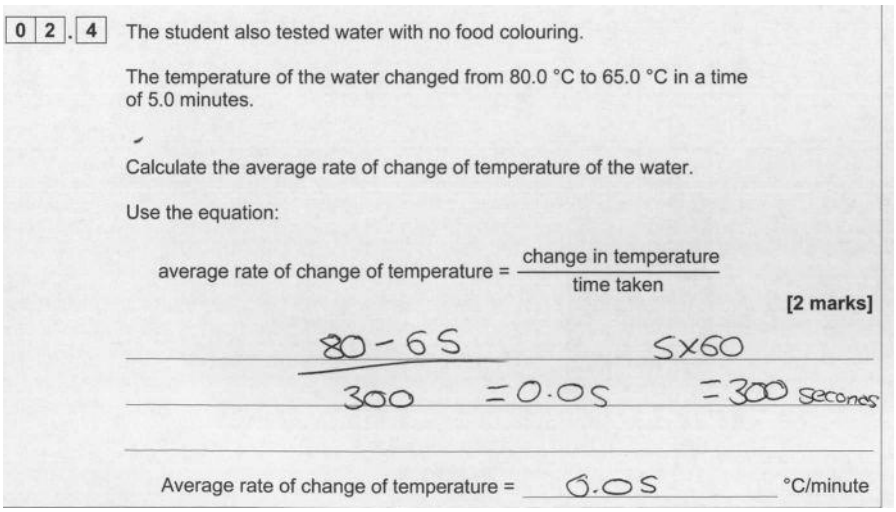
Question 2 (Low demand)

02.1 About half the students correctly identified the independent variable.

02.2 Only about 40% could identify a control variable.

02.3 Slightly more than 8 in 10 students recalled that a volume of water should be measured using a measuring cylinder.

02.4 This question was answered correctly by almost three quarters of students.
Of those who answered incorrectly, it was relatively common for students to divide a temperature by time, rather than dividing the change in temperature by time.



0 2 . 4 The student also tested water with no food colouring.

The temperature of the water changed from 80.0 °C to 65.0 °C in a time of 5.0 minutes.

Calculate the average rate of change of temperature of the water.

Use the equation:

average rate of change of temperature = change in temperature / time taken

[2 marks]

80 - 65 = 15
15 / 300 = 0.05
5 x 60 = 300 seconds

Average rate of change of temperature = 0.05 °C/minute

This student did not recognise that the answer line needed an answer given in °C/minute and calculated a rate in °C/second. Students who did this could still be awarded one mark.

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6.6.2.4 Uses and applications of electromagnetic waves

Answer 12 · Examiner comments June 2025 | 8464/P/2F | Original Q2

02.5 The vast majority of students gained at least one mark on this question, with the most common mark awarded being for the scale on the *y*-axis. The most common mark not scored by students was because they either did not attempt to label the *y*-axis, did not include units in their label, or labelled the *y*-axis incorrectly. A common incorrect label was to write '*y*-axis' instead of writing 'rate of change of temperature in °C/minute'.

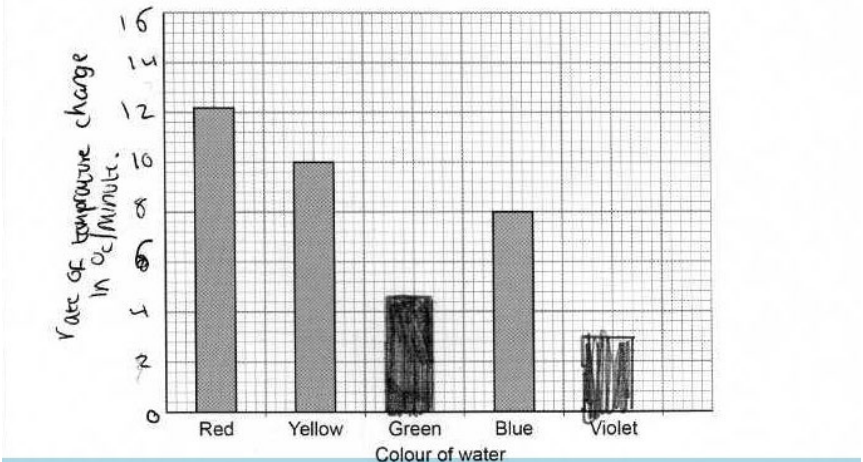
0 2 . 5 Complete **Figure 4**.

You should:

- label the *y*-axis
- add a scale to the *y*-axis
- draw bars for the green water and the violet water.

[3 marks]

Figure 4



This student added an incorrect scale. The height of the bars was marked independently from the scale the students chose – the heights needed to be consistent with the bars for Red, Yellow and Blue already drawn on the paper – so even if this student had drawn their two bars to be consistent with their incorrect scale, they would have not gained credit for this.

02.6 Just over half of students estimated a valid answer. A common incorrect approach was to determine the difference between the values for red and yellow, rather than to determine a value between these two values.

02.7 About 50% of students recognised that colour affects the rate of emission of infrared.

02.8 Slightly more than 60% identified that cooling occurred because the radiation transfers energy.

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6.6.2.4 Uses and applications of electromagnetic waves

Answer 13 · Examiner comments June 2025 | 8464/P/2F | Original Q5

Question 5 (Low and standard demand)

05.1 About 40% of students recalled that microwaves are used to transfer data to satellites.

05.2 Slightly more than half the students remembered that gamma rays have the greatest frequency.

05.3 Just under half selected the definition for the period of a wave.

05.4 Nearly three quarters of students gained at least some credit, but a very small proportion of students were able to calculate the correct answer and give the correct unit. About a third of students scored 3 marks.
It was relatively common to see students writing incorrect calculations, such as '1/48 = 48', and there was a surprising number who decided to give their answer to one significant figure to this question, which is rarely 6.

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6.6.2.4 Uses and applications of electromagnetic waves

Answer 13 · Examiner comments

June 2025 | 8464/P/2F | Original Q5

0 5 . 4 Data is transmitted to the satellites by electromagnetic waves with a frequency of 48 GHz.

Calculate the period of waves with a frequency of 48 GHz.

Use the Physics Equations Sheet.

Choose the unit from the box.

[4 marks]

J	N/kg	s

48 ÷ 1000 = 0.048

1 ÷ 0.048 = 20.8

Period = 20.8 Unit S

This student clearly identified that 48 GHz needed to be converted to Hz but was unsure how to go about this. They scored 2 marks for the calculation, and a further mark for selecting the correct unit.

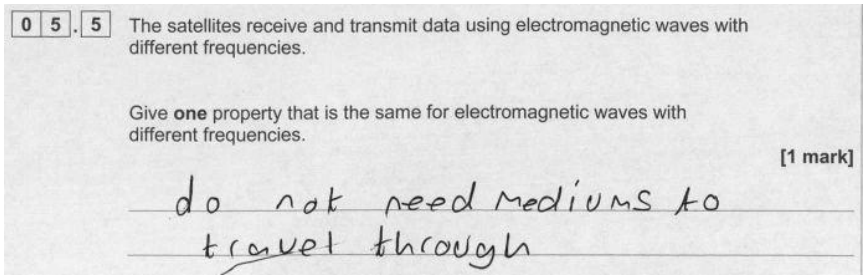
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6.6.2.4 Uses and applications of electromagnetic waves

Answer 13 · Examiner comments

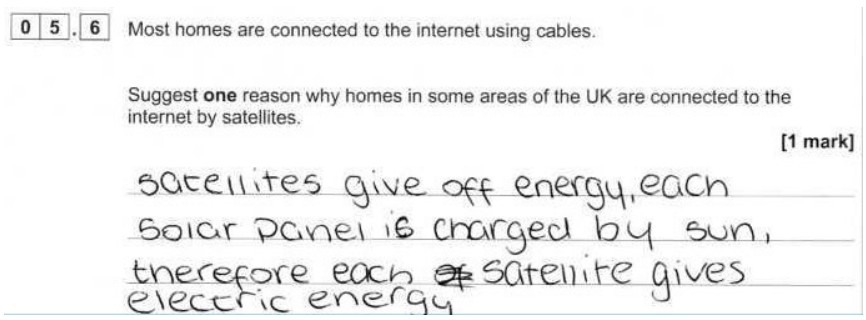
June 2025 | 8464/P/2F | Original Q5

05.5 Only a small minority of students gave a property that is the same for all electromagnetic waves. Many wrote about uses of the waves, rather than their properties, and it was relatively common to see answers that described the waves as something that can be used to transmit data, for example.



This response was awarded the mark for the idea that electromagnetic waves can travel through a vacuum. Alternative wording to express correct physics is always acceptable, unless a mark scheme term is underlined.

05.6 Approximately a fifth of students gave an acceptable answer to this question. Many were confused about the difference between a connection to the internet and a connection to the national grid or to a power source, with many answers referring to solar power, and some referring to benefits to the environment of solar power.



This response illustrates the incorrect link shown by many students between a connection to an electrical energy supply and a connection to the internet.

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