AQA GCSE Combined Science - Trilogy | 8464

SPECIFICATION POINT 6.7.2.1

Electromagnetism

Mark schemes and examiner comments

Tier	**Higher**
Question groups	**12**
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.

6.7.2.1 Electromagnetism

Answer 01 · Mark scheme

June 2018 | 8464/P/2H | Original Q2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.1	1st box ticked		1	AO1 6.7.1.2
02.2	(permanent magnet) has no effect on the aluminium iron is attracted (to the permanent magnet) (only) the (permanent) magnet can be repelled (by the permanent magnet)		1 1 1	AO2 6.7.1.1 6.7.1.2

6.7.2.1 Electromagnetism

Answer 01 · Mark scheme

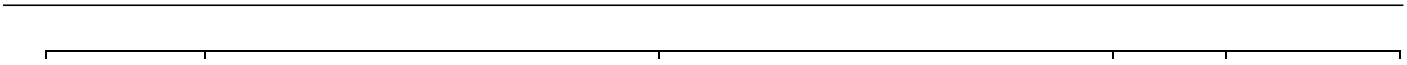
June 2018 | 8464/P/2H | Original Q2

Question	Answers	Mark	AO / Spec. Ref.
02.3	**Level 3:** Relevant points (reasons / causes) are identified, given in detail and logically linked to give a clear account.	5–6	AO2
	Level 2: Relevant points (reasons / causes) are identified, and there are attempts at logically linking. The resulting account is not fully clear.	3–4	AO2
	Level 1: Points are identified and stated simply, but their relevance is not clear and there is no attempt at logical linking.	1–2	AO1
	No relevant content	0	
	Indicative content • completing the circuit • turns the electromagnet on • there is a current in the coil • a magnetic field is produced around the coil • the iron core becomes magnetised • move electromagnet towards the blocks • the block is attracted to the electromagnet • moving the crane moves the block • switching off the current switches off the electromagnet • releasing the block		6.7.2.1
Total			**10**

6.7.2.1 Electromagnetism

Answer 01 · Mark scheme

June 2018 | 8464/P/2H | Original Q2



6.7.2.1 Electromagnetism

Answer 02 · Mark scheme

June 2018 | 8464/P/2H | Original Q5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1	in a longitudinal wave, the oscillations / vibrations are parallel to the direction of energy transfer	allow direction of travel for energy transfer	1	AO1 6.6.1.1
	in a transverse wave, the oscillations / vibrations are perpendicular to the direction of energy transfer	allow direction of travel for energy transfer	1	
		if no other mark scored allow **1** mark for (oscillations / vibrations of) longitudinal waves are parallel **and** (oscillations / vibrations of) transverse waves are perpendicular		
		if no other mark scored allow **1** mark for transverse waves have peaks and troughs **and** longitudinal waves have compressions and rarefactions		
05.2		an answer of 0.063 (m) scores **3** marks		AO2 6.6.1.2
	$3.0 \times 10^8 = 4.8 \times 10^9 \times \lambda$	allow $\lambda = \frac{3.0 \times 10^8}{4.8 \times 10^9}$	1	
		this mark may be awarded if the standard form values are incorrectly converted		
	$\lambda = 0.0625$ (m)		1	
	$\lambda = 0.063$ (m) **or** $\lambda = 6.3 \times 10^{-2}$ (m)	allow an answer to 2 sig figs that is consistent with their calculated value of λ and has required rounding	1	

6.7.2.1 Electromagnetism

Answer 02 · Mark scheme

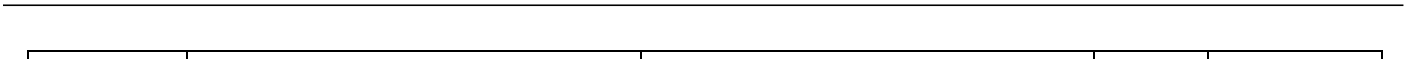
June 2018 | 8464/P/2H | Original Q5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.3	any **three** from: • (the car aerial) absorbs radio waves or energy • electrons are made to vibrate (in the aerial) • creating an alternating current (in the aerial circuit) • the (signal) frequency is the same (as the radio wave)		3	AO1 6.6.2.3
Total			**8**	

6.7.2.1 Electromagnetism

Answer 02 · Mark scheme

June 2018 | 8464/P/2H | Original Q5



6.7.2.1 Electromagnetism

Answer 03 · Mark scheme

June 2019 | 8464/P/2H | Original Q1

Question	Answers	Extra information	Mark	AO / Spec. Ref.	ID
01.1	(4 - 0) + (10 - 7) **or** 4 + 3 **or** 10 - 3 7 (s)	an answer of 7 (s) gains **2** marks	1 1	AO2 6.5.4.1.5	E
01.2	gradient = $\frac{0-2}{24-14}$ (-)0.2 (m/s^2)	an answer of 0.2 (m/s^2) gains **2** marks allow readings from any two points correctly substituted allow correct use of $a = \frac{\Delta v}{t}$	1 1	AO2 6.5.4.1.5	E
01.3	(there are no wires) to get tangled / disconnected	allow easier to move arms allow wires are inconvenient allow easier to transfer data	1	AO3 6.6.2.4	E
01.4	wave speed = frequency × wavelength	allow v = f λ allow any correct re-arrangement	1	AO1 6.6.1.2	E
01.5	300 000 000 = 2 400 000 000 × λ λ = $\frac{300\,000\,000}{2\,400\,000\,000}$ λ = 0.125 (m)	an answer of 0.125 (m) or 0.13 (m) scores **3** marks allow λ = 0.13 (m)	1 1 1	AO2 6.6.1.2	E
01.6	range is far enough (for most uses) power is not too great so the battery will not drain quickly	allow power not too great so the phone will not overheat allow the range per milliwatt is greatest or 4 metres	1 1	AO3 6.6.2.4	E

6.7.2.1 Electromagnetism

Answer 03 · Mark scheme

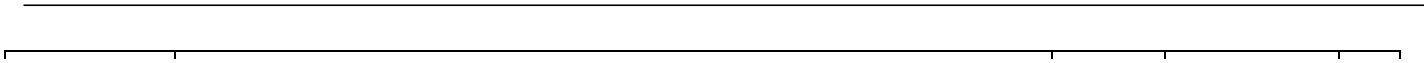
June 2019 | 8464/P/2H | Original Q1

Total			**11**		

6.7.2.1 Electromagnetism

Answer 03 · Mark scheme

June 2019 | 8464/P/2H | Original Q1



6.7.2.1 Electromagnetism

Answer 04 · Mark scheme

June 2019 | 8464/P/2H | Original Q4

Question	Answers	Extra information	Mark	AO / Spec. Ref.	ID
04.1			1	AO1 6.7.2.2	A
04.2	reverse the direction of the current reverse the direction of the magnetic field		1 1	AO1 6.7.2.2	E
04.3	B = 0.360 (T) 0.072 = 0.360 × I × 0.050 $I = \frac{0.072}{(0.360 \times 0.050)}$ I = 4.0 (A)	an answer of 4.0 (A) scores **4** marks allow a correct substitution using an incorrectly / not converted value of B allow a correct rearrangement using an incorrectly / not converted value of B allow a correct calculation using an incorrectly / not converted value of B	 1 1 1 1	AO2 6.7.2.2	E

6.7.2.1 Electromagnetism

Answer 04 · Mark scheme

June 2019 | 8464/P/2H | Original Q4

04.4	there is a magnetic field (due to the permanent magnet) **and** current in a wire causes a magnetic field current is in opposite directions in each side of the coil so forces act in opposite directions on either side of the coil (the split ring ensures that) the current in the left / right side of the coil is always in the same direction	 allow (the split ring ensures that) the force in the left / right side of the coil is always in the same direction allow the current reverses each half rotation	1 1 1 1	AO1 6.7.2.3	E
Total			**11**		

6.7.2.1 Electromagnetism

Answer 04 · Mark scheme June 2019 | 8464/P/2H | Original Q4

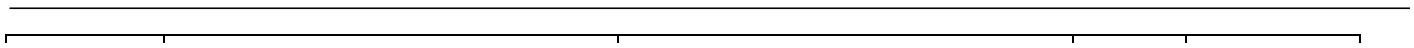
Answer 05 · Mark scheme November 2020 | 8464/P/2H | Original Q5

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**	

6.7.2.1 Electromagnetism

Answer 05 · Mark scheme

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



6.7.2.1 Electromagnetism

Answer 06 · Mark scheme

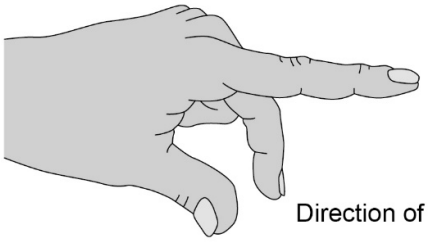
November 2021 | 8464/P/2H | Original Q4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1	at the poles		1	AO1 6.7.1.2
04.2	the distance between the field lines varies		1	AO1 6.7.1.2
04.3	electromagnet is easy to demagnetise so easy to remove separated metal	allow electromagnet can be switched off allow electromagnet is (generally) stronger than a permanent magnet for **1** mark if no other marks are awarded	1 1	AO1 6.7.2.1
04.4	cobalt nickel		1 1	AO1 6.7.1.2
04.5	increases the current in the coil of the electromagnet bring the electromagnet closer to the pieces of iron and steel	allow increase potential difference across the coil	1 1	AO1 AO3 6.7.2.1

6.7.2.1 Electromagnetism

Answer 06 · Mark scheme

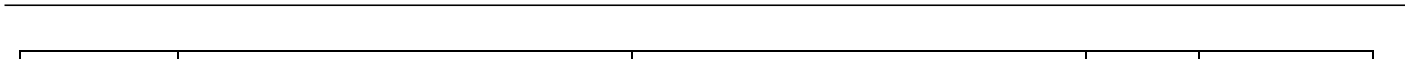
November 2021 | 8464/P/2H | Original Q4

04.6	L = 0.120 m 0.36 = B × 4.0 × 0.120 $B = \frac{0.36}{(4.0 \times 0.120)}$ B = 0.75 T	 allow a correct substitution of an incorrectly / not converted value of L allow a correct rearrangement using an incorrectly / not converted value of L allow a correct calculation using an incorrectly / not converted value of L	1 1 1 1 1	AO2 6.7.2.2
04.7	 Direction of magnetic field Direction of current Direction of force allow **1** mark for 1 or 2 correct		2	AO1 6.7.2.2
Total			**15**	

6.7.2.1 Electromagnetism

Answer 06 · Mark scheme

November 2021 | 8464/P/2H | Original Q4



6.7.2.1 Electromagnetism

Answer 07 · 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

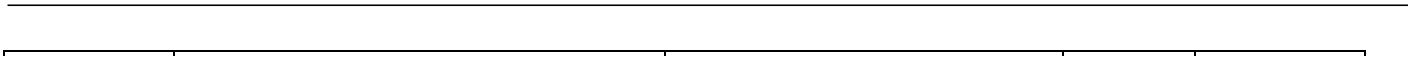
6.7.2.1 Electromagnetism

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**	

6.7.2.1 Electromagnetism

Answer 07 · Mark scheme

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



6.7.2.1 Electromagnetism

Answer 08 · Mark scheme

June 2023 | 8464/P/1H | Original Q3

Question 3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	potential difference is increased (and) current decreases (so) energy/power losses in the transmission cables decrease	allow transformer **X** is a step up transformer allow (so) there is less heating in the transmission cables	1 1 1	AO1 6.2.4.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.2	$11\,000 \times I_s = 400\,000 \times 660$ $I_s = \frac{400\,000 \times 660}{11\,000}$ $I_s = 24\,000$ (A)		1 1 1	AO2 6.2.4.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.3	the street lamps are connected in parallel		1	AO3 6.2.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.4	resistance (of the LDR) increases	allow resistance (of the circuit) increases	1	AO1
	(so) the current decreases	allow so the LDR has a greater (share of the) potential difference	1	AO3
	(so) the potential difference across R decreases	dependent on MP1	1	AO3 6.2.1.4 6.2.1.3 6.2.2 6.2.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.5	20 mA = 0.020 A		1	AO2 6.2.4.1
	$6.0 = 0.020^2 \times R$	allow a correct substitution using an incorrectly / not converted value of current.	1	
	$R = \frac{6.0}{0.020^2}$	allow a correct re-arrangement using their incorrectly / not converted value of current.	1	
	R = 15000 (Ω) **OR** 20 mA = 0.020 A (1) $V = \frac{6.0}{0.020} = 300$ (1) $R = \frac{300}{0.020}$ (1) R = 15000 (Ω) (1)	allow an answer consistent with their incorrectly / not converted value of current	1	

Total Question 3	**14**

6.7.2.1 Electromagnetism

Answer 09 · Mark scheme

June 2023 | 8464/P/2H | Original Q1

Question 1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.1	**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.
01.2	**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.
01.3	refraction		1	AO1 6.6.2.2

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

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.5	$3.0 \times 10^{8} = f \times 5.0 \times 10^{-7}$ $f = \dfrac{3.0 \times 10^{8}}{5.0 \times 10^{-7}}$ $f = 6 \times 10^{14}$ (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 1	9

6.7.2.1 Electromagnetism

Answer 10 · Mark scheme

June 2024 | 8464/P/2H | Original Q3

Question 3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	speed (in a vacuum/air) **or** transfer energy	ignore they can travel through air allow they can be reflected / refracted	1	AO1 6.6.2.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.2	oscillations / vibrations are perpendicular to the direction of energy transfer	allow wave travel for energy transfer	1	AO1 6.6.1.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.3	microwaves	allow radio waves	1	AO1 6.6.2.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.4	violet	allow purple	1	AO1 6.6.2.1

Answer 10 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.5	any **two** from • (ultraviolet and /or X-rays and / or gamma rays) can cause mutations in genes / DNA • ultraviolet can cause skin to age and / or skin cancer • X-rays and / or gamma rays increase the risk of cancers	 allow can damage / kill cells ignore mutations in cells allow ultraviolet can cause sunburn or eye damage allow X-rays and / or gamma rays can cause cancers if no other mark awarded allow **1** mark for (the three highest frequency groups) can cause cancer	2	AO1 6.6.2.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.6	$4.0 \times 10^{-10} = \frac{1}{\text{frequency}}$ $\text{frequency} = \frac{1}{4.0 \times 10^{-10}}$ 2.5×10^{9} (Hz)	 only award if answer is in standard form	1 1 1	AO2 6.6.1.2

6.7.2.1 Electromagnetism

Answer 10 · Mark scheme

June 2024 | 8464/P/2H | Original Q3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.7	radio waves are produced (by the transmitter)	allow microwaves are produced (by the transmitter)	1	AO1 6.7.2.1
	the detector absorbs the waves / energy		1	
	(which produces) an alternating current	allow causing electrons to oscillate	1	
	with the same frequency as the (transmitted) waves	allow with the same frequency as the oscillations in the transmitter	1	

Total Question 3	13

Answer 11 · Mark scheme

June 2024 | 8464/P/2H | Original Q4

Question 4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1	into the page		1	AO2 6.7.2.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.2	$0.092 = B \times 4.6 \times 0.080$ $B = \frac{0.092}{4.6 \times 0.080}$ $B = 0.25$ tesla or T	 allow a correct rearrangement using an incorrectly / not converted value of l allow a correct calculation using an incorrectly / not converted value of l	1 1 1 1	AO2 6.7.2.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.3	Newton's third law		1	AO1 6.5.4.2.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.4	any **two** from: • move the electromagnet closer to the permanent magnet • add more turns to the coil / electromagnet • increase the current (in the coil / electromagnet)	 allow increase the potential difference (across the coil / electromagnet)	2	AO1 6.7.2.1

6.7.2.1 Electromagnetism

Answer 11 · Mark scheme

June 2024 | 8464/P/2H | Original Q4

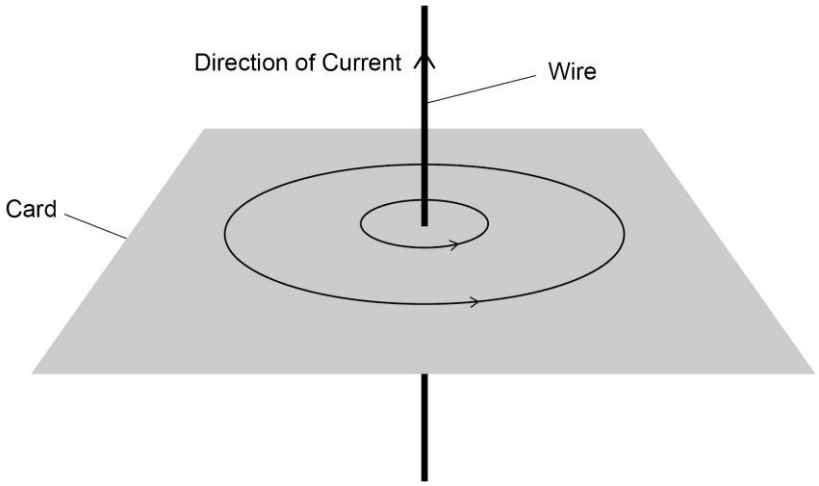
Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.5	any **two** from • reverse the current in the coil / electromagnet • turn the electromagnet around (to reverse the poles) • wrap the coil (around the iron core) in the opposite direction		2	AO1 AO3 6.7.2.1

Total Question 4	**10**

Answer 12 · Mark scheme

June 2025 | 8464/P/2H | Original Q4

Question 4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1	(at least) 2 concentric rings around the point where the wire passes through the card with arrow(s) drawn in anticlockwise direction around the wire		1 1	AO1 6.7.2.1
				

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.2	2.1 mN = 0.0021 N	subsequent marks may be awarded if *F* is incorrectly / not converted	1	AO2
	$0.0021 = B \times 0.56 \times 0.050$		1	AO2
	$B = \frac{0.0021}{0.56 \times 0.050}$		1	AO2
	$B = 0.075$		1	AO2
	tesla **or** T		1	AO1 6.7.2.2

6.7.2.1 Electromagnetism

Answer 12 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.3	there is a magnetic field between the poles of the magnets		1	AO1 6.7.2.2 6.7.2.3
	a current in a loop of wire causes a magnetic field		1	
	the current is in opposite directions in side A and side B		1	
	(so) the (vertical) forces on side A and side B are in opposite directions		1	
	the force on side A is downwards **or** the force on side B is upwards	allow the forces on side A and side B cause the loop to rotate anticlockwise	1	

Total Question 4	12

6.7.2.1 Electromagnetism

Answer 01 · Examiner comments June 2018 | 8464/P/2H | Original Q2

Question 2 (standard demand)

02.1 60% scored this mark. The most common incorrect response was where the direction of the magnetic field lines ran from south to north.

02.2 Many students did not appreciate that they needed to identify all three blocks. Many identified iron and aluminium and not the second permanent magnet.

There appeared to be widespread confusion as to which of iron and aluminium were magnetic and a significant minority simply said that a material was magnetic without indicating how they would identify it.

As a result, 40% scored zero for this question, and 17% scored scored all three marks.

02.3 There were many very vague responses to this question, with few inclusions of the level of detail expected. Many made reference to the ability to turn the electromagnet on and off but there were few descriptions of how the electromagnet worked with many incorrect references to 'electricity' passing through the core.

Many believed that the magnetic blocks were, in fact, magnets themselves and talked about the attraction and repulsion between the blocks and the electromagnet. As a result, only about 8% gave answers worthy of level three and a further 32% gave answers worthy of level two.

Answer 02 · Examiner comments June 2018 | 8464/P/2H | Original Q5

Question 5 (standard & standard / high demand)

05.1 Nearly 13% gave accurate answers to score both marks. A further 20% were able to score a compensation mark by vague references to parallel and perpendicular, but it was clear that many students do not realise the importance of what is oscillating and the direction of energy transfer. There were many vague incorrect descriptions of 'up and down' and 'side to side'.

05.2 25% gained full marks, and a further 18% gained two marks, usually not giving the answer to two significant figures. There were a large number of responses using an incorrect rearrangement of the equation and generally the use of standard form was not the cause of the errors.

6.7.2.1 Electromagnetism

Answer 02 · Examiner comments June 2018 | 8464/P/2H | Original Q5

05.3 This was very poorly done, with just over 1% gaining full marks. There were many vague responses and a significant number of candidates wrote about transverse and longitudinal waves. There was also considerable reference to radio waves being reflected off the ionosphere.

A significant minority of students did not attempt this question which might suggest that they were unfamiliar with the material.

Answer 06 · Examiner comments November 2021 | 8464/P/2H | Original Q4

Question 4 (standard demand and standard/high demand)

04.1 33% of students knew that the field was strongest at the poles.

04.2 12% of students were able to correctly describe how the diagram showed that the field was not the same at all places. Many incorrect answers did not refer to ay feature of Figure 4.

04.3 40% of students gained 1 mark on this question. Most of them identified that the electromagnet could be easily demagnetised. A further 8% went on to say that this meant that the pieces of metal could be easily removed.

Some of the 40% that scored 1 mark scored the mark because they said that electromagnets are (generally) stronger.

04.4 20% of students could name one of the magnetic metals, and 20% of those students could name both the metals. Of those that could only name 1 magnetic metal, there was an approximately even number for each correct answer.

04.5 Approximately 35% of students scored one mark, nearly all of these suggested increasing the current. Only a handful of students also suggested moving the electromagnet closer and scored 2 marks.

04.6 This standard/high demand calculation was reasonably well answered. Nearly 40% scored 3 or 4 marks for a correct calculation, but either did not recall the unit, did not convert the length or did neither. 5% of students scored full marks.

04.7 30% of students scored at least 1 mark for getting at least 1 word correct and in the correct place. 10% were able to write the correct word in the correct place for each finger.

The majority of students that scored 0 marks wrote words that were not related to electromagnetism.

6.7.2.1 Electromagnetism

Answer 07 · 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.

Answer 07 · 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.

6.7.2.1 Electromagnetism

Answer 08 · Examiner comments — June 2023 | 8464/P/1H | Original Q3

Question 03 (Standard/high and high demand)

03.1 Just over half of all students gained at least one mark on this question. Many students seemed to think that greater efficiency means that energy is transferred at a greater rate. It was also common for answers to suggest that the transformer either increases or decreases resistance, which was ignored.

03.2 Slightly less than 60% of students gained full marks on this calculation. Many students who did not score anything attempted to use $V=IR$ for the primary coil and then the secondary coil. Students who used the correct equation but gained or lost a zero in their answer at some point could score a maximum of 2 marks.

03.3 Only about 25% of students answered this multiple-choice question correctly. This was the third most common answer, with more students selecting that current is dissipated to the surroundings, and that the cables have electrical resistance.

03.4 About a quarter of students scored at least one mark, but very few gained more than this. Some thought that the LDR was an LED, suggesting that as it gets darker the LDR needs to emit more light so the current must increase, for example. Some thought that the total resistance of the circuit must remain constant, so as the resistance of the LDR decreased, the resistance of the fixed resistor must increase. Many students struggled to express themselves, finding it difficult to

Answer 08 · Examiner comments — June 2023 | 8464/P/1H | Original Q3

express which potential difference they were writing about – the potential difference across the battery, the fixed resistor or the LDR.

03.5 Approximately a fifth of students gained all 4 marks, with about half of all students scoring 3 marks on this calculation. Many students did not attempt to convert mA to A, and of those who did many conversions were incorrect. Of the students scoring 0 marks, it was reasonably common for them to neglect to square the current when using $P = I^2 R$.

6.7.2.1 Electromagnetism

Answer 09 · Examiner comments

June 2023 | 8464/P/2H | Original Q1

Question 1 (Standard demand)

01.1 60% of students correctly identified all three parts of the electromagnetic spectrum and scored both marks. However, 30% of students scored no marks.

01.2 50% of students were able to gain at least one mark on this question. The similarity was more accessible and was how the majority of the 35% that scored one mark got the mark. Many identified that both waves are transverse. For the difference, most students did not refer to a property of electromagnetic waves.

01.3 A little over 65% of students correctly identified that the process is called refraction.

01.4 Over 99% of students gained the mark. Students were given the equation sheet, which will have contributed to the overall performance on this question.

01.5 Over 70% 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.

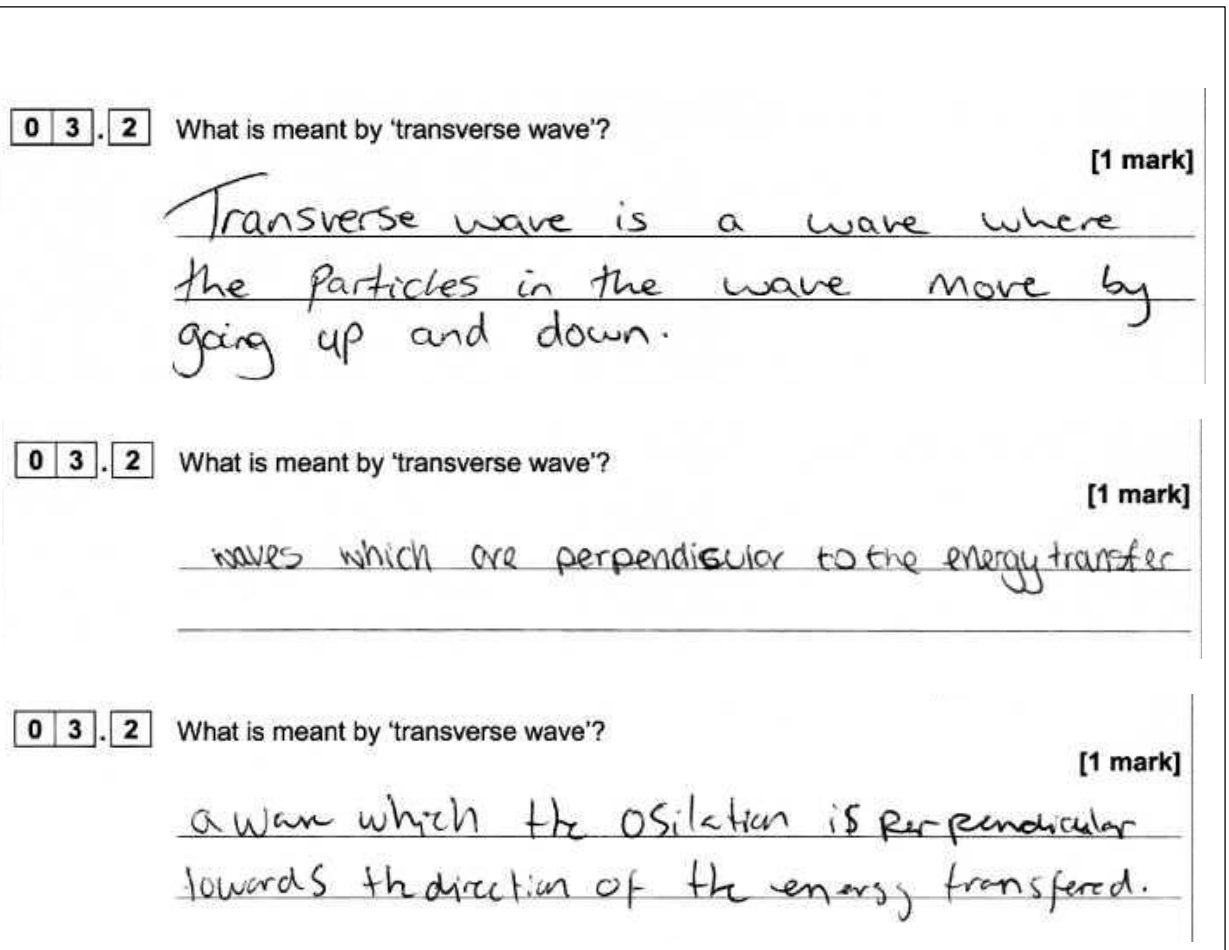
Answer 10 · Examiner comments

June 2024 | 8464/P/2H | Original Q3

Question 3 (standard, standard/high & high demand)

03.1 This question proved to be more demanding than expected, with just over 20% of students able to give a correct property of electromagnetic waves. Many students simply repeated the wording of the stem (that they can travel through a vacuum) even though they were asked of one *other* property. Some students attempted to describe a transverse wave.

03.2 Just over 20% of students were able to describe a transverse wave. Most demonstrated some understanding, but answers were often insufficient or too vague for the mark. When describing transverse waves, it must be clear that oscillations are perpendicular to the direction of energy transfer. Most answers were missing some part of the description.



0 3 . 2 What is meant by 'transverse wave'?

[1 mark]

Transverse wave is a wave where the particles in the wave move by going up and down.

0 3 . 2 What is meant by 'transverse wave'?

[1 mark]

waves which are perpendicular to the energy transfer

0 3 . 2 What is meant by 'transverse wave'?

[1 mark]

a wave which the oscilation is perpendicular towards the direction of the energy transfered.

The first two examples here are not sufficient to gain the marks. In the first, the student demonstrates some understanding but the language is very vague and there is no mention of energy transfer. The second response gives an *almost* complete description but there is no mention of oscillations/vibrations so the mark cannot be awarded.

The third response has all the required aspects of the description so the mark is awarded.

03.3 This AO1 question was well answered with 85% of students giving the correct response.

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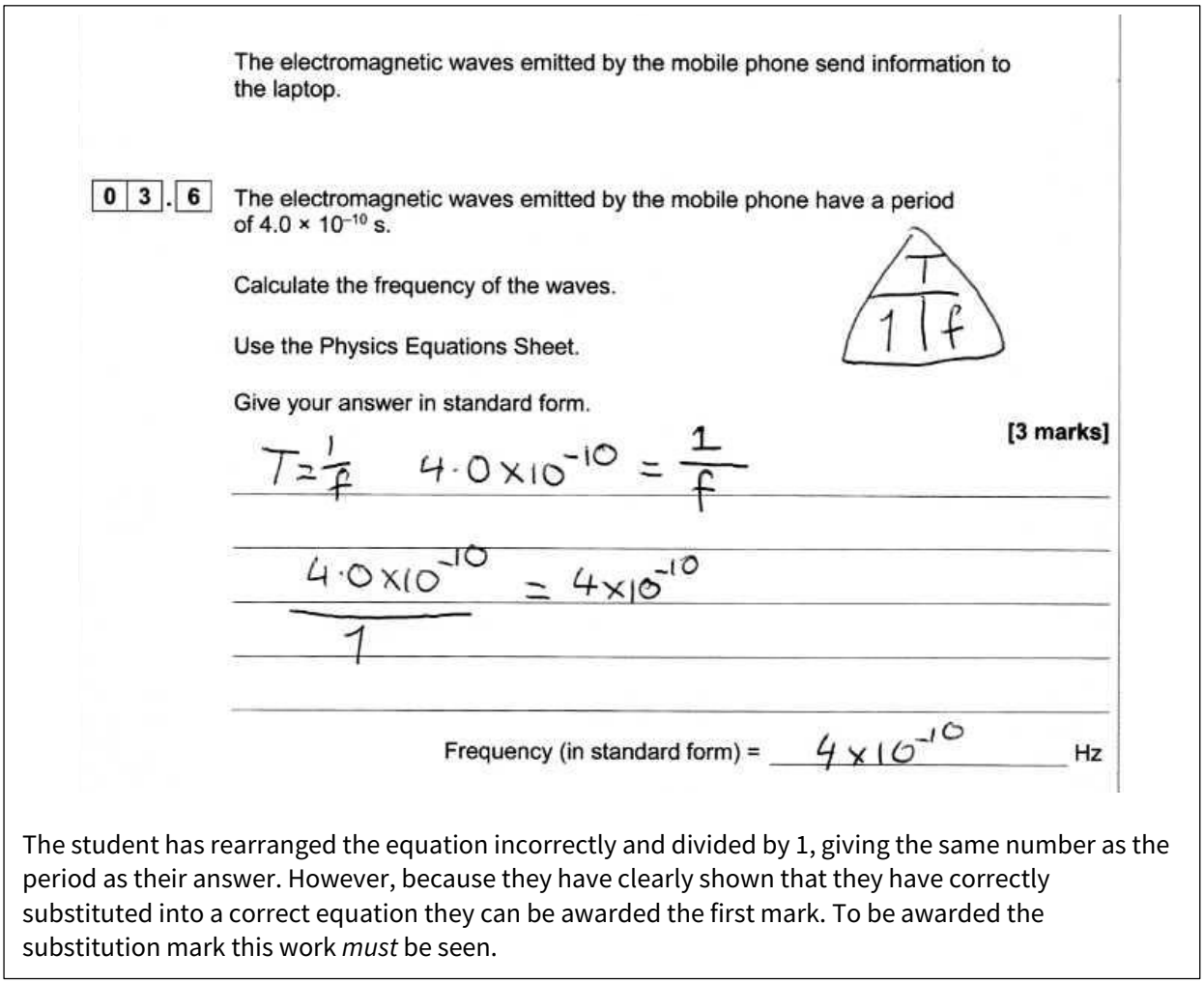
6.7.2.1 Electromagnetism

Answer 10 · Examiner comments June 2024 | 8464/P/2H | Original Q3

03.4 Just over 25% of students gave the correct colour for the shortest wavelength of visible light. Most of those that gained the mark did write violet but some stated purple, which was allowed. The most common incorrect answer was red, but a wide range of colours was given, including black and white.

03.5 Nearly 75% of students gained at least 1 mark for giving a risk, although less than 20% of students listed the three groups and correctly linked each to a specific risk such as UV causes skin cancer. Most of the 1-mark answers gained the compensation mark for stating that high-frequency electromagnetic waves cause cancer.

03.6 This question required students to manipulate numbers in standard form and 60% of students gained all 3 marks. The equation is relatively simple as it contains only two variables. However, this seemed to throw some students, who substituted correctly but then rearranged incorrectly and multiplied the period by one, so gave their final answer as the same number as the period. Approximately 10% of students inputted the power of ten incorrectly into their calculators; these students were, however, still able to score 2 marks.



The electromagnetic waves emitted by the mobile phone send information to the laptop.

0 3 . 6 The electromagnetic waves emitted by the mobile phone have a period of 4.0×10^{-10} s.

Calculate the frequency of the waves.

Use the Physics Equations Sheet.

Give your answer in standard form.

[3 marks]

$T = \frac{1}{f}$ $4.0 \times 10^{-10} = \frac{1}{f}$

$\frac{4.0 \times 10^{-10}}{1} = 4 \times 10^{-10}$

Frequency (in standard form) = 4×10^{-10} Hz

The student has rearranged the equation incorrectly and divided by 1, giving the same number as the period as their answer. However, because they have clearly shown that they have correctly substituted into a correct equation they can be awarded the first mark. To be awarded the substitution mark this work *must* be seen.

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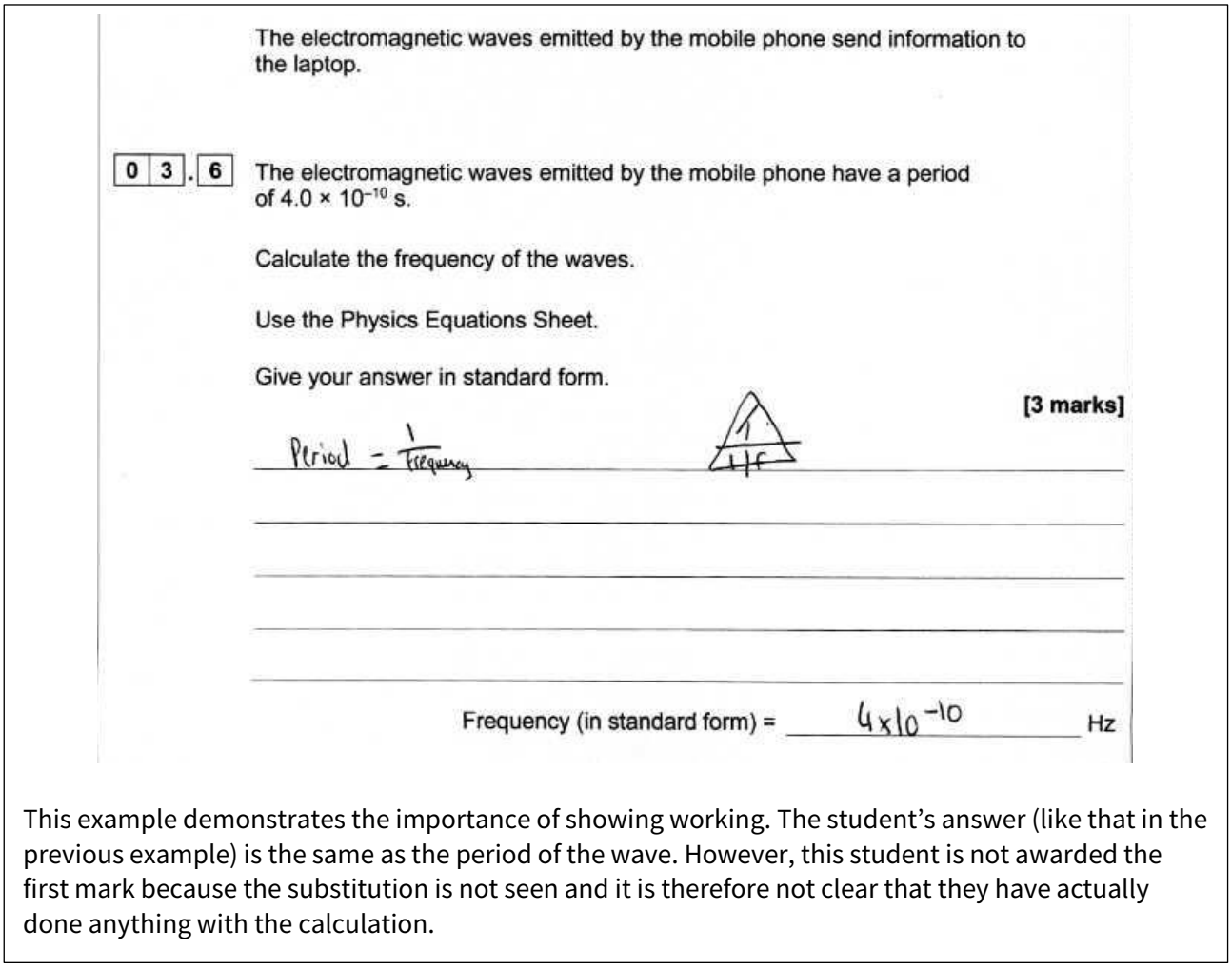
6.7.2.1 Electromagnetism

Answer 10 · Examiner comments June 2024 | 8464/P/2H | Original Q3



The electromagnetic waves emitted by the mobile phone send information to the laptop.

0 3 . 6 The electromagnetic waves emitted by the mobile phone have a period of 4.0×10^{-10} s.

Calculate the frequency of the waves.

Use the Physics Equations Sheet.

Give your answer in standard form.

[3 marks]

Period = 1 / Frequency

Frequency (in standard form) = 4×10^{-10} Hz

This example demonstrates the importance of showing working. The student's answer (like that in the previous example) is the same as the period of the wave. However, this student is not awarded the first mark because the substitution is not seen and it is therefore not clear that they have actually done anything with the calculation.

03.7 The concepts being assessed in this high-demand question are very abstract and complex. Some students had obviously learnt this and wrote excellent explanations. 10% of students scored more than 1 mark.

Answer 11 · Examiner comments

June 2024 | 8464/P/2H | Original Q4

Question 4 (standard & standard/high demand)

04.1 A third of students were able to use Fleming's left-hand rule and give the correct direction.

04.2 The majority of students were able to access this calculation, with 80% gaining at least 2 marks and 13% full marks. 25% of students either did not know the unit or missed the conversion, so were limited to gaining 2 of the 3 marks available.

04.3 About two-thirds of students knew that the forces were an example of Newton's Third Law. The most common incorrect answer was Newton's First Law.

04.4 About a third of students gave two correct changes and a third of students one correct change. The most popular correct answer was to increase the current. Students should be encouraged to state that the number of turns *on the coil* should be increased, as 'increasing the number of coils' is ambiguous and would not gain the mark.

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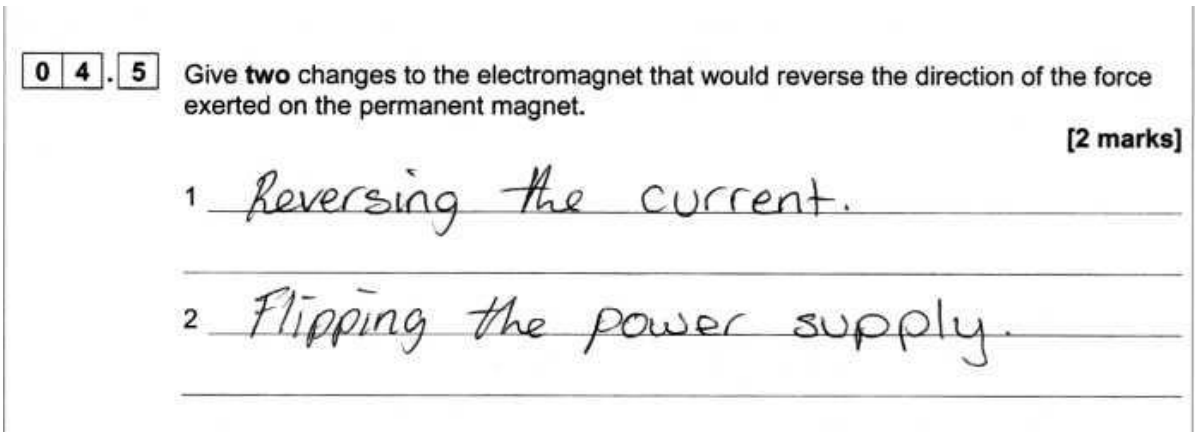
Answer 11 · Examiner comments

June 2024 | 8464/P/2H | Original Q4

04.5 This question was more demanding than question 04.4 with less than 50% of students gaining a mark. 10% of students were able to give two changes that would reverse the direction of the force.



0 4 . 5 Give **two** changes to the electromagnet that would reverse the direction of the force exerted on the permanent magnet.

[2 marks]

1 Reversing the current.

2 Flipping the power supply.

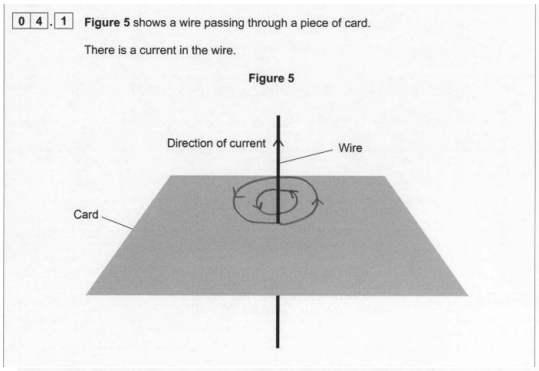
This example shows the most popular correct response, which was to reverse the direction of the current. The second answer would have gained the mark on its own because it will result in the current's direction reversing. However, both answers are the same marking point so only 1 mark is awarded.

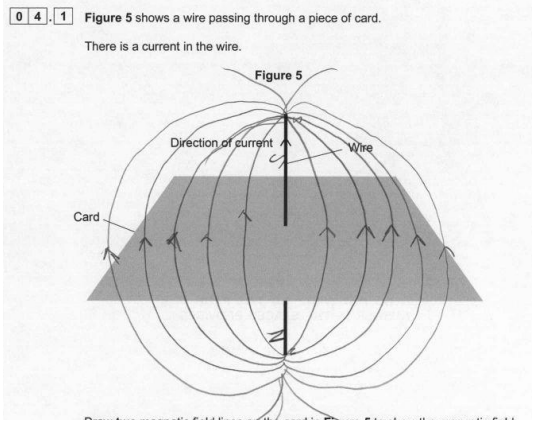
6.7.2.1 Electromagnetism

Answer 12 · Examiner comments June 2025 | 8464/P/2H | Original Q4

Question 4 (Standard, standard/high and high demand)

04.1 Surprisingly few students were able to draw the magnetic field pattern around a current-carrying wire, with only about 40% of students scoring any marks, and only about half of these gaining both marks. The marks were independent, and some students gained credit for giving the correct direction of the magnetic field without drawing 2 concentric rings. Students needed to draw both rings on the card, so that the bottom of each ring was between the lower edge of the drawing of the card and the point in the centre of the card where the wire emerged. Some students drew rings around the very top of the wire and the very bottom of the wire, which did not gain any credit. Common incorrect answers included drawing field lines connecting the wire below the card to the wire above the card, and drawing the field pattern for a bar magnet, with the top of the wire representing a north pole and the bottom of the wire representing a south pole.





Neither of these responses gained any credit. The top response shows a circular field pattern on the card behind the wire, with the field pointing to the right immediately behind the wire, which is incorrect.
The second response suggests that this student knows the field pattern for a bar magnet but is unfamiliar with the field pattern around a current-carrying wire.

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6.7.2.1 Electromagnetism

Answer 12 · Examiner comments June 2025 | 8464/P/2H | Original Q4

04.2 Very few students were able to recall the unit of magnetic flux density. Many used the equation $F = BIl$ to derive an equivalent unit in terms of newtons, metres and amps, but this was insufficient for the mark. It was relatively common for students to either make no attempt to convert mN to N, or to convert incorrectly. Almost 90% gained some credit on this question, with over 80% gaining at least 3 marks.

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6.7.2.1 Electromagnetism

Answer 12 · Examiner comments June 2025 | 8464/P/2H | Original Q4

04.3 Students found it very difficult to explain how the loop begins to rotate. There were many misconceptions communicated, as well as many students who included in their answers explanations of why the loop continued to rotate once the plane of the coil became vertical. References to the commutator were ignored, as the question only asked for an explanation of why the rotation begins.

Misconceptions included ideas that:

- current is attracted or repelled by the north or south pole
- the current is in the axle
- the axle becomes a magnet
- side A has more current than side B, because the current comes from the positive side of the battery and reaches side A first
- side A is positively charged, and positive charge is attracted to the north pole of the magnet, and negative is repelled by the south pole
- the wires become induced magnets.

About a third of students managed to gain some credit on this question, but it was rare to see a full explanation given.

When the switch is closed, magnetic forces on the loop make the loop begin to rotate.

Explain how.

You should refer to side **A** and side **B** of the loop of wire in **Figure 6**.

[5 marks]

When the switch is closed, a magnetic field is made around the wire carrying a current and it would be in the magnetic field of magnets which would create a force. Side A would experience a downward force while side B would experience an upward force as they are the current runs the opposite direction. The split ring commutator splits around and is split so that the positive charge always flows in the same direction. This then causes the loop to spin/rotate on the axle as the force is being generated in the same direction each time - this is called the motor effect. This ensures the circuit is closed and that the motor keeps spinning in the same direction.

Extra space

This answer gives a very clear explanation and gained all 5 marks.

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