AQA GCSE Combined Science - Trilogy | 8464

SPECIFICATION POINT 6.3.1.1

Density of materials

Mark schemes and examiner comments

Tier	**Higher**
Question groups	**11**
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.

6.3.1.1 Density of materials

Answer 01 · Mark scheme June 2018 | 8464/P/1H | Original Q2

Question	Answers	Mark	AO / Spec. Ref.
02.1	**Level 3:** The method would lead to the production of a valid outcome. All key steps are identified and logically sequenced.	5–6	AO1 6.3.1.1
	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 • measure mass • use a top pan balance or scales • part fill a measuring cylinder with water • measure initial volume • place object in water • measure final volume • volume of object = final volume − initial volume • fill a displacement / eureka can with water • water level with spout • place object in water • collect displaced water • measuring cylinder used to determine volume of displaced water • use of: $\text{density} = \frac{\text{mass}}{\text{volume}}$		

6.3.1.1 Density of materials

Answer 01 · Mark scheme

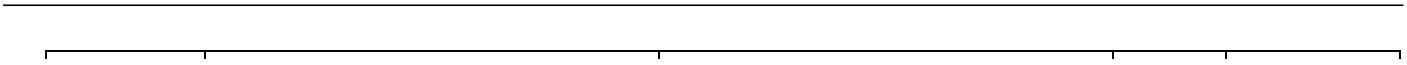
June 2018 | 8464/P/1H | Original Q2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.2	all *y*-axis values correct (minimum of 3)	allow **1** mark for two correct values	2	AO2 6.3.1.1
	all bars drawn to the correct height	allow **1** mark for two correct bars allow ± ½ small square	2	
02.3		an answer of 80 scores **2** marks		AO3 6.3.1.1
	$\frac{(1120 - 960)}{2}$	ignore + and / or − signs	1	
	= 80 (kg/m^3)	an answer of 160 scores **1** mark	1	
Total			**12**	

6.3.1.1 Density of materials

Answer 01 · Mark scheme

June 2018 | 8464/P/1H | Original Q2



6.3.1.1 Density of materials

Answer 02 · 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

6.3.1.1 Density of materials

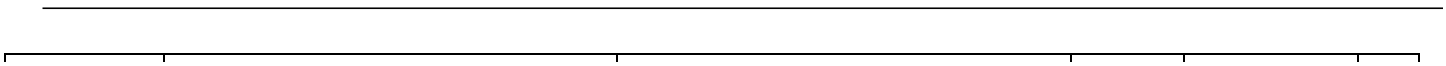
Answer 02 · Mark scheme

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**		

6.3.1.1 Density of materials

Answer 02 · Mark scheme

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



6.3.1.1 Density of materials

Answer 03 · Mark scheme

November 2020 | 8464/P/2H | Original Q7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.1				
	the downward force on the balance increased	allow when there is a current in the wire there is a magnetic field around the wire (which causes a magnetic force)	1	AO3 6.7.2.2 6.5.4.2.3
	therefore the wire must experience an equal and opposite force (which is upwards)		1	
07.2				
	calculate the difference between the two mass readings	allow 254.8 – 252.3 = 2.5	1	AO1 6.7.2.2
	convert to kg **and** multiply by gravitational field strength	allow (2.5 / 1000) × 9.8 = 0.02375 (N)	1	
07.3				
	gradient $= \frac{(0.0210 - 0.0)}{(0.70 - 0.02)}$		1	AO3
	gradient = 0.031	allow answer correctly given to any number of significant figures	1	AO3
	0.031 = B × 0.125	allow correct substitution using correctly calculated value given to any number of significant figures	1	AO2
	B = 0.25 T	allow answer correctly given to any number of significant figures	1	AO2
		any rounding must be correct for subsequent marks to be awarded.		6.7.2.2
		max **2** marks if a pair of readings from the graph are used instead of gradient calculation		
Total			**8**	

6.3.1.1 Density of materials

Answer 04 · Mark scheme November 2021 | 8464/P/1H | Original Q4

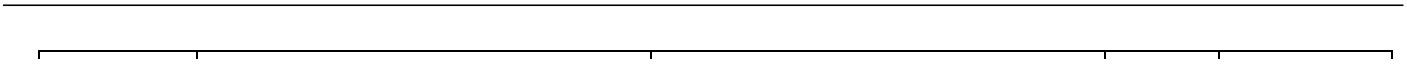
Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1	zero error	allow systematic error	1	AO1 6.3.1.1 RPA17
04.2	reset the balance to zero g	allow subtract the reading shown on the balance from the reading taken	1	AO1 6.3.1.1 RPA17
04.3	resolution	this answer only	1	AO1 6.3.1.1 RPA17
04.4	place the measuring cylinder on a horizontal surface view with eye in line with the level of the water	 allow read from the bottom of the meniscus	1 1	AO1 6.3.1.1 RPA17
04.5	add several coins to the measuring cylinder measure the change in the water level in the measuring cylinder divide by the number of coins added	allow a minimum of 5 coins if a number of coins is given	1 1 1	AO3 AO1 AO3 6.3.1.1 RPA17

04.6	$8.9 = \frac{3.6}{\text{area} \times 0.16}$	allow $8.9 = \frac{3.6}{\text{volume}}$	1	AO3
	$\text{area} = \frac{3.6}{8.9 \times 0.16}$	allow area = 2.5(28…) (cm^2)	1	AO3
	$\text{density} = \frac{3.6}{2.528 \times 0.17}$	allow $\frac{3.6}{\text{their calculated area} \times 0.17}$	1	AO3
	density = 8.37… (g/cm^3)	allow a correct calculation using their calculated area	1	AO3
	density = 8.4 g/cm^3	this mark can only be scored for a correct rounding of a value of density calculated using correct equations	1	AO2 6.3.1.1 RPA17
Total			**13**	

6.3.1.1 Density of materials

Answer 04 · Mark scheme

November 2021 | 8464/P/1H | Original Q4



6.3.1.1 Density of materials

Answer 05 · Mark scheme

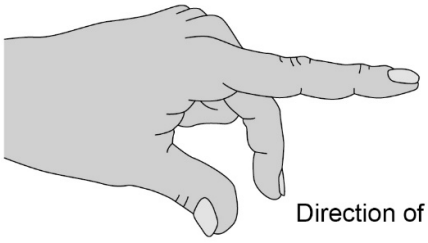
November 2021 | 8464/P/2H | Original Q4

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

6.3.1.1 Density of materials

Answer 05 · Mark scheme

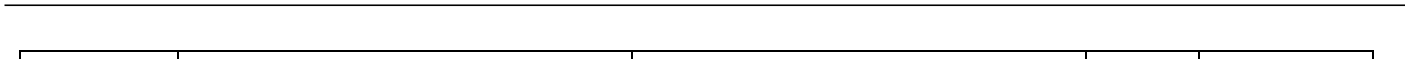
November 2021 | 8464/P/2H | Original Q4

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**	

6.3.1.1 Density of materials

Answer 05 · Mark scheme

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



6.3.1.1 Density of materials

Answer 06 · Mark scheme

June 2022 | 8464/P/1H | Original Q4

Question 4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1	100 (kPa)	allow 10^2 (kPa)	1	AO2 6.3.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.2	range = 0.006 (MPa) uncertainty = ± 0.003 (MPa)	allow mean = 0.118 an answer of uncertainty = 0.118 (MPa) scores **0** marks	1 1	AO2 6.3.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.3	the relationship is linear	allow the relationship obeys y = mx + c allow the gradient (of the graph) is constant do **not** accept (directly) proportional	1	AO2 6.3.3.1

6.3.1.1 Density of materials

Answer 06 · Mark scheme

June 2022 | 8464/P/1H | Original Q4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.4		particles refers to particles in the steam throughout		AO2 6.3.3.1
	(as the amount of steam increases) the number of particles increases		1	
	and (as the temperature increases) particles move faster	allow (as the temperature increases) the (average) kinetic energy of the particles increases	1	
	particles collide with the wall of the cooker		1	
		if MP3 is not awarded no subsequent marks may be awarded		
	these collisions are more frequent		1	
	and each collision exerts more force		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.5	the particles spread out	do **not** allow particles expand	1	AO1 6.3.1.1
	so the steam / gas takes up a greater <u>volume</u>	allow there is less gas in the same <u>volume</u>	1	
	and $\text{density} = \frac{\text{mass}}{\text{volume}}$ so the density decreases	do **not** allow density of particles decreases	1	

Total Question 4		12

6.3.1.1 Density of materials

Answer 07 · Mark scheme

June 2023 | 8464/P/1H | Original Q6

Question 6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.1	(air) particles move faster **or** (air) particles have increased kinetic energy		1	AO1 6.3.3.1
	(so air) particles collide more frequently with the wall / chamber **or** (so air) particles collide with more force with the wall / chamber		1	
	(so) the pressure increases	dependent on MP1 or MP2	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.2	(metals) have a high(er) thermal conductivity	allow metals are good/better (thermal) conductors	1	AO1 6.1.2.1
	which allows a greater rate of (thermal) energy transfer	allow (thermal) energy is transferred more quickly	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.3	(a low) specific heat capacity		1	AO1 6.1.1.3 6.3.2.2

Answer 07 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.4	any **one** from: • lubrication • use hotter coffee • decrease the temperature of the surroundings	allow oil the device/wheel	1	AO3 6.1.2.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.5	$1.1 \times 10^3 = \frac{\text{mass}}{1.9 \times 10^{-4}}$		1	AO2 6.1.1.3 6.3.2.2 6.3.1.1
	mass = 0.209 (kg)	allow m = $1.9 \times 10^{-4} \times 1.1 \times 10^3$ the equation density = $\frac{\text{mass}}{\text{volume}}$ must have been used to score subsequent marks	1	
	15 000 = 0.209 × 4200 × Δθ	allow a correct substitution using their calculated value of mass	1	
	$\Delta\theta = \frac{15\,000}{0.209 \times 4200}$	allow a correct re-arrangement using their value of mass and/or an incorrectly / not converted energy value	1	
	Δθ = 17(.088…)	allow a correct calculation using their value of mass and / or an incorrectly / not converted energy value	1	
	final temperature (= 76 – 17.088) = 59 (°C)	allow 58.9… (°C) allow an answer consistent with their value of mass and / or an incorrectly / not converted energy value	1	

Total Question 6	13

6.3.1.1 Density of materials

Answer 08 · Mark scheme

June 2024 | 8464/P/1H | Original Q6

Question 6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.1	efficiency = 0.72 × 0.86	allow use of percentages if % is seen	1	AO2 6.1.2.2
	efficiency = 0.61(92)		1	
	0.62		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.2	(at higher temperatures) the (average) speed of the particles is greater	allow the (average) kinetic energy of the particles is greater do **not** accept vibrations	1	AO3 6.1.1.1 6.1.1.4 6.3.2.1 6.3.3.1
	so the frequency of collisions (between particles and the turbine) increases		1	
	and the force of each collision (between a particle and the turbine) is greater		1	
	so more energy transferred (each second)	dependent on MP2 or MP3 ignore increases the power	1	

6.3.1.1 Density of materials

Answer 08 · Mark scheme

June 2024 | 8464/P/1H | Original Q6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.3	$48 = \frac{\text{mass}}{5.0 \times 10^5}$		1	AO2 6.3.1.1
	mass = $48 \times 5.0 \times 10^5$		1	6.3.2.2 6.1.1.3
	mass = 24 000 000		1	
		the equation density = $\frac{\text{mass}}{\text{volume}}$ must have been used to score subsequent marks		
	E = 24 000 000 × 1100 × 15	allow a correct substitution using their calculated value for mass	1	
	E = 396 000 000 000	allow an answer consistent with their calculated value for mass	1	
	$E = 3.96 \times 10^{11}$(J)	allow a correctly converted answer consistent with their calculated value for energy using the equation $\Delta E = m\, c\, \Delta\theta$	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.4	(efficient energy storage means) less energy is wasted		1	AO1 6.1.3
	(to reduce carbon dioxide emissions) less fossil fuel used / burned	allow named fossil fuel	1	
	the amount of energy generated from renewable resources will need to increase	allow named renewable resources	1	
	or			
	(most) renewable resources do not generate electricity all the time	allow renewable resources are unreliable		
	(so) efficient energy storage will help to meet the demand for energy / electricity		1	

Total Question 6	17

6.3.1.1 Density of materials

Answer 09 · 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

6.3.1.1 Density of materials

Answer 09 · 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**

6.3.1.1 Density of materials

Answer 10 · Mark scheme June 2025 | 8464/P/1H | Original Q6

Question 6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.1	V (= 5 × 5 × 5) = 125 (m^3)	do **not** allow subsequent marks unless volume is used subsequent marks may be awarded if volume is incorrectly calculated	1	AO2 6.3.1.1
	$4200 = \frac{m}{125}$		1	
	m = 4200 × 125		1	
	m = 525 000 (kg)		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.2	(the greater the density) the greater the mass (for a given volume)		1	AO1
	(so) a greater amount of energy can be stored		1	AO3
	OR			6.1.1.2
	(the greater the density) the smaller the volume (for a given mass) (1)			
	(so) the same amount of energy can be stored (for a smaller volume) (1)			

6.3.1.1 Density of materials

Answer 10 · Mark scheme

June 2025 | 8464/P/1H | Original Q6

Question	Answers		Mark	AO / Spec. Ref.
06.3	measure the energy input from the National Grid **and** measure the energy output to the National Grid	allow measure the energy input to the motor **and** measure the energy output from the generator	1	AO3
	(then) use the equation: efficiency = $\frac{\text{energy output}}{\text{energy input}}$	MP2 dependent on MP1	1	AO1 6.1.2.2
	if no other mark awarded, allow **1** mark for: efficiency = $\frac{\text{energy released when lowering the block}}{\text{energy stored when raising block}}$			

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.4	use a motor with a greater power	allow increase the power of the motor	1	AO1 6.1.1.4
	(so) the cube / weight / mass is lifted more quickly	MP2 dependent on MP1	1	

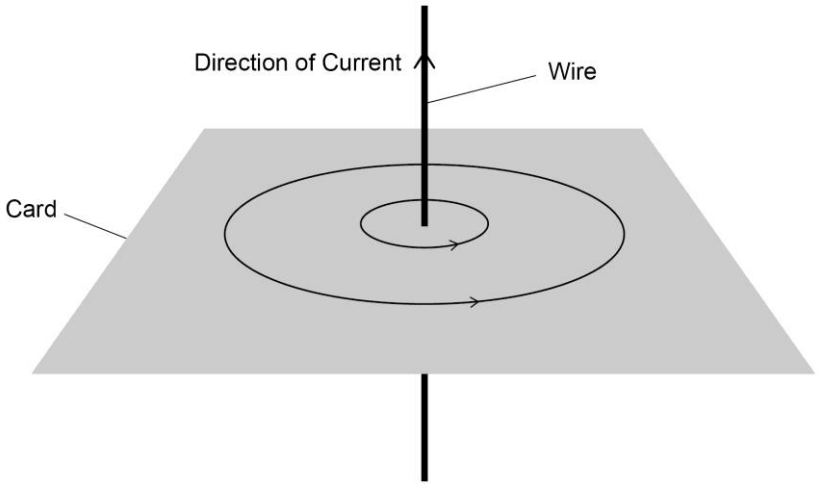
Total Question 6	10

6.3.1.1 Density of materials

Answer 11 · 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
	$B = \dfrac{0.0021}{0.56 \times 0.050}$		1	AO2
	$B = 0.075$		1	AO2
	tesla **or** T		1	AO1 6.7.2.2

6.3.1.1 Density of materials

Answer 11 · 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

6.3.1.1 Density of materials

Answer 01 · Examiner comments

June 2018 | 8464/P/1H | Original Q2

Question 2 (Standard demand)

02.1 This levels of response question had three tiers. When students are asked to describe a plan or method, their answer must contain all of the key steps in a logical sequence and lead to a valid outcome. This practical is one of the Required Practical Activities on the specification, so a displacement technique should have been described but this was not always the case. To achieve a level 3 response students should state:

- the variables to be measured
- the measuring instruments to be used
- how the measurement is to be made
- how the data gathered is to be processed.

Some students described the method without stating that the volume of the displaced water would equal the volume of the object. Measuring cylinders did not always get a mention with a significant number assuming that beakers would give an accurate enough measurement. Whilst some described how the object needed lowering carefully into the water to avoid splashes and excess spillage, others would have obtained very inaccurate measurements by collecting what overflowed from buckets and bowls. Some went no further than the volume measurement which was occasionally described as the density. 'Weighing' the object to get the mass, often without a mention of a balance or scales, was common.

There were some methods described which would not work, such as measuring dimensions, timing falls, or checking for sinking and floating. Some students described melting, smashing and breaking the object.

25% of students we able to write an answer which would lead to a valid outcome with key steps identified and logically sequenced and were judged to have written a level 3 response. A further quarter of students achieved a level 2 mark. Level 1 was awarded to 30%. A significant minority scored zero or did not attempt the question.

02.2 67% of the students scored full marks. There were good answers putting 0, 250, 500 etc. on the *y*-axis and accurate plotting of the three bars required.

Some students tried to put far too many values on the *y*-axis making it difficult to judge if they were correct and giving more of a chance of getting one or more of the values wrong.

02.3 Only a fifth of students gained both marks and just over half scored zero. It was possible to get the correct answer of 80 in a variety of ways, and students did, but the concept of uncertainty seemed to be poorly understood.

6.3.1.1 Density of materials

Answer 04 · Examiner comments

November 2021 | 8464/P/1H | Original Q4

Question 04 (Standard/high demand)

04 This question was mainly set in the Required Practical Activity context of measuring density. The question as a whole was not well answered, and perhaps reflects the lack of practical experience for students during the pandemic lockdowns.

04.1 Many students did not name the type of error, but instead described the fact that the balance shouldn't read 4.2 g when there is nothing on top of it. Fewer than 1 in 5 students gained this mark.

04.2 Many students realised that they either needed to reset the balance before placing the cube on it, or subtract 4.2 g from each reading. A significant minority of students incorrectly suggested that a reading would only be correct if converted into kilograms.

04.3 The most common incorrect answer was for students to use the column headings in the table, and give the answer "length in mm". Identifying that the difference between the two readings was caused by differing resolutions of the equipment was successfully demonstrated by very few students.

04.4 The most common correct answer to this question was that the measuring cylinder should either be positioned vertically on placed on a level surface, with fewer students identifying that the reading should be taken from eye level. Roughly a fifth of students gained 2 marks, with around 50% gaining 1 mark.

04.5 While the mark scheme expected students to add coins to a partially filled measuring cylinder, a fair proportion of students used a displacement can and collected the overspill in a measuring cylinder. This approach could still gain full marks, but the idea of using multiple coins to find a large volume, and then dividing by the number of coins used, was rarely given in students answers. About 45% failed to score any marks on this question, and over a quarter of all students did not attempt to answer the question at all.

04.6 Some students attempted to find the cross sectional area of the disc used to make the old penny, but made mistakes in this part of the calculation. However, these students could still go on to gain up to 3 marks. Some students rounded their cross sectional area to 2.5 cm^2 and used this value to calculate a density of 8.5 g/cm^3 which gained them full marks. There was confusion amongst some students about 2 significant figures, with a small proportion of students instead giving their answer to 2 decimal places. Almost 1 in 10 students gained full marks, with nearly 20% gaining at least 3 marks. Many students, however, failed to make any headway with this high demand question, with around two thirds gaining no marks.

6.3.1.1 Density of materials

Answer 05 · 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.

6.3.1.1 Density of materials

Answer 06 · Examiner comments

June 2022 | 8464/P/1H | Original Q4

Question 04 (Standard, standard/high and high demand)

04.1 Just over half the students could convert this correctly.

04.2 Very few students were able to calculate the uncertainty, with just over 15% gaining both marks.

Many students simply calculated the mean, but if they then demonstrated that they thought the mean is the same as the uncertainty by writing this value on the answer line, they gained no credit. Some students gave the uncertainty as 3, rather than 0.003, but could still gain 1 mark if relevant working had been shown. Some students mixed up the two possible methods and calculated mean divided by two, rather than range divided by two.

04.3 Almost no students were able to identify that the graph shows a linear relationship. A lot of answers described the trend as directly proportional, and there were also many qualitative descriptions such as pressure increases evenly with temperature, which were insufficient to gain the mark. Some students gave an explanation of the relationship, which did not answer the question.

04.4 Slightly more than 55% of students gained some credit on this question, but it was uncommon for students to gain 4 or 5 marks.

A lot of answers did not refer to particles at all, and therefore gained no marks, but students who referred to atoms or molecules instead of particles could still gain full marks. Many answers wrote about successful collisions, which did not prevent them from gaining marks, but demonstrated a misunderstanding of the cause of pressure in gases. A large number of students did not state what collisions were between, or stated that the collisions were between particles in the steam.

6.3.1.1 Density of materials

Answer 06 · Examiner comments June 2022 | 8464/P/1H | Original Q4

Some students referred to an increased number of collisions, but did not indicate that this was in a fixed time period, or did not mention frequency of collisions, so did not gain marking point 4.

Few students identified that collisions at higher temperatures would cause a greater force, or that the number of particles in the steam would increase as the water boiled.

04.5 Only about a third of students gained any marks on this question, with most of these only gaining one mark.

The most commonly awarded mark was for the idea of particles spreading out. Most students gave vague descriptions of particles moving into a larger space or larger area, where they needed to be describing a volume to give an explanation of the density change. Some students stated that the steam would cool and condense, so the particles would move closer together, but the question clearly stated that the steam would expand as it moved into the atmosphere so this gained no credit. A few students stated that particles were less likely to collide, demonstrating a confusion between density and pressure.

Some students described a change in density of the gas remaining in the pressure cooker. This did give the opportunity to describe the correct physics involved, and could lead to full credit being awarded.

6.3.1.1 Density of materials

Answer 07 · Examiner comments

June 2023 | 8464/P/1H | Original Q6

Question 06 (Standard, standard/high and high demand)

06.1 Approximately 35% of students scored 2 or 3 marks for their explanation. Explanations of gas pressure need to mention the idea of particles, and those who did not mention particles (or atoms, molecules etc.) scored no marks. Those who did mention the idea of particles often mentioned collisions but did not state that the collisions were between particles and the wall of the container. It was also common for students to say that the number of collisions increased, but not include any reference to rate of collisions or to a time period.

06.2 Slightly more than half the students scored at least 1 mark, although only the best students gained both marks on this question. It was quite common for students to refer to plastic having a lower melting point than metal, which was ignored. A fair number of students contradicted themselves by stating that metal is a good thermal conductor and a good insulator so that it keeps the coffee hot, which gained no credit.

06.3 Only a very small proportion of students identified that the property is (a low) specific heat capacity.

06.4 A little less than 50% of students suggested a valid way to increase the speed.

06.5 Roughly 30% of students scored 2 marks, and just under 25% scored all 6 marks on this extended calculation. About 20% of students gained no marks at all. Most students got as far as calculating the mass of 0.209 kg. The majority of students did not convert 15kJ to J, and many then incorrectly re-arranged the specific heat capacity equation.

6.3.1.1 Density of materials

Answer 07 · Examiner comments

Mark Ranges and Award of Grades

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

Answer 08 · Examiner comments

June 2024 | 8464/P/1H | Original Q6

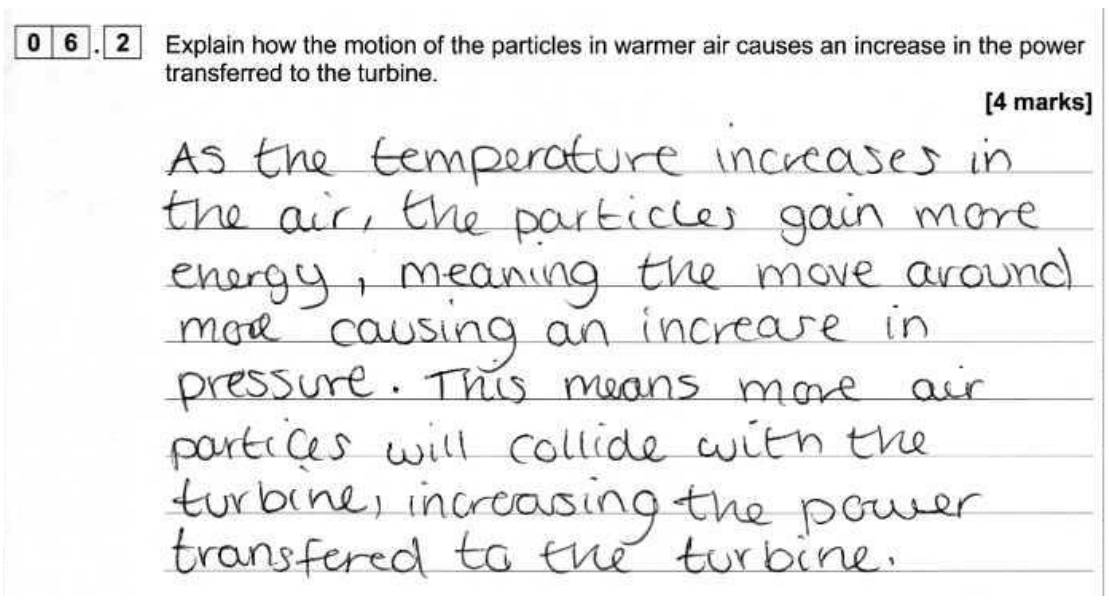
Question 6 (standard/high & high demand)

06.1 Most students struggled to appreciate that the process of compressing the air would reduce the useful energy, and that releasing the air would then reduce this energy further. This lack of understanding of the physics involved meant that a very small proportion of students were able to carry out the correct calculation. Most students who correctly multiplied the two efficiency values tended to also round their answer correctly.

Roughly 20% of students scored 3 marks.

06.2 Many students demonstrated some understanding of how the temperature affects the rate of energy transfer to the turbine. However, many of these answers lacked crucial details. Statements such as 'the number of collisions between the particles and the turbine increases' were common, but without a reference to frequency, or to the collisions happening in a fixed time, marking point 2 was not scored. The proportion of students who referred to the force from each collision was very low.

About 70% of students gained some credit for their answers.



0 6 . 2 Explain how the motion of the particles in warmer air causes an increase in the power transferred to the turbine.

[4 marks]

As the temperature increases in the air, the particles gain more energy, meaning the move around more causing an increase in pressure. This means more air particles will collide with the turbine, increasing the power transfered to the turbine.

This answer demonstrates some understanding, but lacks the detail needed to gain any marks. The student refers to particles gaining more energy but needed to refer to kinetic energy to gain the point. If the particles 'move around more' it could mean that they move a greater distance, rather than moving at a greater speed, so again marking point 1 is not scored. Similarly, 'more particles will collide with the turbine' does not have a reference to frequency or to time, so is not sufficient to score the second marking point.

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6.3.1.1 Density of materials

Answer 08 · Examiner comments June 2024 | 8464/P/1H | Original Q6

06.3 This question proved to be relatively straightforward for a high proportion of students, with over 60% gaining full marks. Having an equation sheet which included all of the physics equations was, no doubt, helpful to many students.

Common errors included spurious conversions of the calculated mass into grams. Some students calculated the correct answer, but then tried to apply the efficiency equation to their answer, often going back to question 06.2 to find an efficiency to use. These responses could still score the first 3 marking points for calculating the mass of air in the tank.

Some students used their calculator to obtain an answer in standard form, but then wrote the answer out in full on the answer line, demonstrating that they did not understand how to give their answer in standard form.

06.4 Many students scored marks for referring to a reduction in wasted energy, but very few discussed both a reduction in the use of fossil fuels and an increase in the use of renewables, so it was very rare for a student to score full marks on this question. Roughly two-fifths of students gained at least 1 mark.

A large number of students seemed confused about what was being asked. Some students wrote about the use of transformers in the National Grid. Some appear to have misread 'efficient energy storage' as 'renewable energy resources' and based their answers around the relative benefits of solar panels and wind turbines. It was common to read answers explaining the impact of carbon dioxide in the atmosphere, but not actually answering the question. Many students seemed to think that the compressed air energy storage system was part of a carbon-capture and storage system.

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6.3.1.1 Density of materials

Answer 08 · Examiner comments

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Tel: 01483 477756
Email: gcsescience@aqa.org.uk

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Answer 09 · 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.

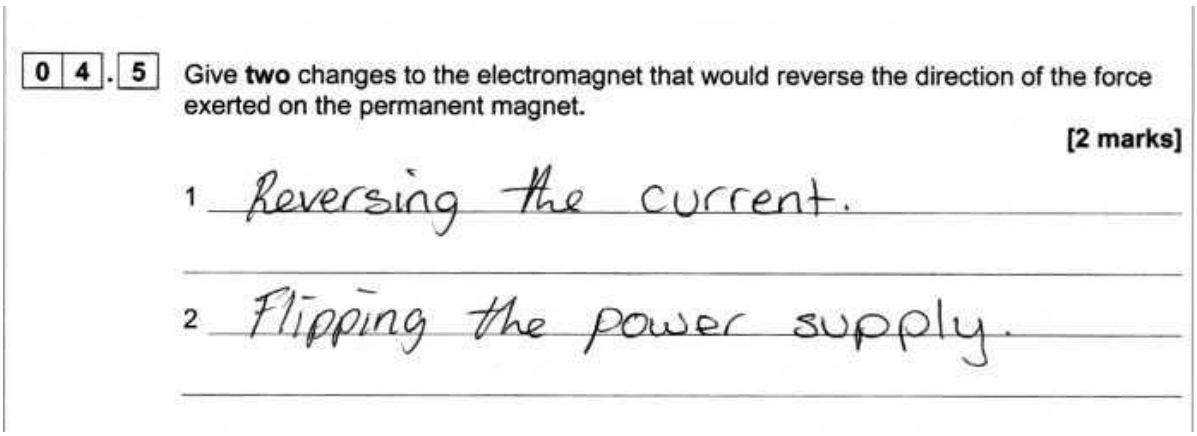
04.4 About a third of students gave two correct changes and a third of students one correct change. The most popular correct answer was to increase the current. Students should be encouraged to state that the number of turns *on the coil* should be increased, as 'increasing the number of coils' is ambiguous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

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Answer 09 · 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.

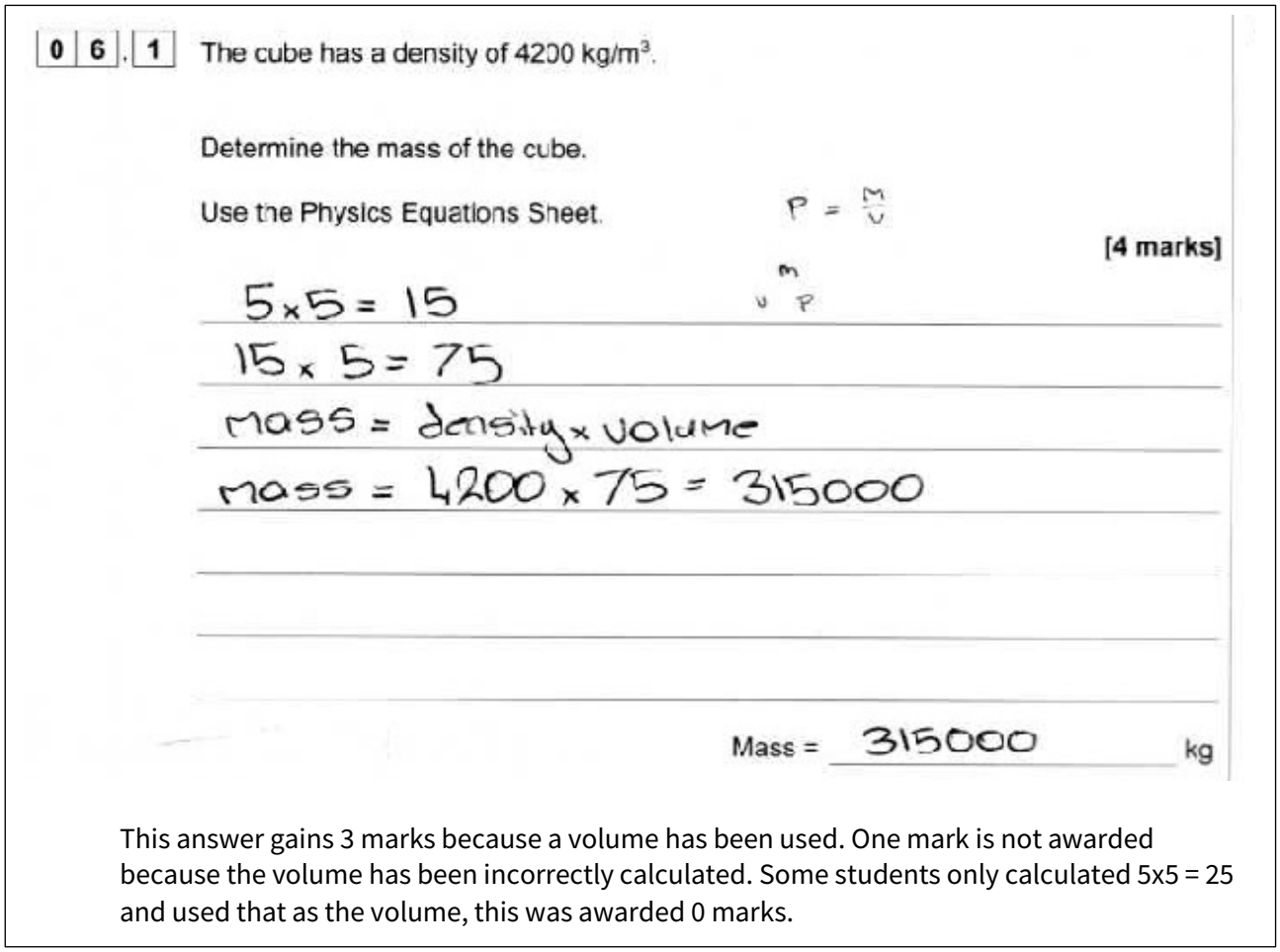
This example shows the most popular correct response, which was to reverse the direction of the current. The second answer would have gained the mark on its own because it will result in the current's direction reversing. However, both answers are the same marking point so only 1 mark is awarded.

Answer 10 · Examiner comments

June 2025 | 8464/P/1H | Original Q6

Question 6 (High demand)

06.1 Students that could not calculate the volume of the cube struggled to gain marks. When using the density equation students had to substitute a volume, or no marks are awarded. Some students used an area and not a volume. 80% of students gained a mark on this question but only 55% gained all 4 marks.



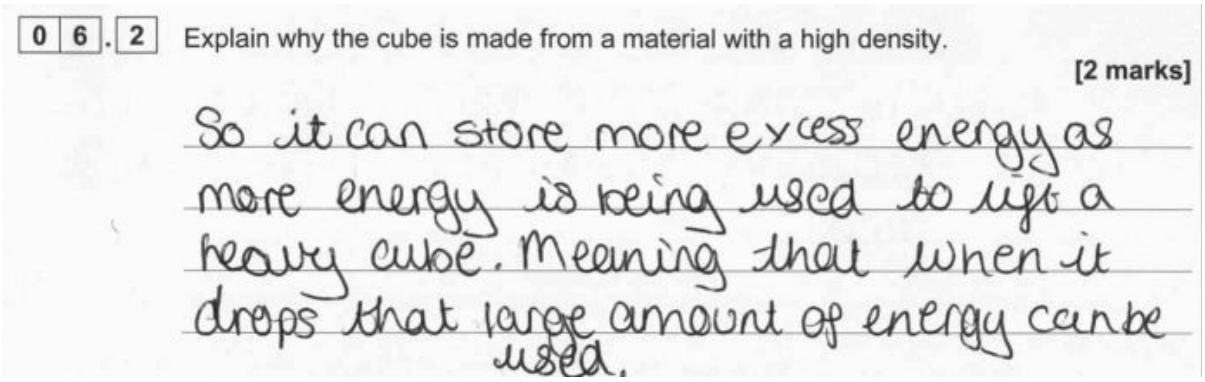
This answer gains 3 marks because a volume has been used. One mark is not awarded because the volume has been incorrectly calculated. Some students only calculated 5x5 = 25 and used that as the volume, this was awarded 0 marks.

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6.3.1.1 Density of materials

Answer 10 · Examiner comments June 2025 | 8464/P/1H | Original Q6

06.2 26% of students gained a mark for identifying the either this meant the cube had a greater mass or that it can store more energy. Less than 5% of students made both statements.



This answer gains 1 mark for stating that more energy can be stored. There is the idea that the cube would be heavy, but the correct scientific terms must be used, so it must state that the mass will be large.

06.3 This high demand question performed as expected with only a small percentage of students gaining any marks. For marks to be awarded answers had to refer to the overall efficiency of the entire system, just quoting the efficiency equation from the equations sheet was insufficient.

06.4 This high demand question performed as expected with only a small percentage of students gaining any marks. The most common incorrect answer only stated that you should lift it faster.

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6.3.1.1 Density of materials

Answer 10 · Examiner comments

June 2025 | 8464/P/1H | Original Q6

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Tel: 01483 477756
Email: gcsescience@aqa.org.uk

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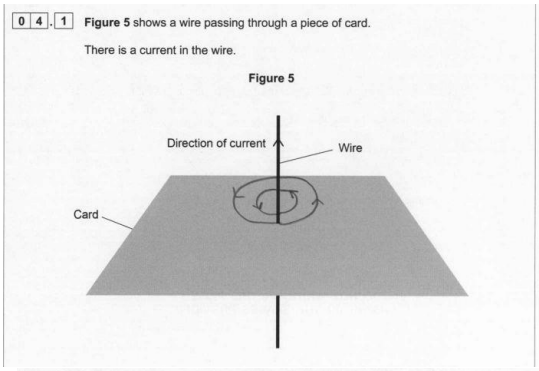
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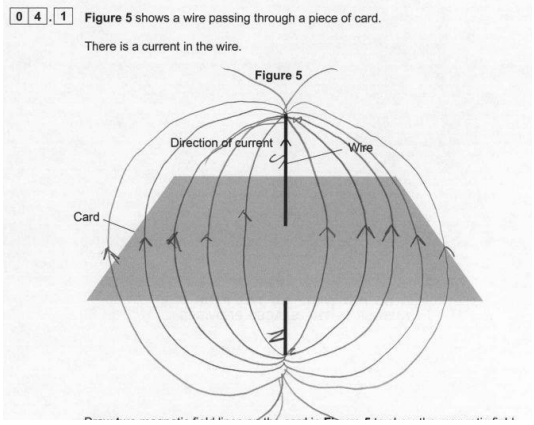
6.3.1.1 Density of materials

Answer 11 · 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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6.3.1.1 Density of materials

Answer 11 · 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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6.3.1.1 Density of materials

Answer 11 · 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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