AQA GCSE Combined Science - Trilogy | 8464

SPECIFICATION POINT 6.1.2.2

Efficiency

Mark schemes and examiner comments

Tier	**Higher**
Question groups	**3**
Available paper years	**2023–2025**

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.

6.1.2.2 Efficiency

Answer 01 · 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

6.1.2.2 Efficiency

Answer 01 · Mark scheme

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

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**

6.1.2.2 Efficiency

Answer 02 · 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	

6.1.2.2 Efficiency

Answer 02 · 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

6.1.2.2 Efficiency

Answer 03 · Mark scheme

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)			

6.1.2.2 Efficiency

Answer 03 · Mark scheme

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

6.1.2.2 Efficiency

Answer 01 · 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 01 · 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 $P = I^2 R$.

Answer 02 · Examiner comments

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

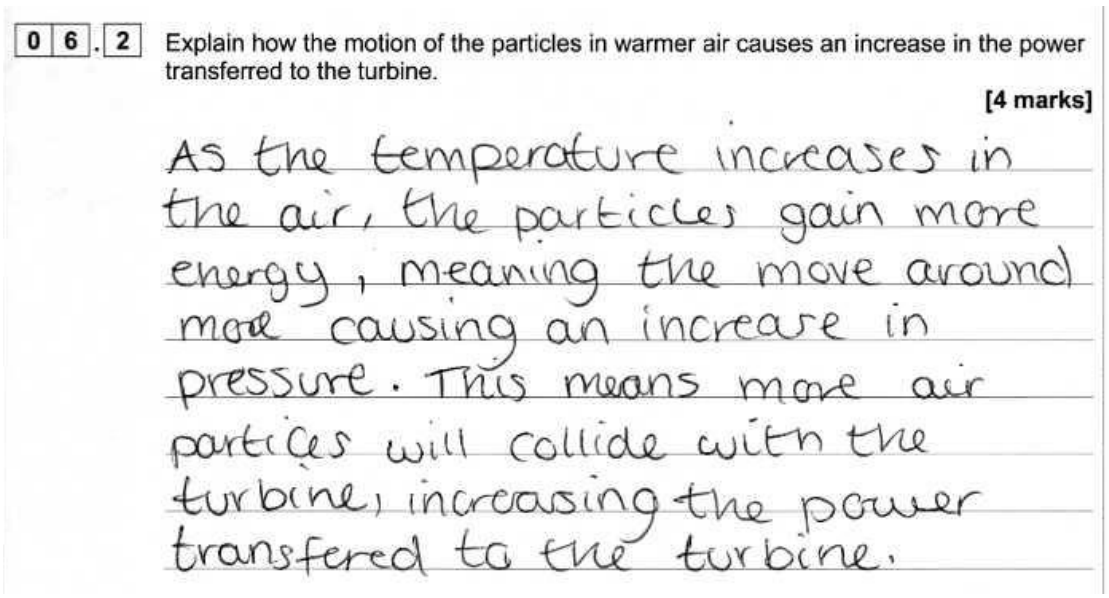
Question 6 (standard/high & high demand)

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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6.1.2.2 Efficiency

Answer 02 · 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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6.1.2.2 Efficiency

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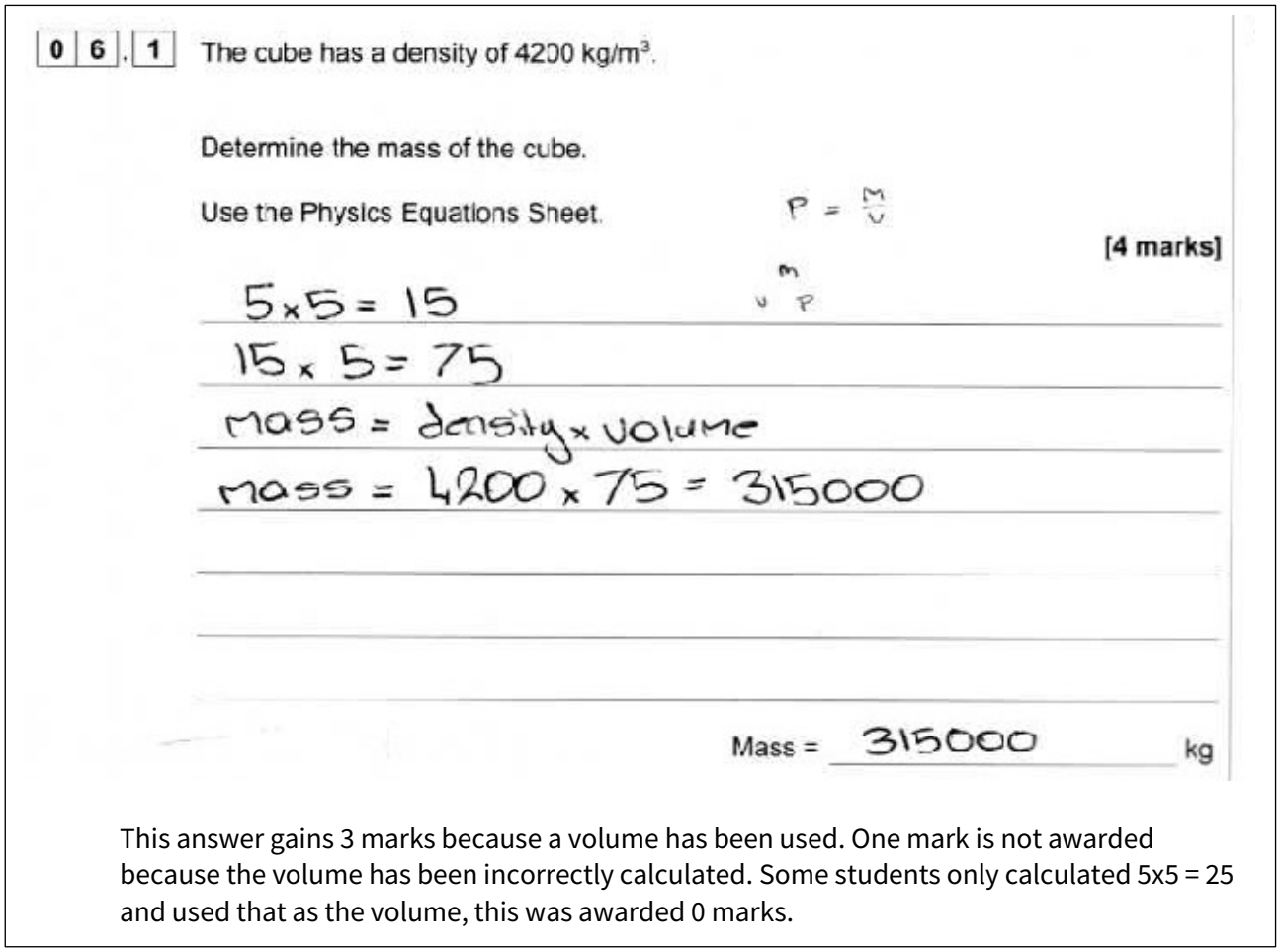
6.1.2.2 Efficiency

Answer 03 · 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.



0 6 . 1 The cube has a density of 4200 kg/m^3.

Determine the mass of the cube.

Use the Physics Equations Sheet. $P = \frac{M}{V}$

[4 marks]

$\frac{M}{V} P$

5 x 5 = 15

15 x 5 = 75

mass = density x volume

mass = 4200 x 75 = 315000

Mass = 315000 kg

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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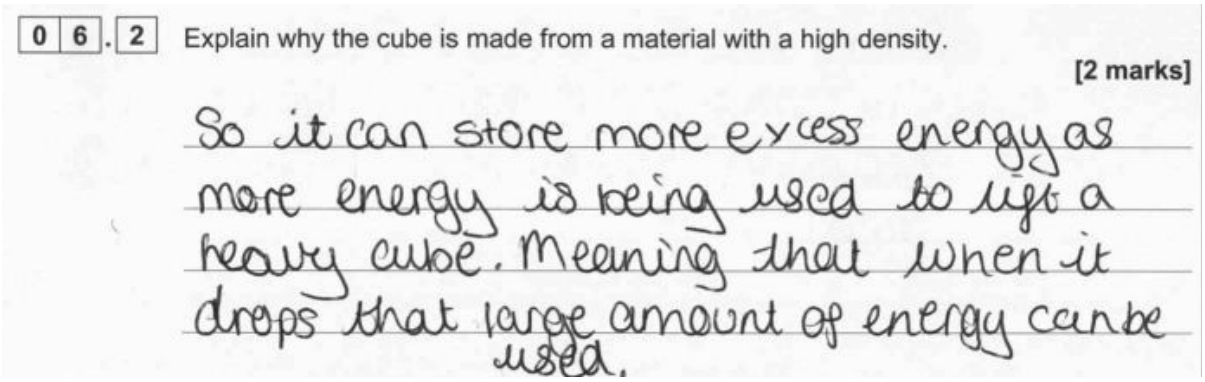
6.1.2.2 Efficiency

Answer 03 · 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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6.1.2.2 Efficiency

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