AQA GCSE Combined Science - Trilogy | 8464

SPECIFICATION POINT 6.5.5.2

Conservation of momentum

Mark schemes and examiner comments

Tier	**Higher**
Question groups	**4**
Available paper years	**2018–2024**

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.

6.5.5.2 Conservation of momentum

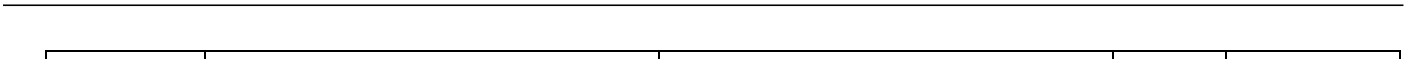
Answer 01 · Mark scheme June 2018 | 8464/P/2H | Original Q3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	momentum = mass × velocity	allow p = mv	1	AO1 6.5.5.1
03.2	200 = m × 3.2	an answer of 63 (kg) scores **3** marks	1	AO2 6.5.5.1
	$m = \frac{200}{3.2}$		1	
	m = 63 (kg)	allow 62.5 (kg)	1	
03.3	(total) momentum before (collision) = (total) momentum after (collision)		1	AO1 6.5.5.2
	either momentum of skater A decreases and momentum of skater B increases	allow (total) momentum is shared between skater A and skater B	1	
	velocity of skater A decreases and velocity of Skater B increases		1	
	or momentum of skater A decreases and so velocity of skater A decreases (1) momentum of skater B increases and so velocity of skater B increases (1)			
Total			**7**	

6.5.5.2 Conservation of momentum

Answer 01 · Mark scheme

June 2018 | 8464/P/2H | Original Q3



6.5.5.2 Conservation of momentum

Answer 02 · 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

6.5.5.2 Conservation of momentum

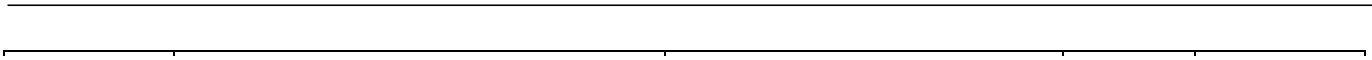
Answer 02 · Mark scheme

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**	

6.5.5.2 Conservation of momentum

Answer 02 · Mark scheme

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



6.5.5.2 Conservation of momentum

Answer 03 · Mark scheme

June 2022 | 8464/P/2H | Original Q3

Question 3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	m = 0.180		1	AO2 6.5.5.1
	0.216 = 0.180 × v	allow a correct substitution using an incorrectly / not converted value of m	1	
	$v = \frac{0.216}{0.180}$	allow a correct rearrangement using an incorrectly / not converted value of m	1	
	v = 1.2 (m/s)	allow a correct calculation using an incorrectly / not converted value of m	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.2	(total) momentum is conserved in the collision	allow (total) momentum before collision = (total) momentum after collision	1	AO1 6.5.5.1
	during the collision the momentum of carriage increases		1	
	so the momentum of train decreases		1	
	since momentum = mass × velocity, velocity (of train) decreases	allow since mass (of train) is constant, velocity (of train) decreases	1	

Total Question 3		8

6.5.5.2 Conservation of momentum

Answer 04 · 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 efficiency = 0.61(92) 0.62	allow use of percentages if % is seen	 1 1 1	AO2 6.1.2.2

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

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

6.5.5.2 Conservation of momentum

Answer 01 · Examiner comments June 2018 | 8464/P/2H | Original Q3

Question 3 (standard & standard / high demand)

03.1 82% scored this mark, with many giving the equation in the form mass = momentum ÷ velocity.

03.2 86% were able to gain 3 marks in this question and only a very small number multiplied the two numerical values.

03.3 Fewer than 2% scored full marks for this question. Very few attempted to describe what happened to the velocity of the skaters, in spite of the very clear lead in the stem of the question. Whilst many realised that the velocity of the two skaters was the same after collision, they talked of velocity being 'shared' rather than saying what had happened to each skater.

A significant number did gain a mark for saying that the momentum before the collision was equal to that after, although many missed this mark, simply repeating the stem of the question.

Answer 02 · 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.

6.5.5.2 Conservation of momentum

Answer 02 · 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.

Answer 03 · Examiner comments June 2022 | 8464/P/2H | Original Q3

Question 3 (Standard and standard/high demand)

03.1 This question was very well answered. Nearly 60% of students used the equation correctly and carried out the conversion to kg and scored full marks. Approximately 30% of students used the equation correctly but did not carry out the conversion and so scored 3 marks.

03.2 Only about 5% of students scored more than 2 marks. 40% of students were able to score 1 mark for either stating that momentum is conserved in the collision or for stating that the momentum of the stationary carriage increased. A significant number of students did not mention momentum at all in their answer.

Answer 04 · Examiner comments

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

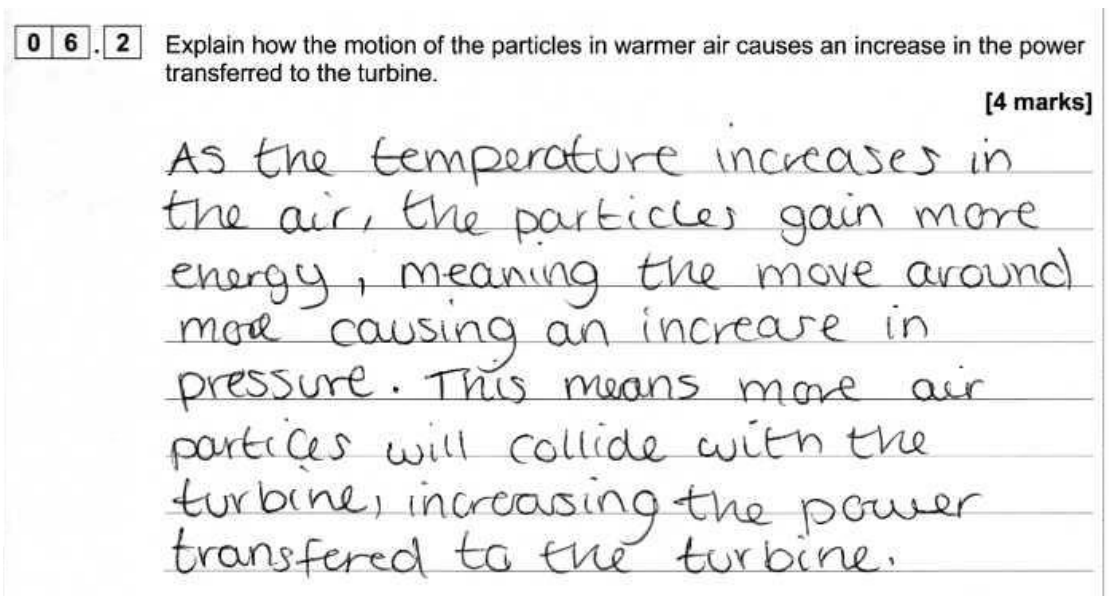
Question 6 (standard/high & high demand)

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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6.5.5.2 Conservation of momentum

Answer 04 · 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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6.5.5.2 Conservation of momentum

Answer 04 · Examiner comments June 2024 | 8464/P/1H | Original Q6

Contact us

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