AQA GCSE Combined Science - Trilogy | 8464

SPECIFICATION POINT 6.3.2.2

Temperature changes in a system and specific heat capacity

Mark schemes and examiner comments

Tier	**Foundation**
Question groups	**7**
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.

6.3.2.2 Temperature changes in a system and specific heat capacity

Answer 01 · Mark scheme June 2018 | 8464/P/1F | Original Q5

<table>
<tr><th>Question</th><th>Answers</th><th>Extra information</th><th>Mark</th><th>AO / Spec. Ref.</th></tr>
<tr><td>05.1</td><td>gamma</td><td></td><td>1</td><td>AO1
6.4.2.1</td></tr>
<tr><td>05.2</td><td>alpha</td><td></td><td>1</td><td>AO1
6.4.2.1</td></tr>
<tr><td>05.3</td><td>gamma</td><td></td><td>1</td><td>AO1
6.4.2.1</td></tr>
<tr><td>05.4</td><td><table><tr><th>isotope</th><th>number of neutrons</th><th>number of protons</th></tr><tr><td>uranium-238</td><td>146</td><td>92</td></tr><tr><td>thorium-234</td><td>144</td><td>90</td></tr></table></td><td></td><td>1
1</td><td>AO2
6.4.1.2</td></tr>
<tr><td>05.5</td><td>$\Delta\theta = 80\ ^\circ C$
$E = 150 \times 4200 \times 80$
$E = 50\ 400\ 000$ (J)</td><td>an answer of 50 400 000 scores 3 marks

allow 50 000 000 (J)

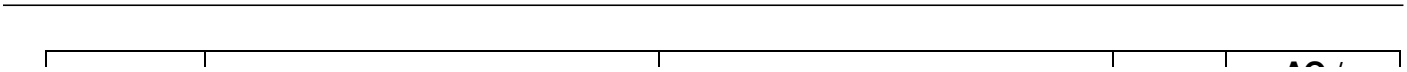
allow max 2 marks for correct calculation using incorrect value of $\Delta\theta$

allow 1 mark for correct calculation using $\theta = 20$ or $\theta = 100$</td><td>
1
1
1</td><td>AO2
6.3.2.2</td></tr>
<tr><td>Total</td><td></td><td></td><td>8</td><td></td></tr>
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6.3.2.2 Temperature changes in a system and specific heat capacity

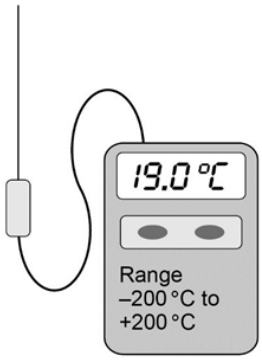
Answer 01 · Mark scheme

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



6.3.2.2 Temperature changes in a system and specific heat capacity

Answer 02 · Mark scheme November 2020 | 8464/P/1F | Original Q4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1	at random speeds in random directions		1	AO1 6.3.3.1
04.2	3rd thermometer ticked  ☐		1	AO2 6.3.2
04.3	to prevent (frost/cold) burns **or** to prevent injury from the cold nitrogen	allow to prevent frostbite	1	AO3 6.3.2.2
04.4	decreased decreased		1 1	AO1 6.3.2.1 6.3.3.1
04.5	860 = 0.00320 × c × 215 $c = \frac{860}{0.00320 \times 215}$ c = 1250 (J/kg°C)		1 1 1	AO2/1 4-5 6.3.2.2 6.1.1.3

6.3.2.2 Temperature changes in a system and specific heat capacity

Answer 02 · Mark scheme

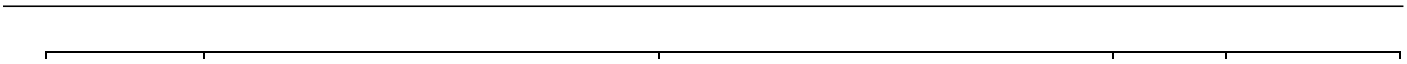
November 2020 | 8464/P/1F | Original Q4

04.6	temperature stays the same		1	AO2 6.3.2.3
04.7	a change of state from liquid to gas		1	AO1 6.3.2.3
04.8	1440 = 0.0072 × L $L = \frac{1440}{0.0072}$ L = 200 000 (J/kg)		1 1 1	AO2 6.3.2.3
Total			**13**	

6.3.2.2 Temperature changes in a system and specific heat capacity

Answer 02 · Mark scheme

November 2020 | 8464/P/1F | Original Q4



6.3.2.2 Temperature changes in a system and specific heat capacity

Answer 03 · Mark scheme November 2021 | 8464/P/1F | Original Q4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1	300 (W/m^2)		1	AO2 6.1.3
04.2	(cities closer to the equator) receive a greater solar intensity	allow (cities closer to the equator) receive more radiation/energy ignore they get more sunshine ignore they are hotter	1	AO2 6.1.3
04.3	carbon dioxide		1	AO1 6.1.3
04.4	0.61 × 1100 671 (W)	 allow 670 (W)	1 1	AO2 6.1.2.2
04.5	larger heating panels have a greater input power	allow larger heating panels have a greater input energy (per second)	1	AO3 6.1.3
04.6	the energy required to increase the temperature of 1kg of water by 1 °C		1	AO1 6.1.1.3 6.3.2.2
04.7	8 400 000 = 80 × 4200 × Δθ $\Delta\theta = \frac{8400000}{80 \times 4200}$ Δθ = 25 (°C)		1 1 1	AO2 6.1.1.3 6.3.2.2

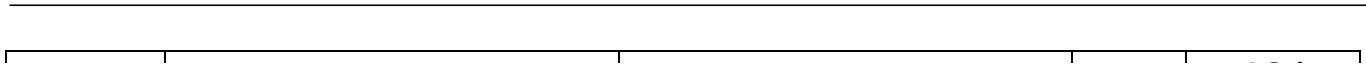
6.3.2.2 Temperature changes in a system and specific heat capacity

04.8	thermal insulation decreases the rate of energy transfer		1	AO1 6.1.2.1
04.9	B		1	AO2 6.1.2.1
Total			**12**	

6.3.2.2 Temperature changes in a system and specific heat capacity

Answer 03 · Mark scheme

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



6.3.2.2 Temperature changes in a system and specific heat capacity

Answer 04 · Mark scheme

June 2022 | 8464/P/1F | Original Q6

Question 6

Question	Answers	Mark	AO / Spec. Ref.
06.1	**Level 3:** The method would lead to the production of a valid outcome. All key steps are identified and logically sequenced.	5–6	AO1 6.1.1.3 6.3.2.2 RPA14
	Level 2: The method would not necessarily lead to a valid outcome. Most steps are identified, but the plan 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 of oil using the top pan balance • measure start temperature of oil using the thermometer • place beaker of oil on heater • switch on heater to heat oil • measure final temperature of oil using the thermometer • measure energy transferred using joulemeter • calculate increase in temperature ($\Delta\theta$) • use the equation $E = mc\Delta\theta$ to determine c		

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.2	burns / scalds	allow cuts from broken glass ignore the heater / oil is hot	1	AO1 6.1.1.3 RPA14

6.3.2.2 Temperature changes in a system and specific heat capacity

Answer 04 · Mark scheme

June 2022 | 8464/P/1F | Original Q6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.3	power = $\frac{\text{energy transferred}}{\text{time}}$ **or** $P = \frac{E}{t}$		1	AO1 6.1.1.4 6.2.4.2 RPA14

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.4	$50 = \frac{4750}{t}$ **or** $4750 = 50 \times t$ $t = \frac{4750}{50}$ t = 95 (s)		1 1 1	AO2 6.1.1.4 6.2.4.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.5	thermistor		1	AO1 6.2.1.4

6.3.2.2 Temperature changes in a system and specific heat capacity

Answer 04 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.6	250 (Ω)	allow an answer in the range 240 (Ω) to 260 (Ω) allow **1** mark for temperature = 160 (°C)	2	AO3 6.2.1.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.7	the water will recover its original properties if the steam is cooled		1	AO1 6.3.1.2

Total Question 6		**15**

6.3.2.2 Temperature changes in a system and specific heat capacity

Answer 05 · Mark scheme

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

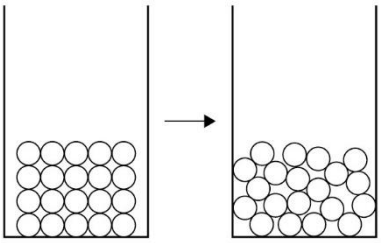
Question 3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	$\Delta E = 4.0 \times 420 \times 50$ $\Delta E = 84\,000$ (J)		1 1	AO2 6.1.1.3 6.3.2.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.2	the total kinetic energy and potential energy of the steel particles		1	AO1 6.3.2.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.3	the particles are in fixed positions		1	AO1 6.3.1.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.4	stays the same		1	AO1 6.3.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.5			1	AO1 6.3.1.1

Answer 05 · Mark scheme

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

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.6	(the space between the particles) increases	allow the particles move further apart	1	AO1 6.3.1.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.7	physical		1	AO1 6.3.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.8	mass per kg = $\frac{18}{4.0}$ mass per kg = 4.5 g medium carbon **OR** mass in 4.0 kg of medium carbon steel = 4.5 × 4.0 (1) mass in 4.0 kg of medium carbon steel = 18 g (1) medium carbon (1)	 dependent on MP2 allow mass in 4.0 kg of low carbon steel = 8 (g) allow mass in 4.0 kg of high carbon steel = 28 (g) dependent on MP1 dependent on MP2	1 1 1	AO3 6.3.1.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.9	280 000 = 4.0 × *L* $L = \frac{280\,000}{4.0}$ *L* = 70 000 (J/kg)		1 1 1	AO2 6.3.2.3

Total Question 3	14

6.3.2.2 Temperature changes in a system and specific heat capacity

Answer 06 · Mark scheme

June 2024 | 8464/P/1F | Original Q2

Question 2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.1	a renewable energy resource that uses hot rocks underground		1	AO1 6.1.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.2	$\Delta E = 15 \times 3800 \times 9.0$ 513 000 (J)		1 1	AO2 6.3.2.2 6.1.1.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.3	9600 (J)		1	AO2 6.1.1.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.4	1 W		1	AO1 6.1.1.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.5	height = $\frac{196}{5.0 \times 9.8}$ 4 (m)	 allow 4.0 (m)	1 1	AO2 6.1.1.2

6.3.2.2 Temperature changes in a system and specific heat capacity

Answer 06 · Mark scheme

June 2024 | 8464/P/1F | Original Q2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.6	**EITHER** releases carbon dioxide	ignore references to pollution	1	AO1 6.1.3
	which contributes to global warming	allow climate change for global warming allow which is a greenhouse gas allow which contributes to the greenhouse effect	1	
	OR releases sulfur / nitrogen dioxide (1)	allow other oxides of nitrogen		
	which causes acid rain (1)			
	OR releases soot (1)	allow carbon for soot allow particulates		
	which can cause global dimming (1)	allow reduces air quality allow causes smog		

Total Question 2	9

6.3.2.2 Temperature changes in a system and specific heat capacity

Answer 07 · Mark scheme June 2025 | 8464/P/1F | Original Q6

Question 6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.1	$13\,800 = 0.75 \times c \times 20$		1	AO2 6.1.1.3 RPA14
	$c = \dfrac{13\,800}{0.75 \times 20}$		1	
	c = 920 (J/kg °C)		1	

6.3.2.2 Temperature changes in a system and specific heat capacity

Answer 07 · Mark scheme

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

Question	Answers	Mark	AO / Spec. Ref.
06.2	**Level 3:** The method would lead to the production of a valid outcome. The key steps are identified and logically sequenced.	5–6	AO1 6.1.1.3 RPA14
	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 **Mass** • use a top pan balance to measure mass of block **Energy transfer** • use a joulemeter to measure energy transferred to block • connect heater to a joulemeter • measure initial energy and switch on • switch off and measure final energy • calculate the difference between initial and final energy • use an ammeter, voltmeter and stopwatch • calculate energy transferred **Temperature change** • use a thermometer to measure temperature of block • measure the initial temperature • measure the final temperature • calculate the difference between initial and final temperature for **Level 3** answers must describe all three measurements		

6.3.2.2 Temperature changes in a system and specific heat capacity

Answer 07 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.3	the amount of wasted energy is less the temperature increase of the aluminium block is greater		1 1	AO3 6.1.1.3 6.1.2.1 RPA14

Total Question 6	**11**

6.3.2.2 Temperature changes in a system and specific heat capacity

Answer 03 · Examiner comments — November 2021 | 8464/P/1F | Original Q4

Question 4 (Low/standard demand)

04.1 The graph was read correctly by slightly more than 50% of the students.

04.2 Many students did not use the information provided in the question. It was not uncommon to see answers such as the equator being closer to the Sun, which gained no credit. Around one in eight students scored a mark.

04.3 The majority of students recalled that carbon dioxide contributes to global warming and is released when fossil fuels are burned.

04.4 Over 90% of students gained both marks.

04.5 Answers such as “bigger panels will heat more water” or “water can be heated up quicker if the panels have a larger surface area” did not answer the question. There were misconceptions which also arose when answering this question, such as the idea that bigger panels hold more water and therefore would take longer to heat up.

If students are asked how the size of the heating panels affects the input power, then their answers need to be in terms of the size of the heating panels and the input power.

Only about a third of students gained this mark, with nearly 10% of students not attempting to answer the question.

Answer 03 · Examiner comments — November 2021 | 8464/P/1F | Original Q4

04.6 Fewer than half of the students chose the correct definition of specific heat capacity.

04.7 Despite being directed to the Physics Equations Sheet, and being given the specific heat capacity value in the question, more than 5% of students did not make any attempt to answer this question. Nearly a third of students gained full marks, but over half of the students gained no marks.

04.8 Just under a third of students answered correctly, with nearly half thinking that thermal insulation increases the rate of energy transfer.

04.9 Only about one in ten students selected the correct answer, with more than 80% choosing option C. Questions 04.8 and 04.9 together suggest that many of the students were confused about the relationship between thermal conduction and thermal insulation.

6.3.2.2 Temperature changes in a system and specific heat capacity

Answer 04 · Examiner comments

June 2022 | 8464/P/1F | Original Q6

Question 06 (Standard demand)

06.1 Nearly 70% of students gained some marks on this question, with about a third of students accessing level 2 of the mark scheme and gaining 3 or 4 marks. Only about 5% of students gave answers which scored in level 3.

It was clear that a lot of students were not aware of what a top pan balance is, with many thinking that it is a device to help prevent things from falling over, or that the pan of the top pan balance was to be used for heating the oil. As a consequence of this misunderstanding, a very large number of students placed the top pan balance on the heater. Many students, who did know what a top pan balance is, thought that it would be used to find the weight of oil, rather than the mass of oil.

While most students realised that the thermometer should be used to measure temperature, some students measured the heat with the thermometer, which was not worth any credit.

The joulemeter was often confused with a voltmeter, or students did not appreciate the function of a joulemeter. Common suggestions included setting the joulemeter to 10 and leaving it for a fixed time, for example.

A lot of students did not mention the measuring equipment at all, and simply stated that they would weigh the oil and measure its temperature. Students who did this could gain some credit but were unable to access level 3 on the mark scheme.

Many students described the wrong experiment, instead of finding the boiling point of the oil, carrying out a cooling-curve experiment, or describing how to use an immersion heater to find the specific heat capacity of a block of metal. These responses could still gain some credit, for example by correctly stating how to use the thermometer.

06.2 Approximately half the students could identify the risk when using the given equipment.

It was clear that many students were unable to distinguish between risks, hazards, and precautions. Some students did not talk about safety at all, instead suggesting that a risk might be inaccurate results, for example.

06.3 Nearly 90% of students chose a correct equation from the equation sheet.

Some students omitted important parts of the equation, such as the equals sign, and therefore did not gain the mark.

06.4 Over 60% of students gained full marks on this question, with just over a quarter of all students who attempted the question gaining 0 marks.

Students who started the question by using the equation $E = P\,t$ tended to make fewer mistakes when rearranging than those who used the equation $P = E / t$.

6.3.2.2 Temperature changes in a system and specific heat capacity

Answer 04 · Examiner comments June 2022 | 8464/P/1F | Original Q6

06.5 Fewer than 5% of students recognised that the electrical component whose resistance decreases as temperature increases is a thermistor.

06.6 Just over 10% of students gained both marks, with a further 20% gaining one mark on this question. About 1 in 5 students did not attempt this question.

Some students misread the temperature scale, deciding that the maximum temperature reached was 152 °C or 170 °C, for example. Some students thought that the relevant temperature was the change in temperature of 140 °C. Of those students who correctly read 160 °C from figure 12, but did not then use figure 11, many decided to divide the temperature by a time read from the graph. Some students used their temperature with the maximum resistance of 1000 Ω shown on figure 11.

Students who read 160 °C on figure 12, but decided that this was the resistance of the resistor by writing 160 on the answer line, gained no marks.

06.7 About 20% of students chose the correct answer to why this was a physical change.

6.3.2.2 Temperature changes in a system and specific heat capacity

Answer 04 · Examiner comments

June 2022 | 8464/P/1F | Original Q6

Mark Ranges and Award of Grades

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

6.3.2.2 Temperature changes in a system and specific heat capacity

Answer 05 · Examiner comments June 2023 | 8464/P/1F | Original Q3

Question 03 (Low demand and standard demand)

03.1 Nearly 90% of students gained both marks for this calculation. A fairly common incorrect method was to subtract 50°C from 420 J/Kg°C, and give a value for the temperature change of 370°C, which gained no credit.

03.2 Slightly less than 40% of students selected the correct meaning for internal energy. It was (very) slightly more common for students to think that internal energy is the energy added to the steel particles as they are heated than to select the correct answer.

03.3 About 70% of students chose the correct statement describing the particles in a solid.

03.4 Approximately 45% of students knew the mass of steel stays the same.

Answer 05 · Examiner comments June 2023 | 8464/P/1F | Original Q3

03.5 The correct diagram to show the change in arrangement of the particles was chosen by over 95% of students.

03.6 Roughly two fifths of students answered this correctly. Many students wrote about the motion of particles, which was ignored, rather than the arrangement of particles. Students who stated that the particles spread out but remained in contact with each other scored this mark.

03.7 Just over three quarters of students recognised that melting is a physical change.

03.8 Over half of the students gained full marks on this question. Almost no students gained 1 or 2 marks, but about 10% did not attempt it at all. Evidence of a relevant calculation had to be shown before any credit could be awarded. So, for example, students who calculated the average of 2, 4.5 and 7 and came up with an answer of 4.5 g, and then selected medium carbon did not score any marks.

03.9 Nearly 60% of students gained full marks on this standard demand calculation. A small proportion of students attempted to convert 4.0 kg to g, which limited them to a maximum mark of 2.

Answer 06 · Examiner comments

June 2024 | 8464/P/1F | Original Q2

Question 2 (low demand)

02.1 Just under two-thirds of students correctly identified geothermal energy as a renewable energy resource that uses hot rocks underground.

02.2 This calculation question was answered well, with almost 90% of students gaining both marks. A small minority of students incorrectly converted the mass from kilograms to grams as part of their calculation.

02.3 Some students were confused by the unit of m^2 and decided that the 120 should also be squared. The correct value of energy was given by approximately 65% of students.

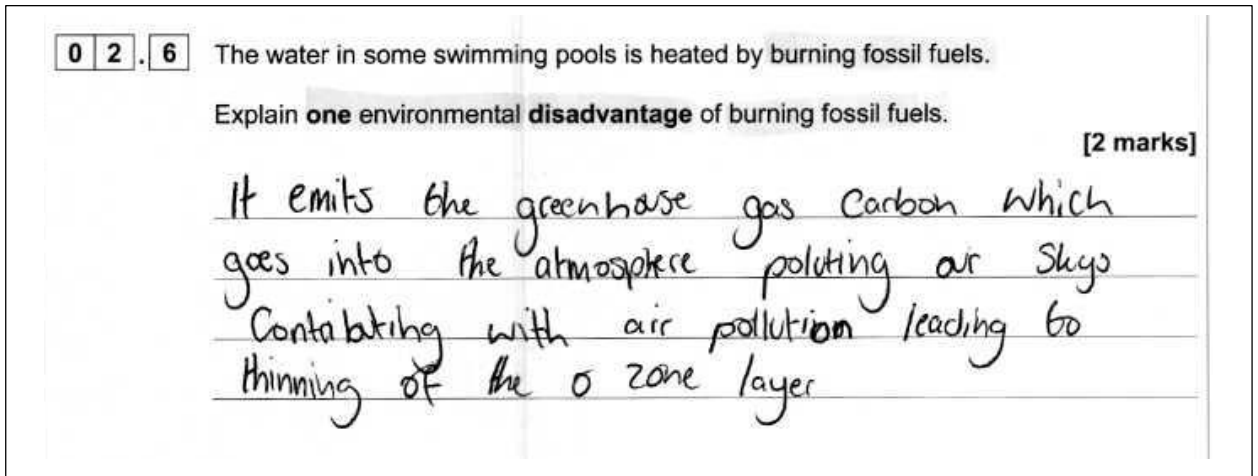
02.4 Around 55% of students correctly identified that 1 J/s is equivalent to 1 W.

02.5 Roughly 70% of students were able to answer this question correctly. Amongst students who did not calculate the correct height, it was relatively common to see substitutions made where brackets should have been used, but were not, eg height = 196 J ÷ 5.0 kg × 9.8 N/kg.

02.6 Almost two-thirds of students gained at least 1 mark on this question, with approximately a fifth of students gaining both marks. Of those who scored both marks, the most common answers referred to a release of carbon dioxide contributing to global warming.

Many students gave vague answers which were not creditworthy, often referring to pollution or toxic chemicals rather than named pollutants. It was also relatively common for students to refer to a 'carbon footprint', which did not prevent marks from being awarded but did not answer the question.

Some students stated that an environmental disadvantage of fossil fuels is that they are non-renewable, which did not score any credit.



0 2 . 6 The water in some swimming pools is heated by burning fossil fuels.

Explain **one** environmental **disadvantage** of burning fossil fuels.

[2 marks]

It emits the greenhouse gas carbon which goes into the atmosphere poluting our Skys Contributing with air pollution leading to thinning of the o zone layer

This student scored marking point 1 for identifying that carbon is released. This scored against the third alternative in the mark scheme, as carbon is equivalent to soot. However, marking point 2 was not awarded, as the environmental disadvantages associated with soot are global dimming, reduced air quality, or smog. There was a small, but noticeable, minority of students who incorrectly linked carbon dioxide with thinning of the ozone layer or holes in the ozone layer.

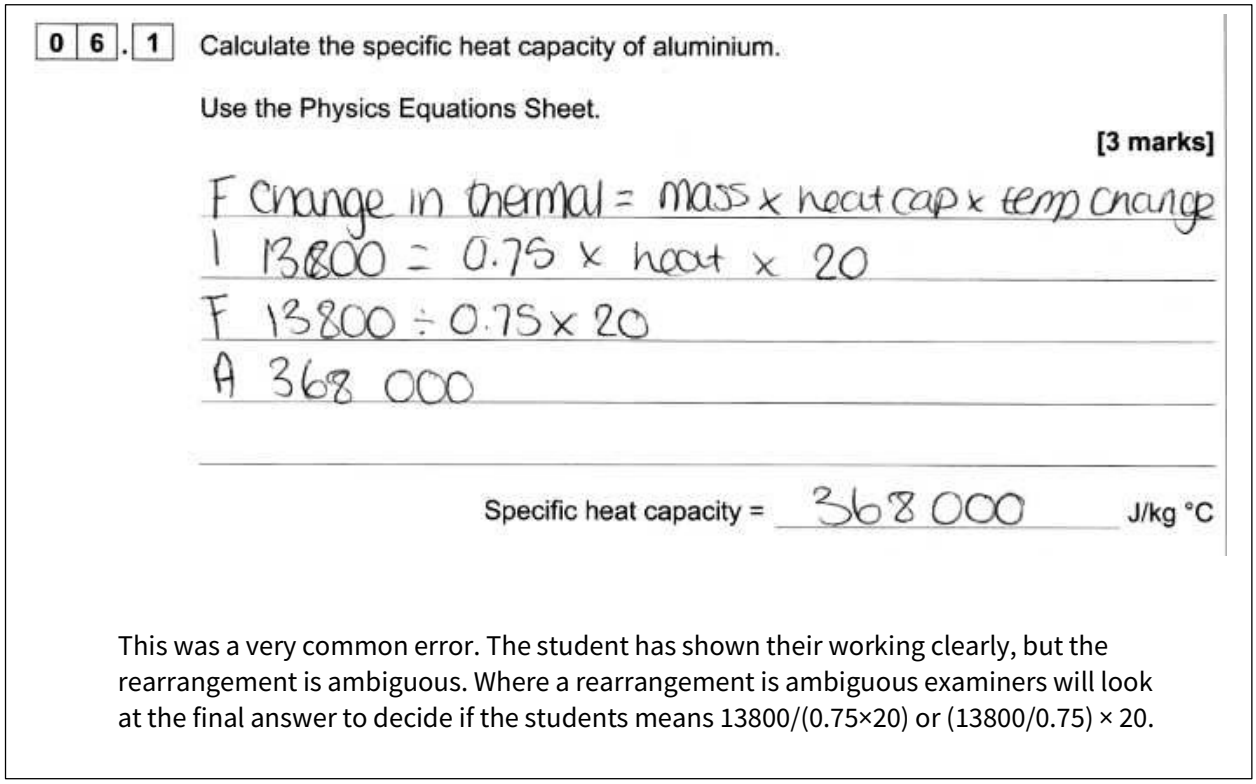
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Answer 07 · Examiner comments

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

Question 6 (Standard demand)

06.1 This standard demand calculation performed as expected with 40% of students gaining at least one mark. Many students that did a correct substitution found the rearrangement difficult or could not use their calculator correctly



0 6 . 1 Calculate the specific heat capacity of aluminium.

Use the Physics Equations Sheet.

[3 marks]

F change in thermal = mass x heat cap x temp change
I 13800 = 0.75 x heat x 20
F 13800 ÷ 0.75 x 20
A 368 000

Specific heat capacity = 368 000 J/kg °C

This was a very common error. The student has shown their working clearly, but the rearrangement is ambiguous. Where a rearrangement is ambiguous examiners will look at the final answer to decide if the students means 13800/(0.75×20) or (13800/0.75) × 20.

06.2 Students found this question very demanding. Over 20% of students did not attempt the question. 40% of students were able to write something creditworthy. The majority of Level 1 answers gained some credit for suggesting that the temperature could be measured with a thermometer. The 10% of students that wrote Level 2 or 3 answers went on to describe measuring the energy transferred with either a joulemeter or other method and/or measuring mass using a top pan balance.

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6.3.2.2 Temperature changes in a system and specific heat capacity

Answer 07 · Examiner comments June 2025 | 8464/P/1F | Original Q6

0 6 . 2 Describe a method the student could have used to obtain the results in **Table 2**.
[6 marks]

outside the box

1. Calculate the mass in kg of our aluminium block.
2. Set up our electric heater facing the aluminium block and turn it on.
3. Calculate the energy transferred in joules from the heater from what it was before the experiment until after.
4. Measure the temperature change in °C from before the experiment until after.
5. Use these results to calculate our specific heat capacity which is $c = \Delta E \div m \times \Delta\theta$.
6. See the outcome and compare our results on a table.

All of the quantaties to be measured were given in the question, so no credit is given for simply stating that they need to be measured.

0 6 . 2 Describe a method the student could have used to obtain the results in **Table 2**.
[6 marks]

outside box

- Place aluminium on top pan balance to find its mass
- place a thermometer in the aluminium to find its starting temperature
- Connect a power supply and a joulemeter to the aluminium
- leave to aluminium to heat for 5 minutes
- Use thermometer to find its new temperature and joulemeter to find how much energy was needed to increase the temperature.

In this response the students has given the equipment needed and stated what it is measuring.

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6.3.2.2 Temperature changes in a system and specific heat capacity

Answer 07 · Examiner comments June 2025 | 8464/P/1F | Original Q6

Contact us

Our friendly team will be happy to support you between 8am and 5pm, Monday to Friday.

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