

GCSE Combined Science: Trilogy

Worksheet: Energy changes in systems

TIME 30 min	TOTAL 30 marks	CALCULATOR Allowed	DIFFICULTY Easy, Medium
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Topics: Energy changes in systems

NAME _____

CLASS _____

DATE _____

- Use black ink or black ball-point pen. Pencil should only be used for drawing.
- Answer all questions in the spaces provided.
- In all calculations, show clearly how you work out your answer.
- The marks for questions are shown in brackets.

0 1

A student is planning to determine the specific heat capacity of a metal block using an electric heater and a joulemeter.

0 1 . 1

State **one** hazard in this investigation and a control measure to reduce the risk from it.

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[2 marks]

0 1 . 2

The student wants to investigate whether a larger mass of metal needs more energy to reach the same temperature rise.

Write a hypothesis for this investigation.

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.....

[1 mark]

0 2

A student heats some water in a beaker.

0 2 . 1

What is meant by the specific heat capacity of a substance?

Tick (✓) **one** box.

The energy needed to change the state of 1 kg of the substance.

☐

The energy needed to raise the temperature of 1 kg of the substance by 1 °C.

☐

The energy needed to raise the temperature of the substance by 1 °C.

☐

The temperature rise of 1 kg of the substance when 1 J of energy is supplied.

☐

[1 mark]

0 2 . 2

The mass of the water is 2.0 kg. The temperature of the water increases by 15 °C.

The specific heat capacity of water is 4200 J/kg °C.

Calculate the energy transferred to the water.

Use the equation:

change in thermal energy = mass × specific heat capacity × temperature change

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Energy transferred = J

[2 marks]

0 2 . 3

The student then transfers the same amount of energy to 2.0 kg of cooking oil. Cooking oil has a lower specific heat capacity than water. How does the temperature rise of the oil compare with the temperature rise of the water?

Tick (✓) **one** box.

The temperature rise of the oil is greater.

☐

The temperature rise of the oil is the same.

☐

The temperature rise of the oil is smaller.

☐

[1 mark]

0 3

A student plans to investigate whether the metal a block is made from affects its specific heat capacity. The student will heat blocks of aluminium, copper and steel, all of the same mass, using an identical electric immersion heater for the same time, and measure the temperature rise of each block.

0 3 . 1

Write a hypothesis for this investigation.

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[1 mark]

0 3 . 2

Identify the independent variable and the dependent variable in this investigation.

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[2 marks]

0 3 . 3

State one variable that must be kept the same for each block, and explain why this matters.

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[2 marks]

0 3 . 4

Give one hazard in this investigation and a suitable control measure.

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[2 marks]

0 4

Heating a 2.8 kg block of steel by 24 °C transfers 28 200 J to its thermal energy store.

0 4 . 1

Calculate the specific heat capacity of steel shown by these figures.
Use the Physics Equations Sheet.

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Specific heat capacity = J/kg °C

[3 marks]

0 5

A student uses an electric heater to raise the temperature of a 0.50 kg block of aluminium by 15 °C. The student uses a stopwatch that shows time to the nearest 0.01 s, but estimates their own reaction time when starting and stopping the stopwatch to be about 0.3 s. The student repeats the timing three times for the same 15 °C rise, obtaining 118 s, 124 s and 121 s.

0 5 . 1

Which is the more significant source of uncertainty in a single timing: the resolution of the stopwatch or the student's reaction time? Give a reason.

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[2 marks]

0 5 . 2

Calculate the mean of the three repeat timings, and the uncertainty in the mean using the range of the readings.

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Mean time = s

[3 marks]

0 5 . 3

A second student carries out the same investigation, using a different heater with the same power rating and a different 0.50 kg aluminium block. The second student obtains a mean time of 145 s for the same 15 °C rise.

What does this comparison show about the first student's results? Suggest one reason for the difference.

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[2 marks]

0 6

A student determines the specific heat capacity of a block of metal by heating it with an electric immersion heater and recording the energy supplied and the temperature rise.

0 6 . 1

Identify the independent variable, the dependent variable and **one** control variable in this investigation.

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[3 marks]

0 7

Heating a 3.0 kg block of iron by 26 °C transfers 35 100 J to its thermal energy store.

0 7 . 1

Calculate the specific heat capacity of iron shown by these figures.
Use the Physics Equations Sheet.

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Specific heat capacity = J/kg °C

[3 marks]

END OF QUESTIONS

Original practice questions written to match the specification. Not produced by, affiliated with or endorsed by AQA.

Mark scheme

GCSE Combined Science: Trilogy · Worksheet: Energy changes in systems · 30 marks

Question 1 (3 marks)

01.1 [2 marks]

Answer: The heater and block get hot and could burn skin — allow time to cool before handling, or use gloves / tongs.

- a hazard, e.g. the heater / block gets hot and could burn skin, or trailing wires are a trip hazard, or a mains power supply could give an electric shock if wet (1)
- a suitable control measure for that hazard, e.g. allow to cool / use gloves or tongs before touching the block, keep wires tidy, keep liquids away from the mains supply (1)

Notes: The control measure must match the hazard given.

01.2 [1 mark]

Answer: A larger mass of the same metal needs more energy to produce the same temperature rise (energy needed is proportional to mass).

- a larger mass of the (same) metal needs more energy for the same temperature rise / energy needed is directly proportional to mass (1)
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Question 2 (4 marks)

02.1 [1 mark]

Correct: The energy needed to raise the temperature of 1 kg of the substance by 1 °C.

02.2 [2 marks]

Answer: 126 000 J

- $\Delta E = 2.0 \times 4200 \times 15$ (1)
- $\Delta E = 126\,000$ (J) (1)

Notes: An answer of 126 000 J scores 2 marks.

02.3 [1 mark]

Correct: The temperature rise of the oil is greater.

Question 3 (7 marks)

03.1 [1 mark]

Answer: Different metals have different specific heat capacities, so for the same energy input the blocks will show different temperature rises.

- different metals (have different specific heat capacities, so) will show different temperature rises for the same energy input (1)

Notes: Allow any testable prediction linking the metal to the temperature rise, e.g. 'the metal with the lowest specific heat capacity will have the biggest temperature rise'. Do not accept a statement that does not mention the temperature rise or the specific heat capacity.

03.2 [2 marks]

Answer: Independent: the metal the block is made from. Dependent: the temperature rise of the block.

- independent variable: the metal / material the block is made from (1)
- dependent variable: the temperature rise of the block (1)

03.3 [2 marks]

Answer: The mass of each block must be the same; if the masses were different, a difference in temperature rise could be caused by the different mass rather than the different metal, making the comparison unfair.

- a control variable, e.g. the mass of the block, the power of the heater, the time the heater is on, or the starting temperature (1)
- a correct reason it must be controlled, e.g. so that any difference in temperature rise is caused only by the metal, not another variable (a fair test) (1)

03.4 [2 marks]

Answer: The heater and blocks become hot and could burn skin; allow them to cool before handling, or use tongs / insulated gloves.

- a hazard, e.g. the heater or block becomes hot and could burn skin, or trailing wires are a trip hazard (1)
 - a control measure that matches the hazard given, e.g. allow to cool / use tongs or heat-resistant gloves before touching, do not touch the heater while it is switched on, keep wires tidy (1)
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Question 4 (3 marks)

04.1 [3 marks]

Answer: 420 J/kg °C

- $28\,200 = 2.8 \times c \times 24$ (1)
 - $c = 28\,200 \div 67.2$ (1)
 - $c = 420$ (J/kg °C) (1)
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Question 5 (7 marks)

05.1 [2 marks]

Answer: The reaction time, because 0.3 s is much larger than the stopwatch's resolution of 0.01 s.

- the student's reaction time (about 0.3 s) (1)
 - because it is much larger than the resolution of the stopwatch (0.01 s) (1)
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05.2 [3 marks]

Answer: 121 s, uncertainty = ± 3 s

- mean = $(118 + 124 + 121) \div 3$ (1)
 - = 121 (s) (1)
 - uncertainty = $\pm$ half the range = $\pm (124 - 118) \div 2 = \pm 3$ (s) (1)
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05.3 [2 marks]

Answer: The results are not reproducible: 145 s is well outside 121 ± 3 s, even though the same method was used with equivalent equipment. A possible reason is that the second student's block was not insulated (or not as well insulated), so more energy was transferred to the surroundings.

- the results are not reproducible (145 s is well outside 121 ± 3 s when the investigation is repeated with different equipment) (1)
- a plausible reason for the difference, e.g. the second heater's actual power output was lower than its rating, the second block was less well insulated so more energy was transferred to the surroundings, or poorer thermal contact between the heater and the block (1)

Notes: Do not accept 'the results are not repeatable' for the first mark. Do not accept 'a different mass of block' as the reason, since both blocks were 0.50 kg.

Question 6 (3 marks)

06.1 [3 marks]

Answer: Independent: energy supplied (or time). Dependent: temperature (rise) of the block.

Control: mass of the block (or the material of the block).

- independent variable: energy supplied by the heater (or time the heater is on) (1)
- dependent variable: temperature (rise) of the block (1)
- a control variable, e.g. the mass of the block, the material of the block, or the starting temperature (1)

Question 7 (3 marks)

07.1 [3 marks]

Answer: 450 J/kg °C

- $35\,100 = 3.0 \times c \times 26$ (1)
- $c = 35\,100 \div 78$ (1)
- $c = 450$ (J/kg °C) (1)