

GCSE Physics

Worksheet: Energy changes in systems

TIME 35 min	TOTAL 32 marks	CALCULATOR Allowed	DIFFICULTY Easy, Medium
----------------	-------------------	-----------------------	----------------------------

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.

[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.

[1 mark]

0 2

A block of steel has a mass of 1.7 kg. The specific heat capacity of steel is 420 J/kg °C.

0 2 . 1

Calculate the energy needed to raise the temperature of the block by 34 °C.

Use the equation:

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

.....

.....

.....

.....

Energy needed = J

[2 marks]

0 3

A student heats some water in a beaker.

0 3 . 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 3 . 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

.....

.....

.....

.....

Energy transferred = J

[2 marks]

0 3 . 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 4

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 4 . 1

Write a hypothesis for this investigation.

.....

.....

[1 mark]

0 4 . 2

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

.....

.....

.....

.....

[2 marks]

0 4 . 3

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

.....

.....

.....

.....

[2 marks]

0 4 . 4

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

.....

.....

.....

.....

[2 marks]

.....

0 5

Heating 0.9 kg of water by 40 °C transfers 151 000 J to its thermal energy store.

0 5 . 1

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

.....

.....

.....

.....

.....

Specific heat capacity = J/kg °C

[3 marks]

0 6

A student hypothesises that, for the same energy input, the temperature rise of a liquid is inversely proportional to its mass. The student heats different masses of water for the same time with the same immersion heater and measures the temperature rise. Table 1 shows the results.

Table 1

Mass of water in kg	0.20	0.40	0.60	0.80
Temperature rise in °C	25.0	12.6	8.3	6.3

0 6 . 1

Use Table 1 to judge whether the results support the student's hypothesis. Show your working.

.....

.....

.....

.....

.....

.....

[3 marks]

0 6 . 2

Explain why the water should be stirred while it is being heated.

.....

.....

[1 mark]

0 6 . 3

Give one hazard of heating water with an electric immersion heater, and a suitable control measure.

.....

.....

.....

.....

[2 marks]

0 7

A student used the following apparatus to determine the specific heat capacity of aluminium:

- an aluminium block of mass 1.00 kg with two holes drilled in it
- an electric heater placed in one hole
- a thermometer placed in the other hole
- a joulemeter connected between the power supply and the heater.

0 7 . 1

The student wrapped the block in a layer of insulation.
Give the reason why.

.....

.....

[1 mark]

0 7 . 2

The student put a few drops of water into the hole containing the thermometer.
Suggest why.

.....

.....

[1 mark]

Table 2

Measurement	Value
Energy transferred by the heater in J	19 800
Temperature of block at the start in °C	19.5
Temperature of block at the end in °C	40.0

Table 2 shows the student's results.

Calculate the specific heat capacity of aluminium given by these results.

Use the Physics Equations Sheet.

.....

.....

.....

.....

.....

Specific heat capacity = J/kg °C

[3 marks]

The accepted value for the specific heat capacity of aluminium is 900 J/kg °C.

Explain why the student's value was higher than the accepted value.

.....

.....

.....

.....

[2 marks]

END OF QUESTIONS

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

Mark scheme

GCSE Physics · Worksheet: Energy changes in systems · 32 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)
-

Question 2 (2 marks)

02.1 [2 marks]

Answer: 24 276 J

- $\Delta E = 1.7 \times 420 \times 34$ (1)
 - $\Delta E = 24\,276$ (J) (1)
-

Question 3 (4 marks)

03.1 [1 mark]

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

03.2 [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.

03.3 [1 mark]

Correct: The temperature rise of the oil is greater.

Question 4 (7 marks)

04.1 [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.

04.2 [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)

04.3 [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)

04.4 [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)
-

Question 5 (3 marks)

05.1 [3 marks]

Answer: 4190 J/kg °C

- $151\,000 = 0.9 \times c \times 40$ (1)
 - $c = 151\,000 \div 36$ (1)
 - $c = 4190$ (J/kg °C) (1)
-

Question 6 (6 marks)

06.1 [3 marks]

Answer: Yes: mass $\times$ temperature rise is approximately constant (about 5.0 kg °C) for all four masses, so temperature rise is inversely proportional to mass, supporting the hypothesis.

- calculates mass $\times$ temperature rise for at least three masses: $0.20 \times 25.0 = 5.0$, $0.40 \times 12.6 = 5.04$, $0.60 \times 8.3 = 4.98$, $0.80 \times 6.3 = 5.04$ (kg °C) (1)
- all four values are approximately equal / constant (allow 4.9–5.1) (1)
- yes, the results support the hypothesis, because mass $\times$ temperature rise is constant, so temperature rise is inversely proportional to mass (1)

Notes: Allow an alternative correct method for the first two marks, e.g. showing that doubling the mass (0.20 kg $\rightarrow$ 0.40 kg, or 0.40 kg $\rightarrow$ 0.80 kg) halves the temperature rise (25.0 $\rightarrow$ 12.6, or 12.6 $\rightarrow$ 6.3 °C). 'As mass increases, temperature rise decreases' alone scores 0 for the working marks.

06.2 [1 mark]

Answer: Stirring keeps the water at a uniform temperature, so the thermometer gives a true (representative) reading of the whole liquid's temperature.

- (without stirring) the water may not be at a uniform temperature, so the thermometer might not give a valid / representative reading of the temperature of all the water (1)
-

06.3 [2 marks]

Answer: Hot water or steam can scald; use a heatproof mat and keep hands away from the hot water/steam, or switch off and allow to cool before removing the thermometer or heater.

- a hazard, e.g. hot water or steam can scald, or a mains electrical supply could give a shock (1)
 - a control measure that matches the hazard, e.g. use a heatproof mat and keep hands away from the hot water / steam, or keep electrical connections dry and switch off before touching the apparatus (1)
-

Question 7 (7 marks)

07.1 [1 mark]

Answer: To reduce the energy dissipated to the surroundings.

- to reduce energy transfer / dissipation to the surroundings (1)

Notes: Do not accept 'to stop heat escaping'. Accept 'to reduce heat loss'.

07.2 [1 mark]

Answer: To improve thermal contact between the block and the thermometer.

- to improve (thermal) contact between the thermometer and the block / so the thermometer reads the temperature of the block (accurately) (1)
-

07.3 [3 marks]

Answer: 966 J/kg °C

- temperature change = 20.5 (°C) (1)
- $19\,800 = 1.00 \times c \times 20.5$ (1)
- $c = 966$ (J/kg °C) (1)

Notes: An answer of 966 (J/kg °C) scores 3 marks. Allow 970 (J/kg °C).

07.4 [2 marks]

Answer: Some of the energy from the heater was dissipated to the surroundings (or heated the heater and thermometer), so the temperature rise of the block was smaller than it would have been — the energy used in the calculation was more than the block actually received.

- some of the energy (from the heater) was dissipated to the surroundings / was used to heat the heater, thermometer or insulation (1)
 - so not all of the 19 800 J was transferred to the block / the temperature rise was smaller than expected (1)
-