Exercise walk-through

1.3

Energy changes in systems – specific heat capacity (4.1.1.3, RP1)

AQA · GCSE · Physics

Specific heat capacity

- When a substance is heated, the energy in its thermal store increases and its temperature rises:
- ΔE is the change in thermal energy in J, m the mass in kg and $\Delta\theta$ the temperature change in °C.
- The **specific heat capacity** c is the energy needed to raise the temperature of 1 kg of a substance by 1 °C, in J/kg °C.
- This equation is on the equations sheet.

$$\Delta E = m\,c\,\Delta\theta$$

National and global energy resources

- The main energy resources are **fossil fuels** (coal, oil and gas), **nuclear fuel**, bio-fuel, wind, hydroelectricity, geothermal, the tides, the Sun and water waves.
- We use them for transport, electricity generation and **heating**.
- A **renewable** resource is one that is being, or can be, replaced as it is used.
- **Fossil fuels** and **nuclear fuel** are **non-renewable**: they will run out.

Sources for this lesson

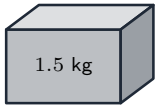
- AQA, *GCSE Physics (8463) specification*, section 4.1 Energy, and the *Required practical handbook* (sample results for practical 2).
- J. P. Joule, "On the mechanical equivalent of heat", *Philosophical Transactions of the Royal Society*, 140 (1850), read 21 June 1849.
- AQA, *GCSE Physics* Paper 1 Higher, June 2024, questions 1, 2, 6 and 8 (adapted).

Exercises 2.1·2.2

2.1 Calculate the energy needed to heat 0.80 kg of oil by 25 °C. The specific heat capacity of the oil is 2000 J/kg °C. [2]



2.2 A 1.5 kg copper block is given 11 550 J. The specific heat capacity of copper is 385 J/kg °C. Calculate its temperature rise. [2]



Exercises 2.1·2.2

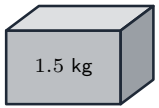
2.1 Calculate the energy needed to heat 0.80 kg of oil by 25 °C. The specific heat capacity of the oil is 2000 J/kg °C. [2]



2.1

- $0.80 \times 2000 \times 25 = \mathbf{40\,000}$ J

2.2 A 1.5 kg copper block is given 11 550 J. The specific heat capacity of copper is 385 J/kg °C. Calculate its temperature rise. [2]

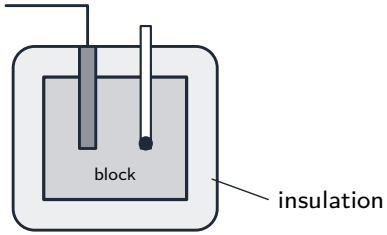


2.2

- $11\,550 \div (1.5 \times 385) = \mathbf{20}$ °C

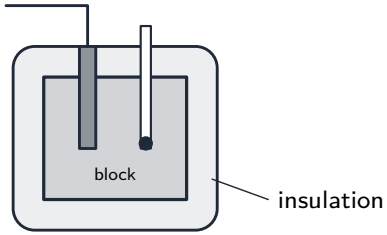
Exercise 2.3

2.3 In the practical, the metal block is wrapped in insulation. Explain why. [2]



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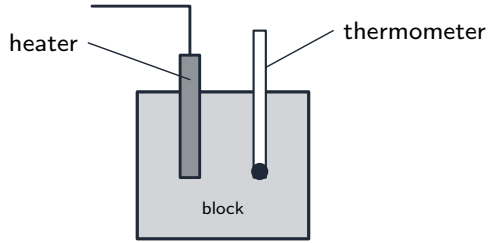


2.3

- to reduce the energy lost to the surroundings; so more of the energy supplied heats the block and the value of c is more accurate

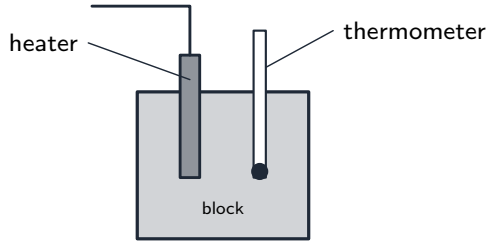
Exercise 3.1

3.1 A 50 W heater is used for 600 s to heat a 1.0 kg block. The temperature of the block rises by 30 °C. Calculate the specific heat capacity of the block. [3]



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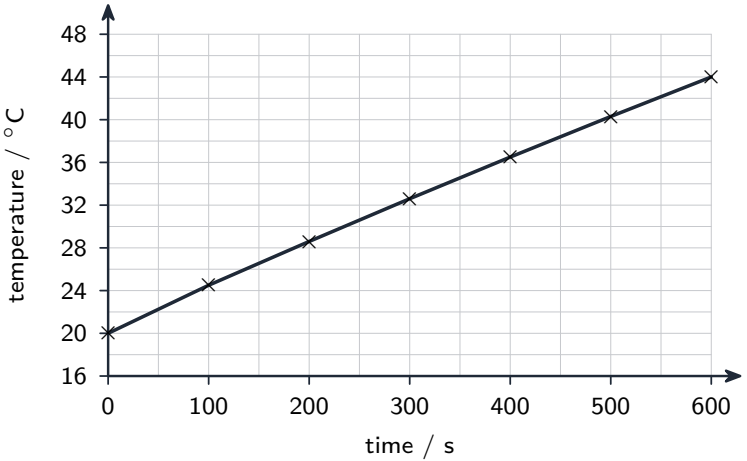
3.1

- $E = 50 \times 600 = 30\,000$ J
- $c = 30\,000 \div (1.0 \times 30)$
- $c = \mathbf{1000}$ J/kg °C

Exercise 3.2 (a)

3.2 A student heats a 1.0 kg aluminium block with a 40 W heater. The graph shows the temperature of the block.

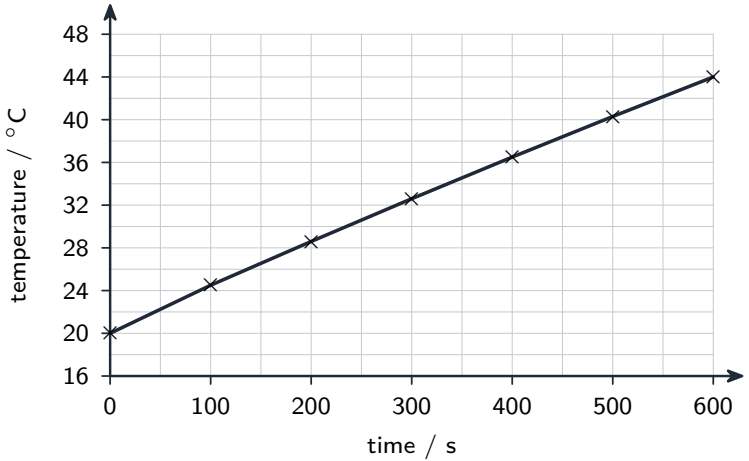
(a) Use the graph to find the temperature rise in 600 s. [2]



Exercise 3.2 (a)

3.2 A student heats a 1.0 kg aluminium block with a 40 W heater. The graph shows the temperature of the block.

(a) Use the graph to find the temperature rise in 600 s. [2]



(a) $44 - 20 = \mathbf{24}\,^{\circ}\mathrm{C}$

Exercise 3.2 (b)

3.2 A student heats a 1.0 kg aluminium block with a 40 W heater. The graph shows the temperature of the block.

(b) Calculate the specific heat capacity of aluminium from these results. [3]

Exercise 3.2 (b)

3.2 A student heats a 1.0 kg aluminium block with a 40 W heater. The graph shows the temperature of the block.

(b) Calculate the specific heat capacity of aluminium from these results. [3]

(b) $E = 40 \times 600 = 24\,000$ J; $c = 24\,000 \div (1.0 \times 24) = \mathbf{1000}$ J/kg °C

Exercise 3.2 (c)

3.2 A student heats a 1.0 kg aluminium block with a 40 W heater. The graph shows the temperature of the block.

(c) The true value is 900 J/kg °C. Explain why the student's value is higher. [2]

Exercise 3.2 (c)

3.2 A student heats a 1.0 kg aluminium block with a 40 W heater. The graph shows the temperature of the block.

(c) The true value is 900 J/kg °C. Explain why the student's value is higher. [2]

(c) some energy is lost to the surroundings, so not all of it heats the block; the temperature rise is smaller, so the calculated c is larger

Exercise 3.2 (d)

3.2 A student heats a 1.0 kg aluminium block with a 40 W heater. The graph shows the temperature of the block.

(d) Describe how the student should carry out this investigation. [6]

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(d) Describe how the student should carry out this investigation. [6]

(d) points to include:

- measure the mass of the block on a balance
- put the heater and a thermometer in the holes in the block, with a drop of oil or water for good contact
- wrap the block in insulation
- record the starting temperature, then switch on the heater and start a timer
- record the temperature every minute for 10 minutes, and the power of the heater (or use a joulemeter)
- calculate the energy, $E = Pt$, and $c = \Delta E \div (m\Delta\theta)$

Levels: **5–6** a full, logical answer with correct physics and correct terms; **3–4** several correct points, partly linked; **1–2** one or two relevant points.