

Heating, melting and boiling: energy calculations

Physics grades 9-10 (GCSE · IGCSE · O Level · Class 9-10) · Lab

Name: _____ Date: _____ Class: _____

How much energy does it take to warm a block of metal? You will heat an aluminium block with a known power, record the temperature at regular times, and use the results to calculate the specific heat capacity. You will also judge how heat losses affect the answer.

Level: Physics grades 9-10 (GCSE · IGCSE · O Level · Class 9-10) · **Curriculum:** GCSE P3, IGCSE 2.2

Aim

To measure the specific heat capacity of aluminium by supplying a known amount of electrical energy to a 1.00 kg block and recording its temperature.

Equipment

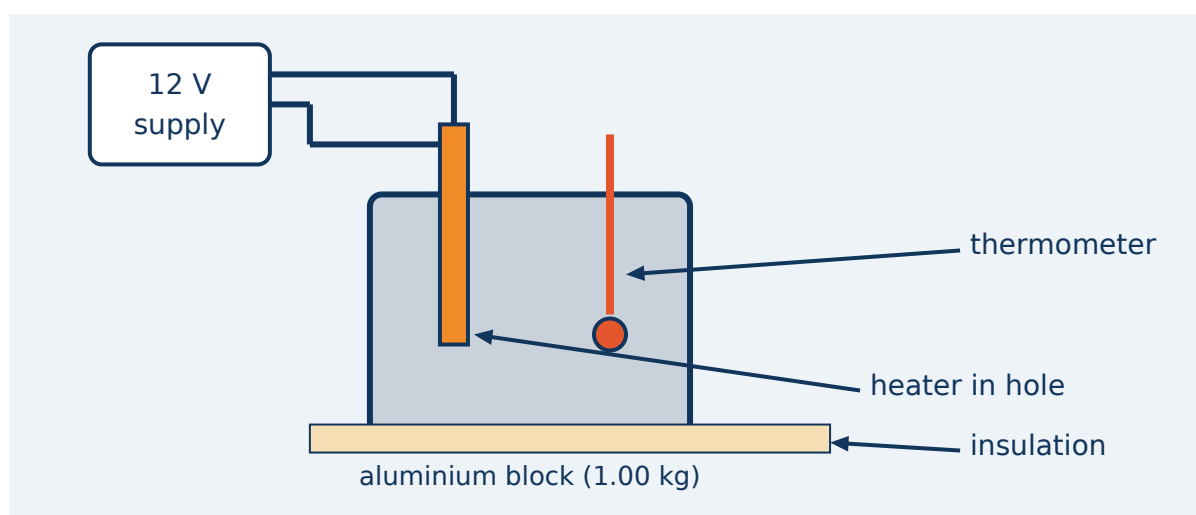
- 1.00 kg aluminium block with two holes
- 12 V, 48 W immersion heater (or a joulemeter) and a low-voltage supply
- thermometer ($-10\text{ }^{\circ}\text{C}$ to $110\text{ }^{\circ}\text{C}$)
- stopwatch
- a few drops of oil for the holes
- insulating material (wool or foam) and a heat-proof mat

Safety

Safety

The heater and block become hot enough to burn skin. Switch off and wait at least five minutes before touching the block. Keep the supply away from water and do not touch bare wires.

Method



Set-up to measure the specific heat capacity of an aluminium block.

1. Measure the mass of the block with a balance. Add a few drops of oil to the holes so the heater and thermometer touch the metal well.
2. Wrap the block in insulation and place it on the mat. Record the starting temperature.
3. Switch on the heater and start the stopwatch. Record the voltage and current once: $V = 12.0 \text{ V}$ and $I = 4.0 \text{ A}$, so $P = 48 \text{ W}$.
4. Read the temperature every 150 s for 600 s, leaving the thermometer in place.
5. Switch off. Keep watching the thermometer: the highest reading is the final temperature.

Results

Sample measurements (mass of block 1.00 kg, $P = 48 \text{ W}$):

Time (s)	Energy supplied (kJ)	Temperature ($^{\circ}\text{C}$)
0	0	20.0
150	7.2	27.4
300	14.4	35.0
450	21.6	42.6
600	28.8	50.2

Analysis questions

Question 1 Energy values

Show how the energy supplied after 300 s was found and check the value 14.4 kJ.

Question 2 Temperature rise

Calculate the total temperature rise after 600 s.

Question 3 Calculating c

Use the readings after 600 s to calculate the specific heat capacity of aluminium.

Question 4 Graph method

Describe how a graph of energy (y-axis) against temperature (x-axis) gives c, and calculate the gradient from the first and last points.

Question 5 Comparing with the data book

The data book value is 900 J/(kg °C). Calculate the percentage difference between your result and 900.

Question 6 Why the value is too high

Explain why the measured value is higher than the book value and why insulation helps.

Question 7 Uncertainty

The thermometer is read to ± 0.5 °C. Estimate the percentage uncertainty in the rise of 30.2 °C.

Question 8 Improvements

Suggest two improvements that would give a more reliable value of c.