

Heating, melting and boiling: energy calculations

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

Model answers use the sample data. Your own values will differ a little, but the specific heat capacity should lie between 900 and 1100 J/(kg °C) with decent insulation. Always compare with the book value and explain the sign of the error.

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

Question 1 Energy values

$$E = P t = 48 \times 300 = 14\,400 \text{ J} = \mathbf{14.4 \text{ kJ}}.$$

Question 2 Temperature rise

$$50.2 - 20.0 = \mathbf{30.2 \text{ }^{\circ}\text{C}}.$$

Question 3 Calculating c

$$c = E / (m \Delta\theta) = 28\,800 / (1.00 \times 30.2) = 953.6 \approx \mathbf{950 \text{ J/(kg }^{\circ}\text{C)}} \text{ (2 s.f.)}.$$

Question 4 Graph method

The gradient is $\Delta E / \Delta\theta = m c$, so $c = \text{gradient} / m$. Gradient = $(28\,800 - 0) / (50.2 - 20.0) = 28\,800 / 30.2 = 954 \text{ J/}^{\circ}\text{C}$, giving $\mathbf{c \approx 950 \text{ J/(kg }^{\circ}\text{C)}}$.

Question 5 Comparing with the data book

$$(954 - 900) / 900 \times 100 = 6.0 \%, \text{ so the result is about } \mathbf{6 \% \text{ too high}}.$$

Question 6 Why the value is too high

Some energy escapes from the block to the air, so the block gains less energy than the 48 W supplied. The calculation assumes all the energy was gained, so it divides by a temperature rise that is too small and gives a value too large. Insulation reduces the loss and brings the result **closer to 900 J/(kg °C)**.

Question 7 Uncertainty

The rise uses two readings, so the uncertainty is about $\pm 1.0 \text{ }^{\circ}\text{C}$. $1.0 / 30.2 \times 100 \approx \mathbf{3.3 \%}$.

Question 8 Improvements

Wrap the block in thicker insulation (and put a lid on top) to reduce losses; continue heating for a few minutes after switching off to find the true maximum; use a joulemeter for the energy; **repeat and average**.