

Heating, melting and boiling: energy calculations

Physics grades 9-10 (GCSE · IGCSE · O Level · Class 9-10) · Test answers (mark scheme)

Award marks as indicated. Accept equivalent wording and follow-through from a wrong earlier value. Deduct one mark at most per question for a missing or wrong unit, and do not penalise sensible rounding to 2 or 3 significant figures.

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

Question 1 Definition (2 marks)

- a. The energy needed to raise the temperature of 1 kg of a substance by 1 °C.
- b. J/kg (joule per kilogram).

Marking: 1 mark each part. Accept J/(kg °C) for part a.

Question 2 Warming water (3 marks)

$$\Delta\theta = 63 - 18 = 45\text{ °C}; \Delta E = 1.8 \times 4200 \times 45 = 340\,200\text{ J} = \mathbf{3.4 \times 10^5\text{ J}}.$$

Marking: $\Delta\theta$ (1), substitution (1), answer with unit (1).

Question 3 Constant temperature (2 marks)

The energy supplied is used to overcome the forces between the particles and separate them to form steam, increasing their potential energy. It does not increase the average kinetic energy, so the temperature stays constant.

Marking: energy used to break bonds / separate particles (1); not to speed particles up so no temperature rise (1).

Question 4 Melting wax (3 marks)

$$L = E / m = 70\,000 / 0.35 = \mathbf{2.0 \times 10^5\text{ J/kg}}.$$

Marking: rearrangement (1), substitution (1), answer with unit (1).

Question 5 Reading the graph (4 marks)

- a. 80 °C.
- b. 140 °C.

c. $8 - 3 = 5$ minutes.

d. The liquid has a larger specific heat capacity, so the same energy per second raises its temperature more slowly (gradient = $P / (m c)$).

Marking: 1 mark each part.

Question 6 Kettle time (3 marks)

$$E = 4.0 \times 4200 \times 25 = 420\,000 \text{ J}; t = E / P = 420\,000 / 2500 = \mathbf{168 \text{ s}}.$$

Marking: energy (1), $t = E / P$ (1), answer with unit (1).

Question 7 Steam burns (2 marks)

When steam condenses on the skin it releases its latent heat ($2.26 \times 10^6 \text{ J/kg}$) as well as the energy released as the water cools. Boiling water only releases the second amount, so steam transfers much more energy.

Marking: steam condenses and releases latent heat (1); this is extra energy compared with water (1).

Question 8 Coolant (1 mark)

Water has a high specific heat capacity, so it absorbs a lot of energy for a small temperature rise.

Marking: 1 mark for high specific heat capacity.