Exercise walk-through

Specific Heat and Thermal Conductivity ▪ 9.5

eXercise

You must be able to

- use $Q = mc\Delta T$ with **specific heat** 比热容 to find the heat needed for a temperature change
- explain how **thermal conductivity** 热导率 governs the rate of heat transfer
- compare how different materials store and conduct thermal energy

Method — Specific heat

$Q = mc\Delta T$, where c is in J kg^{-1} K^{-1}. Water's large $c \approx 4200$ means it takes a lot of heat to warm up.

Method — Thermal conductivity

A **high** conductivity (metals) transfers heat quickly; a **low** conductivity (wood, air, foam) makes a good insulator.

Method — Example

To warm 2.0 kg of water by 10 K: $Q = 2.0 \times 4200 \times 10 = 8.4 \times 10^4$ J.

Practice 2.1 ▪ 2 marks

Find the heat needed to raise 0.50 kg of water by 20 K (take $c = 4200$ J kg^{-1} K^{-1}).

Solution 2.1

Method: Specific heat

Worked steps

$Q = mc\Delta T = 0.50 \times 4200 \times 20 = 4.2 \times 10^4$ J M1 A1.

Practice 2.2 ▪ 1 mark

State what a high thermal conductivity means for the rate of heat transfer.

Solution 2.2

Method: Thermal conductivity

Worked steps

heat is transferred quickly (a fast rate) B1.

Practice 2.3 ▪ 1 mark

Two blocks receive the same heat. State which has the greater temperature rise — the one with the larger or smaller specific heat.

Solution 2.3

Method: Specific heat

Worked steps

the one with the smaller specific heat B1.

Exam-style 3.1 ▪ 1 mark

The equation $Q = mc\Delta T$ gives the

A power

B heat transferred

C temperature

D conductivity

Solution 3.1

A power

B heat transferred ✓

C temperature

D conductivity

Worked steps

B.

Exam-style 3.2 ▪ 1 mark

A good thermal insulator has a

A high thermal conductivity

B low thermal conductivity

C high specific heat only

D zero mass

Solution 3.2

Method: Thermal conductivity

A high thermal conductivity

B low thermal conductivity ✓

C high specific heat only

D zero mass

Worked steps

B.

Exam-style 3.3 ▪ 3 marks

A 0.30 kg metal block ($c = 900$ J kg^{-1} K^{-1}) is heated from $20\,^{\circ}$C to $70\,^{\circ}$C.
(a) Find the heat needed.
(b) State the heat needed if the mass were doubled.

Solution 3.3

Method: Specific heat

Worked steps

(a) $Q = 0.30 \times 900 \times 50 = 1.35 \times 10^4$ J M1 M1 A1. (b) 2.7×10^4 J (double) B1.