Exercise walk-through

Heat Transfer and Thermal Equilibrium ▪ 6.3

eXercise

You must be able to

- state that heat flows from **hot to cold** until **thermal equilibrium** 热平衡
- apply conservation of energy ($q_{\text{lost}} = q_{\text{gained}}$)
- reason about the final temperature

Method — Heat flows hot to cold

When two objects touch, heat flows from the **hotter** to the **cooler** one until they reach the **same temperature** — thermal equilibrium. Then net heat flow stops.

Method — Conservation of energy

In an isolated system, the heat **lost** by the hot object equals the heat **gained** by the cold object:

$$q_{\text{lost}} = q_{\text{gained}} \quad \text{(equal magnitudes, opposite signs).}$$

Method — A worked direction

Drop a hot metal into cool water: the metal cools (loses heat), the water warms (gains the same heat), and both settle at one final temperature between the two starting values.

Method — Where the final temperature lands

The final temperature is **closer** to the object with the larger heat capacity (more mass or higher specific heat) — it changes temperature less for the same heat.

Practice 2.1 ▪ 1 mark

In which direction does heat flow between a hot and a cold object?

Solution 2.1

Worked steps

From hot to cold B1.

Practice 2.2 ▪ 1 mark

What is thermal equilibrium?

Solution 2.2

Method: Heat flows hot to cold

Worked steps

When both objects reach the same temperature and net heat flow stops B1.

Practice 2.3 ▪ 1 mark

If a hot metal loses 500 J to water (isolated), how much does the water gain?

Solution 2.3

Method: A worked direction

Worked steps

500 J B1.

Exam-style 3.1 ▪ 1 mark

Two objects reach thermal equilibrium when they have the same

A mass

B temperature

C heat capacity

D volume

Solution 3.1

Method: Heat flows hot to cold

A mass

B temperature ✓

C heat capacity

D volume

Worked steps

B — the same temperature.

Exam-style 3.2 ▪ 1 mark

A 200 g block of hot metal is placed in 200 g of cool water.
(a) State the direction of heat flow.
(b) Explain why the final temperature is closer to the water's starting temperature (water has a higher specific heat).

Solution 3.2

Method: A worked direction

Worked steps

(a) From the hot metal to the cool water B1. (b) Water's higher specific heat means it takes more energy to change its temperature, so it warms less than the metal cools — the final temperature ends up nearer the water's start M1 A1.

Exam-style 3.3 ▪ 2 marks

Write the energy-conservation equation relating the heat lost by the metal to the heat gained by the water.

Solution 3.3

Method: Conservation of energy

Worked steps

$q_{\text{metal}} = -q_{\text{water}}$ (the heat lost by the metal equals the heat gained by the water) M1 A1.