Exercise walk-through

Heat Capacity and Calorimetry ▪ 6.4

eXercise

You must be able to

- use $q = mc\Delta T$
- carry out a **calorimetry 量热法** calculation
- find a specific heat or a heat of reaction from data

Method — The heat equation

$$q = mc\Delta T,$$

where q is heat (J), m mass (g), c **specific heat 比热容** (J $g^{-1}{}^{\circ}C^{-1}$), and $\Delta T = T_{\text{final}} - T_{\text{initial}}$.

Method — A worked heat

Heat 50 g of water ($c = 4.18$) from 20 to 30°C:

$$q = (50)(4.18)(10) = 2090 \text{ J}.$$

Method — Calorimetry

In a calorimeter, the heat released by a reaction is absorbed by the water: $q_{\text{reaction}} = -q_{\text{water}} = -mc\Delta T$. Measure the water's temperature change to find the reaction's heat.

Method — Heat of reaction per mole

Divide the total heat by the moles reacted to get ΔH **per mole**: $\Delta H = \frac{q}{n}$ (with the right sign — negative if the water warmed).

Practice 2.1 ▪ 2 marks

Write the equation $q = mc\Delta T$ and name each symbol.

Solution 2.1

Method: The heat equation

Worked steps

q heat, m mass, c specific heat, ΔT temperature change B1 B1 *equation, symbols.*

Practice 2.2 ▪ 2 marks

Find the heat to warm 100 g of water ($c = 4.18$) by $5.0°$C.

Solution 2.2

Method: A worked heat

Worked steps

$q = (100)(4.18)(5.0) = 2090$ J M1 A1.

Practice 2.3 ▪ 1 mark

In a calorimeter the water warms. Was the reaction exo- or endothermic?

Solution 2.3

Method: Calorimetry

Worked steps

Exothermic (it released heat to the water) B1.

Exam-style 3.1 ▪ 1 mark

In $q = mc\Delta T$, ΔT is

A $T_{\text{initial}} - T_{\text{final}}$

B $T_{\text{final}} - T_{\text{initial}}$

C the average temperature

D always positive

Solution 3.1

A $T_{\text{initial}} - T_{\text{final}}$

B $T_{\text{final}} - T_{\text{initial}}$ ✓

C the average temperature

D always positive

Worked steps

B — $T_{\text{final}} - T_{\text{initial}}$.

Exam-style 3.2 ▪ 2 marks

A reaction in a calorimeter warms 200 g of water ($c = 4.18$) by 6.0°C.
(a) Find the heat absorbed by the water.
(b) State q for the reaction (sign and value).

Solution 3.2

Method: Calorimetry

Worked steps

(a) $q = (200)(4.18)(6.0) = 5016$ J ≈ 5.0 kJ M1 A1. (b) $q_{\text{reaction}} = -5.0$ kJ (exothermic) M1 A1.

Exam-style 3.3 ▪ 4 marks

Burning 0.50 g of a fuel raises 100 g of water ($c = 4.18$) by $10.0°$C. Find the heat released per gram of fuel.

Solution 3.3

Worked steps

$q_{\text{water}} = (100)(4.18)(10.0) = 4180$ J (M1)(M1); heat released $= 4180$ J for 0.50 g (M1); per gram $= 4180/0.50 = 8360$ J/g (A1).