

Exercise walk-through

6.3

Heat Transfer and Thermal Equilibrium

AP Chemistry

Endothermic and exothermic

Energy flows between the
system and its
surroundings :

exothermic : releases energy (warms)

endothermic : absorbs energy (cools)



*Endothermic packs absorb heat from
surroundings*

Calorimetry

Specific heat c warms 1 g by 1°:

Heat transferred

$$q = mc\Delta T$$

Calorimetry : an isolated system, so

$$q_{\text{rxn}} = -q_{\text{water}}.$$

Worked example

100 g water warms 5.0°:

$$q = 100(4.18)(5.0) = 2090 \text{ J}$$

The reaction released -2090 J – exothermic. For 0.010 mol: $\Delta H = -209 \text{ kJ/mol}$.

Heat, equilibrium, and the enthalpies

heat

flows from **hot to cold** until objects reach **thermal equilibrium**

equilibrium means

equal temperature – not equal energy, and not no motion

enthalpy of reaction

ΔH_{rxn} – the heat released or absorbed at constant pressure

the sign

negative for exothermic, positive for endothermic

standard enthalpy of formation

ΔH_f° – one mole of a compound from its elements in their standard states

why it is useful

$$\Delta H_{\text{rxn}} = \sum \Delta H_f^\circ(\text{products}) - \sum \Delta H_f^\circ(\text{reactants})$$

An element in its standard state has $\Delta H_f^\circ = 0$ **by definition**. Forgetting that is what breaks the subtraction.

Exercises 2.1-2.3

2.1 In which direction does heat flow between a hot and a cold object? [1]

2.2 What is thermal equilibrium? [1]

2.3 If a hot metal loses 500 J to water (isolated), how much does the water gain? [1]

Exercises 2.1-2.3

2.1 In which direction does heat flow between a hot and a cold object? [1]

2.1

- From hot to cold
-

2.2 What is thermal equilibrium? [1]

2.2

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

2.3 If a hot metal loses 500 J to water (isolated), how much does the water gain? [1]

2.3

- 500 J

Exercise 3.1

3.1 Two objects reach thermal equilibrium when they have the same

[1]

☐

A mass

B temperature

C heat capacity

D volume

Exercise 3.1

3.1 Two objects reach thermal equilibrium when they have the same

[1]

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A mass

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3.1 B

- the same temperature

Exercise 3.2 (a)

3.2 A 200 g block of hot metal is placed in 200 g of cool water.

(a) State the direction of heat flow.

[1]

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(a) State the direction of heat flow.

[1]

(a)

- From the hot metal to the cool water

Exercise 3.2 (b)

3.2 A 200 g block of hot metal is placed in 200 g of cool water.

(b) Explain why the final temperature is closer to the water's starting temperature (water has a higher specific heat). [2]

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(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

Exercise 3.3

3.3 Write the energy-conservation equation relating the heat lost by the metal to the heat gained by the water. [2]

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3.3

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