AP CHEMISTRY • EXERCISE SHEET

6.3 Heat Transfer and Thermal Equilibrium

Name: _____ Class: _____ Date: _____ **Total: 9 marks**

Objective

Build the skills to answer exam questions on **heat transfer and thermal equilibrium**.

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

1 Worked examples

Study these first. Each one shows the method for a question type used later —follow the steps and you can do the Practice and Exam-style questions yourself.

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.

Conservation of energy

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

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

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.

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.

2 Practice

Now apply the methods above.

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]

3 Exam-style questions

3.1 Two objects reach thermal equilibrium when they have the same [1]

- **A** mass
- **B** temperature
- **C** heat capacity
- **D** volume

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]

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

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

4 Go further

You are now ready for the real exam questions on this subtopic:

- work through the **6.3 Heat Transfer and Thermal Equilibrium** lesson on the **Learn** page;
- read the **Heat Transfer and Thermal Equilibrium** section of the AP Chemistry handout on the **Know** page.

Solutions

2.1 From hot to cold.

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

2.3 500 J.

3.1 B —the same temperature.

3.2 (a) From the hot metal to the cool water. (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.

3.3 $q_{\text{metal}} = -q_{\text{water}}$ (the heat lost by the metal equals the heat gained by the water).