

14.1 Thermal equilibrium

Name: _____ Class: _____ Date: _____

Total: 19 marks

KEY WORDS temperature 温度 • thermal equilibrium 热平衡 • thermal energy 热能 • heat 热量
• energy 能量

Objective

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

You must be able to:

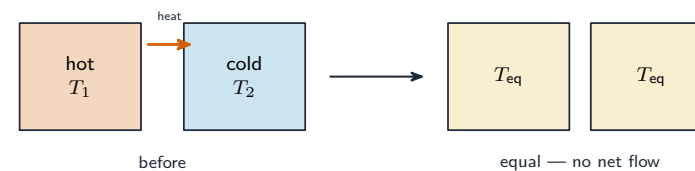
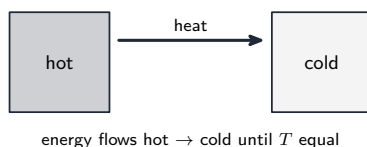
- state that thermal energy flows from **higher** to **lower** temperature
- explain **thermal equilibrium** and that temperature is not the same as thermal energy

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 flow and equilibrium

Thermal energy flows from **hot to cold**. When two bodies touch, energy moves until their temperatures are equal — **thermal equilibrium**, with **no net** energy flow:



Heat flows until thermal equilibrium

Temperature decides the **direction** of flow — it is **not** how much thermal energy a body holds. A cup of boiling water holds far less energy than a warm swimming pool, but heat still flows **from** the cup **to** a cooler object.

2 Practice

Now apply the methods above.

2.1 State the direction in which thermal energy flows. [1]

2.2 State what is meant by **thermal equilibrium**. [2]

2.3 Two objects at the **same temperature** are in contact. State the **net** flow of energy between them. [1]

3 Exam-style questions

3.1 State what is meant by two objects being in **thermal equilibrium**. [2]

3.2 Explain why a small cup of boiling water ($100\text{ }^{\circ}\text{C}$) may hold **less** thermal energy than a swimming pool at $25\text{ }^{\circ}\text{C}$. [2]

3.3 Thermal energy flows from object A to object B. This tells you that: [1]

- | | |
|---|---|
| A | B |
| C | D |
- A** A is at a higher temperature than B
B B is at a higher temperature than A
C A and B are at the same temperature
D A contains more thermal energy than B

3.4 Two blocks, P and Q, are made of the same metal. P has mass 0.50 kg and is at $80\text{ }^{\circ}\text{C}$; Q has mass 1.5 kg and is at $20\text{ }^{\circ}\text{C}$. They are placed in contact inside a perfectly insulating box.

(a) **State**, with a reason, the direction of the net flow of thermal energy at the moment they touch. [2]

(b) **Explain**, in terms of the molecules, what “thermal equilibrium” means for these two blocks, and what is true of their temperatures when it is reached. [3]

(c) The specific heat capacity of the metal is $390\text{ J kg}^{-1}\text{ K}^{-1}$. **Determine** the final temperature of the two blocks. [3]

(d) **State and explain** whether the two blocks hold equal amounts of internal energy once they are in thermal equilibrium. [2]
