Exercise walk-through

Energy of Phase Changes ▪ 6.5

eXercise

You must be able to

- use the **heat of fusion 熔化热** and **heat of vaporization 汽化热**
- explain the flat plateaus on a heating curve
- combine heating and phase-change steps

Method — Phase-change energy

Melting and boiling require energy to overcome intermolecular forces, at **constant temperature**:

$$q = n\,\Delta H_{\text{fus}} \quad \text{(melting)}, \qquad q = n\,\Delta H_{\text{vap}} \quad \text{(boiling)}.$$

Method — Why the temperature is flat

During a phase change the added energy goes into **separating particles**, not raising their kinetic energy — so the temperature holds steady (the plateau on a heating curve).

Method — Combining steps

To take ice below 0°C to steam, add up: warm ice ($mc\Delta T$) + melt ($n\Delta H_{\text{fus}}$) + warm water ($mc\Delta T$) + boil ($n\Delta H_{\text{vap}}$) + warm steam.

Method — A worked plateau

Boiling always needs **more** energy than melting for the same substance ($\Delta H_{\text{vap}} > \Delta H_{\text{fus}}$), because boiling fully separates the particles.

Practice 2.1 ▪ 1 mark

During melting, what happens to the temperature?

Solution 2.1

Worked steps

It stays constant B1.

Practice 2.2 ▪ 1 mark

Write the equation for the heat to melt n moles of a solid.

Solution 2.2

Worked steps

$q = n\,\Delta H_{\text{fus}}$ B1.

Practice 2.3 ▪ 1 mark

Which needs more energy per mole: melting or boiling (same substance)?

Solution 2.3

Method: A worked plateau

Worked steps

Boiling B1.

Exam-style 3.1 ▪ 1 mark

During a phase change, added energy goes into

A raising the temperature

B overcoming intermolecular forces

C breaking covalent bonds

D speeding up the particles

Solution 3.1

Method: Why the temperature is flat

A raising the temperature

B overcoming intermolecular forces ✓

C breaking covalent bonds

D speeding up the particles

Worked steps

B — overcoming intermolecular forces.

Exam-style 3.2 ▪ 2 marks

2.0 mol of ice melts. $\Delta H_{\text{fus}} = 6.0$ kJ/mol.
(a) Find the heat needed.
(b) State what happens to the temperature during melting.

Solution 3.2

Method: Phase-change energy

Worked steps

(a) $q = (2.0)(6.0) = 12$ kJ M1 A1. (b) The temperature stays constant (at the melting point) B1.

Exam-style 3.3 ▪ 2 marks

Explain why the boiling plateau on a heating curve is longer than the melting plateau for the same substance and heating rate.

Solution 3.3

Method: A worked plateau

Worked steps

Boiling requires more energy ($\Delta H_{\text{vap}} > \Delta H_{\text{fus}}$) because it fully separates the particles, so at the same heating rate it takes longer, giving a longer plateau **M1** **A1**.