Exercise walk-through

Solids, Liquids, and Gases ▪ 3.3

eXercise

You must be able to

- describe particle arrangement, motion, and spacing in each state
- explain state changes in terms of energy and IMFs
- read a **heating curve** **加热曲线**

Method — The three states

- **Solid** — particles packed close in a fixed arrangement, vibrating in place.
- **Liquid** — particles close but free to move past each other.
- **Gas** — particles far apart, moving fast and randomly, filling the container.

Method — State changes and energy

Adding energy loosens the particles: solid → liquid (melting) → gas (boiling). Energy goes into **overcoming IMFs**, not raising temperature, during a change of state.

Method — The heating curve

On a temperature-vs-time graph of steady heating, the **flat plateaus** are the melting and boiling points: temperature stays constant while the state changes (energy breaks IMFs). The sloped parts warm a single state.

Method — Which state at a temperature

Compare the temperature to the melting and boiling points. Below the melting point $\rightarrow$ solid; between $\rightarrow$ liquid; above the boiling point $\rightarrow$ gas.

Practice 2.1 ▪ 1 mark

In which state are particles far apart and fast-moving?

Solution 2.1

Method: The three states

Worked steps

Gas B1.

Practice 2.2 ▪ 1 mark

On a heating curve, what is happening during a flat plateau?

Solution 2.2

Method: The heating curve

Worked steps

A change of state (melting or boiling) at constant temperature B1.

Practice 2.3 ▪ 1 mark

A substance melts at $0°$C and boils at $100°$C. State its state at $50°$C.

Solution 2.3

Worked steps

Liquid B1.

Exam-style 3.1 ▪ 1 mark

During boiling, the energy added is used to

A raise the temperature

B overcome intermolecular forces

C break covalent bonds

D create new atoms

Solution 3.1

Method: State changes and energy

A raise the temperature

B overcome intermolecular forces ✓

C break covalent bonds

D create new atoms

Worked steps

B — energy overcomes the intermolecular forces to separate the particles.

Exam-style 3.2 ▪ 2 marks

A heating curve for a pure substance shows two flat plateaus.
(a) What do the two plateaus represent?
(b) Why does the temperature stay constant during each?

Solution 3.2

Method: The heating curve

Worked steps

(a) The melting point and the boiling point M1 A1. (b) The added energy goes into overcoming intermolecular forces (changing state), not into raising the kinetic energy/temperature M1 A1.

Exam-style 3.3 ▪ 2 marks

Explain, in terms of particle spacing and forces, why gases are much easier to compress than liquids.

Solution 3.3

Worked steps

In a gas the particles are far apart with large empty spaces and negligible forces, so they can be pushed closer; in a liquid the particles are already touching, leaving little room to compress M1 A1.