

3.3 Solids, Liquids, and Gases

Name: _____ Class: _____ Date: _____

Total: 10 marks

Objective

Build the skills to answer exam questions on **solids, liquids, and gases** —the particle picture of the three states.

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

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.

■ 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.

■ 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.

■ 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.

■ Which state at a temperature

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

2 Practice

Now apply the methods above.

2.1 In which state are particles far apart and fast-moving? [1]

2.2 On a heating curve, what is happening during a flat plateau? [1]

2.3 A substance melts at 0°C and boils at 100°C . State its state at 50°C . [1]

3 Exam-style questions

3.1 During boiling, the energy added is used to [1]

- **A** raise the temperature
- **B** overcome intermolecular forces
- **C** break covalent bonds
- **D** create new atoms

3.2 A heating curve for a pure substance shows two flat plateaus.

(a) What do the two plateaus represent? [2]

(b) Why does the temperature stay constant during each? [2]

3.3 Explain, in terms of particle spacing and forces, why gases are much easier to compress than liquids. [2]

4 Go further

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

- work through the **3.3 Solids, Liquids, and Gases** lesson on the **Learn** page;
- read the **Solids, Liquids, and Gases** section of the AP Chemistry handout on the **Know** page.

Solutions

2.1 Gas.

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

2.3 Liquid.

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

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

3.3 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.