

Exercise walk-through

Structure of Ionic Solids ■ 2.3

eXercise

You must be able to

- describe an ionic solid as a **lattice** 晶格 of alternating + and – ions
- explain properties (high melting point, brittle, conducts only when molten/dissolved) from the structure
- link **lattice energy** 晶格能 to ion charge and size

Method — The ionic lattice

An ionic solid is a giant regular array (**lattice**) of cations and anions, each surrounded by ions of opposite charge. Strong electrostatic forces act in all directions.

Method — Properties from structure

- **High melting point** — many strong ionic attractions must be broken.
- **Brittle** — a shifted layer puts like charges together, and they repel, cracking the crystal.
- **Conducts electricity only when molten or dissolved** — ions are then free to move; in the solid they are locked in place.

Method — Lattice energy

The **lattice energy** (energy to separate the ions) rises with **larger ion charges** and **smaller ion sizes** ($E \propto \frac{q_1 q_2}{r}$). MgO has a much larger lattice energy than NaCl.

Method — Predicting melting point

More lattice energy → higher melting point. Compare compounds by their ion charges first, then their sizes.

Practice 2.1 ■ 1 mark

Why do ionic solids have high melting points?

Solution 2.1

Method: Properties from structure

Worked steps

Many strong electrostatic attractions between oppositely charged ions must be overcome **B1**.

Practice 2.2 ■ 2 marks

Why does solid NaCl not conduct electricity, but molten NaCl does?

Solution 2.2

Method: Properties from structure

Worked steps

In the solid the ions are fixed in the lattice and cannot move; when molten the ions are free to move and carry charge **M1** **A1**.

Practice 2.3 ■ 2 marks

State two factors that increase lattice energy.

Solution 2.3

Worked steps

Larger ion charges; smaller ion sizes **B1** **B1**.

Exam-style 3.1 ■ 1 mark

An ionic solid conducts electricity when

- A** solid
- B** molten or dissolved in water
- C** cooled
- D** never

Solution 3.1

Method: Properties from structure

- A solid
- B molten or dissolved in water
- C cooled
- D never



Worked steps

B — when molten or dissolved, so the ions can move.

Exam-style 3.2 ■ 2 marks

Compare NaF and MgO.

- (a) State which has the larger lattice energy, with a reason.
- (b) Predict which has the higher melting point.

Solution 3.2

Method: Predicting melting point

Worked steps

(a) MgO — its ions have charges $2+ / 2-$ vs $1+ / 1-$ for NaF , giving a much larger lattice energy **M1** **A1**. (b) MgO **B1**.

Exam-style 3.3 ■ 2 marks

Explain why ionic solids are brittle, in terms of what happens when a layer of ions is shifted.

Solution 3.3

Method: Properties from structure

Worked steps

Shifting a layer brings ions of the **same** charge next to each other; they repel, so the crystal splits **M1** **A1**.