AP CHEMISTRY • EXERCISE SHEET

2.3 Structure of Ionic Solids

Name: _____ Class: _____ Date: _____ **Total: 11 marks**

Objective

Build the skills to answer exam questions on the **structure of ionic solids**.

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

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 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.

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.

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.

Predicting melting point

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

2 Practice

Now apply the methods above.

2.1 Why do ionic solids have high melting points? [1]

2.2 Why does solid NaCl not conduct electricity, but molten NaCl does? [2]

2.3 State two factors that increase lattice energy. [2]

3 Exam-style questions

3.1 An ionic solid conducts electricity when [1]

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

3.2 Compare NaF and MgO.

(a) State which has the larger lattice energy, with a reason. [2]

(b) Predict which has the higher melting point. [1]

3.3 Explain why ionic solids are brittle, in terms of what happens when a layer of ions is shifted. [2]

4 Go further

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

- work through the **2.3 Structure of Ionic Solids** lesson on the **Learn** page;
- read the **Structure of Ionic Solids** section of the AP Chemistry handout on the **Know** page.

Solutions

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

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

2.3 Larger ion charges; smaller ion sizes.

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

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

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