Properties of ionic compounds

4.2.2.3 · Bonding, structure and the properties of matter · revision notes

Why ionic compounds have high melting and boiling points, and why they conduct electricity only when melted or dissolved in water. These are classic 2 to 4 mark 'explain' questions, and they often appear alongside metals and covalent substances in comparison questions.

Key facts

- Ionic compounds: high melting and boiling points; solids at room temperature
- Solid: does not conduct (ions fixed in place, can only vibrate)
- Ionic compounds conduct by moving ions, not electrons
- Reason: many strong electrostatic forces between oppositely charged ions → lots of energy to overcome
- Molten or dissolved: conducts (ions free to move and carry charge)
- Grade 8+ only Bigger charges on the ions → stronger attraction → higher melting point (MgO higher than NaCl)

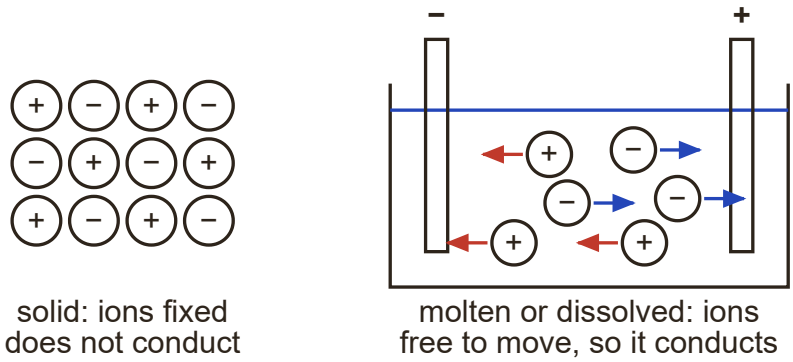
Notes

High melting and boiling points

- Ionic compounds are **giant ionic lattices** with **strong electrostatic forces of attraction** between oppositely charged ions, acting in all directions.
- To melt or boil the compound, these forces must be overcome. There are a very large number of strong forces, so a **large amount of energy** is needed.
- So ionic compounds have **high melting and boiling points** and are solids at room temperature. For example, sodium chloride melts at 801 °C.
- The bigger the charges on the ions, the stronger the attraction between them. Magnesium oxide (Mg^{2+} and O^{2-} ions) has a much higher melting point than sodium chloride (Na^{+} and Cl^{-} ions). Grade 8+ only

Conducting electricity

- To conduct electricity, a substance must contain **charged particles that are free to move**.
- In a **solid** ionic compound the ions are held in fixed positions in the lattice. They can only vibrate, so the solid **does not conduct**.
- When the compound is **melted** or **dissolved in water**, the ions are **free to move**, so they can carry charge through the liquid or solution: it **conducts**.



Ions can only carry charge when they are free to move.

- In ionic compounds it is the **ions** that move and carry the charge, not electrons. This is the basis of electrolysis.

Using the ideas

- A substance with a high melting point that conducts only when molten or dissolved is likely to be ionic.
- Compare with metals, which conduct when solid because their delocalised electrons can move, and with small molecules, which never conduct.

How to answer each type of question

Explain why an ionic compound has a high melting point 3 marks **Grade 5**

1. Name the structure: a giant ionic lattice.
2. Name the forces: strong electrostatic forces of attraction between oppositely charged ions.
3. Link: a lot of energy is needed to overcome these forces.

Example. Potassium chloride has a melting point of 770 °C.
Explain why potassium chloride has a high melting point.

Model answer. It has a giant ionic lattice (1). There are strong electrostatic forces of attraction between the oppositely charged K^+ and Cl^- ions (1). A large amount of energy is needed to overcome these forces (1).

Identify an ionic compound from data

2 to 3 marks | Grade 5

1. Look for a high melting point.
2. Look for 'conducts when molten or dissolved, but not when solid'.
3. Give the answer and quote the evidence.

Example. The table gives information about three substances.

Substance	Melting point in °C	Conducts when solid?	Conducts when liquid (molten)?
P	993	no	yes
Q	1085	yes	yes
R	−95	no	no

Which substance is ionic? Give two reasons for your answer.

Model answer. P (1). It has a high melting point (1). It conducts when molten but not when solid (1).

Explain when an ionic compound conducts electricity

3 marks | Grade 5

1. Solid: the ions are in fixed positions, so they cannot move.
2. Molten or dissolved: the ions are free to move.
3. So the ions can carry charge through the liquid or solution.

Example. Solid sodium chloride does not conduct electricity, but sodium chloride solution does. Explain why.

Model answer. In the solid, the ions are held in fixed positions in the lattice, so they cannot move (1). In the solution, the ions are free to move (1) and carry charge through the solution (1).

Compare the melting points of two ionic compounds

3 marks | Grade 8

1. Compare the charges on the ions in each compound.
2. Bigger charges mean stronger electrostatic forces of attraction.
3. Stronger forces need more energy to overcome.

Example. Magnesium oxide melts at about 2800 °C. Sodium chloride melts at 801 °C. Explain the difference in melting points.

Model answer. Magnesium ions (2+) and oxide ions (2−) have bigger charges than sodium ions (1+) and chloride ions (1−) (1). So the electrostatic forces of attraction between the ions in magnesium oxide are stronger (1). More energy is needed to overcome them (1).

Don’t lose marks

- Saying ionic compounds conduct because of free or delocalised electrons. It is the ions that move.
- Saying the ions are free to move in the solid, or that solid ionic compounds conduct.
- Writing only 'strong bonds'. Say what they are: electrostatic forces of attraction between oppositely charged ions.
- Mentioning intermolecular forces for an ionic compound. There are no molecules.
- Saying 'it takes a lot of energy to break' without saying what is being overcome.

More tips

Memory tricks

- Ionic conduction: solid, no; molten or aqueous, yes. The ions have to be free to move.
- Three-step melting point answer: structure → forces → energy.
- Ask 'what is moving?': electrons in metals, ions in molten or dissolved ionic compounds.

Exam technique

- Learn the full chain for high melting points: giant lattice, strong electrostatic forces between oppositely charged ions, lots of energy needed to overcome them.
- If asked why it conducts when molten but not when solid, cover both states.
- Say 'free to move', not just 'move': the key idea is that the ions can move through the substance.

What each grade needs

What you need to be able to do, from the first marks up to the top grade.

Grade 3

State that ionic compounds have high melting points

Ionic compounds such as sodium chloride are solids at room temperature with high melting and boiling points.

Grade 4

State when ionic compounds conduct electricity

When melted (molten) or dissolved in water, but not when solid.

Grade 5

Explain high melting points using electrostatic forces

A lot of energy is needed to overcome the many strong electrostatic forces between oppositely charged ions.

Grade 5

Explain conduction in terms of moving ions

When molten or dissolved, the ions are free to move and carry charge; in the solid they are held in fixed positions.

Grade 8

Compare melting points using the charges on ions

Ions with bigger charges (e.g. Mg^{2+} and O^{2-}) attract each other more strongly, so more energy is needed to separate them.

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