3.3 Metallic bonding

Name: _____ Class: _____ Date: _____ **Total: 12 marks**

KEY WORDS delocalised electrons • metallic bonding • electron • ion • electrostatic attraction

Objective

Build the skills to answer exam questions on **metallic bonding** – defining it and using it to explain the properties of metals.

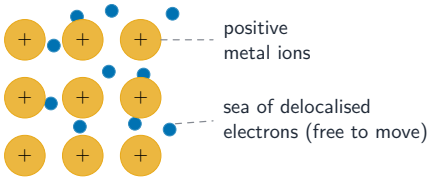
You must be able to:

- define metallic bonding as the attraction between positive metal ions and delocalised electrons
- use it to explain electrical conductivity and strength

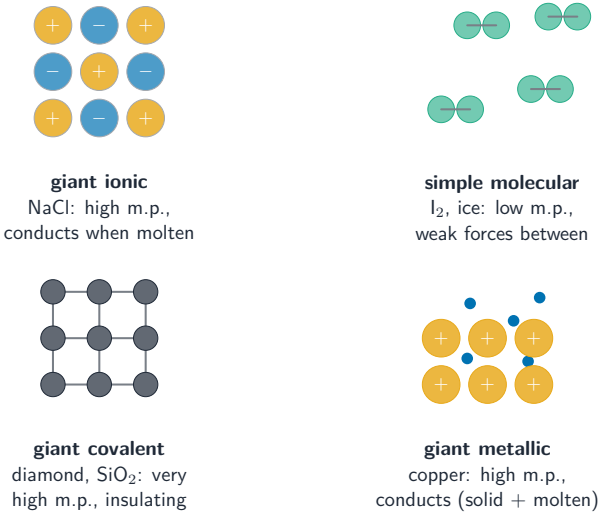
1 Key knowledge and worked examples

■ Metallic bonding

Metallic bonding is the **electrostatic attraction** between positive metal ions and a "sea" of **delocalised electrons** .



Positive metal ions sit in a sea of delocalised electrons that are free to move

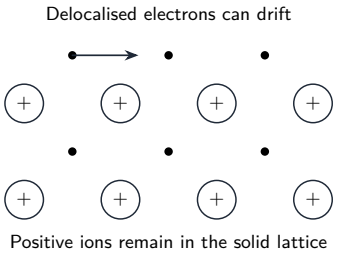


The metallic lattice among the four structures

The free electrons explain why metals **conduct electricity** (the electrons move and carry charge) and are **strong** (the attraction acts throughout the lattice).

■ Worked application: Explain charge movement without moving the lattice

A solid metal conducts because delocalised electrons can drift through its lattice when a potential difference is applied. The positive metal ions remain in their lattice positions, apart from vibration; they are not the moving charge carriers in the solid. Under a force, layers of ions can slide while attraction to the delocalised electrons remains, explaining malleability. Do not use the ionic-solid argument that sliding necessarily brings like-charged ions together and breaks the crystal: metallic attraction is not restricted to one neighbouring ion pair. An alloy can impede layer movement when differently sized atoms disturb the regular arrangement.



2 Practice

2.1 Define **metallic bonding**. [2]

2.2 Name the particles that carry charge when a metal conducts electricity. [1]

3 Exam-style questions

3.1 Metals conduct electricity because they contain: [1]

- **A** oppositely charged ions
- **B** delocalised electrons that are free to move
- **C** shared pairs of electrons
- **D** weak intermolecular forces

3.2 Explain, in terms of metallic bonding, why metals are good conductors of electricity. [2]

3.3 Magnesium has a higher melting point than sodium. Suggest why, in terms of metallic bonding. [2]

3.4 A metal wire carries current and can be bent without shattering. Explain both properties using metallic structure and identify which particles carry the current. [4]

Solutions

Each answer shows the steps, then the **result**.

2.1

- the electrostatic attraction between positive metal ions and delocalised (sea of) electrons

2.2

- delocalised electrons

3.1 B

- Delocalised electrons are free to move and carry charge

3.2

- the delocalised electrons are free to move through the metal; they carry charge when a voltage is applied

3.3

- magnesium ions have a 2+ charge (vs 1+ for sodium) and contribute more delocalised electrons; the stronger attraction needs more energy to break, so a higher melting point

3.4

Delocalised electrons are mobile and carry charge through the solid under an applied potential difference; metal-ion layers can slide while attraction between positive ions and delocalised electrons remains.