8.1 The metallic model

Name: _____ Class: _____ Date: _____ **Total: 25 marks**

KEY WORDS metallic bond • delocalized electrons • cation • malleable • ductile • transition element

Objective

Build the skills to answer exam questions on **the metallic model** : metallic bonding, the properties of metals and what makes a metallic bond strong.

You must be able to:

- describe metallic bonding as cations in a sea of delocalized electrons
- explain electrical and thermal conductivity, malleability and ductility
- explain trends in melting point using ion charge, ion radius and the number of delocalized electrons
- explain the high melting points and conductivity of transition elements using delocalized d electrons

1 Key knowledge and worked examples

■ Metallic bonding

A metal is a lattice of **cations** in a "sea" of **delocalized electrons**. The **metallic bond** is the electrostatic attraction between the cations and the delocalized electrons.

property	reason
conducts electricity	delocalized electrons move through the lattice when a voltage is applied
conducts heat	delocalized electrons (and vibrating cations) pass on kinetic energy
malleable and ductile	layers of cations can slide; the delocalized electrons still hold them together
high melting point (usually)	strong attraction between cations and electrons in all directions

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Bond strength rises with a higher cation charge (more delocalized electrons) and a smaller cation radius.

metal	**Na**	**Mg**	**Al**	**K**
melting point / °C	98	650	660	63

Transition elements (HL): both 4s and 3d electrons can be delocalized, so there are many delocalized electrons per atom: high melting points and good conductivity.

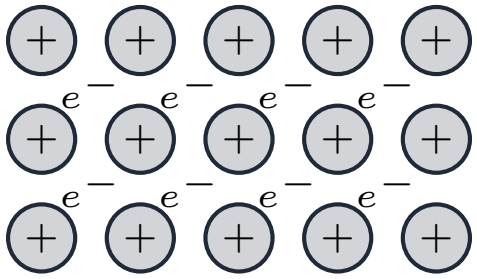
Worked example 1: size. Li (181 °C) melts higher than Na (98 °C): Li^+ is **smaller**, so its delocalized electrons are closer and attracted more strongly.

Worked example 2: a use. Copper is used for wires because it is **ductile** and a **very good conductor**.

Answer shapes: link each property to the delocalized electrons or to the cations.

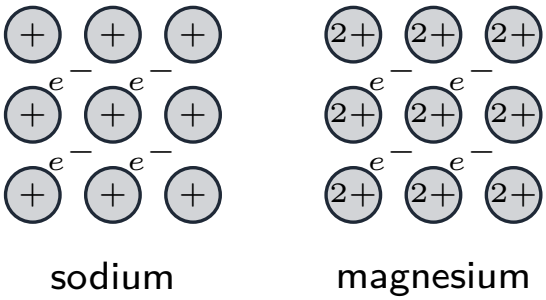
2 Practice

2.1 Describe the bonding in a metal. [2]

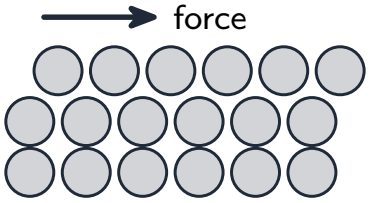


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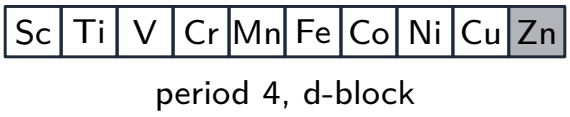
2.2 Magnesium melts at 650 °C and sodium at 98 °C. Explain the difference. [3]



2.3 Explain why copper can be drawn into wires, and why it conducts electricity. [3]

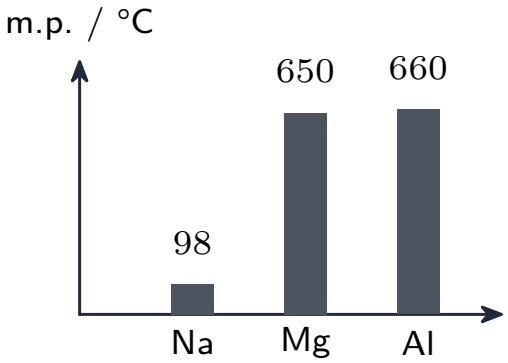


2.4 Explain why zinc is not a transition element, although it is in the d-block. [2]



3 Exam-style questions

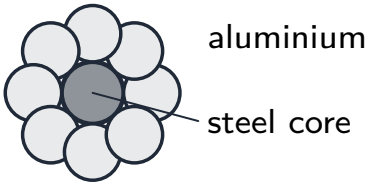
3.1 The graph shows the melting points of sodium, magnesium and aluminium.



(a) Describe and explain the trend from sodium to aluminium. [3]

(b) Potassium melts at 63 °C. Explain why it melts at a lower temperature than sodium. [2]

3.2 Overhead power cables are made of aluminium around a steel core. House wiring is made of copper.



(a) State two properties of aluminium that make it suitable for overhead cables. [2]

(b) Explain, in terms of bonding, why aluminium conducts electricity. [2]

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(c) Suggest why aluminium, not copper, is used for overhead cables. [1]

(d) Explain why metals are good conductors of heat. [2]

(e) Chromium melts at 1907 °C and calcium at 842 °C. Both are in period 4. Explain the difference. [3]

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