

The metallic model

Structure 2.3 · SL and AHL

Why can a copper wire bend and conduct?

One picture explains both properties of metals.

- Copper conducts cold or red hot, and bends without shattering.
- An ionic crystal conducts only when molten, and shatters.
- This unit: the bond $\rightarrow$ properties $\rightarrow$ bond strength $\rightarrow$ transition metals.

Cations in a sea of electrons

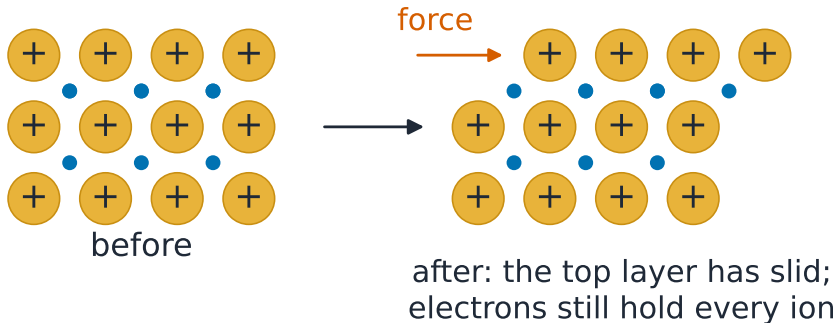
- Metal atoms lose outer electrons easily (low ionization energy).
- The cations sit in a **lattice**; the electrons are delocalized.
- There are no anions, and the bonding is **non-directional**.

Metallic bond the electrostatic attraction between a lattice of cations and delocalized electrons

Each property from the model

Property	Explanation
electrical conductivity	delocalized electrons move when a voltage is applied
thermal conductivity	electrons pass kinetic energy quickly through the metal
malleability , ductility	layers slide; electrons move with them
high melting point	strong attraction in a giant lattice

Why metals bend instead of shattering

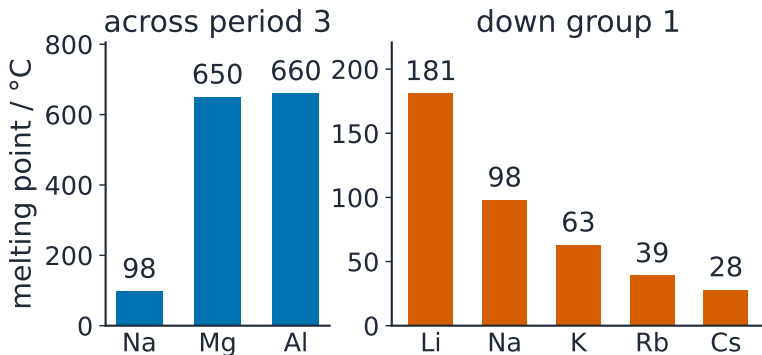


Non-directional bonding means a shifted layer is held as strongly as before.

Metals against ionic compounds

	Metal	Ionic compound
particles	cations, electrons	cations, anions
solid conducts	yes, electrons	no, ions fixed
molten conducts	yes, electrons	yes, ions
a blow	layers slide, bends	like charges meet, shatters

Charge and size set the strength



A stronger metallic bond means a higher melting and boiling point.

Worked example: Mg against Na

- 1 Structure.** Both are giant metallic lattices; melting overcomes metallic bonding.
- 2 Ions.** Mg^{2+} has a higher charge and is smaller than Na^+ .
- 3 Electrons.** Two delocalized electrons per Mg atom, one per Na atom.

Decision

Stronger attraction in magnesium, so more energy is needed to melt it.

Check: the metallic bond trend

Your turn

Which group 1 metal has the lowest melting point?

- ☐ A. lithium
- ☐ B. sodium
- ☐ C. potassium
- ☐ D. caesium

AHL: Transition metals use d electrons

Metal	Block	Melting point / °C
potassium	s	63
calcium	s	842
iron	d	1538
chromium	d	1907

Use the evidence

Zinc, with a full 3d sublevel, melts at only 420 °C.

Exam tips

Always name the mobile charge carrier when explaining conduction.

- Metallic bond: cations and delocalized electrons; never anions.
- Metals conduct by electrons; molten ionic compounds by ions.
- **Malleability**: layers slide, **non-directional** bonding kept.
- Compare charge, then radius, and link to energy needed.

Check yourself

Try these

Explain why solid copper conducts but solid copper(II) chloride does not.

Explain why aluminium has a higher boiling point than sodium.

Predict whether potassium or calcium melts higher, and why.

AHL. Explain why iron melts far higher than calcium.