Metallic bonding

Student activity • desk activity

YEAR 10 / LESSON 27 / CHEMISTRY ONLY

The question

How can a lattice of positive ions and delocalised electrons explain metallic properties?

Chemistry-only lesson. Build a two-dimensional metallic-lattice model and use it to explain electrical conduction and malleability. Compare a flexible foil sample with a paper model, but do not treat the model as a measured conductivity test. This version replaces the unrelated iodine/sulfur heating and open-sample instructions.

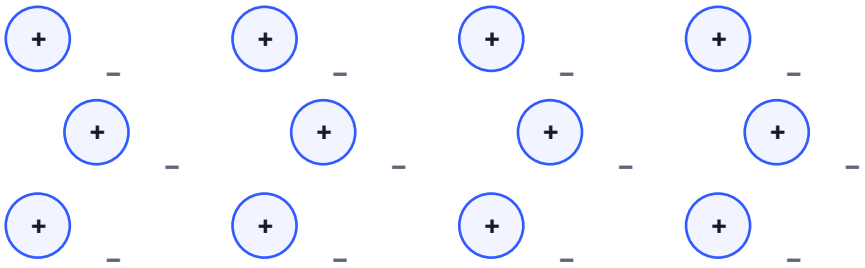
Equipment

- Student booklet, pencil and ruler
- Per pair: 12 positive-ion paper discs and 12 small electron counters or pencil marks
- Optional teacher-supplied smooth-edged aluminium foil square per pair; no circuit, heating or chemical powders

Desk activity only. Use pre-cut blunt modelling pieces and keep small parts out of mouths. Keep the workspace clear; no chemicals, flames or electrical supply are required. Use smooth-edged foil only; do not tear it into sharp pieces. Stop if an edge is sharp.

Course coverage: CHEMISTRY ONLY: 1.52C–1.54C — two-dimensional metallic lattice, electrostatic attraction and typical properties including electrical conductivity and malleability. Not required for Science (Double Award).

2D model • positive ions and mobile electrons



Ion discs: +. Electron tokens: –. Shift a row while keeping the electrons delocalised; do not attach each electron to one ion.

Method and reasoning

Read the whole sequence before starting

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1. Arrange 12 positive-ion discs in three offset rows. Add small electron symbols in the surrounding space rather than attaching each electron permanently to one ion. Label both parts.

2. Draw the model and label metallic bonding as electrostatic attraction between positive metal ions and delocalised electrons. State that the 2D model simplifies a 3D structure.

3. For this simple monovalent model use one electron token per +1 ion. Explain that real metals can contribute different numbers of delocalised electrons; the token count is a model choice.

4. Show how electron tokens can move through the structure while the ions remain in their lattice positions apart from vibration. Use this to explain conduction in a solid metal.

5. Shift one whole row of ion discs sideways. Keep electron symbols spread through the model. Explain why attraction can remain as layers move, supporting malleability.

6. If supplied, gently bend the smooth-edged foil without tearing it. Label this as a qualitative observation of shape change, not evidence that you have seen electrons or proved the microscopic mechanism.

7. Complete the explanations and evaluate the model. Do not heat metal, iodine, sulfur or unknown samples and do not set up the old circuit test.

Cleanup

• Keep your evidence and corrections. Count and return reusable model pieces; recycle unwanted paper. No chemical waste is produced.

Record your evidence

Blank spaces are for your own work

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Reference and task data

Chemistry-only 1.52C–1.54C. Model convention: 12 +1 ion discs and 12 electron tokens keep the represented sample neutral; this is not a universal valency for every metal. Electrons are delocalised throughout the structure. A metal's positive ions are not free to flow through the solid. No numerical conductivity, strength or melting data are supplied.

Property / model task	What the model shows	Explanation / limitation
Label ions and electrons		
Conduction in a solid metal		
Rows shifted sideways		
Optional foil observation		
A limitation of 2D tokens		

Show your calculations, labelled model or correction here.

Explain and evaluate

Use evidence and show calculation steps where relevant

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1. Draw a labelled 2D metallic lattice showing positive ions and delocalised electrons.

2. Define metallic bonding in terms of electrostatic attraction.

3. Explain why a solid metal conducts electricity without its positive ions moving through the solid.

4. Explain malleability using your shifted-row model.

5. Correct: “All metals contain one delocalised electron per atom, and the electrons stay attached to one ion.”

6. Give two limits of the model and separate any foil observation from the explanation you inferred.