

GCSE Combined Science: Trilogy

Worksheet: Metals as conductors

TIME 25 min	TOTAL 25 marks	CALCULATOR Allowed	DIFFICULTY Easy, Medium
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Topics: Metals as conductors

NAME	CLASS	DATE
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- Use black ink or black ball-point pen. Pencil should only be used for drawing.
- Answer all questions in the spaces provided.
- In all calculations, show clearly how you work out your answer.
- The marks for questions are shown in brackets.

0 1

Metals are good conductors of electricity and of thermal energy.

0 1 . 1

Which particles are responsible for both the electrical conductivity and the thermal conductivity of metals?

Tick (✓) **one** box.

Delocalised electrons

☐

Positive ions

☐

Protons

☐

Neutrons

☐

[1 mark]

0 2

Metals are good conductors of electricity.

0 2 . 1

Why are metals good conductors of electricity?

Tick (✓) **one** box.

Delocalised electrons carry charge through the metal.

☐

Ions move through the metal.

☐

Metal atoms are shiny.

☐

Metals have high melting points.

☐

[1 mark]

0 2 . 2

Give **one** use of copper that depends on it being a good conductor of electricity.

.....

.....

[1 mark]

0 2 . 3

Which of these substances does **not** conduct electricity when it is solid?

Tick (✓) **one** box.

Aluminium

☐

Copper

☐

Graphite

☐

Sodium chloride

☐

[1 mark]

0 2 . 4

A saucepan is made of steel and has a plastic handle.

Suggest why.

.....

.....

.....

.....

[2 marks]

.....

0 3

An electric soldering iron is used to melt solder to join electrical wires. An electric current passes through a metal heating wire inside the iron. The heating wire heats a copper tip, and the hot copper tip melts the solder. The handle of the soldering iron is made of a hard polymer.

0 3 . 1

Explain, in terms of structure and bonding, why metals are used for the heating wire and the tip, and why a polymer is used for the handle.

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[6 marks]

0 4

A student compared how well rods of different materials conduct thermal energy. The student heated one end of each rod and timed how long it took for a piece of wax at the other end to melt.

Table 1 shows the results.

Table 1

Material of rod	Time for wax to melt in s
Copper	35
Aluminium	50
Iron	140
Glass	did not melt within 600 s
Poly(propene)	did not melt within 600 s

0 4 . 1

Which rod was the best thermal conductor?

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.....

.....

.....
[1 mark]

0 4 . 2

Explain why the metal rods conducted thermal energy much better than the glass and poly(propene) rods.

.....

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[2 marks]

0 4 . 3

Give **two** variables the student should have kept the same.

.....

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.....

[2 marks]

0 4 . 4

Predict the order of electrical conductivity of iron, copper and aluminium, starting with the best conductor.

Give a reason for your prediction.

.....

.....

.....

.....

[2 marks]

0 5

Copper is used for electrical wiring and for the bases of some saucepans.

0 5 . 1

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

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.....

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[3 marks]

0 5 . 2

Explain how thermal energy is transferred through a metal.

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.....

.....

.....

[2 marks]

0 5 . 3

Aluminium is used for overhead power cables, even though copper is a better conductor.
Suggest **one** reason why.

.....

.....

[1 mark]

END OF QUESTIONS

Original practice questions written to match the specification. Not produced by, affiliated with or endorsed by AQA.

Mark scheme

GCSE Combined Science: Trilogy · Worksheet: Metals as conductors · 25 marks

Question 1 (1 mark)

01.1 [1 mark]

Correct: Delocalised electrons

Question 2 (5 marks)

02.1 [1 mark]

Correct: Delocalised electrons carry charge through the metal.

02.2 [1 mark]

Answer: electrical wires / cables

- electrical wires / cables / circuit connections (1)
-

02.3 [1 mark]

Correct: Sodium chloride

02.4 [2 marks]

Answer: Steel conducts thermal energy well, so it heats the food; plastic is a poor conductor, so the handle stays cool enough to hold.

- steel is a good (thermal) conductor so it transfers energy to the food (1)
 - plastic is a poor conductor / insulator so the handle stays cool (safe to hold) (1)
-

Question 3 (6 marks)

03.1 [6 marks]

Answer: Metals have a giant structure of positive ions with delocalised electrons that are free to move: they flow through the heating wire carrying charge (a current), and they transfer energy quickly through the copper tip to the solder. The polymer is made of covalently bonded molecules with no delocalised electrons or free ions, so it does not conduct electricity (and conducts thermal energy poorly), which keeps the user safe.

Levels of response

- **Level 3 (5–6)** A detailed, coherent answer. Relevant points are accurate, linked in a logical sequence and use correct scientific terms.
- **Level 2 (3–4)** Several relevant points with some linking, but the answer has gaps, errors or lacks detail.
- **Level 1 (1–2)** Simple statements making one or two relevant points, with little or no linking.
- **No marks (0)** Nothing relevant or worthy of credit.

Indicative content

- metals have a giant structure of positive metal ions arranged in a regular lattice, with delocalised electrons
- the delocalised electrons are free to move through the whole structure
- when a potential difference is applied, the delocalised electrons flow through the heating wire, carrying electrical charge (an electric current)
- thermal energy is transferred through the copper tip by the delocalised electrons, which move and carry energy quickly from the hot part to the tip
- so the copper tip quickly becomes hot and transfers energy to the solder, melting it
- the polymer is made of molecules with covalent bonds and has no delocalised electrons or ions that are free to move, so it does not conduct electricity and the user is protected from an electric shock
- the polymer is also a poor thermal conductor, so the handle stays cool enough to hold

Notes: Allow 'sea of electrons' for delocalised electrons. Do not accept 'free ions' as the charge carriers in the metal.

Level 3 (5–6 marks): explains electrical conduction in the wire and thermal conduction in the tip in terms of delocalised electrons, and explains why the polymer handle does not conduct (no delocalised electrons or free ions).

Level 2 (3–4 marks): explains conduction by delocalised electrons for electricity or for thermal energy, with a reason for using the polymer, but some explanation is missing or unclear.

Level 1 (1–2 marks): simple statements, e.g. 'metals conduct because they have free electrons' or 'the handle is an insulator'.

Question 4 (7 marks)

04.1 [1 mark]

Answer: copper

- copper (1)
-

04.2 [2 marks]

Answer: Metals have delocalised electrons, which move and transfer energy through the metal; glass and poly(propene) have no delocalised electrons.

- metals have delocalised electrons (glass and poly(propene) do not) (1)
 - the delocalised electrons move and transfer energy through the metal (1)
-

04.3 [2 marks]

Answer: e.g. the length and diameter of the rods

- length of the rod (1)
- diameter / thickness of the rod (1)
- the heat source / Bunsen flame and its distance from the rod (1)
- mass / size of the piece of wax (1)
- starting temperature of the rods (1)

Any 2 of the points above.

04.4 [2 marks]

Answer: Copper, aluminium, iron; the same delocalised electrons carry both thermal energy and electric charge.

- copper, aluminium, iron (1)
 - delocalised electrons carry both thermal energy and electrical charge (so the order should be the same) (1)
-

Question 5 (6 marks)

05.1 [3 marks]

Answer: Copper has delocalised electrons that move through the structure carrying charge; in solid copper(II) chloride the ions are fixed and there are no delocalised electrons.

- copper has delocalised electrons (1)
- which move through the structure and carry (electrical) charge (1)
- in solid copper(II) chloride the ions are in fixed positions / cannot move (and there are no delocalised electrons) (1)

05.2 [2 marks]

Answer: Delocalised electrons gain kinetic energy and move through the metal, transferring energy to other particles.

- delocalised electrons gain (kinetic) energy (1)
- they move through the metal and transfer the energy (to other particles) (1)

05.3 [1 mark]

Answer: Aluminium has a lower density, so the cables are lighter.

- aluminium has a lower density / is lighter / is cheaper (1)
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