

GCSE Combined Science: Trilogy

Worksheet: Electrolysis of molten ionic compounds

TIME 30 min	TOTAL 26 marks	CALCULATOR Allowed	DIFFICULTY Easy, Medium
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Topics: Electrolysis of molten ionic compounds

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

When a molten metal halide is electrolysed using inert electrodes, one product always forms at each electrode.

0 1 . 1

What is always produced at the positive electrode?

Tick (✓) **one** box.

The metal

☐

The halogen

☐

Oxygen

☐

Hydrogen

☐

[1 mark]

0 1 . 2

State what is always produced at the negative electrode.

.....

.....

[1 mark]

0 2

A teacher electrolysed molten lead bromide using inert electrodes in a fume cupboard.

0 2 . 1

Name the product formed at the negative electrode (cathode).

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.....

.....

[1 mark]

0 2 . 2

Name the product formed at the positive electrode (anode).

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.....

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[1 mark]

0 2 . 3

Describe what the teacher would see at the positive electrode.

.....

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[1 mark]

0 2 . 4

Explain why the lead bromide must be molten.

.....

.....

[1 mark]

0 3

Binary ionic compounds can be electrolysed when they are molten.

Table 1 shows three molten compounds.

Table 1

Molten compound	Product at negative electrode	Product at positive electrode
Potassium iodide		
Zinc chloride		
Calcium oxide		

0 3 . 1

Complete Table 1 by giving the product at each electrode for each compound.

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[3 marks]

0 3 . 2

Explain why the metal is always produced at the negative electrode when a molten ionic compound is electrolysed.

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[2 marks]

0 4

Table 2 shows three molten binary compounds. Complete the table to show the product formed at each electrode when each is electrolysed with inert electrodes.

Table 2

Molten compound	Product at negative electrode	Product at positive electrode
Lithium chloride, LiCl	?	?
Calcium bromide, CaBr ₂	?	?
Potassium iodide, KI	?	?

0 4 . 1 Complete the table.

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[3 marks]

0 5

In a fume cupboard, a teacher connects a d.c. power supply, a lamp and two graphite electrodes in series. The electrodes dip into solid zinc bromide, ZnBr_2 , in a crucible. The teacher heats the crucible until the zinc bromide melts, keeps it molten for several minutes, and then stops heating and lets it cool until it is solid again.

0 5 . 1

Describe and explain what would be observed during this experiment.

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[6 marks]

0 6

Electrolysis experiments usually use inert electrodes.

0 6 . 1

Explain why using copper electrodes, which are not inert, could cause a problem when investigating the products of electrolysis.

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[2 marks]

0 6 . 2

Name two materials commonly used as inert electrodes.

[1 mark]

0 7

Molten ionic compounds must be heated to very high temperatures (often several hundred °C) before they can be electrolysed.

0 7 . 1

Explain why the compound must be molten, rather than solid, for electrolysis to work.

[2 marks]

0 7 . 2

Suggest one practical difficulty of electrolysing a molten ionic compound on an industrial scale.

[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: Electrolysis of molten ionic compounds · 26 marks

Question 1 (2 marks)

01.1 [1 mark]

Correct: The halogen

01.2 [1 mark]

Answer: the metal

- the metal (1)
-
-

Question 2 (4 marks)

02.1 [1 mark]

Answer: lead

- lead (1)
-

02.2 [1 mark]

Answer: bromine

- bromine (1)
-

02.3 [1 mark]

- (red-)brown / orange-brown vapour / gas (1)
-

02.4 [1 mark]

- so that the ions are free to move (1)

Notes: Do not accept 'so that electrons can move'.

Question 3 (5 marks)

03.1 [3 marks]

Answer: potassium and iodine; zinc and chlorine; calcium and oxygen

- potassium (negative) and iodine (positive) (1)
- zinc (negative) and chlorine (positive) (1)
- calcium (negative) and oxygen (positive) (1)

Notes: Each mark needs both products for that compound, at the correct electrodes.

03.2 [2 marks]

- metal ions are positive (1)
- so they are attracted to the negative electrode, where they gain electrons (to form metal atoms) (1)

Question 4 (3 marks)

04.1 [3 marks]

Answer: LiCl: lithium, chlorine; CaBr₂: calcium, bromine; KI: potassium, iodine

- lithium chloride: lithium (negative), chlorine (positive) (1)
 - calcium bromide: calcium (negative), bromine (positive) (1)
 - potassium iodide: potassium (negative), iodine (positive) (1)
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Question 5 (6 marks)

05.1 [6 marks]

Answer: Solid: the lamp is off because the ions are held in fixed positions. Molten: the lamp lights because the ions are free to move; Zn^{2+} ions go to the negative electrode, gain electrons and form zinc (a grey deposit); Br^- ions go to the positive electrode, lose electrons and form bromine (a brown vapour). When it solidifies again the ions stop moving, the lamp goes out and the electrolysis stops.

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

- while the zinc bromide is solid, the lamp does not light: the ions are held in fixed positions in the lattice and cannot move, so no current flows
- when the zinc bromide melts, the lamp lights: the ions are free to move, so the molten compound conducts (it is an electrolyte)
- positive zinc ions are attracted to the negative electrode (cathode), where they gain electrons and form zinc metal (a grey/silvery deposit)
- negative bromide ions are attracted to the positive electrode (anode), where they lose electrons and form bromine (a red-brown/orange-brown vapour)
- half equations: $\text{Zn}^{2+} + 2\text{e}^- \rightarrow \text{Zn}$ and $2\text{Br}^- \rightarrow \text{Br}_2 + 2\text{e}^-$
- the zinc bromide is decomposed into its elements by the electric current (electrolysis)
- when the zinc bromide becomes solid again, the ions can no longer move, so the lamp goes out and the electrolysis stops
- the fume cupboard is needed because bromine vapour is toxic

Notes: Half equations are creditworthy but not required for Level 3.

Level 3 (5–6 marks): describes the lamp being off, then on, then off again and explains each stage in terms of the movement of ions, and gives the products at both electrodes with an explanation of why each ion goes to that electrode.

Level 2 (3–4 marks): explains why the molten compound conducts and names at least one product at the correct electrode, but the explanation is incomplete.

Level 1 (1–2 marks): simple statements, e.g. 'the lamp lights when it melts' or 'zinc and bromine are made'.

Question 6 (3 marks)

06.1 [2 marks]

- a reactive electrode could itself react with the electrolyte, or be oxidised/dissolved, during electrolysis (1)
- this could contaminate the results, making it unclear which products came from the electrolyte and which came from the electrode reacting (1)

06.2 [1 mark]

Answer: graphite (carbon) and platinum

- graphite (carbon) and platinum (1)
-

Question 7 (3 marks)

07.1 [2 marks]

- ions must be free to move (to the electrodes) to conduct electricity and be discharged (1)
- in a solid, the ions are fixed in a lattice and cannot move (1)

07.2 [1 mark]

- allow: a large amount of energy is needed to melt and maintain the compound at a high temperature (expensive) / special heat-resistant equipment is needed for safety (1)
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