AQA GCSE Combined Science - Trilogy | 8464

SPECIFICATION POINT 5.4.3.3

# Using electrolysis to extract metals

## Past-paper questions

| | |
|---|---|
| Tier | **Higher** |
| Question groups | **7** |
| Available paper years | **2018–2025** |

## Using this booklet

1. Answer the questions in order and show your working.
2. Original question numbers and marks are retained.
3. Print at actual size (100%) for measuring questions.
4. Use the companion answer booklet to check your work.

**Name:** _____ **Date:** _____

Whole questions are retained for context, so some parts assess other specification points. Current and legacy sources are labelled. Continue on extra paper if needed.

### 5.4.3.3 Using electrolysis to extract metals

**Question 01**

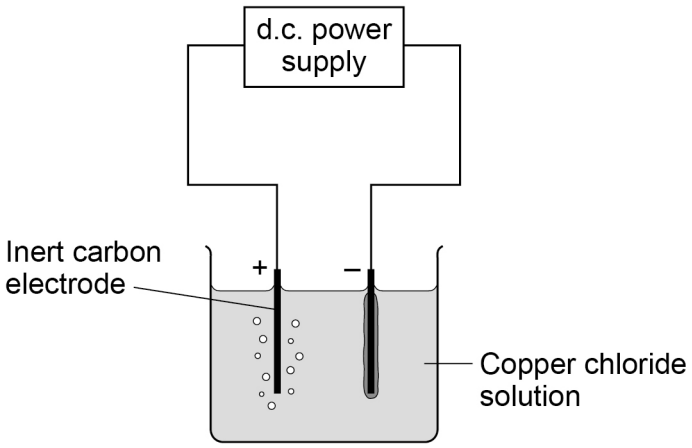
June 2018 | 8464/C/1H | Original Q1

**0 1** This question is about electrolysis.

A student investigates the mass of copper produced during electrolysis of copper chloride solution.

**Figure 1** shows the apparatus.

**Figure 1**




**0 1 . 1** Which gas is produced at the positive electrode (anode)?

**[1 mark]**

Tick **one** box.

- carbon dioxide ☐
- chlorine ☐
- hydrogen ☐
- oxygen ☐

Question 01 · continued



**0 1 . 2** Copper is produced at the negative electrode (cathode).

What does this tell you about the reactivity of copper?

**[1 mark]**

Tick **one** box.

Copper is less reactive than hydrogen ☐

Copper is less reactive than oxygen ☐

Copper is more reactive than carbon ☐

Copper is more reactive than chlorine ☐

**Table 1** shows the student's results.

**Table 1**

| | Total mass of copper produced in mg | | | |
|---|---|---|---|---|
| **Time in mins** | **Experiment 1** | **Experiment 2** | **Experiment 3** | **Mean** |
| **1** | 0.60 | 0.58 | 0.62 | 0.60 |
| **2** | 1.17 | 1.22 | 1.21 | 1.20 |
| **4** | 2.40 | 2.41 | 2.39 | 2.40 |
| **5** | 3.02 | **X** | 3.01 | 3.06 |

**0 1 . 3** Determine the **mean** mass of copper produced after 3 minutes.

**[1 mark]**

Mass = _____ mg

**Question 1 continues on the next page**

5.4.3.3 Using electrolysis to extract metals

Question 01 · continued



**0 1 . 4** Calculate the mass **X** of copper produced in **Experiment 2** after 5 minutes.

Use **Table 1** on page 3

**[2 marks]**

Mass **X** = _____ mg

**0 1 . 5** The copper chloride solution used in the investigation contained 300 grams per $dm^3$ of solid $CuCl_2$ dissolved in 1 $dm^3$ of water.

The student used 50 $cm^3$ of copper chloride solution in each experiment.

Calculate the mass of solid copper chloride used in each experiment.

**[3 marks]**

Mass = _____ g

8

### 5.4.3.3 Using electrolysis to extract metals

**Question 02**

June 2019 | 8464/C/1H | Original Q5

**0 5** This question is about electrolysis.

**0 5 . 1** Some metals are extracted from molten compounds using electrolysis.

Why is electrolysis used to extract some metals?

**[1 mark]**

_____

_____

**0 5 . 2** Aluminium is produced by electrolysis of a molten mixture.

What **two** substances does the molten mixture contain?

**[2 marks]**

1 _____

2 _____

**0 5 . 3** Copper and chlorine are produced when molten copper chloride is electrolysed.

Complete the half equation for the reaction at each electrode.

**[2 marks]**

Half equation at negative electrode

$Cu^{2+}$ _____ $\rightarrow$ _____

Half equation at positive electrode

$2\ Cl^{-} \rightarrow$ _____

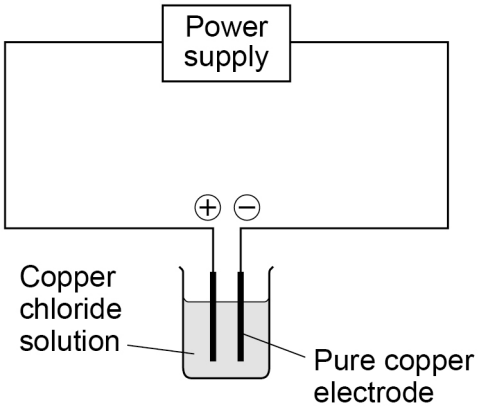
5.4.3.3 Using electrolysis to extract metals

Question 02 · continued



**Figure 4** shows the apparatus a student used to electrolyse copper chloride solution.

**Figure 4**




The student:

- measured the mass of copper deposited on the negative electrode after 60 minutes
- compared the mass deposited with the expected value.

**0 5 . 4** Suggest **two** reasons why the mass deposited was different from the expected value.

**[2 marks]**

1 _____

_____

2 _____

_____

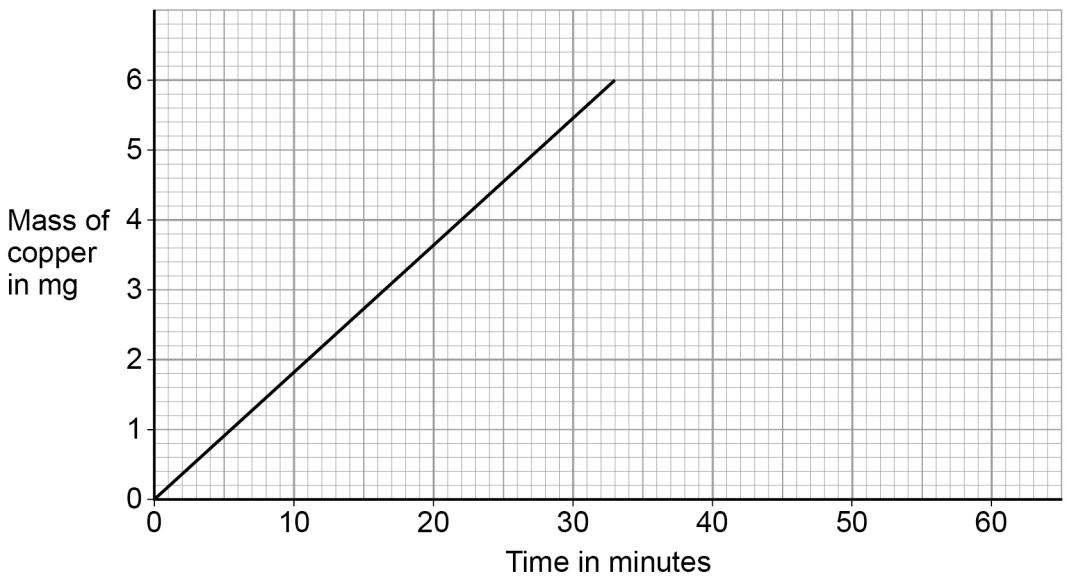
**Question 5 continues on the next page**

Question 02 · continued



**0 5 . 5** **Figure 5** shows the expected mass of copper produced each minute.

**Figure 5**




Determine the expected mass of copper after 24 hours.

Use **Figure 5**.

**[3 marks]**

Mass = _____ mg

5.4.3.3 Using electrolysis to extract metals

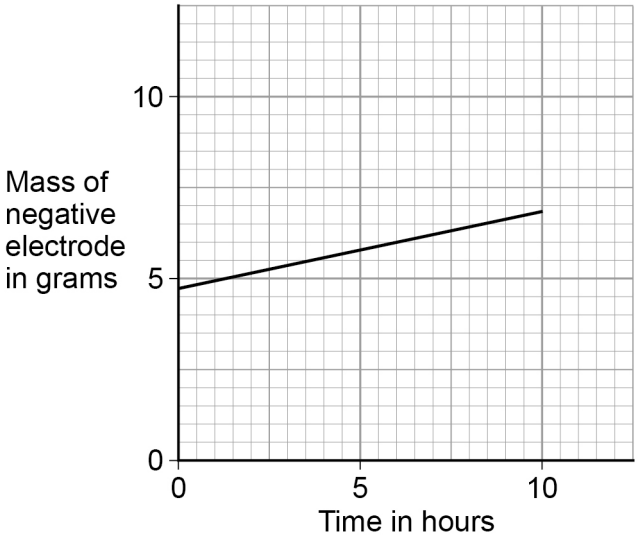
Question 02 · continued



Silver nitrate solution is electrolysed.

**Figure 6** shows the change in mass of the negative electrode over 10 hours.

**Figure 6**




**0 5 . 6** Determine the mass of the negative electrode at the start of the experiment.

Use **Figure 6**.

**[1 mark]**

**0 5 . 7** Calculate the gradient of the line in **Figure 6**.

Give the unit.

**[3 marks]**

Gradient _____

Unit _____

14

### 5.4.3.3 Using electrolysis to extract metals

**Question 03**

November 2020 | 8464/C/1H | Original Q1

**0 1** This question is about the extraction of aluminium.

**0 1 . 1** An aluminium atom is represented as:

$$^{27}_{13}Al$$

Give the number of electrons and neutrons in the aluminium atom.

**[2 marks]**

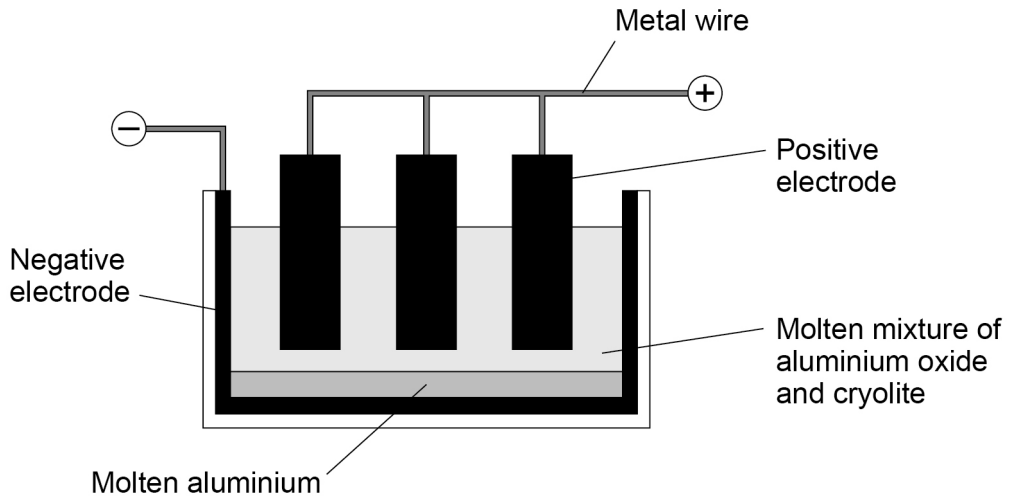
Number of electrons _____

Number of neutrons _____

Aluminium is extracted by the electrolysis of a molten mixture of aluminium oxide and cryolite.

**Figure 1** shows the cell used for the electrolysis.

**Figure 1**




**0 1 . 2** Aluminium is produced by the reduction of aluminium oxide ($Al_2O_3$).

What is meant by the term reduction?

**[1 mark]**

_____

_____

5.4.3.3 Using electrolysis to extract metals

Question 03 · continued



**0 1 . 3** Oxygen is formed at the positive carbon electrodes.

Explain why the positive carbon electrodes must be continually replaced.

**[3 marks]**

**0 1 . 4** A substance conducts electricity because of free moving, charged particles.

What are the free moving, charged particles in a:

- carbon electrode (made from graphite)
- molten mixture of aluminium oxide and cryolite
- metal wire?

**[3 marks]**

Carbon electrode (made from graphite) _____

Molten mixture of aluminium oxide and cryolite _____

Metal wire _____

9

5.4.3.3 Using electrolysis to extract metals

Question 04

November 2021 | 8464/C/1H | Original Q5

**0 5** This question is about the electrolysis of aqueous solutions.

Hydrogen gas and chlorine gas are produced when sodium chloride solution is electrolysed.

**0 5 . 1** Hydrogen ions ($H^+$) are attracted to the negative electrode.

The half equation for the reaction at the negative electrode is:

$$2H^+ + 2e^- \rightarrow H_2$$

What type of reaction happens at the negative electrode?

Give the reason for your answer.

**[2 marks]**

Type of reaction _____

Reason _____

_____

**0 5 . 2** Chloride ions are attracted to the positive electrode.

Complete the half equation for the production of chlorine gas ($Cl_2$).

**[2 marks]**

$$___ Cl^- \rightarrow _____ + _____$$

5.4.3.3 Using electrolysis to extract metals

Question 04 · continued



**0 5 . 3** Hydrogen gas and oxygen gas are produced when sodium sulfate solution is electrolysed.

Explain how oxygen gas is produced in the electrolysis of sodium sulfate solution.

**[4 marks]**

8

**Turn over for the next question**

### 5.4.3.3 Using electrolysis to extract metals

**Question 05**

June 2023 | 8464/C/1H | Original Q5

**0 5** During electrolysis ions are discharged at the electrodes to produce elements.

A student investigates the electrolysis of sodium chloride.

**0 5 . 1** Why does solid sodium chloride **not** conduct electricity?

**[1 mark]**

_____

_____

**0 5 . 2** Sodium chloride solution conducts electricity.

Complete the sentence.

**[1 mark]**

Sodium chloride **also** conducts electricity when _____ .

**Question 5 continues on the next page**

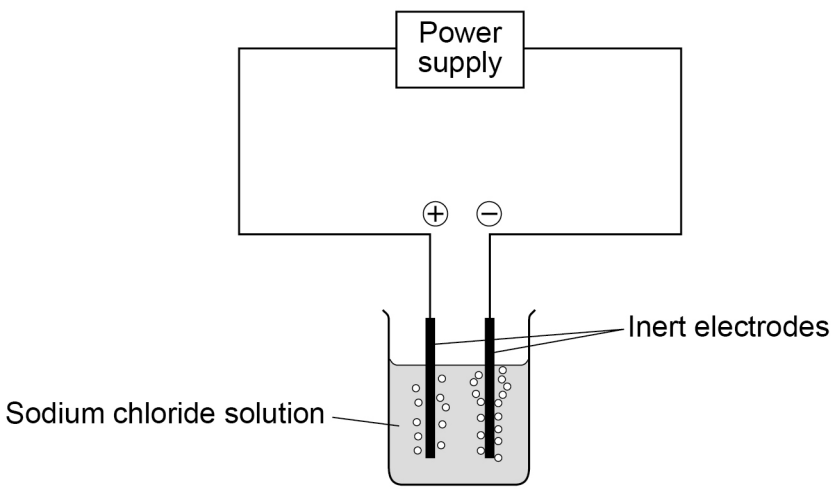
5.4.3.3 Using electrolysis to extract metals

Question 05 · continued



**Figure 5** shows the apparatus for the electrolysis of sodium chloride solution.

**Figure 5**




**0 5 . 3** Suggest an element that could be used to make the inert electrodes.

**[1 mark]**

**0 5 . 4** Complete the half equation for the production of chlorine ($Cl_2$) at the positive electrode.

**[2 marks]**

____ $Cl^-$ → _____ + _____

**5.4.3.3 Using electrolysis to extract metals**

**Question 05 · continued**



**0 5 . 5** Sodium chloride solution has a pH of 7

During the electrolysis of sodium chloride solution:

- hydrogen gas is produced at the negative electrode
- the pH of the solution increases.

Explain why.

**[4 marks]**

9

5.4.3.3 Using electrolysis to extract metals

Question 06

June 2024 | 8464/C/1H | Original Q6

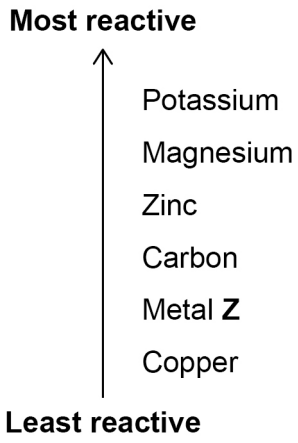
**0 6** In the Earth most metals are found as compounds.

**0 6 . 1** Name **one** metal that is found in the Earth as the metal itself.

**[1 mark]**

**Figure 9** shows a reactivity series.

**Figure 9**




**0 6 . 2** Suggest the most economical method for extracting metal **Z** from an oxide of metal **Z**.

**[1 mark]**

**Question 6 continues on the next page**

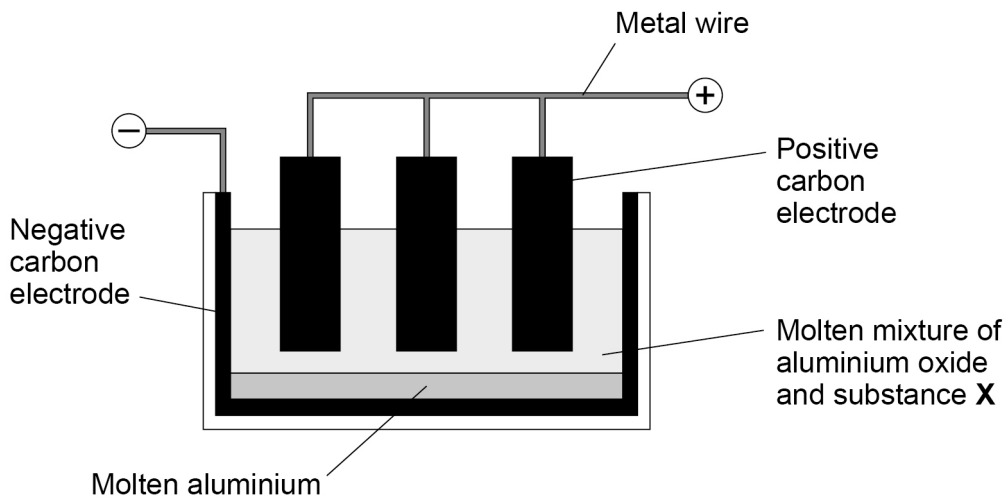
5.4.3.3 Using electrolysis to extract metals

Question 06 · continued



**Figure 10** shows the electrolysis cell used to extract aluminium from aluminium oxide.

**Figure 10**




**0 6 . 3** Name substance **X** shown in **Figure 10**.

**[1 mark]**

5.4.3.3 Using electrolysis to extract metals

Question 06 · continued



**0 6 . 4** Explain what happens to the **positive** carbon electrodes during the extraction of aluminium from aluminium oxide.

**[3 marks]**

**0 6 . 5** The formula of aluminium oxide is $Al_2O_3$

Write a half equation for the reaction at the **negative** electrode in **Figure 10**.

**[2 marks]**

_____ + _____ → _____

8

5.4.3.3 Using electrolysis to extract metals

Question 07

June 2025 | 8464/C/1H | Original Q4

**0 4** This question is about metals.

**0 4 . 1** Iron is extracted from iron oxide by reduction with carbon.

Why can iron be extracted by reduction with carbon?

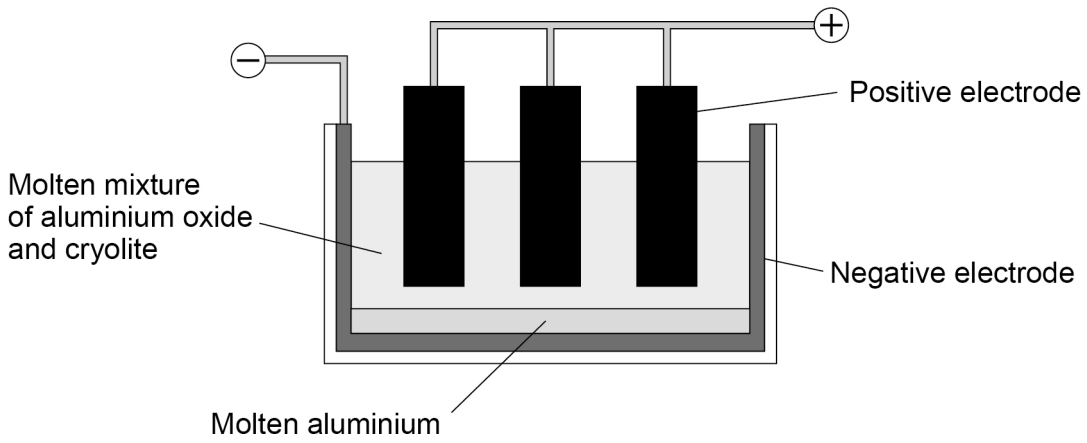
Answer in terms of reactivity.

**[1 mark]**

Aluminium is extracted by the electrolysis of aluminium oxide.

**Figure 4** shows the apparatus used to extract aluminium.

**Figure 4**



5.4.3.3 Using electrolysis to extract metals

Question 07 · continued



**0 4 . 2** Explain why a mixture of aluminium oxide and cryolite is used as the electrolyte instead of only aluminium oxide.

**[2 marks]**

**0 4 . 3** Oxygen gas is produced at the positive electrode.

Write a balanced half equation for the production of oxygen at the positive electrode.

**[2 marks]**

_____ → _____ + _____

**Question 4 continues on the next page**

Question 07 · continued



Chromium is extracted by reacting chromium oxide with aluminium.

The equation for the reaction is:

$$Cr_2O_3 + 2\,Al \rightarrow Al_2O_3 + 2\,Cr$$

**0 4 . 4** Which substance in the equation is reduced?

**[1 mark]**

**Table 3** shows the relative cost of extracting equal masses of aluminium, chromium and iron.

**Table 3**

| Metal | Relative cost of extraction |
|---|---|
| Aluminium | 2 |
| Chromium | 20 |
| Iron | 1 |

**0 4 . 5** Give **one** reason for the difference in the cost of extracting aluminium and **iron**.

Use **Table 3**.

**[1 mark]**

5.4.3.3 Using electrolysis to extract metals

Question 07 · continued



**0 4 . 6** Give **one** reason for the difference in the cost of extracting aluminium and **chromium**.

Use **Table 3**.

**[1 mark]**

**0 4 . 7** Metals are mixed together to form alloys.

Explain why alloys are harder than pure metals.

**[3 marks]**

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