AQA GCSE Combined Science - Trilogy | 8464

SPECIFICATION POINT 5.4.3.1

The process of electrolysis

Past-paper questions

Tier	**Higher**
Question groups	**10**
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.

5.4.3.1 The process of electrolysis

Question 01

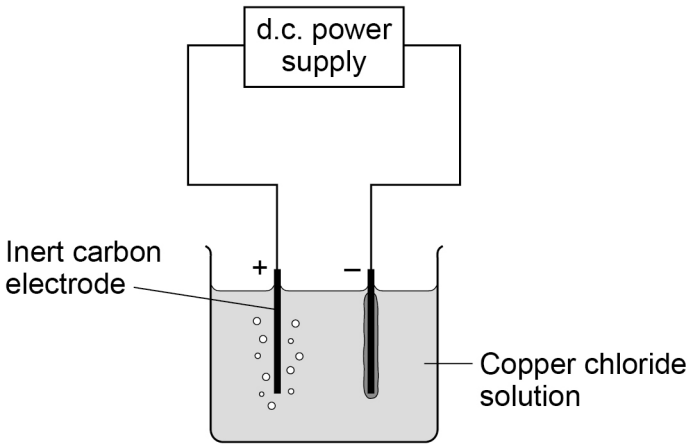
June 2018 | 8464/C/1H | Original Q1

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 ☐

5.4.3.1 The process of electrolysis

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

5.4.3.1 The process of electrolysis

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

5.4.3.1 The process of electrolysis

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

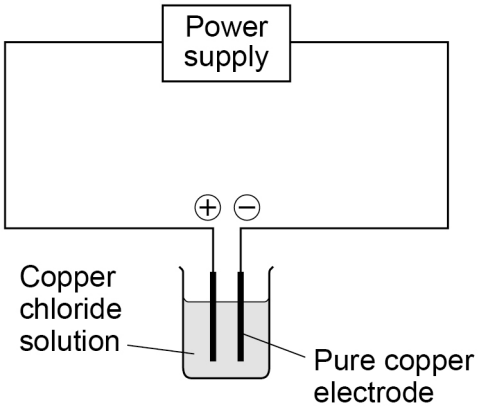
$2\ Cl^{-} \rightarrow$ _____

5.4.3.1 The process of electrolysis

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 _____

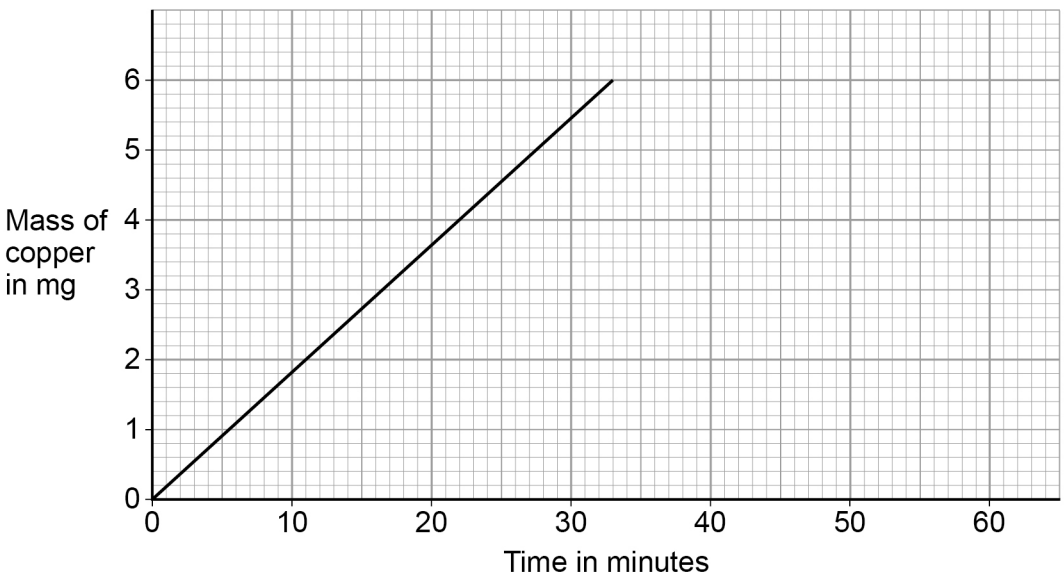
_____

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

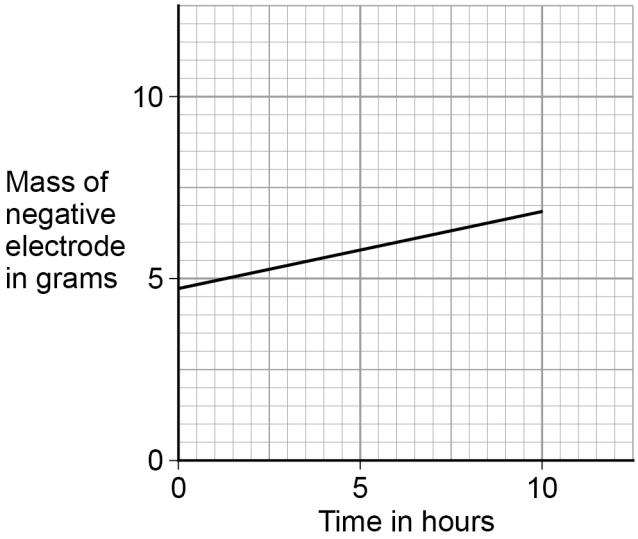
5.4.3.1 The process of electrolysis

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

5.4.3.1 The process of electrolysis

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]

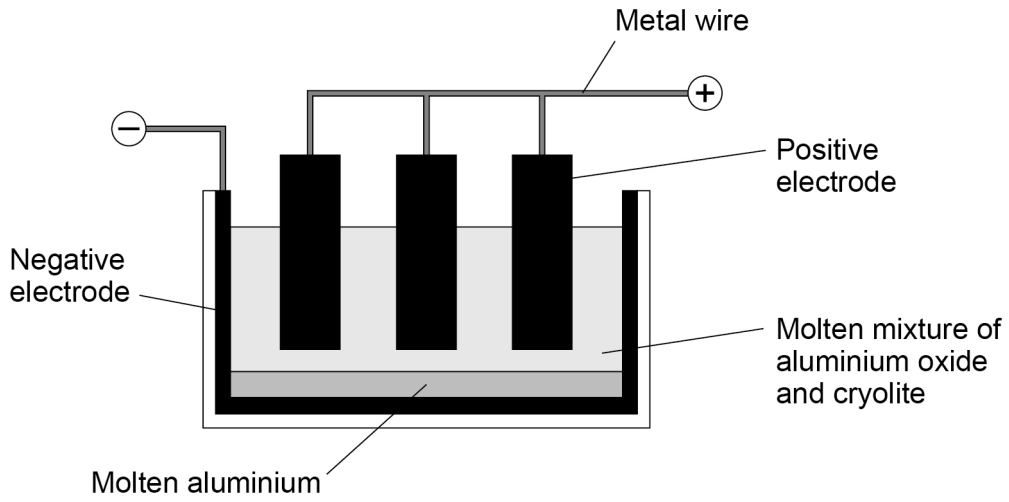
Number of electrons _____

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]

_____

_____

5.4.3.1 The process of electrolysis

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

5.4.3.1 The process of electrolysis

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]

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

5.4.3.1 The process of electrolysis

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

5.4.3.1 The process of electrolysis

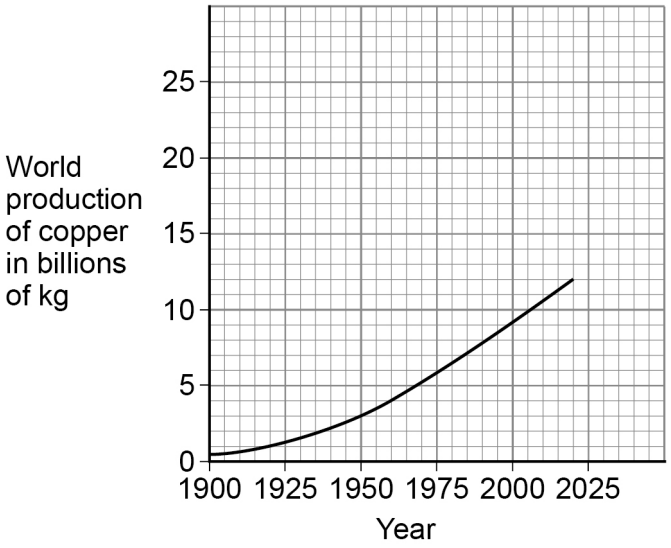
Question 05

November 2021 | 8464/C/2H | Original Q4

0 4 Industries use the Earth's natural copper resources to produce useful products.

Figure 4 shows the world production of copper from 1900 to 2020.

Figure 4



0 4 . 1 Describe the trend shown by the graph in **Figure 4**.

[2 marks]

0 4 . 2 Suggest **one** reason for the trend in **Figure 4**.

[1 mark]

5.4.3.1 The process of electrolysis

Question 05 · continued

0 4 . 3 Suggest **one** reason why the trend cannot be used to accurately predict the future world production of copper.

[1 mark]

Question 4 continues on the next page

5.4.3.1 The process of electrolysis

Question 05 · continued

0 4 . 4 High-grade copper resources are now difficult to find.

Phytomining is used to extract copper from low-grade ores.

There are five stages, **A**, **B**, **C**, **D** and **E**, in phytomining.

The stages are **not** in the correct order.

Stage **A** Copper compounds from ash are dissolved in acid.

Stage **B** Plants absorb metal compounds.

Stage **C** Plants are burned.

Stage **D** Plants are harvested.

Stage **E** Solution of copper compound is electrolysed.

What is the correct order of stages **A**, **B**, **C**, **D**, and **E**?

[1 mark]

Tick (✓) **one** box.

B, **C**, **D**, **E**, **A** ☐

B, **D**, **C**, **A**, **E** ☐

D, **B**, **C**, **E**, **A** ☐

D, **C**, **B**, **A**, **E** ☐

5.4.3.1 The process of electrolysis

Question 05 · continued

0 4 . 5 Give **two** disadvantages of phytomining compared with traditional mining methods.

Do **not** refer to cost in your answer.

[2 marks]

1 _____

_____

2 _____

_____

0 4 . 6 In one year, 8.89×10^9 kg of copper was produced.

41.0% of this copper was produced from recycled copper.

The energy needed to produce 1 kg of copper from copper ore is 70.4 MJ.

The energy needed to produce 1 kg of recycled copper is 27.2 MJ.

Calculate the difference in energy used if all the copper was produced from recycling.

Give your answer to 3 significant figures.

[5 marks]

_____

_____

_____

_____

_____

_____

_____

_____

Difference in energy used (3 significant figures) = _____ MJ

12

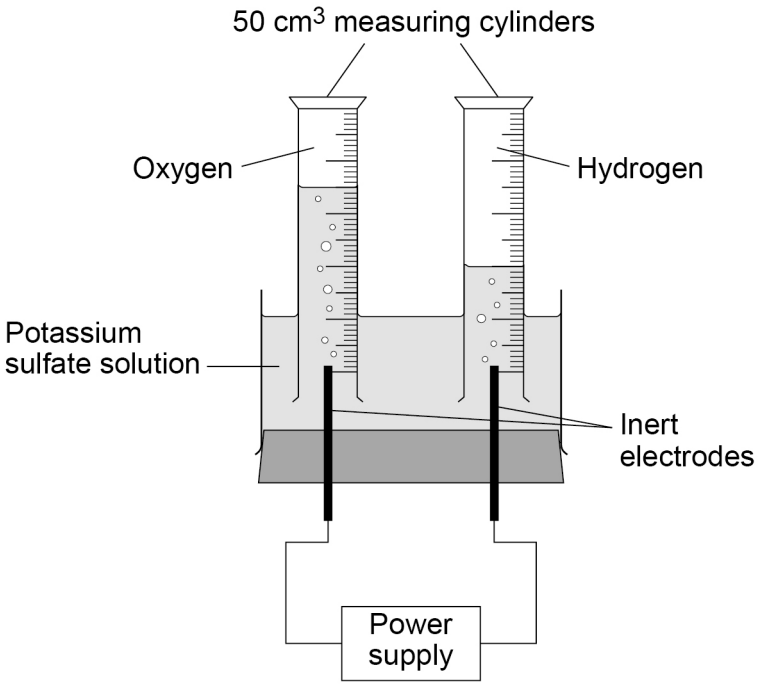
5.4.3.1 The process of electrolysis

Question 06

0 2 This question is about electrolysis.

Figure 2 shows the apparatus used to investigate the electrolysis of potassium sulfate solution.

Figure 2



0 2 . 1 Potassium sulfate contains K^+ and SO_4^{2-} ions.

What is the formula of potassium sulfate?

[1 mark]

Tick (✓) **one** box.

- KSO_4 ☐
- K_2SO_4 ☐
- $K(SO_4)_2$ ☐
- $K_2(SO_4)_2$ ☐

5.4.3.1 The process of electrolysis

Question 06 · continued

0 2 . 2 What are the volumes of gases collected in the electrolysis experiment?

Use **Figure 2**.

[1 mark]

Volume of hydrogen = _____ cm^3

Volume of oxygen = _____ cm^3

0 2 . 3 A student made the following hypothesis:

'The volumes of gases collected in this electrolysis experiment are in the same ratio as hydrogen atoms to oxygen atoms in a water molecule.'

Explain how the volumes of gases collected in the experiment in **Figure 2** support the student's hypothesis.

Use your answer to Question **02.2**

[2 marks]

Question 2 continues on the next page

Question 06 · continued

0 2 . 4 The experiment is repeated 4 times.

The volumes of oxygen collected in the 4 experiments are:

6 cm^3 9 cm^3 10 cm^3 11 cm^3

The mean volume of oxygen collected in the 4 experiments is 9 cm^3

The measure of uncertainty is the range of a set of measurements about the mean.

What is the measure of uncertainty in the 4 experiments?

[1 mark]

Tick (✓) **one** box.

9 ± 1 cm^3 ☐

9 ± 2 cm^3 ☐

9 ± 3 cm^3 ☐

0 2 . 5 The potassium sulfate solution has 0.86 g of potassium sulfate dissolved in 25 cm^3 of water.

Calculate the mass of potassium sulfate needed to make 1.0 dm^3 of solution.

[3 marks]

Mass = _____ g

8

5.4.3.1 The process of electrolysis

Question 07

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 _____ .

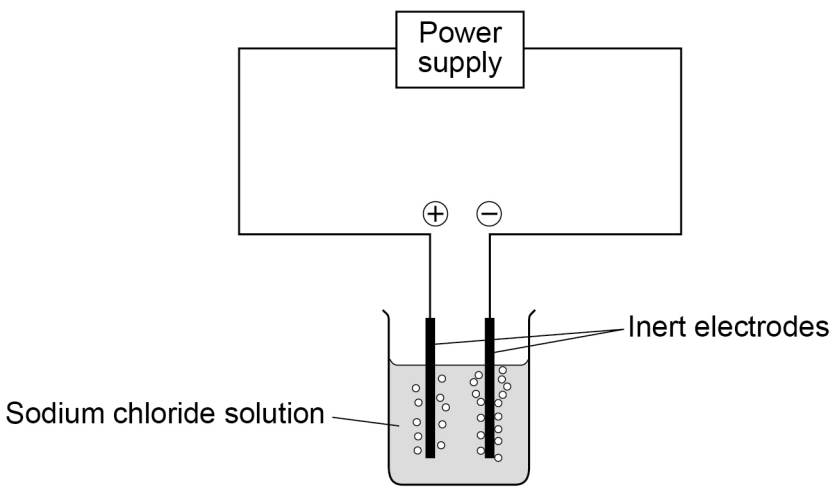
Question 5 continues on the next page

5.4.3.1 The process of electrolysis

Question 07 · 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^- → _____ + _____

5.4.3.1 The process of electrolysis

Question 07 · 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

5.4.3.1 The process of electrolysis

Question 08

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

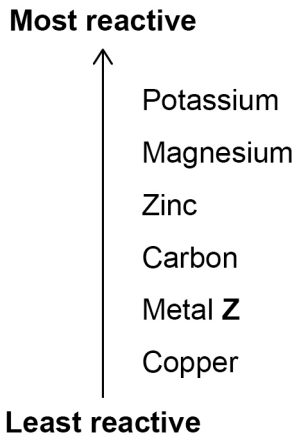
0 6 In the Earth most metals are found as compounds.

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]

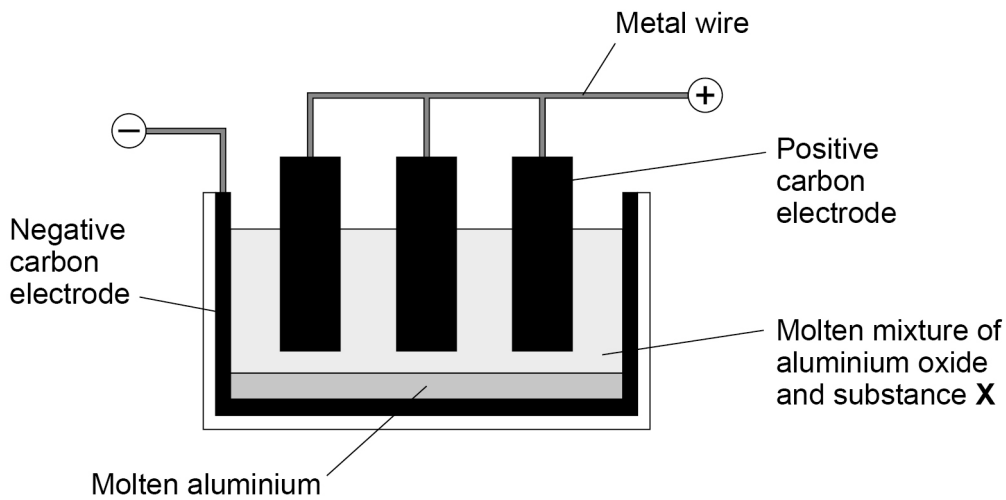
Question 6 continues on the next page

5.4.3.1 The process of electrolysis

Question 08 · 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]

5.4.3.1 The process of electrolysis

Question 08 · 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

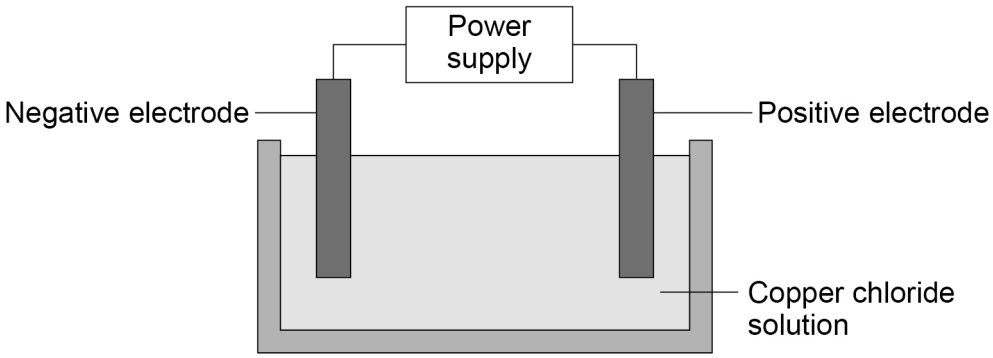
5.4.3.1 The process of electrolysis

Question 09

0 1 A teacher demonstrated the electrolysis of copper chloride solution.

Figure 1 shows the apparatus.

Figure 1



The teacher measured the mass of the negative electrode every 60 seconds.

0 1 . 1 Chlorine gas is given off during the electrolysis of copper chloride solution.

Chlorine gas is poisonous.

Give **one** way of reducing the risk of harm.

[1 mark]

Question 1 continues on the next page

Question 09 · continued

Table 1 shows the results.

Table 1

Time in seconds	Mass of negative electrode in grams
0	20.2
60	22.0
120	23.4
180	24.2
240	24.8
300	25.2
360	25.2

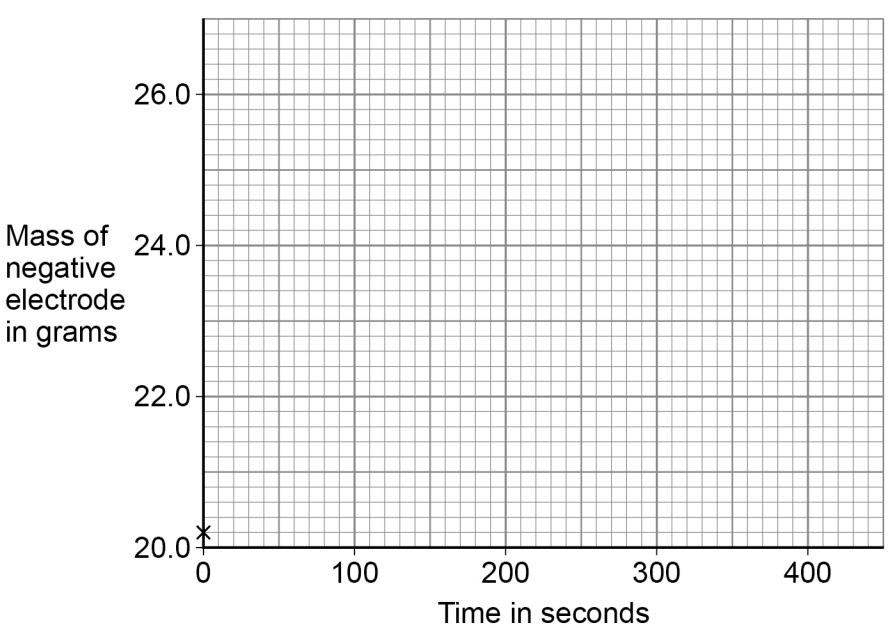
0 1 . 2 Plot the data from **Table 1** on **Figure 2**.

Draw a line of best fit.

The first point has been plotted for you.

[3 marks]

Figure 2



5.4.3.1 The process of electrolysis

Question 09 · continued

0 1 . 3 A student made the hypothesis:

'The negative electrode will increase by a constant mass every 60 seconds.'

How do the results in **Table 1** show that the hypothesis is **not** correct?

[1 mark]

0 1 . 4 25 cm^3 of the solution of copper chloride contained 5.5 g of copper chloride.

Calculate the concentration of the solution in g/dm^3.

1 dm^3 = 1000 cm^3

[3 marks]

Concentration = _____ g/dm^3

Question 1 continues on the next page

5.4.3.1 The process of electrolysis

Question 09 · continued

0 1 . 5 The teacher also electrolysed potassium chloride solution.

Hydrogen gas was given off at the negative electrode.

Why was hydrogen gas given off?

[1 mark]

Tick (✓) **one** box.

Hydrogen is less reactive than potassium. ☐

Hydrogen has the same reactivity as potassium. ☐

Hydrogen is more reactive than potassium. ☐

9

5.4.3.1 The process of electrolysis

Question 10

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?

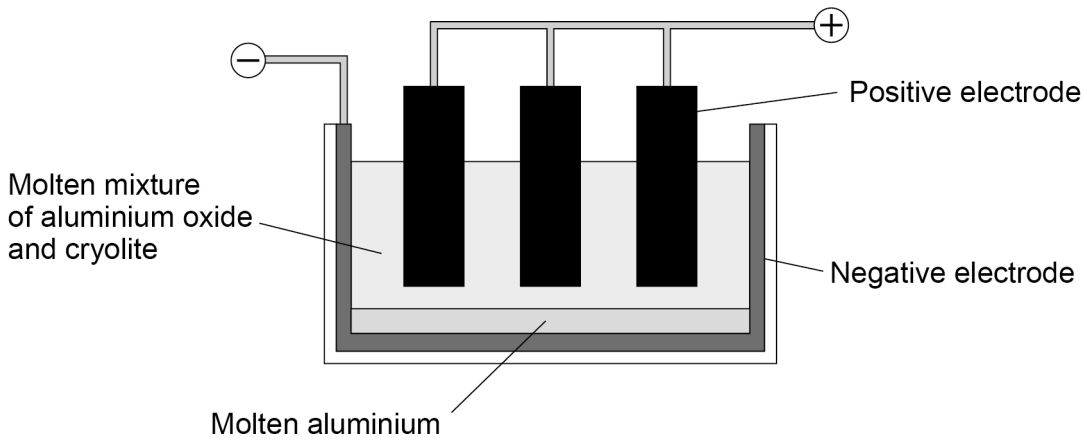
Answer in terms of reactivity.

[1 mark]

Aluminium is extracted by the electrolysis of aluminium oxide.

Figure 4 shows the apparatus used to extract aluminium.

Figure 4



5.4.3.1 The process of electrolysis

Question 10 · 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

5.4.3.1 The process of electrolysis

Question 10 · 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]

5.4.3.1 The process of electrolysis

Question 10 · 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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