AQA GCSE Combined Science - Trilogy | 8464

SPECIFICATION POINT 5.4.3.1

The process of electrolysis

Past-paper questions

Tier	**Foundation**
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

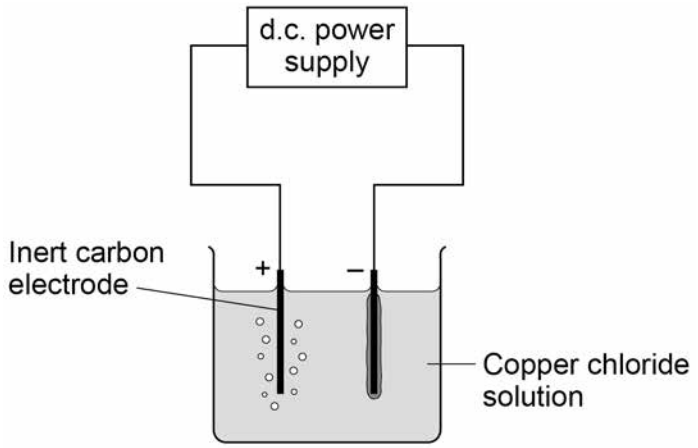
June 2018 | 8464/C/1F | Original Q5

0 5 This question is about electrolysis.

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

Figure 12 shows the apparatus.

Figure 12



0 5 . 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 5 . 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 4 shows the student's results.

Table 4

	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 5 . 3 Determine the **mean** mass of copper produced after 3 minutes.

[1 mark]

Mass = _____ mg

Question 5 continues on the next page

5.4.3.1 The process of electrolysis

Question 01 · continued

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

Use **Table 4** on page 19

[2 marks]

Mass **X** = _____ mg

0 5 . 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 students 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/1F | Original Q2

0 2 This question is about salts and electrolysis.

A student wants to make copper chloride crystals.

The student adds excess copper oxide to some hot acid.

The student stirs the mixture.

0 2 . 1 Which acid should the student use?

[1 mark]

Tick (✓) **one** box.

- Hydrochloric acid ☐
- Nitric acid ☐
- Sulfuric acid ☐

0 2 . 2 Suggest how the student would know that excess copper oxide has been added.

[1 mark]

_____

_____

Question 2 continues on the next page

5.4.3.1 The process of electrolysis

Question 02 · continued

0 2 . 3 There are four more stages, **A**, **B**, **C** and **D**, to make copper chloride crystals.

The stages **A**, **B**, **C** and **D** are not in the correct order.

Stage **A**	Partially evaporate by heating with a water bath
Stage **B**	Filter the mixture into an evaporating basin
Stage **C**	Leave to crystallise
Stage **D**	Remove and dry the crystals

Put stages **A**, **B**, **C** and **D** in the correct order.

[2 marks]

First stage _____

Second stage _____

Third stage _____

Fourth stage _____

0 2 . 4 Molten copper chloride can be electrolysed.

State the product at each electrode when molten copper chloride is electrolysed.

[2 marks]

Negative electrode _____

Positive electrode _____

5.4.3.1 The process of electrolysis

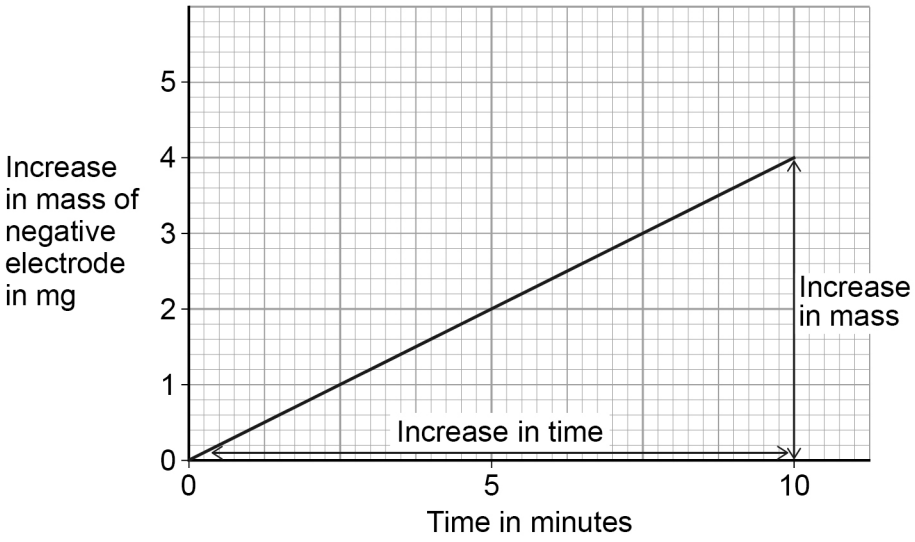
Question 02 · continued

0 2 . 5 A solution of copper chloride is electrolysed.

Figure 3 shows a graph of the increase in mass of the negative electrode.

This increase is shown over a time of 10 minutes.

Figure 3



Calculate the gradient of the line in **Figure 3**.

Use the equation:

$$\text{Gradient} = \frac{\text{increase in mass in mg}}{\text{increase in time in minutes}}$$

[3 marks]

Increase in mass _____

_____

Increase in time _____

_____

Gradient _____

_____

_____

_____

Gradient = _____ mg per minute

5.4.3.1 The process of electrolysis

Question 02 · continued

0 2 . 6 Aluminium is produced by electrolysis of a molten mixture.

Complete the sentence.

Choose the answers from the box.

[2 marks]

carbon	**chloride**	**cryolite**	**oxide**	**sulfate**	**water**

The molten mixture contains _____ and

aluminium _____ .

11

5.4.3.1 The process of electrolysis

Question 03

November 2020 | 8464/C/1F | Original Q6

0 6 This question is about the extraction of aluminium.

0 6 . 1 An aluminium atom is represented as:

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

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

[2 marks]

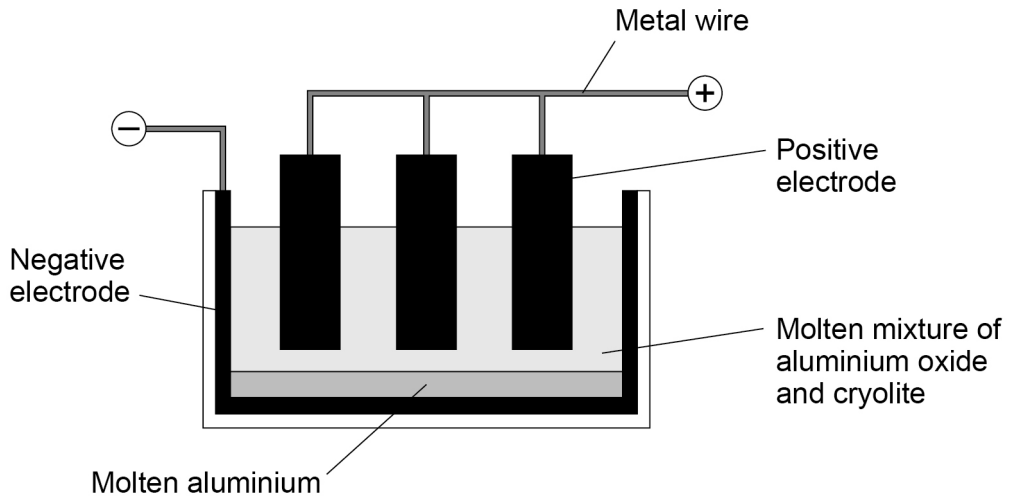
Number of electrons _____

Number of neutrons _____

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

Figure 11 shows the cell used for the electrolysis.

Figure 11



0 6 . 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 6 . 3 Oxygen is formed at the positive carbon electrodes.

Explain why the positive carbon electrodes must be continually replaced.

[3 marks]

0 6 . 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/1F | Original Q2

0 2 This question is about electrolysis.

0 2 . 1 Complete the sentence.

Choose the answer from the box.

[1 mark]

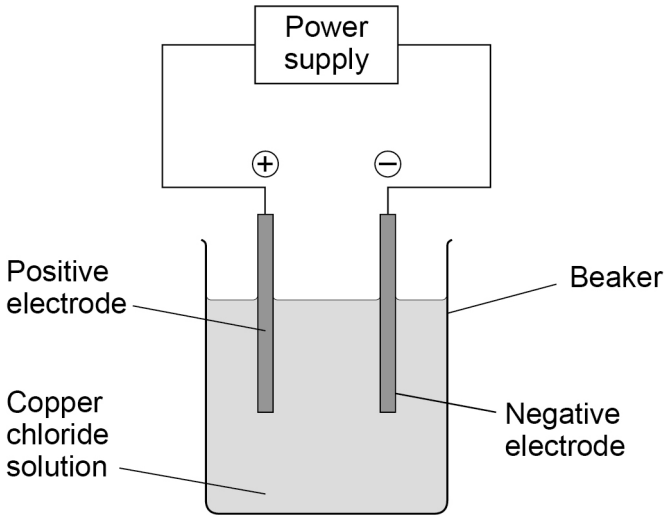
gaseous	**molten**	**solid**

Copper chloride can conduct electricity when in solution or

when _____ .

Figure 1 shows the apparatus used for the electrolysis of copper chloride solution.

Figure 1



There are four ions in copper chloride solution:

- Cu^{2+}
- Cl^{-}
- H^{+}
- OH^{-}

5.4.3.1 The process of electrolysis

Question 04 · continued

0 2 . 2 Why do Cl^- ions and OH^- ions move to the positive electrode?

[1 mark]

0 2 . 3 Where do the H^+ and OH^- ions come from in the electrolysis of copper chloride solution?

[1 mark]

Tick (✓) **one** box.

- Air ☐
- Copper chloride ☐
- Water ☐

0 2 . 4 Which ion produces a metal?

[1 mark]

Tick (✓) **one** box.

- Cu^{2+} ☐
- Cl^- ☐
- H^+ ☐
- OH^- ☐

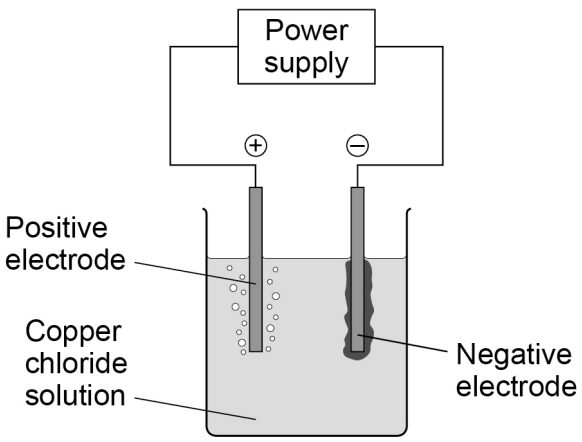
Question 2 continues on the next page

5.4.3.1 The process of electrolysis

Question 04 · continued

0 2 . 5 **Figure 2** shows the apparatus during the electrolysis of copper chloride solution.

Figure 2



Describe what is seen at each electrode during the electrolysis of copper chloride solution.

[2 marks]

Positive electrode _____

_____

Negative electrode _____

_____

0 2 . 6 500 cm^3 of copper chloride solution contains 6.50 g of copper chloride.

Calculate the mass of copper chloride in 40.0 cm^3 of this copper chloride solution.

[2 marks]

_____

_____

_____

Mass = _____ g

8

5.4.3.1 The process of electrolysis

Question 05

June 2022 | 8464/C/1F | Original Q4

0 4 This question is about elements and compounds.

0 4 . 1 Magnesium and oxygen react to produce magnesium oxide.

Balance the equation for the reaction.

[1 mark]

$$_____ Mg + O_2 \rightarrow 2\,MgO$$

0 4 . 2 Suggest **one** safety precaution that should be taken when heating magnesium and oxygen.

[1 mark]

0 4 . 3 Calculate the relative formula mass (M_r) of magnesium fluoride (MgF_2).

Relative atomic masses (A_r): F = 19 Mg = 24

[2 marks]

Relative formula mass (M_r) = _____

0 4 . 4 Argon is a noble gas.

Explain why **no** product is formed when magnesium and argon are heated together.

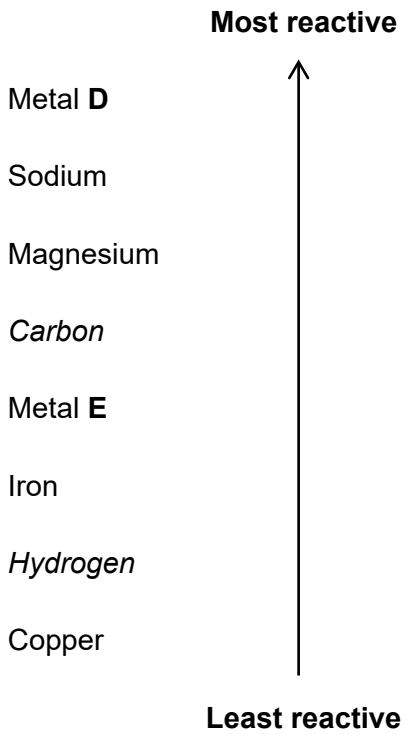
[2 marks]

5.4.3.1 The process of electrolysis

Question 05 · continued

0 4 . 5 **Figure 10** shows a reactivity series.

Figure 10



5.4.3.1 The process of electrolysis

Question 05 · continued

Draw **one** line from each metal to the method used to extract that metal.

Use **Figure 10**.

[2 marks]

Metal	Method used to extract that metal
	Extracted by electrolysis of a molten ionic compound.
Metal **D**	Extracted from its oxide by reduction with carbon.
	Extracted from its oxide by reduction with hydrogen.
Metal **E**	
	Removed from the Earth as the metal itself.

Question 4 continues on the next page

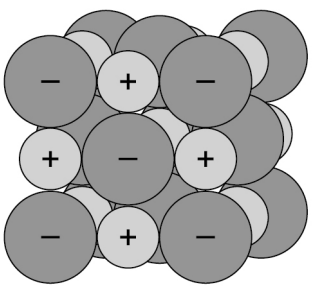
5.4.3.1 The process of electrolysis

Question 05 · continued

A substance conducts electricity when it has charged particles that are free to move.

0 4 . 6 **Figure 11** represents the structure of sodium chloride.

Figure 11



Sodium chloride

Explain why sodium chloride conducts electricity when molten but **not** when solid.

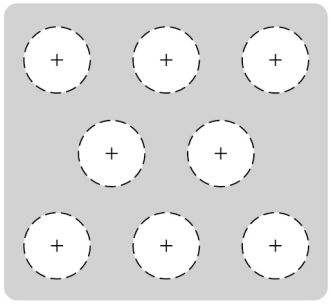
[3 marks]

5.4.3.1 The process of electrolysis

Question 05 · continued

0 4 . 7 **Figure 12** represents the structure of sodium metal.

Figure 12



Sodium metal

Explain why sodium metal conducts electricity when solid.

[2 marks]

13

5.4.3.1 The process of electrolysis

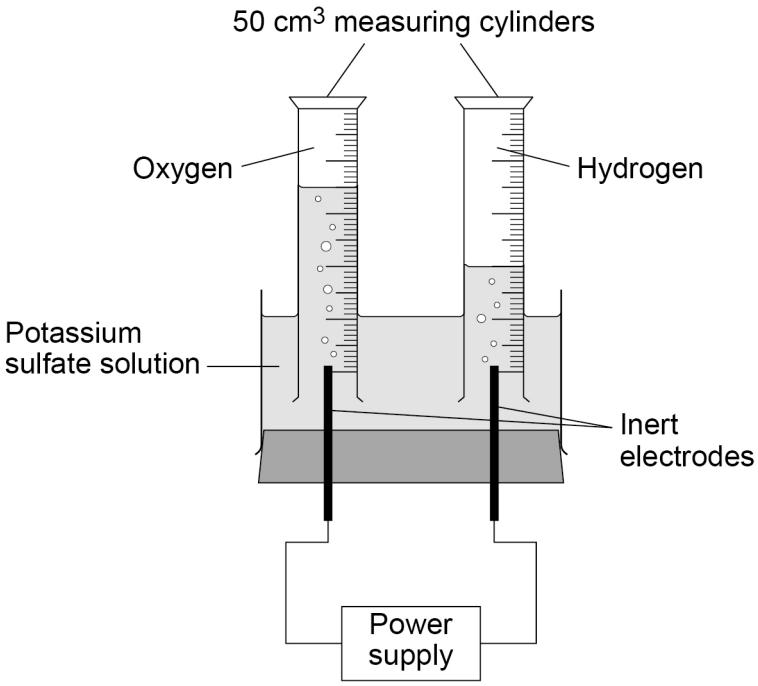
Question 06

June 2022 | 8464/C/1F | Original Q6

0 6 This question is about electrolysis.

Figure 14 shows the apparatus used to investigate the electrolysis of potassium sulfate solution.

Figure 14



0 6 . 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 6 . 2 What are the volumes of gases collected in the electrolysis experiment?

Use **Figure 14**.

[1 mark]

Volume of hydrogen = _____ cm^3

Volume of oxygen = _____ cm^3

0 6 . 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 14** support the student's hypothesis.

Use your answer to Question **06.2**

[2 marks]

Question 6 continues on the next page

5.4.3.1 The process of electrolysis

Question 06 · continued

0 6 . 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 6 . 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

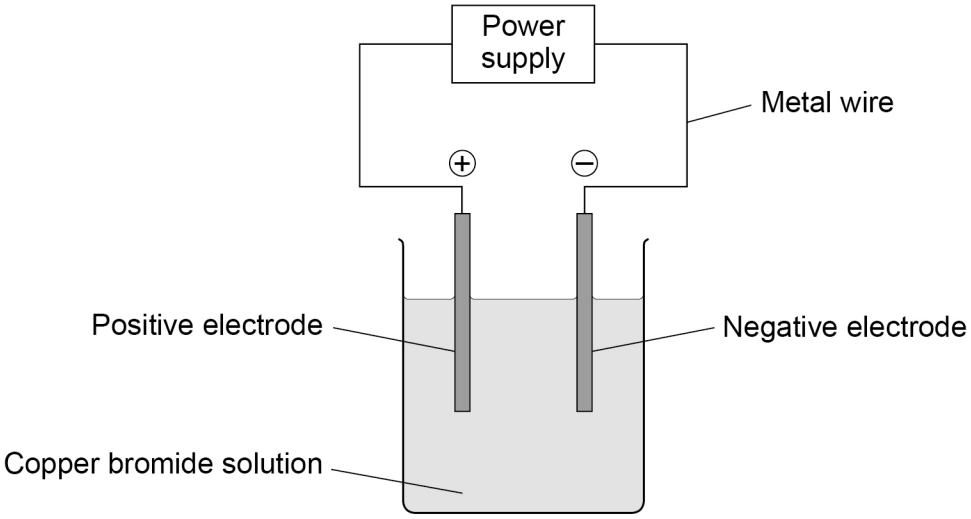
Question 07

June 2023 | 8464/C/1F | Original Q4

0 4 Copper bromide solution is electrolysed using inert electrodes.

Figure 11 shows the apparatus.

Figure 11



0 4 . 1 Which particles carry the electrical charge through the metal wire?

[1 mark]

Tick (✓) **one** box.

Electrons ☐

Neutrons ☐

Protons ☐

Question 4 continues on the next page

5.4.3.1 The process of electrolysis

Question 07 · continued

There are four ions in copper bromide solution:

- Cu^{2+}
- Br^-
- H^+
- OH^-

0 4 . 2 Two of these ions are formed when a water molecule breaks down.

The symbol equation when a water molecule breaks down is:

$$H_2O \rightarrow H^+ + OH^-$$

Complete the **word** equation for the breakdown of a water molecule.

[2 marks]

water → _____ ion + _____ ion

0 4 . 3 Copper ions and bromide ions carry the electrical charge through the solution.

The formula of a copper ion is Cu^{2+}

The formula of a bromide ion is Br^-

What is the formula of copper bromide?

[1 mark]

Tick (✓) **one** box.

CuBr ☐

Cu_2Br ☐

$CuBr_2$ ☐

5.4.3.1 The process of electrolysis

Question 07 · continued

0 4 . 4 Explain why copper ions (Cu^{2+}) move to the negative electrode.

[2 marks]

0 4 . 5 Complete the sentence.

Choose the answer from the box.

[1 mark]

decomposed	**discharged**	**distilled**

At the negative electrode copper metal is produced when the

copper ions are _____ .

0 4 . 6 What happens to the mass of the **negative** electrode during electrolysis?

[1 mark]

Tick (✓) **one** box.

Decreases ☐

No change ☐

Increases ☐

5.4.3.1 The process of electrolysis

Question 07 · continued

There are four ions in copper bromide solution:

- Cu^{2+}
- Br^-
- H^+
- OH^-

0 4 . 7 What is produced at the **positive** electrode when copper bromide solution is electrolysed?

[1 mark]

Tick (✓) **one** box.

Bromine ☐

Hydrogen ☐

Oxygen ☐

9

5.4.3.1 The process of electrolysis

Question 08

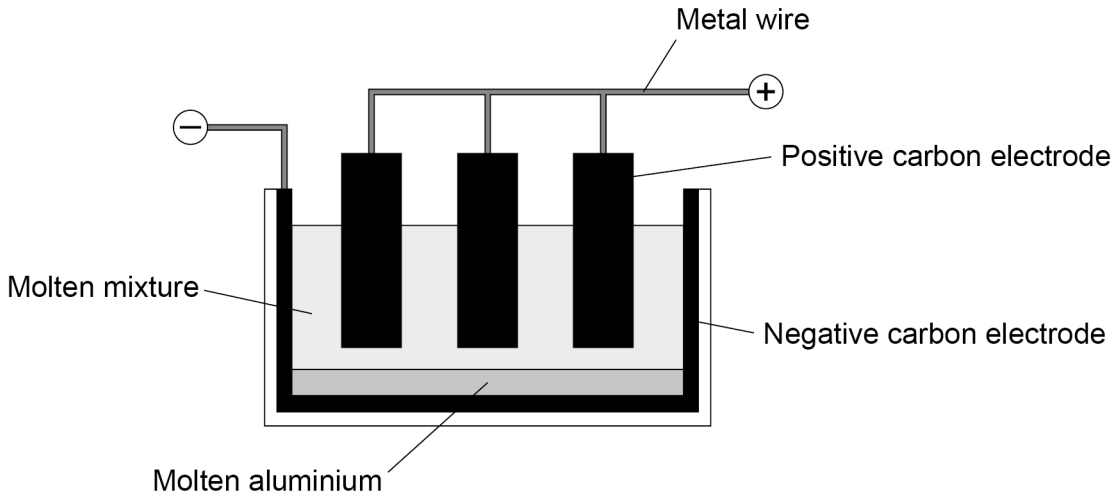
June 2023 | 8464/C/1F | Original Q5

0 5 This question is about extraction of metals.

Aluminium is extracted from a molten mixture of aluminium oxide and cryolite using electrolysis.

Figure 12 shows the electrolysis cell.

Figure 12



0 5 . 1 Complete the sentence.

[1 mark]

The extraction of aluminium is expensive because the process uses large amounts of _____ .

0 5 . 2 Oxygen is produced at the positive carbon electrodes.

The oxygen reacts with the carbon electrodes.

Which gas is produced when oxygen reacts with the positive carbon electrodes?

[1 mark]

_____

5.4.3.1 The process of electrolysis

Question 08 · continued June 2023 | 8464/C/1F | Original Q5

Titanium is extracted from titanium chloride by reacting titanium chloride with sodium.

The reaction between titanium chloride and sodium is carried out in an inert atmosphere.

0 5 . 3 Suggest why the reaction is carried out in an inert atmosphere.

[1 mark]

0 5 . 4 Complete the sentence.

Choose the answer from the box.

[1 mark]

argon	**chlorine**	**hydrogen**

The gas used for the inert atmosphere is _____ .

0 5 . 5 Balance the equation for the reaction.

[1 mark]

$$TiCl_4 + 4\,Na \rightarrow Ti + ____\ NaCl$$

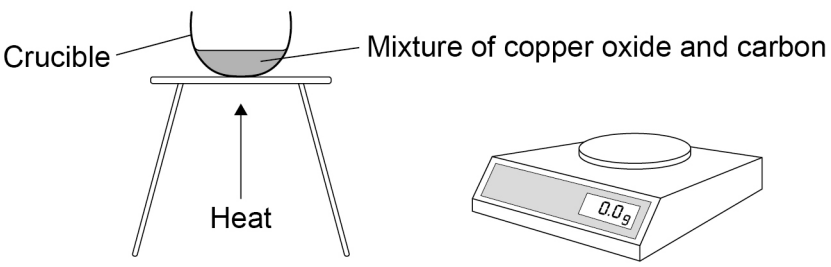
5.4.3.1 The process of electrolysis

Question 08 · continued

Copper is extracted from copper oxide by reacting copper oxide with carbon.

Figure 13 shows the apparatus.

Figure 13



The equation for the reaction is:

$$2\,CuO(s) + C(s) \rightarrow 2\,Cu(s) + CO_2(g)$$

In an experiment 15.9 g of copper oxide and 1.2 g of carbon reacted.

12.7 g of copper was produced in the reaction.

0 5 . 6 Calculate the mass of carbon dioxide produced in this experiment.

[1 mark]

Mass of carbon dioxide = _____ g

0 5 . 7 Explain why the mass of the contents in the crucible changed during the experiment.

[2 marks]

5.4.3.1 The process of electrolysis

Question 08 · continued

0 5 . 8 What happens to copper oxide in the reaction?

Give **one** reason for your answer.

Use the equation for the reaction.

[2 marks]

Tick (✓) **one** box.

The copper oxide is dissolved ☐

The copper oxide is oxidised ☐

The copper oxide is reduced ☐

Reason _____

_____

10

Turn over for the next question

5.4.3.1 The process of electrolysis

Question 09

June 2024 | 8464/C/1F | Original Q5

0 5 Magnesium chloride is a soluble salt.

0 5 . 1 Magnesium reacts with hydrochloric acid to produce magnesium chloride and a gas.

Which gas is produced?

[1 mark]

Tick (✓) **one** box.

Hydrogen ☐

Nitrogen ☐

Oxygen ☐

Question 5 continues on the next page

5.4.3.1 The process of electrolysis

Question 09 · continued June 2024 | 8464/C/1F | Original Q5

Magnesium chloride ($MgCl_2$) can be electrolysed when molten.

0 5 . 2 Which represents molten magnesium chloride?

[1 mark]

Tick (✓) **one** box.

$MgCl_2(g)$ ☐

$MgCl_2(l)$ ☐

$MgCl_2(s)$ ☐

0 5 . 3 Magnesium chloride contains Mg^{2+} ions and Cl^- ions.

Name the product at each electrode when molten magnesium chloride is electrolysed.

[2 marks]

Negative electrode _____

Positive electrode _____

5.4.3.1 The process of electrolysis

Question 09 · continued

A student investigated the reactivity of three metals: copper, magnesium and iron.

The student mixed each metal with each metal chloride solution.

Table 6 shows the results.

Table 6

	Copper chloride solution	**Magnesium chloride solution**	**Iron chloride solution**
Copper	No reaction	No reaction	No reaction
Magnesium	Reaction	No reaction	Reaction
Iron	Reaction	No reaction	No reaction

0 5 . 4 What is the order of reactivity for copper, magnesium and iron?

Give **two** reasons for your answer.

Use **Table 6**.

[3 marks]

Most reactive _____

_____

Least reactive _____

Reason 1 _____

_____

Reason 2 _____

_____

Question 5 continues on the next page

5.4.3.1 The process of electrolysis

Question 09 · continued

0 5 . 5 When heated 0.72 g of magnesium reacts with iron oxide to produce 2.32 g of products.

Calculate the mass of iron oxide that reacts with 0.72 g of magnesium.

[1 mark]

Mass of iron oxide = _____ g

0 5 . 6 The student used 30 cm^3 of magnesium chloride solution.

1 dm^3 of magnesium chloride solution contains 180 g of magnesium chloride.

1 dm^3 = 1000 cm^3

Calculate the mass of magnesium chloride in 30 cm^3 of magnesium chloride solution.

[3 marks]

Mass of magnesium chloride = _____ g

11

5.4.3.1 The process of electrolysis

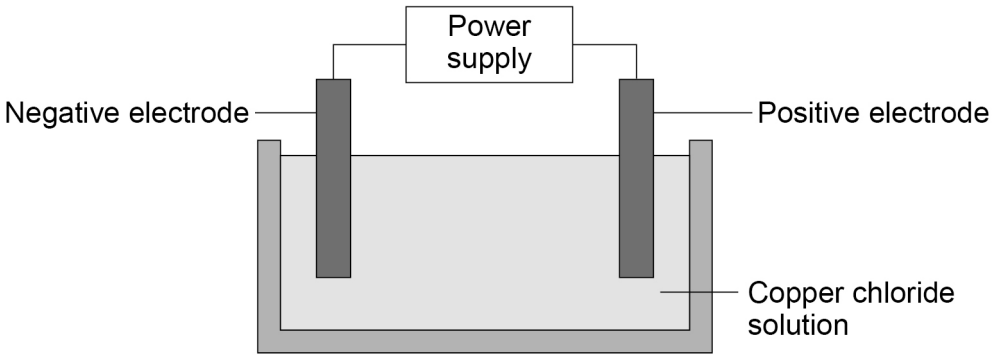
Question 10

June 2025 | 8464/C/1F | Original Q6

0 6 A teacher demonstrated the electrolysis of copper chloride solution.

Figure 12 shows the apparatus.

Figure 12



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

0 6 . 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 6 continues on the next page

Table 5 shows the results.

Table 5

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

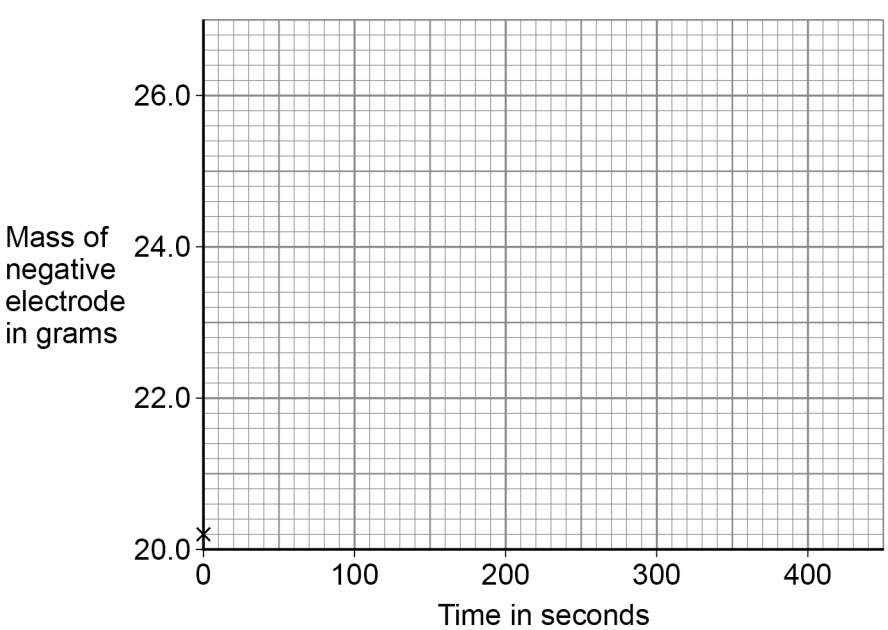
0 6 . 2 Plot the data from **Table 5** on **Figure 13**.

Draw a line of best fit.

The first point has been plotted for you.

[3 marks]

Figure 13



5.4.3.1 The process of electrolysis

Question 10 · continued

0 6 . 3 A student made the hypothesis:

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

How do the results in **Table 5** show that the hypothesis is **not** correct?

[1 mark]

0 6 . 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 6 continues on the next page

5.4.3.1 The process of electrolysis

Question 10 · continued

0 6 . 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