AQA GCSE Combined Science - Trilogy | 8464

SPECIFICATION POINT 5.4.3.2

Electrolysis of molten ionic compounds

Past-paper questions

Tier	**Foundation**
Question groups	**6**
Available paper years	**2019–2024**

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.

5.4.3.2 Electrolysis of molten ionic compounds

Question 01

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

5.4.3.2 Electrolysis of molten ionic compounds

Question 01 · 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 _____

5.4.3.2 Electrolysis of molten ionic compounds

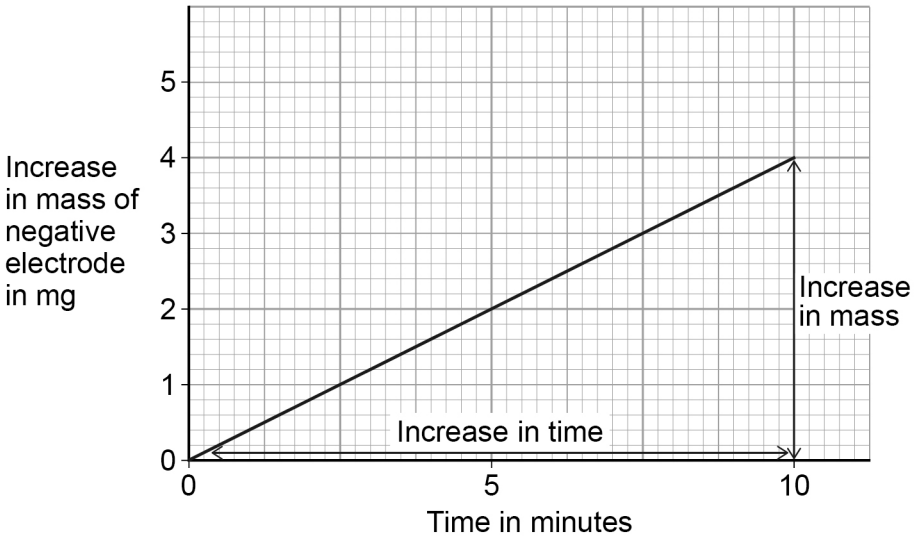
Question 01 · continued

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

5.4.3.2 Electrolysis of molten ionic compounds

Question 01 · 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

5.4.3.2 Electrolysis of molten ionic compounds

Question 02

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]

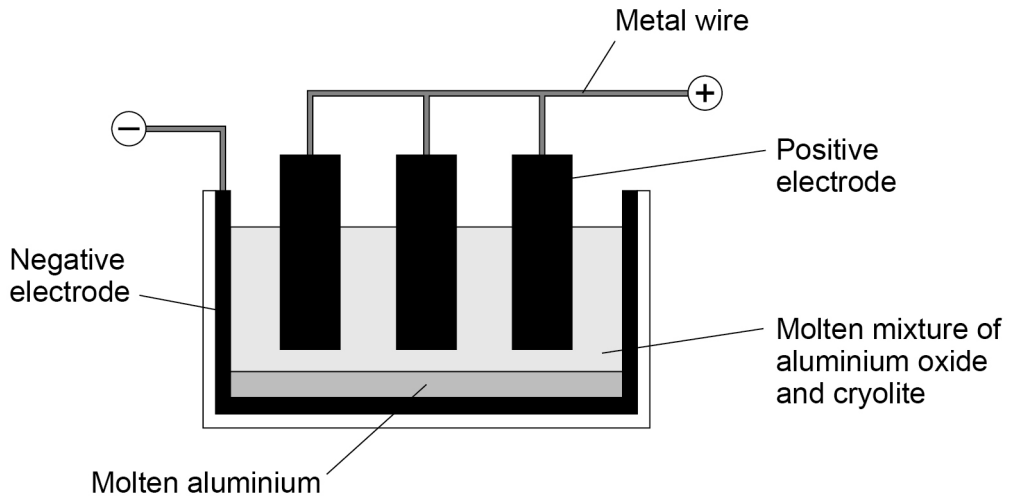
Number of electrons _____

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]

_____

_____

5.4.3.2 Electrolysis of molten ionic compounds

Question 02 · 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

5.4.3.2 Electrolysis of molten ionic compounds

Question 03

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]

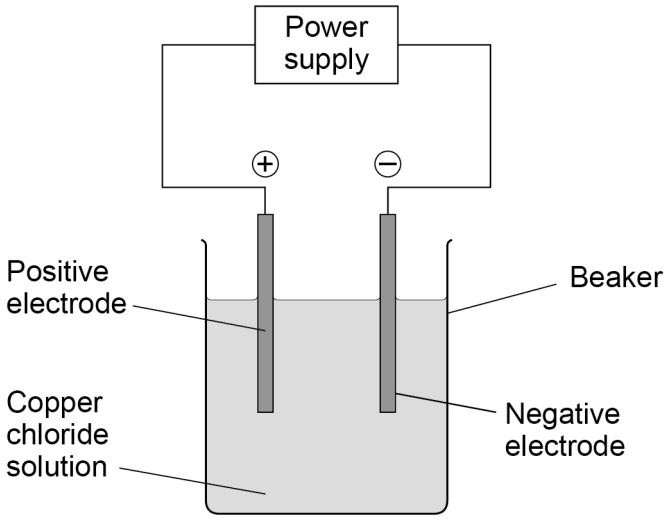
gaseous	**molten**	**solid**

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^{-}

5.4.3.2 Electrolysis of molten ionic compounds

Question 03 · 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^- ☐

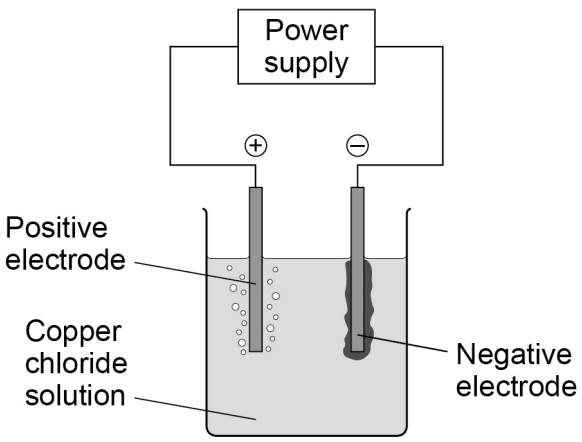
Question 2 continues on the next page

5.4.3.2 Electrolysis of molten ionic compounds

Question 03 · 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

5.4.3.2 Electrolysis of molten ionic compounds

Question 04

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.

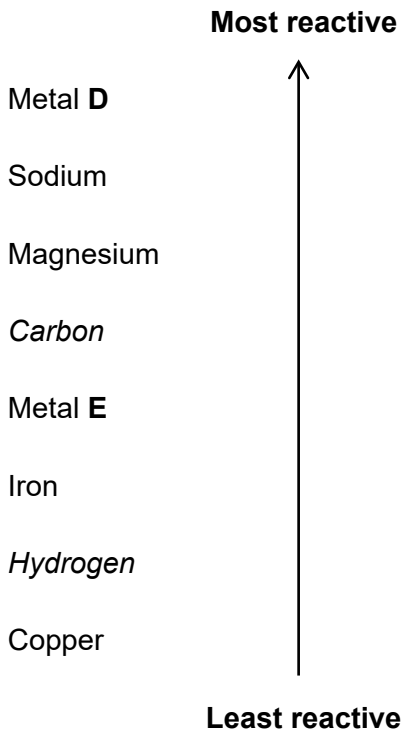
Explain why **no** product is formed when magnesium and argon are heated together.

[2 marks]

5.4.3.2 Electrolysis of molten ionic compounds

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

Figure 10



5.4.3.2 Electrolysis of molten ionic compounds

Question 04 · 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

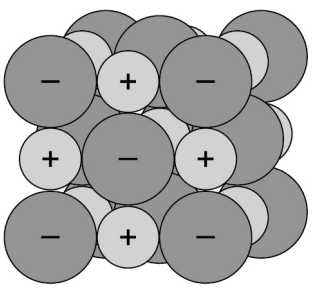
5.4.3.2 Electrolysis of molten ionic compounds

Question 04 · 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.

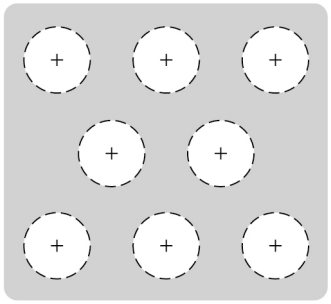
[3 marks]

5.4.3.2 Electrolysis of molten ionic compounds

Question 04 · 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

5.4.3.2 Electrolysis of molten ionic compounds

Question 05

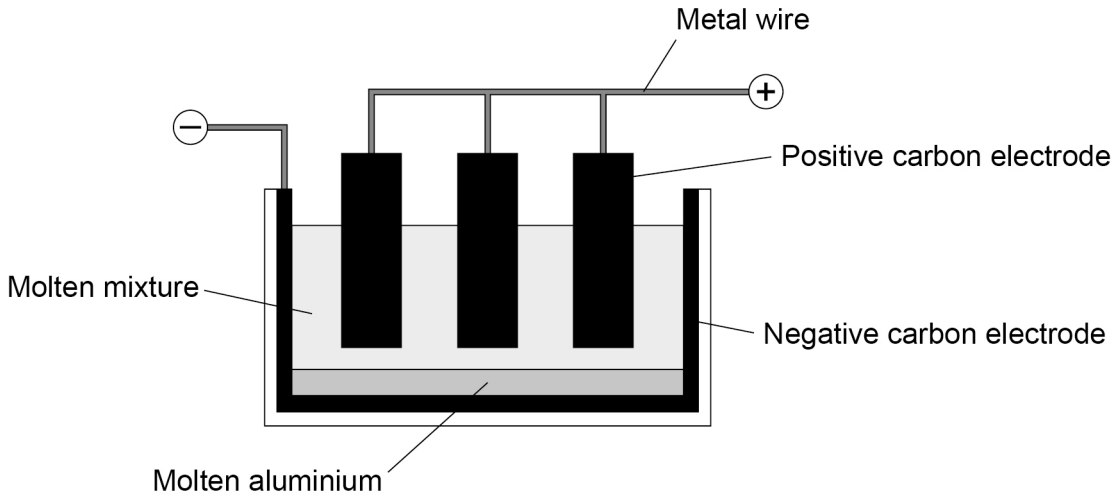
June 2023 | 8464/C/1F | Original Q5

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]

_____

5.4.3.2 Electrolysis of molten ionic compounds

Question 05 · 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]

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

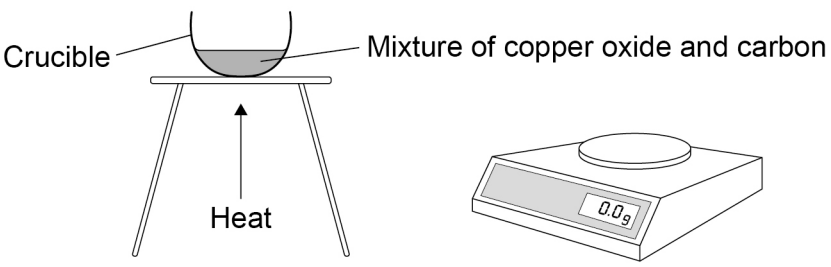
5.4.3.2 Electrolysis of molten ionic compounds

Question 05 · 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]

5.4.3.2 Electrolysis of molten ionic compounds

Question 05 · 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

5.4.3.2 Electrolysis of molten ionic compounds

Question 06

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

5.4.3.2 Electrolysis of molten ionic compounds

Question 06 · continued

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 _____

5.4.3.2 Electrolysis of molten ionic compounds

Question 06 · 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

5.4.3.2 Electrolysis of molten ionic compounds

Question 06 · 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