AQA GCSE Chemistry | 8462

SPECIFICATION POINT 4.4.3.2

Electrolysis of molten ionic compounds

Past-paper questions

Tier	**Higher**
Question groups	**13**
Available paper years	**2010–2025**

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.

4.4.3.2 Electrolysis of molten ionic compounds

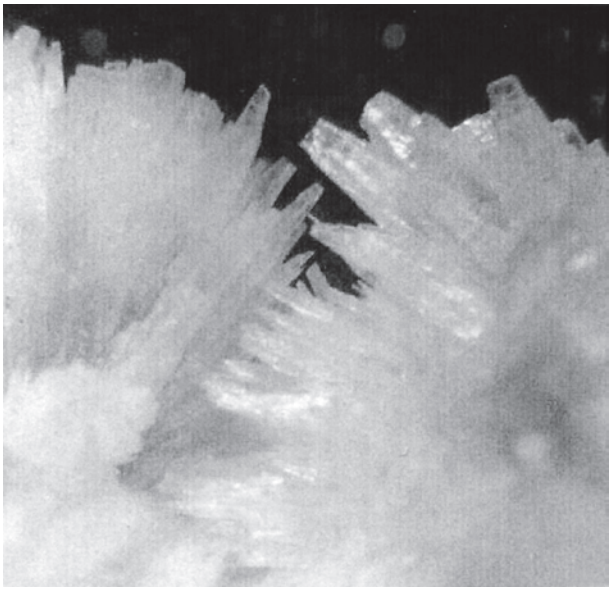
Question 01

June 2010 | CHY2H | Original Q2 | Legacy

2 (a) Read the article about the mineral strontianite.

Strontianite is a mineral that was discovered near the village of Strontian in Scotland. At first some scientists thought that strontianite was barium carbonate.

Strontianite



In 1790, Professor Adair Crawford and William Cruikshank were both lecturers in chemistry and doctors of medicine. They investigated the properties of strontianite. They found that strontianite had different properties from barium carbonate. They concluded that strontianite contained a new element.

After this, other scientists also showed that strontianite and barium carbonate had different properties. Strontianite is now known to be strontium carbonate.

2 (a) (i) What evidence did Crawford and Cruikshank use to prove that strontianite was **not** barium carbonate?

.....

.....

(1 mark)

2 (a) (ii) Crawford and Cruikshank's conclusion was immediately accepted by other scientists. Suggest why.

.....

.....

(1 mark)

2 (a) (iii) How was the reliability of the work of Crawford and Cruikshank confirmed?

.....

.....

(1 mark)

4.4.3.2 Electrolysis of molten ionic compounds

Question 01 · continued

2 (b) One of Crawford and Cruikshank's experiments was repeated in a school laboratory. Samples of strontianite and barium carbonate were reacted with hydrochloric acid to produce strontium chloride and barium chloride.

Solid strontium chloride and solid barium chloride were separately added to water. The change in temperature of the water was measured.

The results of the experiments are shown below.

	Experiment 1 Strontium chloride dissolved in water	**Experiment 2** Barium chloride dissolved in water
Temperature of water before adding the chloride in ºC	19.5	19.6
Temperature of water after adding the chloride in ºC	21.2	17.5

2 (b) (i) State **one** variable that should be controlled to make it a fair test.

.....

.....

(1 mark)

2 (b) (ii) Which experiment, **1** or **2**, is endothermic?

Explain how you know.

Experiment ☐ because .....

.....

(1 mark)

2 (b) (iii) The results prove that strontium chloride and barium chloride must be different even if all of the variables had not been controlled when they were dissolved. Explain why.

.....

.....

(1 mark)

2 (c) In 1808, Humphry Davy was the first person to extract strontium. He did this by the electrolysis of molten strontium chloride. Strontium formed at the negative electrode.

Suggest why strontium ions are attracted to the negative electrode.

.....

.....

(1 mark)

7

4.4.3.2 Electrolysis of molten ionic compounds

Question 02

November 2010 | CHY1AP | Original Q1 | Legacy

QUESTION ONE

This question is about how we obtain some metals.

Match statements, **A**, **B**, **C** and **D**, with the numbers **1–4** in the table.

A uses another metal

B does **not** use a chemical reaction

C could be done in a blast furnace

D is called electrolysis

1	Aluminium is made when an electric current passes through a molten aluminium compound.
2	Gold can be found at the bottom of some streams.
3	Titanium is made by reacting titanium chloride with magnesium.
4	Zinc is made when a mixture of zinc oxide and carbon is heated.

4.4.3.2 Electrolysis of molten ionic compounds

Question 03

1 The flow diagram shows the main stages used to extract a metal from its ore.

mining the ore → purifying the ore → extracting the metal

The table shows some information about three metals.

Metal	Metal ore	Purified ore	% of metal in the ore	% of metal in the Earth's crust
aluminium	bauxite	aluminium oxide, Al_2O_3	28.0	8.0
copper	chalcocite	copper sulfide, Cu_2S	0.5	0.001
iron	haematite	iron oxide, Fe_2O_3	29.0	5.0

1 (a) Use the information in the table and your knowledge and understanding to help you to answer the questions.

1 (a) (i) Suggest why purifying the copper ore produces large quantities of waste.

.....

.....

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(1 mark)

1 (a) (ii) Suggest why the annual world production of iron is forty times greater than that of aluminium.

.....

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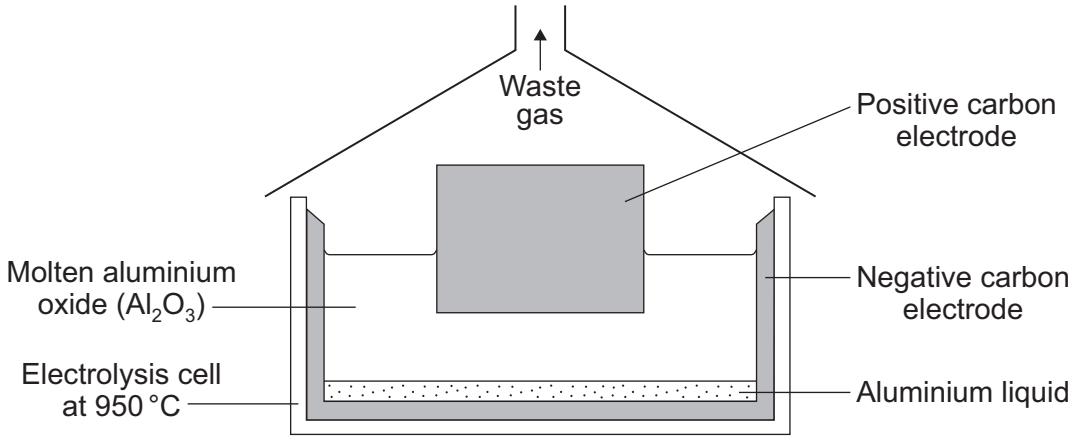
.....

(1 mark)

4.4.3.2 Electrolysis of molten ionic compounds

Question 03 · continued

1 (b) Aluminium is used for drinks cans.
Aluminium is extracted from its purified ore by electrolysis.



1 (b) (i) Suggest why the aluminium produced in the electrolysis cell is a liquid.

.....

.....

(1 mark)

1 (b) (ii) In this electrolysis, aluminium and oxygen gas are produced from the aluminium oxide.

Use the information in the diagram to suggest why most of the waste gas is carbon dioxide and not oxygen.

.....

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.....

.....

(2 marks)

1 (b) (iii) Aluminium is the most abundant metal in the Earth's crust.

Suggest **two** reasons why we should recycle aluminium drinks cans.

1 .....

.....

2 .....

.....

(2 marks)

7

4.4.3.2 Electrolysis of molten ionic compounds

Question 04

June 2011 | CHY1AP | Original Q9 | Legacy

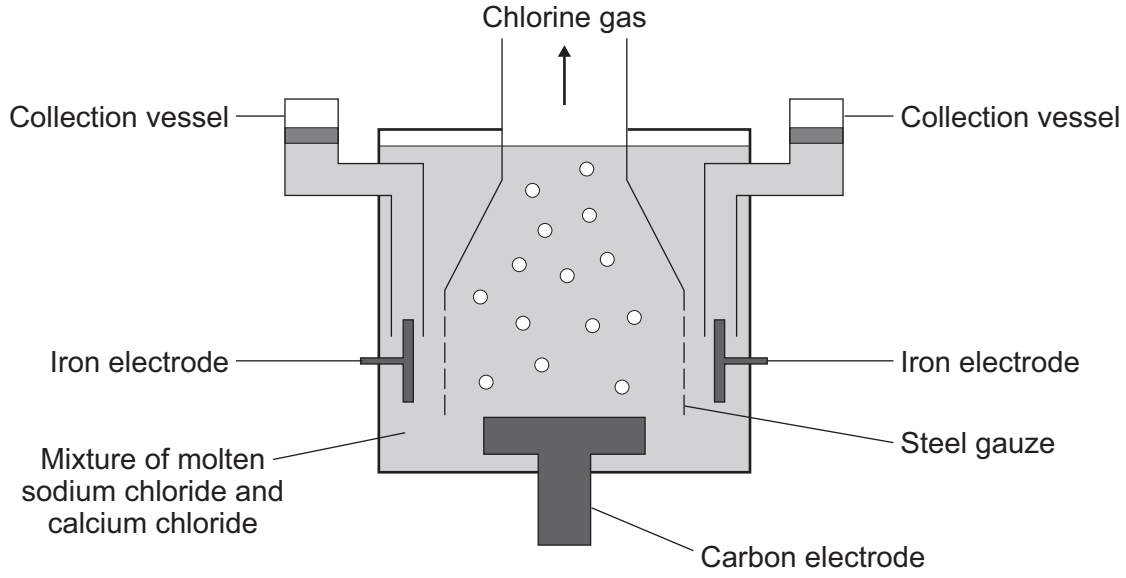
QUESTION NINE

Sodium cannot be extracted from its oxide by reduction with carbon.

Sodium metal is extracted by electrolysis of molten sodium chloride. The melting point of sodium chloride is very high (800°C), so calcium chloride is added to reduce the melting point of the mixture to about 550°C.

During electrolysis, both sodium and calcium are obtained at the iron electrodes, and chlorine at the carbon electrode.

The diagram shows the electrolysis cell used for the extraction of sodium.



The table shows some properties of sodium and calcium.

	Melting point in °C	Density in g per cm^3	Reactivity
Sodium	97	0.97	Very reactive
Calcium	839	1.55	Reactive

9A In the extraction of sodium, a mixture of sodium chloride and calcium chloride is used to . . .

1 reduce the amount of energy required to melt the mixture.

2 obtain a pure sample of sodium.

3 absorb the chlorine gas.

4 increase the temperature of the mixture.

4.4.3.2 Electrolysis of molten ionic compounds

9B The purpose of the steel gauze is to prevent the reaction of . . .

1 sodium with calcium.

2 sodium with chlorine.

3 iron electrodes with sodium chloride.

4 sodium chloride with calcium chloride.

9C In the collection vessel there is . . .

1 solid sodium below a layer of liquid calcium.

2 solid calcium below a layer of liquid sodium.

3 a mixture of liquid sodium and liquid calcium.

4 a mixture of solid calcium and solid sodium.

9D The information in the diagram suggests that the element carbon . . .

1 has a melting point lower than 550 °C.

2 reacts rapidly with chlorine gas.

3 is an electrical conductor.

4 is more reactive than iron.

END OF TEST

4.4.3.2 Electrolysis of molten ionic compounds

Question 05

June 2013 | CH2HP | Original Q4 | Legacy

4 This question is about potassium.

4 (a) Humphrey Davy was a professor of chemistry.

In 1807 Davy did an electrolysis experiment to produce potassium.

4 (a) (i) Davy first tried to electrolyse a solid potassium salt to produce potassium.

Explain why this electrolysis did **not** work.

.....

.....

.....

.....

(2 marks)

4 (a) (ii) Humphrey Davy was the first person to produce potassium.

Humphrey Davy's experiment to produce this new element was quickly accepted by other scientists.

Suggest why.

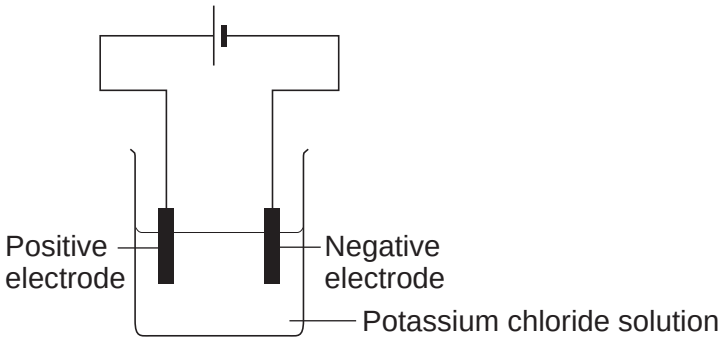
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(1 mark)

4 (b) A student dissolved some potassium chloride in water.
The student tried to electrolyse the potassium chloride solution to produce potassium.

The apparatus the student used is shown in the diagram.



4.4.3.2 Electrolysis of molten ionic compounds

Question 05 · continued

The student expected to see potassium metal at the negative electrode, but instead saw bubbles of a gas.

- Name the gas produced at the negative electrode.
- Explain why this gas was produced at the negative electrode **and** why potassium was not produced.

The reactivity series of metals on the Chemistry Data Sheet may help you to answer this question.

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(3 marks)

4 (c) The student tried to electrolyse molten potassium chloride to produce potassium.

4 (c) (i) Potassium metal was produced at the negative electrode.

Describe how potassium atoms are formed from potassium ions.

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.....

.....

(2 marks)

Question 4 continues on the next page

4.4.3.2 Electrolysis of molten ionic compounds

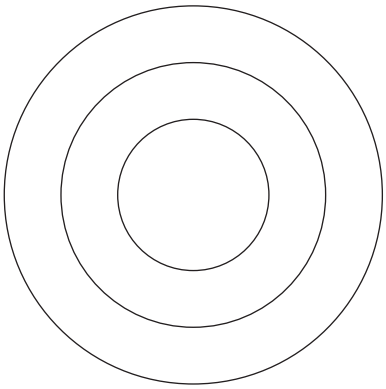
Question 05 · continued

4 (c) (ii) Complete and balance the equation for the reaction at the positive electrode.

.....Cl^- $\longrightarrow$ Cl_2 + ...

(1 mark)

4 (c) (iii) Complete the diagram to show the electronic structure of a chloride ion (Cl^-).



(1 mark)

10

4.4.3.2 Electrolysis of molten ionic compounds

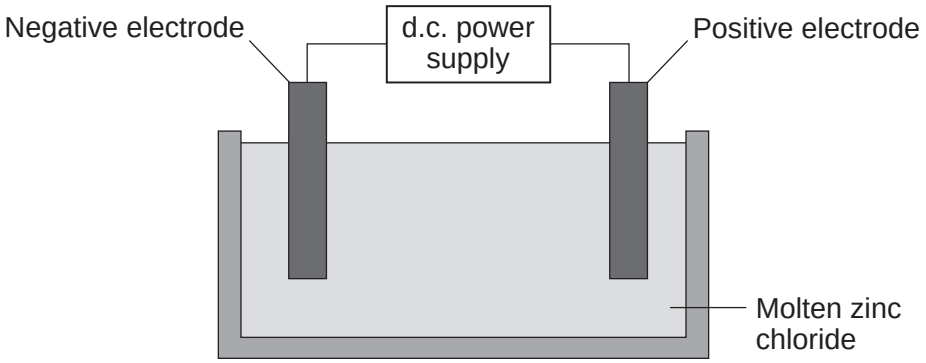
Question 06

June 2014 | CH2HP | Original Q4 | Legacy

4 This question is about zinc and magnesium.

Zinc is produced by electrolysis of molten zinc chloride, as shown in **Figure 4**.

Figure 4



4 (a) (i) Why must the zinc chloride be molten for electrolysis?

[1 mark]

.....

.....

4 (a) (ii) Describe what happens at the negative electrode.

[3 marks]

.....

.....

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.....

.....

.....

4 (a) (iii) Complete the half equation for the reaction at the positive electrode.

[1 mark]

..... $\longrightarrow$ Cl_2 + ... e^-

4.4.3.2 Electrolysis of molten ionic compounds

Question 06 · continued

4 (b) Magnesium can be produced from magnesium oxide.

The equation for the reaction is:

$$Si(s) + 2\,MgO(s) \rightleftharpoons SiO_2(s) + 2\,Mg(g)$$

4 (b) (i) How can you tell from the equation that the reaction is done at a high temperature?

[1 mark]

.....

.....

4 (b) (ii) This reaction to produce magnesium from magnesium oxide is **endothermic**.

What is meant by an **endothermic** reaction?

[1 mark]

.....

.....

4 (b) (iii) A company made magnesium using this reaction.

Calculate the mass of magnesium oxide needed to produce 1.2 tonnes of magnesium.

Relative atomic masses (A_r): O = 16; Mg = 24

[3 marks]

.....

.....

.....

.....

Mass of magnesium oxide needed = ... tonnes

4.4.3.2 Electrolysis of molten ionic compounds

Question 06 · continued

4 (b) (iv) The company calculated that they would produce 1.2 tonnes of magnesium, but only 0.9 tonnes was produced.

Calculate the percentage yield.

[1 mark]

.....

.....

Percentage yield = ... %

4 (b) (v) Give **one** reason why the calculated yield of magnesium might not be obtained.

[1 mark]

.....

.....

12

Turn over for the next question

4.4.3.2 Electrolysis of molten ionic compounds

Question 07

June 2015 | CH2HP | Original Q3 | Legacy

3 This question is about metals and alloys.

3 (a) Explain how electricity is conducted in a metal.

To gain full marks you must include a description of the structure and bonding of a metal.

[4 marks]

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3 (b) Describe how the structure of an alloy is different from the structure of a pure metal.

[2 marks]

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3 (c) Alloys are used to make dental braces and coins.

3 (c) (i) Nitinol is an alloy used in dental braces.

Why is Nitinol used in dental braces?

[1 mark]

.....

.....

4.4.3.2 Electrolysis of molten ionic compounds

Question 07 · continued

3 (c) (ii) Suggest **one** reason why coins are not made of pure copper.

Do **not** give cost as a reason.

[1 mark]

.....

.....

3 (c) (iii) Some coins are made from an alloy of aluminium.

Complete the sentence.

[1 mark]

Aluminium is manufactured by the electrolysis of a molten mixture of

cryolite and ..... .

3 (c) (iv) Banks keep coins in poly(ethene) bags. These bags are made from low density poly(ethene).

High density poly(ethene) can also be made from the same monomer.

How can the same reaction produce two different products?

[1 mark]

.....

.....

3 (d) Give **two** reasons why instrumental methods of analysis are used to detect impurities in metals.

[1 mark]

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.....

.....

11

4.4.3.2 Electrolysis of molten ionic compounds

Question 08

June 2016 | CH2HP | Original Q5 | Legacy

5 This question is about magnesium and magnesium chloride.

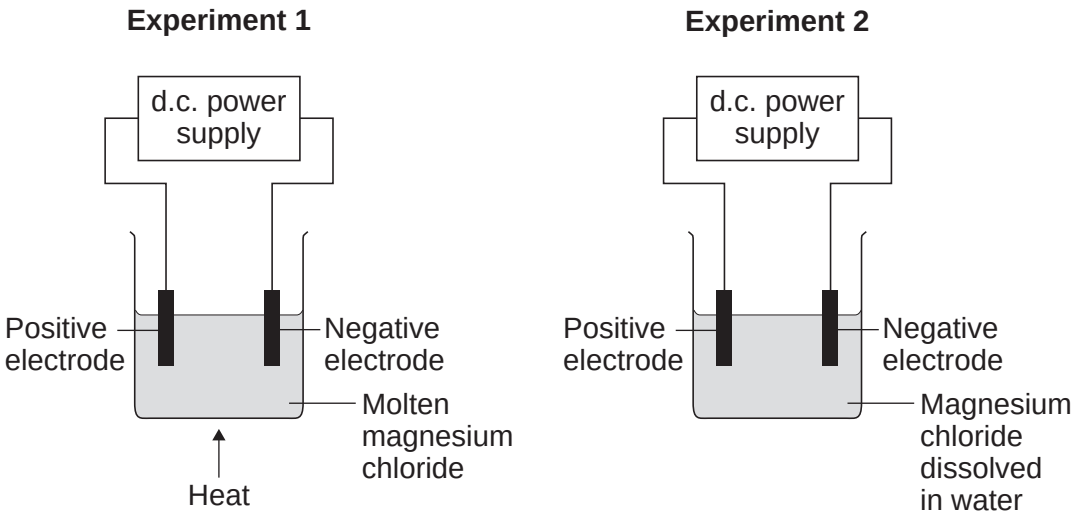
5 (a) Magnesium chloride contains magnesium ions (Mg^{2+}) and chloride ions (Cl^-).

Describe, in terms of electrons, what happens when a magnesium atom reacts with chlorine atoms to produce magnesium chloride.

[4 marks]

5 (b) Magnesium chloride can be electrolysed.
Figure 5 shows two experiments for electrolysing magnesium chloride.

Figure 5



4.4.3.2 Electrolysis of molten ionic compounds

Question 08 · continued

5 (b) (i) Explain why magnesium chloride must be molten or dissolved in water to be electrolysed.

[2 marks]

5 (b) (ii) Explain how magnesium is produced at the negative electrode in **Experiment 1**.

[3 marks]

5 (b) (iii) In **Experiment 2** a gas is produced at the negative electrode.
Name the gas produced at the negative electrode.

[1 mark]

5 (b) (iv) Suggest why magnesium is **not** produced at the negative electrode in **Experiment 2**.

[1 mark]

Question 5 continues on the next page

4.4.3.2 Electrolysis of molten ionic compounds

Question 08 · continued

5 (b) (v) Complete and balance the half equation for the reaction at the positive electrode.

[1 mark]

$$____ Cl^- \longrightarrow Cl_2 + _____$$

5 (c) Magnesium is a metal.
Explain why metals can be bent and shaped.

[2 marks]

_____

_____

_____

_____

14

4.4.3.2 Electrolysis of molten ionic compounds

Question 09

0 7 This question is about electrolysis.

Aluminium is produced by electrolysing a molten mixture of aluminium oxide and cryolite.

0 7 . 1 Explain why a mixture is used as the electrolyte instead of using only aluminium oxide.

[2 marks]

0 7 . 2 What happens at the negative electrode during the production of aluminium?

[1 mark]

Tick (✓) **one** box.

- Aluminium atoms gain electrons. ☐
- Aluminium atoms lose electrons. ☐
- Aluminium ions gain electrons. ☐
- Aluminium ions lose electrons. ☐

0 7 . 3 Oxygen is produced at the positive electrode.

Complete the balanced half-equation for the process at the positive electrode.

[2 marks]

$\rightarrow \quad O_2 \quad +$

4.4.3.2 Electrolysis of molten ionic compounds

Question 09 · continued

0 7 . 4 Explain why the positive electrode must be continually replaced.

[3 marks]

0 7 . 5 The overall equation for the electrolysis of aluminium oxide is:

$$2Al_2O_3 \rightarrow 4Al + 3O_2$$

Calculate the mass of oxygen produced when 2000 kg of aluminium oxide is completely electrolysed.

Relative atomic masses (A_r): O = 16 Al = 27

[4 marks]

Mass of oxygen = _____ kg

4.4.3.2 Electrolysis of molten ionic compounds

Question 09 · continued

Sodium metal and chlorine gas are produced by the electrolysis of molten sodium chloride.

0 7 . 6 Explain why sodium chloride solution **cannot** be used as the electrolyte to produce sodium metal.

[2 marks]

0 7 . 7 Calculate the volume of 150 kg of chlorine gas at room temperature and pressure.

The volume of one mole of any gas at room temperature and pressure is 24.0 dm^3

Relative formula mass (M_r): Cl_2 = 71

[2 marks]

Volume = _____ dm^3

16

4.4.3.2 Electrolysis of molten ionic compounds

Question 10

November 2021 | 8462/1H | Original Q7

0 7 This question is about chemical reactions and electricity.

0 7 . 1 Electrolysis and chemical cells both involve chemical reactions and electricity.

Explain the difference between the processes in electrolysis and in a chemical cell.

[2 marks]

0 7 . 2 A teacher demonstrates the electrolysis of molten lead bromide.

Bromine is produced at the positive electrode.

Complete the half equation for the production of bromine.

You should balance the half equation.

[2 marks]

$$Br^- \rightarrow \quad +$$

0 7 . 3 Two aqueous salt solutions are electrolysed using inert electrodes.

Complete **Table 4** to show the product at each electrode.

[3 marks]

Table 4

Salt solution	Product at positive electrode	Product at negative electrode
Copper nitrate		copper
Potassium iodide		

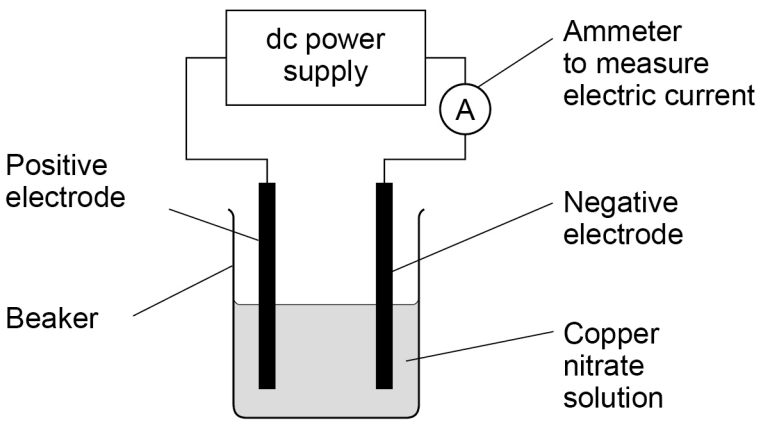
4.4.3.2 Electrolysis of molten ionic compounds

Question 10 · continued

Some students investigated the electrolysis of copper nitrate solution using inert electrodes.

Figure 4 shows the apparatus.

Figure 4



The students investigated how the mass of copper produced at the negative electrode varied with:

- time
- current.

This is the method used.

1. Weigh the negative electrode.
2. Set up the apparatus shown in **Figure 4**.
3. Adjust the power supply until the ammeter shows a current of 0.3 A
4. Switch off the power supply after 5 minutes.
5. Rinse the negative electrode with water and allow to dry.
6. Reweigh the negative electrode.
7. Repeat steps 1 to 6 for different times.
8. Repeat steps 1 to 7 at different currents.

4.4.3.2 Electrolysis of molten ionic compounds

Question 10 · continued

0 7 . 4 Some of the copper produced did not stick to the negative electrode but fell to the bottom of the beaker.

Suggest how the students could find the total mass of copper produced.

[4 marks]

Question 7 continues on the next page

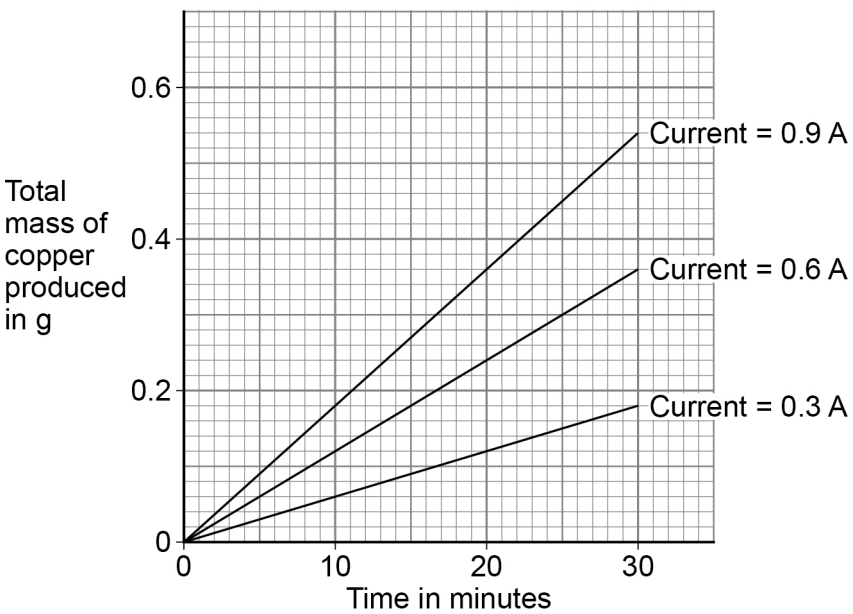
4.4.3.2 Electrolysis of molten ionic compounds

Question 10 · continued

The students plotted their results on a graph.

Figure 5 shows the graph.

Figure 5



A student correctly concluded that the total mass of copper produced is directly proportional both to the time and to the current.

0 7 . 5 How do the results in **Figure 5** support the conclusion that the total mass of copper produced is directly proportional to the time?

[1 mark]

0 7 . 6 How do the results in **Figure 5** support the conclusion that the total mass of copper produced is directly proportional to the current?

Use data from **Figure 5** in your answer.

[1 mark]

4.4.3.2 Electrolysis of molten ionic compounds

Question 10 · continued

0 7 . 7 Copper nitrate solution is blue.

Suggest why the blue colour of the copper nitrate solution fades during the electrolysis.

[1 mark]

0 7 . 8 Determine the number of atoms of copper produced when copper nitrate solution is electrolysed for 20 minutes at a current of 0.6 A

Give your answer to 3 significant figures.

Use **Figure 5**.

Relative atomic mass (A_r): Cu = 63.5

The Avogadro constant = 6.02×10^{23} per mole

[3 marks]

Number of atoms (3 significant figures) = _____

17

4.4.3.2 Electrolysis of molten ionic compounds

Question 11

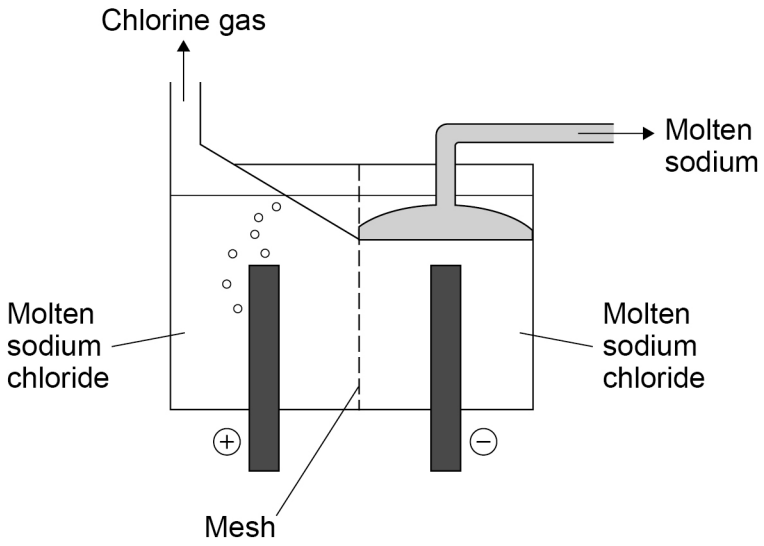
June 2022 | 8462/1H | Original Q6

0 6 This question is about electrolysis.

Molten sodium chloride is electrolysed in an industrial process to produce sodium.

Figure 8 shows a simplified version of the electrolysis cell used.

Figure 8



0 6 . 1 Which is the correct half equation for the production of sodium?

[1 mark]

Tick (✓) **one** box.

$Na + e^- \rightarrow Na^+$ ☐

$Na \rightarrow Na^+ + e^-$ ☐

$Na^+ + e^- \rightarrow Na$ ☐

$Na^+ \rightarrow Na + e^-$ ☐

4.4.3.2 Electrolysis of molten ionic compounds

Question 11 · continued

A mesh is used to keep the products of the electrolysis apart.

0 6 . 2 Suggest **one** reason why the products of the electrolysis must be kept apart.

[1 mark]

0 6 . 3 Which type of particle passes through the mesh in the electrolysis of molten sodium chloride?

[1 mark]

Tick (✓) **one** box.

- Atom ☐
- Electron ☐
- Ion ☐
- Molecule ☐

Question 6 continues on the next page

4.4.3.2 Electrolysis of molten ionic compounds

Question 11 · continued

Aqueous sodium chloride solution is electrolysed in a different industrial process.

Two gases and an alkaline solution are produced.

0 6 . 4 Which **two** ions are present in aqueous sodium chloride solution in addition to sodium ions and chloride ions?

[2 marks]

1 _____

2 _____

0 6 . 5 Name the alkaline solution produced.

[1 mark]

_____

0 6 . 6 Explain how the alkaline solution is produced.

You should refer to the processes at the electrodes.

[3 marks]

_____

_____

_____

_____

_____

_____

9

4.4.3.2 Electrolysis of molten ionic compounds

Question 12

June 2023 | 8462/1H | Original Q7

0 7 This question is about electrolysis.

Aluminium is manufactured by electrolysing a molten mixture of aluminium oxide (Al_2O_3) and cryolite (Na_3AlF_6).

0 7 . 1 Complete the half equation for the reaction occurring at the negative electrode.

[1 mark]

$$Al^{3+} + ____ e^- \rightarrow Al$$

0 7 . 2 Cryolite contains Na^+ ions as well as Al^{3+} ions.

Suggest **one** reason why sodium is **not** a product of the electrolysis.

[1 mark]

Question 7 continues on the next page

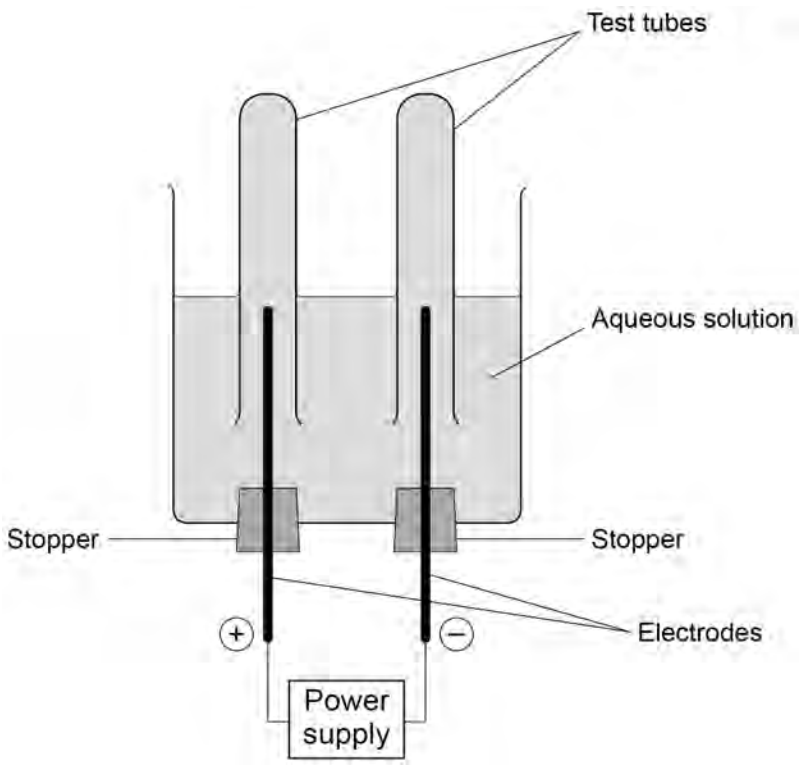
4.4.3.2 Electrolysis of molten ionic compounds

Question 12 · continued

A student investigated the electrolysis of an aqueous solution of a different compound.

Figure 7 shows the apparatus.

Figure 7



4.4.3.2 Electrolysis of molten ionic compounds

Question 12 · continued

Hydrogen was produced at the negative electrode and oxygen was produced at the positive electrode.

0 7 . 3 Explain how oxygen was produced from water during the electrolysis of this aqueous solution.

[4 marks]

0 7 . 4 The student compared the volumes of the two gases collected.

How can the student change the apparatus in **Figure 7** to compare the volumes of the two gases produced more accurately?

Give **one** reason for your answer.

[2 marks]

Change

Reason

0 7 . 5 The overall equation for the reaction is:

$$2\,H_2O(l) \rightarrow 2\,H_2(g) + O_2(g)$$

What is the volume of oxygen produced when 20 cm^3 of hydrogen has been produced?

[1 mark]

Tick (✓) **one** box.

10 cm^3 ☐ 20 cm^3 ☐ 30 cm^3 ☐ 40 cm^3 ☐

9

4.4.3.2 Electrolysis of molten ionic compounds

Question 13

June 2025 | 8462/1H | Original Q6

0 6 Aluminium is extracted by the electrolysis of a molten mixture.

The mixture contains aluminium oxide and one other substance.

0 6 . 1 Aluminium oxide is an ionic compound.

Explain why aluminium oxide has a very high melting point.

[4 marks]

Extra space

0 6 . 2 Name the substance added to aluminium oxide to form the mixture.

[1 mark]

0 6 . 3 Give **one** reason why a mixture is used as the electrolyte.

[1 mark]

4.4.3.2 Electrolysis of molten ionic compounds

Question 13 · continued

Oxygen is produced at the positive electrode.

0 6 . 4 Write the half equation for the reaction that produces oxygen at the positive electrode.

[2 marks]

_____ → _____ + _____

0 6 . 5 The positive electrode must be continually replaced.

Explain why.

[3 marks]

_____

_____

_____

_____

_____

_____

11