AQA GCSE Chemistry | 8462

SPECIFICATION POINT 4.4.3.4

Electrolysis of aqueous solutions

Past-paper questions

Tier	**Foundation**
Question groups	**19**
Available paper years	**2008–2024**

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.

4.4.3.4 Electrolysis of aqueous solutions

Question 01

January 2008 | CHY2F | Original Q4 | Legacy

4 The electrolysis of sodium chloride solution produces useful substances.

(a) (i) Choose a word from the box to complete the sentence.

covalent	**ionic**	**non-metallic**

Electrolysis takes place when electricity passes through ..... compounds when they are molten or in solution.

(1 mark)

(ii) Choose a word from the box to complete the sentence.

alkenes	**elements**	**salts**

During electrolysis the compound is broken down to form ..... .

(1 mark)

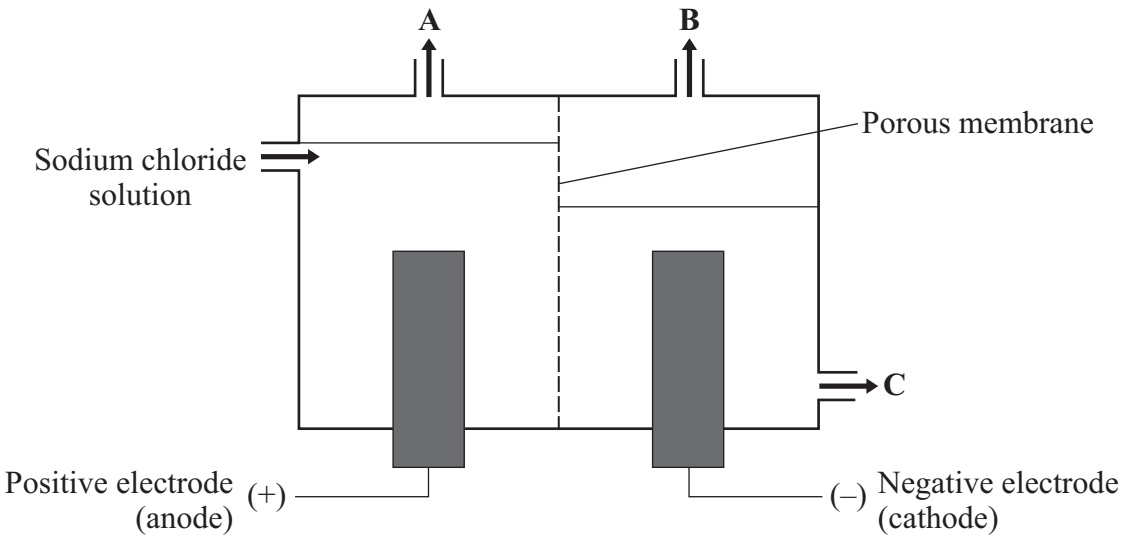
4.4.3.4 Electrolysis of aqueous solutions

Question 01 · continued

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(b) The table of ions on the Data Sheet may help you to answer this question.

The diagram shows an apparatus used for the electrolysis of sodium chloride solution.



Identify the products **A**, **B** and **C** on the diagram using substances from the box.

chlorine gas	**hydrogen gas**	**oxygen gas**
sodium hydroxide solution		**sodium metal**

(i) **A** is ..... .
(1 mark)

(ii) **B** is ..... .
(1 mark)

(iii) **C** is ..... .
(1 mark)

5

4.4.3.4 Electrolysis of aqueous solutions

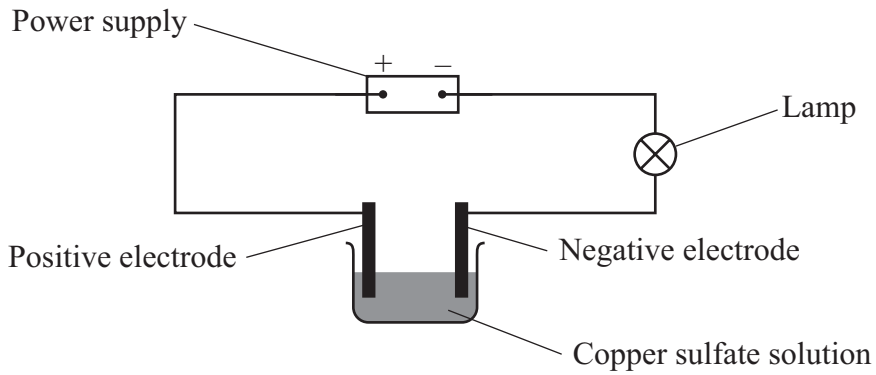
Question 02

June 2008 | CHY2F | Original Q8 | Legacy

8 A student investigated the electrolysis of copper sulfate solution.
The student's method is shown in the box.

Two clean pieces of copper were weighed. One piece was used as the positive electrode and the other piece was used as the negative electrode.

The circuit was set up as shown in the diagram.



After the electrolysis, the pieces of copper were:

- washed with distilled water
- washed with propanone (a liquid with a lower boiling point than water)
- allowed to dry
- weighed.

8 (a) Explain why the electrode would dry faster when washed with propanone instead of water.

.....

.....

(1 mark)

8 (b) The student's results are given in the table.

	Positive electrode	**Negative electrode**
mass of electrode before electrolysis, in grams	16.41	15.46
mass of electrode after electrolysis, in grams	16.10	15.75

The mass of the positive electrode decreased by 0.31 g.

4.4.3.4 Electrolysis of aqueous solutions

Question 02 · continued

for mark

8 (b) (i) What is the change in mass of the negative electrode? ..... g

(1 mark)

8 (b) (ii) The mass lost by the positive electrode should equal the mass gained by the negative electrode.

Suggest **two** reasons why the results were **not** as expected.

1 .....

.....

2 .....

.....

(2 marks)

8 (c) Describe and explain how electrolysis is used to make pure copper from a lump of impure copper.

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(4 marks)

8

4.4.3.4 Electrolysis of aqueous solutions

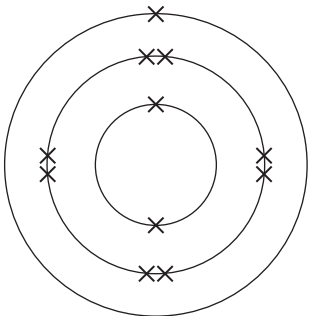
Question 03

7 Sodium chloride is a raw material.

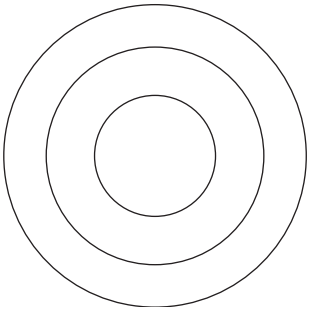
7 (a) The electronic structure of a sodium atom is shown below.

Complete the diagram for the electronic structure of a chlorine atom. A chlorine atom has 17 electrons.

Sodium atom



Chlorine atom



(1 mark)

7 (b) When sodium and chlorine react to form sodium chloride they form sodium ions (Na^+) and chloride ions (Cl^-).

How does a sodium atom change into a sodium ion?

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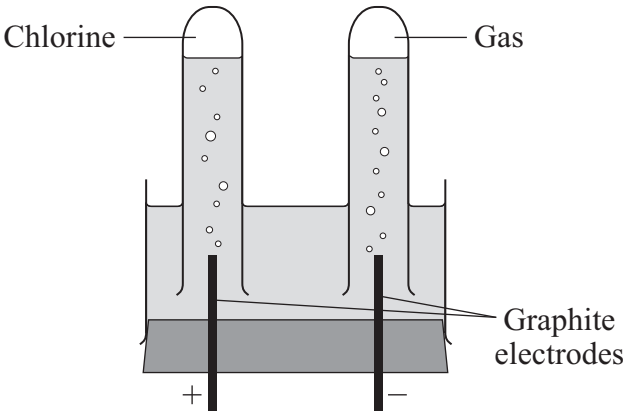
(2 marks)

4.4.3.4 Electrolysis of aqueous solutions

Question 03 · continued

for mark

7 (c) The diagram shows apparatus used in a school laboratory for the electrolysis of sodium chloride solution.



The solution contains sodium ions (Na^+), chloride ions (Cl^-), hydrogen ions (H^+) and hydroxide ions (OH^-).

7 (c) (i) Why do chloride ions move to the positive electrode?

.....

(1 mark)

7 (c) (ii) Name the gas formed at the negative electrode.

.....

(1 mark)

Question 7 continues on the next page

4.4.3.4 Electrolysis of aqueous solutions

Question 03 · continued

for mark

7 (d) Chlorine and chlorine compounds are used to bleach wood pulp that is used to make paper.

The article below is from a newspaper.

> Local people have been protesting outside a paper factory. They say:
> 'We want the company to stop using chlorine compounds. Chlorine compounds release poisons into the environment. The company should use safer compounds.'
>
> The company replied:
> 'Chlorine has been used safely for many years to treat drinking water. Only tiny amounts of chlorine are released, which cause no harm. Using other compounds will be more expensive and may put us out of business.'

7 (d) (i) Why are some local people worried about the use of chlorine compounds?

.....

.....

(1 mark)

7 (d) (ii) Why might other local people want the company to continue to use chlorine compounds?

.....

.....

(1 mark)

7 (d) (iii) It is decided to have an enquiry.
Why should this be done by independent scientists?

.....

.....

(1 mark)

8

4.4.3.4 Electrolysis of aqueous solutions

Question 04

January 2011 | CHY2F | Original Q3 | Legacy

3 (a) A magnesium atom contains 12 protons (●),12 neutrons (o) and 12 electrons (×).

Which diagram, **A**, **B** or **C**, represents this magnesium atom?

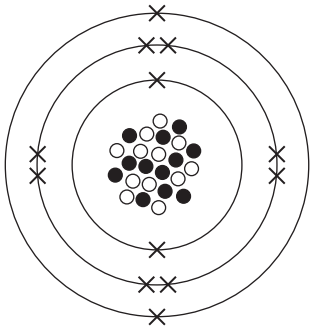


Diagram A

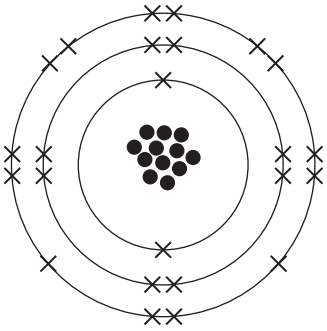


Diagram B

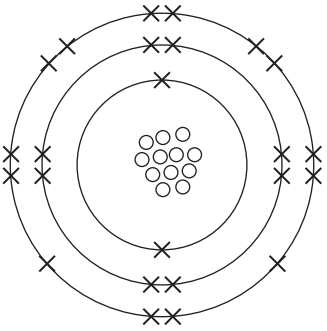
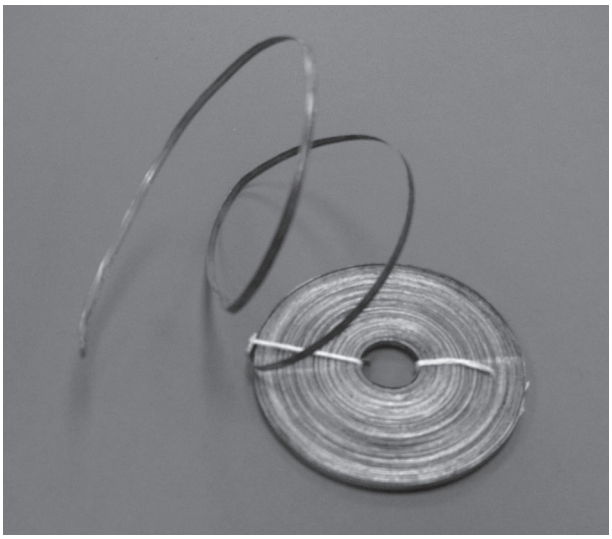


Diagram C

This magnesium atom is **Diagram** ☐ .

(1 mark)

3 (b) Magnesium metal is shaped to make magnesium ribbon.



Tick (✓) **two** reasons which explain why metals can be shaped.

Reason why	Tick (✓)
The atoms are all joined by covalent bonds.	
The atoms can slide over each other.	
The atoms are large.	
The atoms are in layers.	

(2 marks)

4.4.3.4 Electrolysis of aqueous solutions

Question 04 · continued January 2011 | CHY2F | Original Q3 | Legacy

3 (c) Magnesium sulfate is a salt of magnesium.

It can be prepared by the reaction of magnesium metal with an acid. The equation for the reaction of magnesium with this acid is:

$$\underset{\text{magnesium}}{Mg(s)} + \underset{\text{acid}}{H_2SO_4(aq)} \rightarrow \underset{\text{magnesium sulfate solution}}{MgSO_4(aq)} + \underset{\text{hydrogen}}{H_2(g)}$$

3 (c) (i) Draw a ring around the name of the acid used in this reaction.

hydrochloric **nitric** **sulfuric**

(1 mark)

3 (c) (ii) Use the equation to help you to answer this question.

Tick (✓) **two** things that happen when this reaction takes place.

	Tick (✓)
Bubbles are produced.	
The magnesium disappears.	
A solid is formed.	
Water is formed.	

(2 marks)

3 (c) (iii) Draw a ring around a method to get solid magnesium sulfate from magnesium sulfate solution.

crystallisation **electrolysis** **oxidation**

(1 mark)

7

4.4.3.4 Electrolysis of aqueous solutions

Question 05

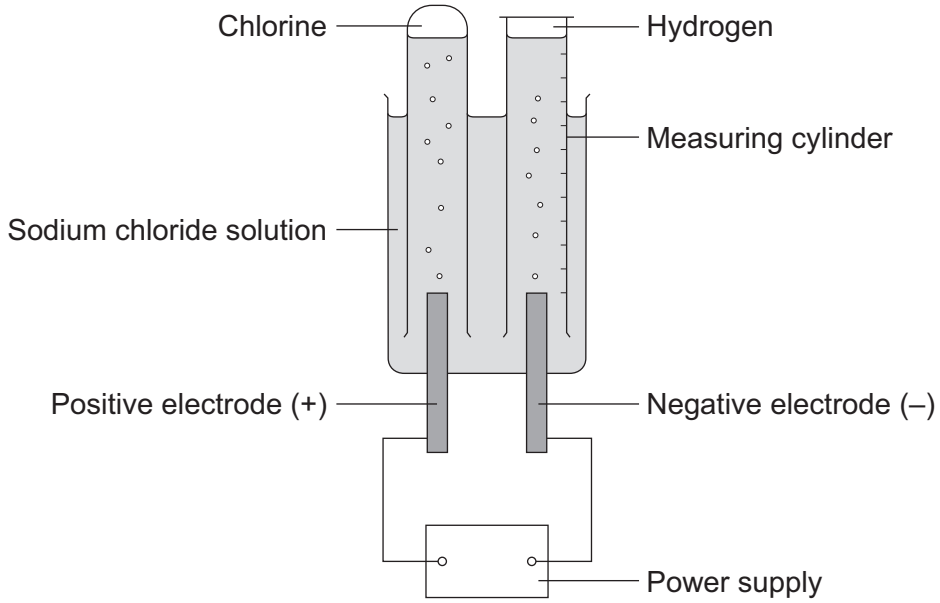
6 A student investigated the electrolysis of sodium chloride solution.

Five sodium chloride solutions were made. Each solution had a different concentration.

To make each solution the student:

- weighed the amount of sodium chloride needed
- dissolved it in water
- added more water until the total volume was one cubic decimetre (1 dm^3).

The solutions were placed one at a time in the apparatus shown below.



The student measured the volume of hydrogen gas produced in ten minutes.

The results are shown on the graph on the next page.

6 (a) Sodium chloride does not conduct electricity when it is solid.

Explain, in terms of ions, why sodium chloride solution conducts electricity.

.....

.....

(1 mark)

6 (b) Chlorine is produced at the positive electrode.

Why are chloride ions attracted to the positive electrode?

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(1 mark)

Question 6 continues on the next page

4.4.3.4 Electrolysis of aqueous solutions

Question 05 · continued

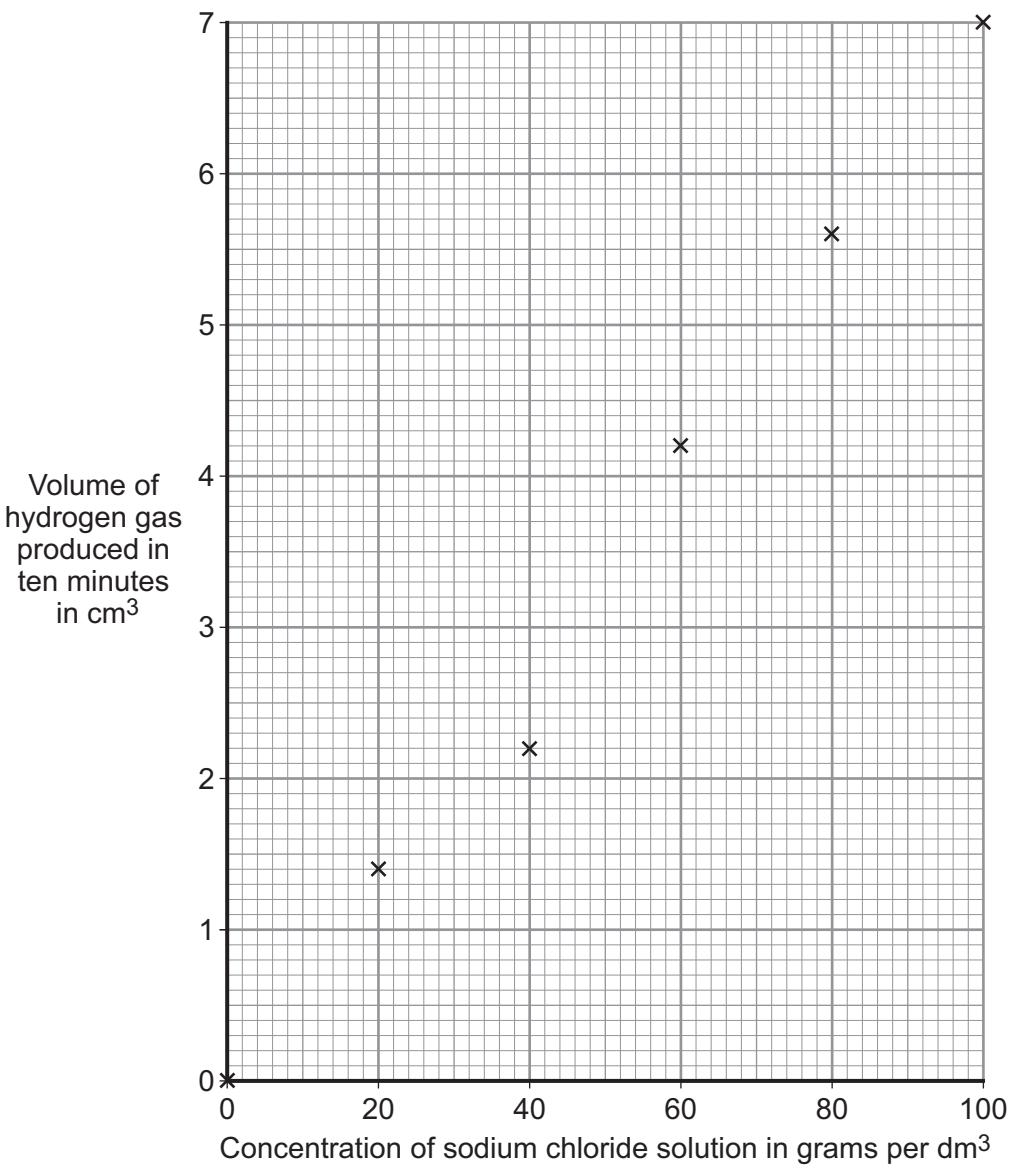
6 (c) The solution left at the end of each experiment contains sodium hydroxide.

Draw a ring around **one** number which could be the pH of this solution.

2 **5** **7** **13**

(1 mark)

6 (d) The results for the experiment on the previous page are shown on the graph.



4.4.3.4 Electrolysis of aqueous solutions

Question 05 · continued

6 (d) (i) Draw a line of best fit on the graph.

(1 mark)

6 (d) (ii) The result for one concentration is anomalous.
Which result is anomalous?

The result at concentration ..... grams per dm^3

(1 mark)

6 (d) (iii) Suggest **two** possible causes of this anomalous result.

1 .....

.....

2 .....

.....

(2 marks)

6 (d) (iv) Suggest how the student could check the reliability of the results.

.....

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(1 mark)

6 (d) (v) How did an increase in the concentration of the sodium chloride solution affect the volume of hydrogen gas produced in ten minutes?

.....

.....

(1 mark)

9

4.4.3.4 Electrolysis of aqueous solutions

Question 06

June 2011 | CHY1F | Original Q7 | Legacy

7 The raw materials used to make the polymer polyvinyl chloride (PVC) are crude oil and sea salt (sodium chloride).

7 (a) There are three main stages in the production of PVC.

7 (a) (i) **Stage 1** Cracking of hydrocarbons from crude oil produces ethene, C_2H_4

$$C_{10}H_{22} \longrightarrow C_8H_{18} + C_2H_4$$

How are hydrocarbons cracked?

.....

.....

.....

.....

(2 marks)

7 (a) (ii) **Stage 2** Electrolysis of sodium chloride solution produces chlorine.
Ethene from **Stage 1** is then reacted with this chlorine.
One of the hydrogen atoms in each ethene molecule is replaced by a chlorine atom to produce vinyl chloride.

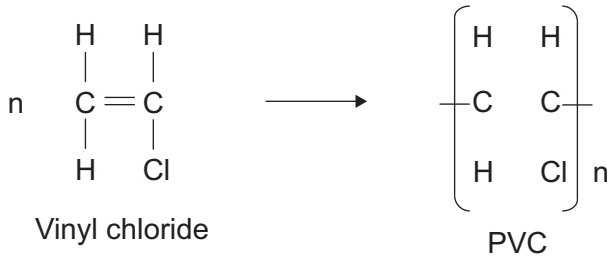
Complete the chemical equation by writing in the formula of the product vinyl chloride.

$$C_2H_4 + Cl_2 \longrightarrow \text{.....} + HCl$$

(1 mark)

7 (a) (iii) **Stage 3** Polymerisation of vinyl chloride produces polyvinyl chloride (PVC).

Complete the chemical equation by drawing in the missing bonds of the product, PVC.



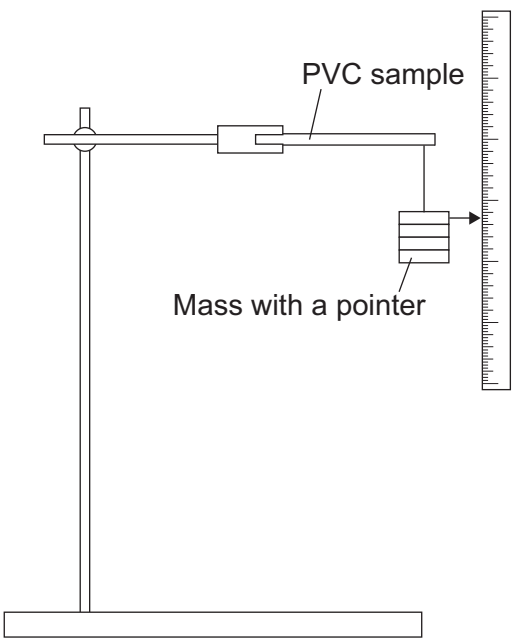
(1 mark)

Question 7 continues on the next page

Question 06 · continued

7 (b) Unplasticised polyvinyl chloride (uPVC) is used to make door and window frames.
PVC with a plasticiser added is used to make cling film for wrapping food.
A plasticiser is a chemical compound.

A student investigated how the percentage of plasticiser added to PVC affected its flexibility.
The student measured the bending of PVC samples when a mass was added.



The student's results are shown in the table.

Sample of PVC	Percentage (%) of plasticiser added	Bending of PVC sample in mm				
		Test 1	Test 2	Test 3	Test 4	Mean
A	**0**	2	3	3	4	3
B	**5**	22	15	23	24	
C	**10**	27	27	29	29	28
D	**15**	34	35	35	36	35

7 (b) (i) Each PVC sample should be the same size to make it a fair test.
Explain why.

.....

.....

(1 mark)

4.4.3.4 Electrolysis of aqueous solutions

Question 06 · continued

7 (b) (ii) The student repeated the test four times for each sample.
Explain why.

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(1 mark)

7 (b) (iii) Calculate the mean value for sample **B**.

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(2 marks)

7 (b) (iv) Each of the samples bent the most in test **4**.
Suggest a possible reason for this.

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(1 mark)

7 (c) Suggest why unplasticised polyvinyl chloride (uPVC) is used to make door and window frames.

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(1 mark)

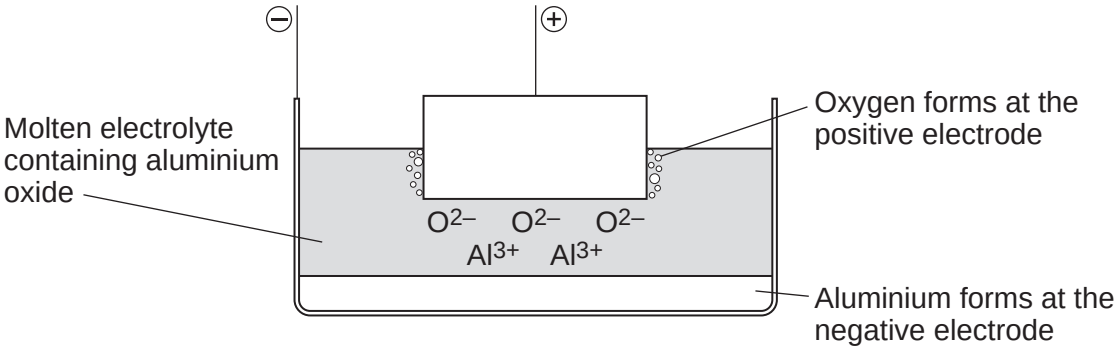
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4.4.3.4 Electrolysis of aqueous solutions

Question 07

June 2012 | CH2FP | Original Q4 | Legacy

4 The diagram represents an electrolysis cell for extracting aluminium.
The current will only flow when the electrolyte is molten.



4 (a) The electrolyte is aluminium oxide mixed with another substance.

4 (a) (i) What is the name of the other substance in the electrolyte?

Draw a ring around the correct answer.

cryolite **rock salt** **limestone**

(1 mark)

4 (a) (ii) Draw a ring around the correct answer to complete the sentence.

This other substance is added to

condense the aluminium oxide.
lower the melting point of the aluminium oxide.
raise the boiling point of the aluminium oxide.

(1 mark)

4 (b) (i) Oxide ions (O^{2-}) move to the positive electrode.

Explain why.

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.....

.....

(2 marks)

4.4.3.4 Electrolysis of aqueous solutions

Question 07 · continued

4 (b) (ii) Oxygen is formed at the positive electrode. The oxygen then forms carbon dioxide.

The equation for the reaction is shown below.

$$C + O_2 \rightarrow CO_2$$

Complete the sentence.

The name of the element which reacts with oxygen is ..... .

(1 mark)

4 (b) (iii) The positive electrode gets smaller.

Suggest why.

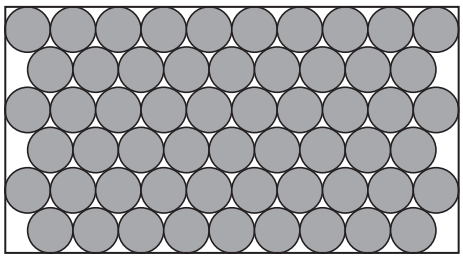
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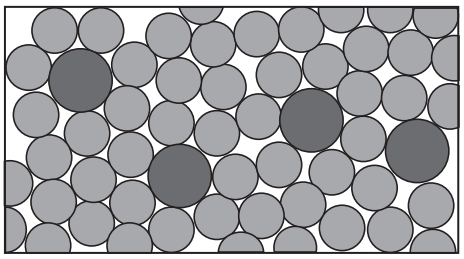
(1 mark)

4 (c) Aluminium is used in an alloy with magnesium to make drinks cans.

The diagrams show the arrangement of atoms in pure aluminium and in the alloy.



Pure aluminium



Alloy

The alloy is harder than pure aluminium.

Explain why. Use the diagrams to help you.

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(2 marks)

8

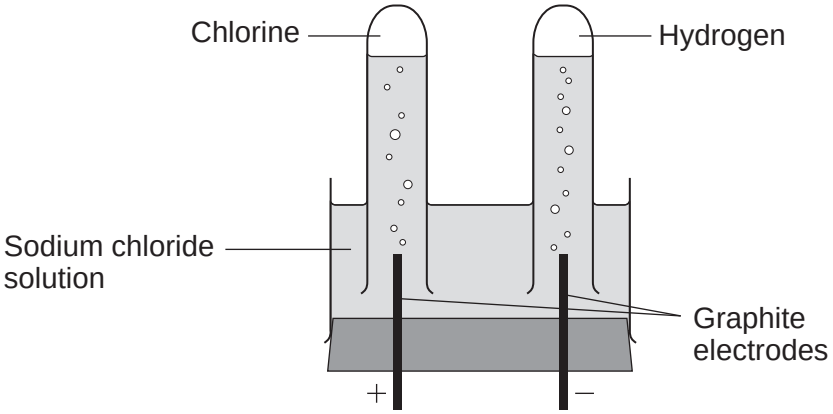
4.4.3.4 Electrolysis of aqueous solutions

Question 08

January 2013 | CH2FP | Original Q8 | Legacy

8 The electrolysis of sodium chloride solution is an industrial process.

The diagram shows the apparatus used in a school experiment.



8 (a) One of the products of the electrolysis of sodium chloride solution is hydrogen.

8 (a) (i) Why do hydrogen ions move to the negative electrode?

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(1 mark)

8 (a) (ii) How does a hydrogen ion change into a hydrogen atom?

.....

.....

(1 mark)

4.4.3.4 Electrolysis of aqueous solutions

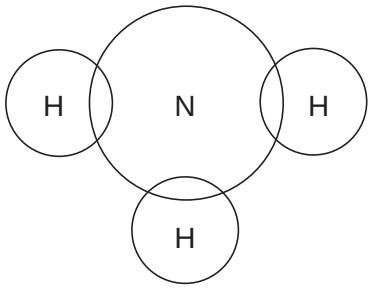
Question 08 · continued

8 (b) Hydrogen is used to make ammonia (NH_3).

Complete the diagram to show the bonding in ammonia.

Use dots (●) and crosses (x) to show electrons.

Show only outer shell electrons.



(2 marks)

8 (c) The table shows the ions in sodium chloride solution.

Positive ions	Negative ions
hydrogen	chloride
sodium	hydroxide

In industry, some of the waste from the electrolysis of sodium chloride solution is alkaline and has to be neutralised.

8 (c) (i) Which ion makes the waste alkaline?

.....

(1 mark)

8 (c) (ii) This waste must be neutralised.

Write the ionic equation for the neutralisation reaction.

.....

(1 mark)

Question 8 continues on the next page

4.4.3.4 Electrolysis of aqueous solutions

Question 08 · continued

8 (d) *In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.*

The electrolysis of sodium chloride solution also produces chlorine and sodium hydroxide.

In industry, the electrolysis of sodium chloride solution can be done in several types of electrolysis cell.

Some information about two different types of electrolysis cell is given below.

	Mercury cell	Membrane cell
Cost of construction	Expensive	Relatively cheap
Additional substances used	Mercury, which is recycled. Mercury is toxic so any traces of mercury must be removed from the waste.	Membrane, which is made of a polymer. The membrane must be replaced every 3 years.
Amount of electricity used for each tonne of chlorine produced in kWh	3400	2950
Quality of chlorine produced	Pure	Needs to be liquefied and distilled to make it pure.
Quality of sodium hydroxide solution produced	50% concentration. Steam is used to concentrate the sodium hydroxide solution produced.	30% concentration. Steam is used to concentrate the sodium hydroxide solution produced.

Use the information and your knowledge and understanding to compare the environmental and economic advantages and disadvantages of these **two** types of electrolysis cell.

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4.4.3.4 Electrolysis of aqueous solutions

Question 09

June 2013 | CH1FP | Original Q7 | Legacy

7 Metals are extracted from their ores.

Many copper ores contain only 2% of copper compounds.

7 (a) Copper is now extracted from ores containing a low percentage of copper compounds.

Suggest **two** reasons why.

.....

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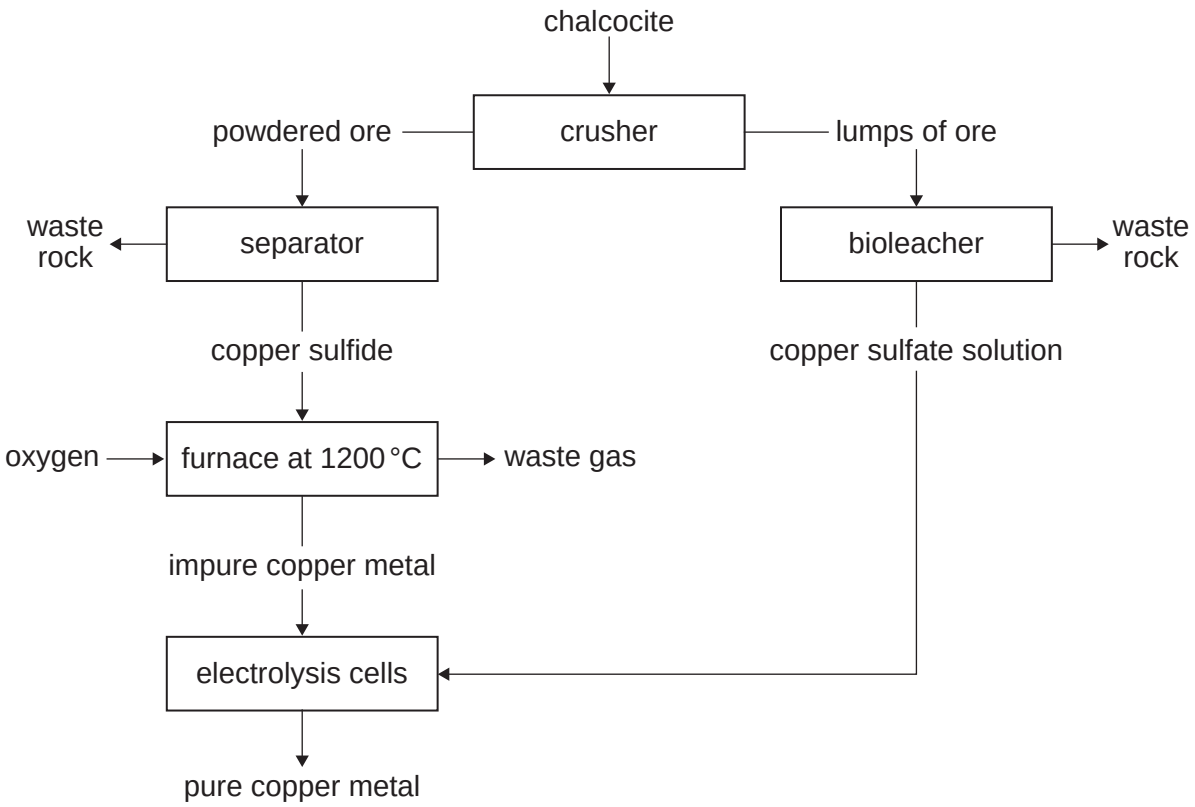
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(2 marks)

7 (b) Chalcocite, an ore of copper, contains copper sulfide.

The flow diagram shows how copper metal is extracted from chalcocite.



4.4.3.4 Electrolysis of aqueous solutions

Question 09 · continued

7 (b) (i) Suggest **one** reason why it is difficult to dispose of the waste rock.

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(1 mark)

7 (b) (ii) The reaction in the furnace could cause environmental pollution.
Explain how.

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.....

(2 marks)

7 (b) (iii) The extraction of pure copper is expensive.
Give **one** reason why.

.....

.....

(1 mark)

7 (b) (iv) Pure copper is produced by electrolysis of copper sulfate solution.

Which electrode do the copper ions move towards?
Give a reason for your answer.

.....

.....

.....

.....

(2 marks)

7 (b) (v) Large areas of land are contaminated with copper compounds.
Phytomining can be used to remove these copper compounds from the land.

What is used in phytomining to remove copper compounds from the land?

.....

.....

(1 mark)

9

4.4.3.4 Electrolysis of aqueous solutions

Question 10

June 2014 | CH1FP | Original Q5 | Legacy

5 Where copper ore has been mined there are areas of land that contain very low percentages of copper compounds.

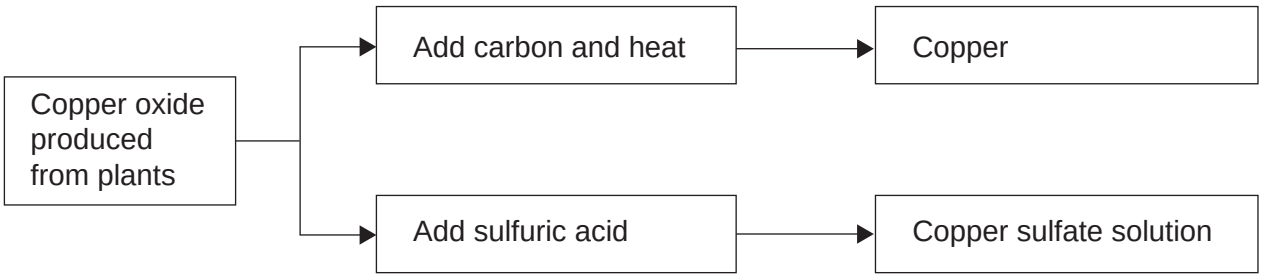
One way to extract the copper is to grow plants on the land.

The plants absorb copper compounds through their roots.

The plants are burned to produce copper oxide.

The copper oxide produced from plants can be reacted to produce copper or copper sulfate solution, as shown in **Figure 6**.

Figure 6



5 (a) Draw a ring around the correct answer to complete each sentence.

5 (a) (i) Copper ores contain enough copper to make extraction of the metal

carbon neutral.
economical.
reversible.

[1 mark]

5 (a) (ii) Using plants to extract metals is called

photosynthesis.
phytomining.
polymerisation.

[1 mark]

5 (a) (iii) Copper oxide reacts with carbon to produce copper and

carbon dioxide.
oxygen.
sulfur dioxide.

[1 mark]

4.4.3.4 Electrolysis of aqueous solutions

Question 10 · continued

5 (b) Copper is produced from copper sulfate solution by displacement using iron or by electrolysis.

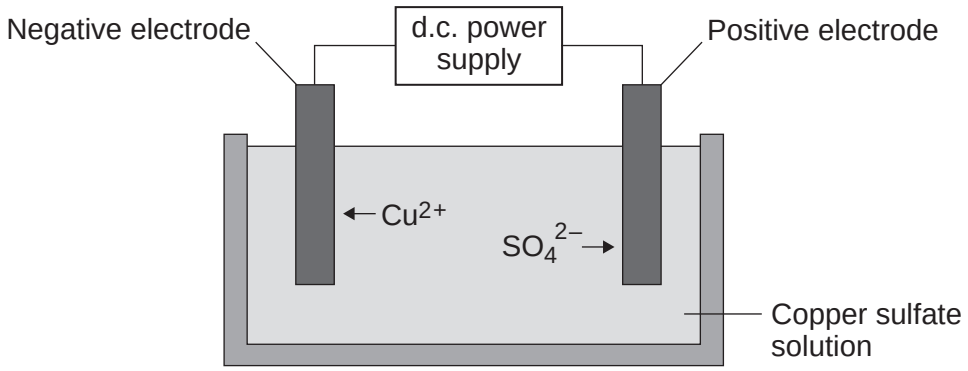
5 (b) (i) Complete the word equation.

[2 marks]

copper sulfate + iron ⟶ ..... + ...

5 (b) (ii) **Figure 7** shows the electrolysis of copper sulfate solution.

Figure 7



Why do copper ions go to the negative electrode?

[1 mark]

.....

.....

5 (c) Suggest **two** reasons why copper should **not** be disposed of in landfill sites.

[2 marks]

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8

4.4.3.4 Electrolysis of aqueous solutions

Question 11

June 2015 | CH2FP | Original Q4 | Legacy

4 This question is about electrolysis.

4 (a) Metal spoons can be coated with silver.
This is called electroplating.

Suggest **one** reason why spoons are electroplated.

[1 mark]

.....

.....

4 (b) When sodium chloride solution is electrolysed the products are hydrogen and chlorine.

4 (b) (i) What is made from chlorine?

[1 mark]

Tick (✓) **one** box.

Bleach ☐

Fertiliser ☐

Soap ☐

4 (b) (ii) Sodium chloride solution contains two types of positive ions, hydrogen ions (H^+) and sodium ions (Na^+).

Why is hydrogen produced at the negative electrode and **not** sodium?

[1 mark]

Tick (✓) **one** box.

Hydrogen is a gas. ☐

Hydrogen is less reactive than sodium. ☐

Hydrogen ions move faster than sodium ions. ☐

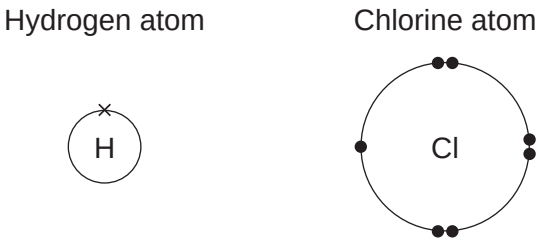
4.4.3.4 Electrolysis of aqueous solutions

Question 11 · continued

4 (b) (iii) Hydrogen and chlorine can be used to produce hydrogen chloride.

The diagrams in **Figure 4** show how the outer electrons are arranged in an atom of hydrogen and an atom of chlorine.

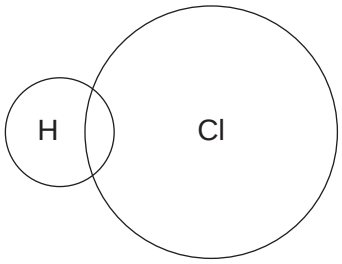
Figure 4



Complete **Figure 5** to show how the outer electrons are arranged in a molecule of hydrogen chloride (HCl).

[1 mark]

Figure 5



4 (b) (iv) What is the type of bond in a molecule of hydrogen chloride?

[1 mark]

Tick (✓) **one** box.

Covalent ☐

Ionic ☐

Metallic ☐

Question 4 continues on the next page

4.4.3.4 Electrolysis of aqueous solutions

Question 11 · continued

4 (b) (v) Why is hydrogen chloride a gas at room temperature (20 °C)?

[2 marks]

Tick (✓) **two** boxes.

Hydrogen chloride has a low boiling point. ☐

Hydrogen chloride has a high melting point. ☐

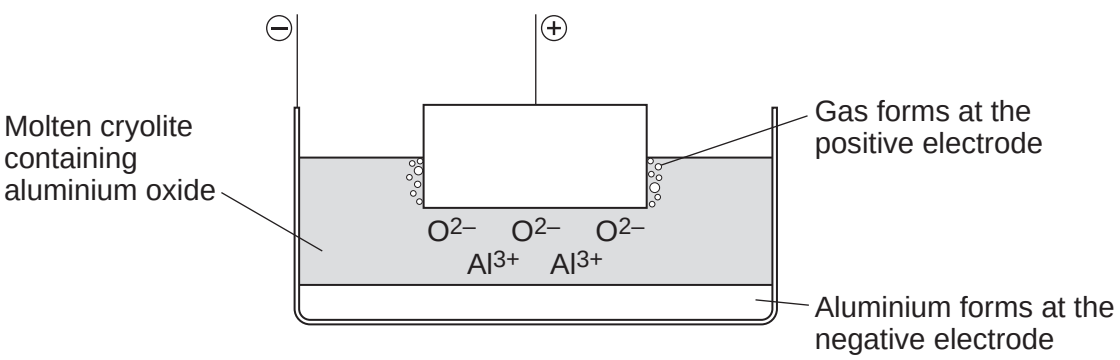
Hydrogen chloride is made of simple molecules. ☐

Hydrogen chloride does not conduct electricity. ☐

Hydrogen chloride has a giant structure. ☐

4 (c) Aluminium is produced by electrolysis of a molten mixture of aluminium oxide and cryolite.
This is shown in **Figure 6**.

Figure 6



4 (c) (i) Name a gas produced at the positive electrode.

[1 mark]

.....

4.4.3.4 Electrolysis of aqueous solutions

Question 11 · continued

4 (c) (ii) Aluminium ions move to the negative electrode.

Explain why.

[2 marks]

.....

.....

.....

.....

4 (c) (iii) At the negative electrode, the aluminium ions gain electrons to produce aluminium.

What is this type of reaction called?

[1 mark]

Tick (✓) **one** box.

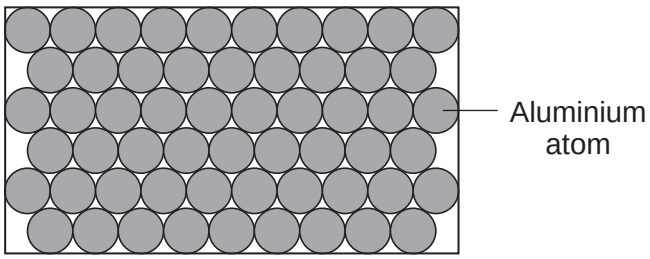
Combustion ☐

Oxidation ☐

Reduction ☐

4 (c) (iv) Aluminium has layers of atoms, as shown in **Figure 7**.

Figure 7



Complete the sentence.

[1 mark]

Metals can be bent and shaped because the layers of atoms can ..... .

Question 4 continues on the next page

4.4.3.4 Electrolysis of aqueous solutions

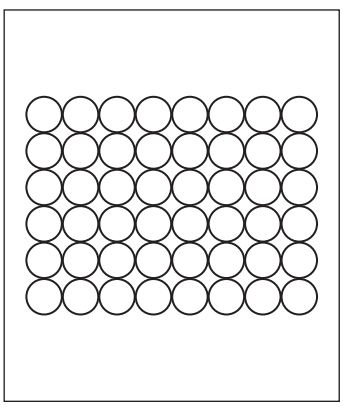
Question 11 · continued

4 (d) Electrodes used in the production of aluminium are made from graphite.

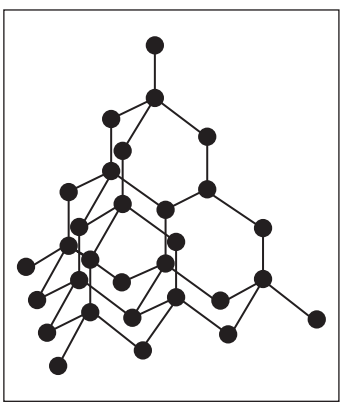
4 (d) (i) Which diagram, **A**, **B** or **C**, shows the structure of graphite?

[1 mark]

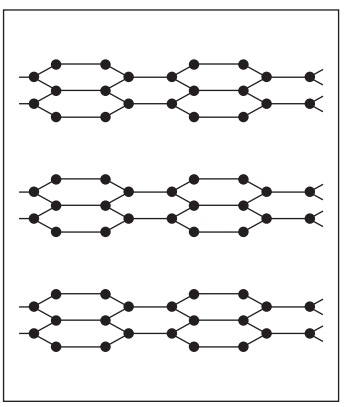
A



B



C



The structure of graphite is shown in diagram ☐.

4 (d) (ii) The temperature for the electrolysis is 950 °C.

Use the correct answer from the box to complete the sentence.

[1 mark]

cross links	**a giant ionic lattice**	**strong covalent bonds**

The graphite does not melt at 950 °C because

graphite has ..... .

14

4.4.3.4 Electrolysis of aqueous solutions

Question 12

June 2017 | CH2FP | Original Q4 | Legacy

4 This question is about sodium chloride.

4 (a) Calculate the relative formula mass (M_r) of sodium chloride (NaCl).

Relative atomic masses (A_r): Na = 23; Cl = 35.5

[1 mark]

Relative formula mass (M_r) = _____

4 (b) A student reacted hydrochloric acid and sodium hydroxide solution to produce sodium chloride and another product.

Use the correct answer from the box to complete the word equation for the reaction.

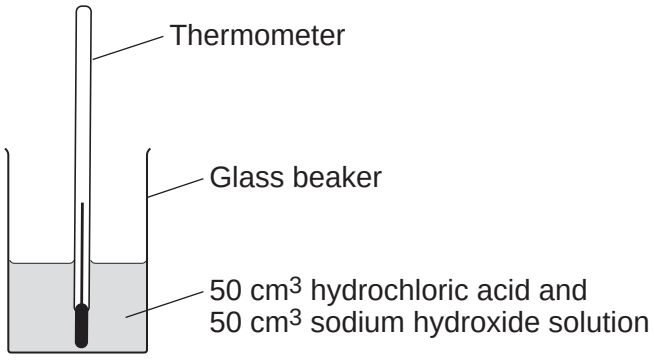
[1 mark]

chlorine	hydrogen	oxygen	water

hydrochloric acid + sodium hydroxide ⟶ sodium chloride + _____

4 (c) **Figure 7** shows the apparatus the student used to measure the temperature change in the reaction between hydrochloric acid and sodium hydroxide solution.

Figure 7



The student:

- measured 50 cm^3 hydrochloric acid into a glass beaker
- measured the temperature of the hydrochloric acid
- added 50 cm^3 of sodium hydroxide solution
- measured the highest temperature of the solution
- repeated the experiment with insulation around the glass beaker.

Question 12 · continued

4 (c) (i) Suggest **one** reason why the insulation around the glass beaker gives more accurate results.

[1 mark]

_____

_____

4 (c) (ii) The student did the investigation using the insulation three times.

Table 2 shows the results.

Table 2

Experiment number	Temperature of acid before reaction in °C	Highest temperature of solution in °C	Temperature change in °C
1	20	33	13
2	20	34	14
3	19	32	

Calculate the temperature change in **Experiment 3**.

Write your answer in **Table 2**.

[1 mark]

4 (c) (iii) How does **Table 2** show that the results are repeatable?

[1 mark]

_____

_____

4 (c) (iv) Complete the sentence.

[1 mark]

The temperature increase shows that the reaction between hydrochloric acid and sodium hydroxide is _____ .

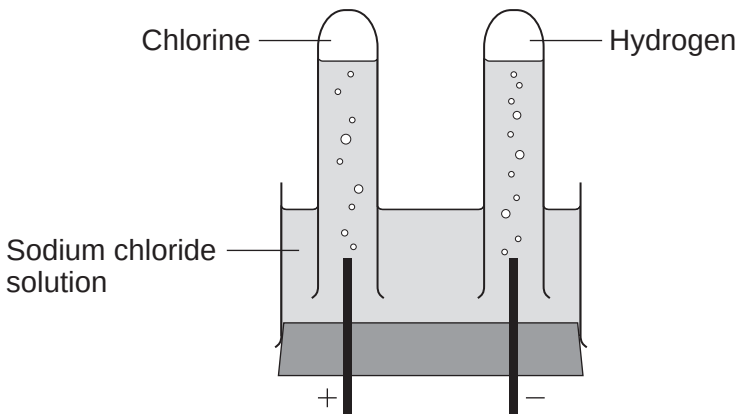
Question 4 continues on the next page

4.4.3.4 Electrolysis of aqueous solutions

Question 12 · continued

4 (d) A student investigated the electrolysis of sodium chloride solution, as shown in **Figure 8**.

Figure 8



4 (d) (i) State, in terms of ions, why sodium chloride solution conducts electricity.

[1 mark]

_____

_____

4 (d) (ii) Chlorine is produced at the positive electrode.

Why are chloride ions attracted to the positive electrode?

[1 mark]

_____

_____

4 (d) (iii) When sodium chloride solution is electrolysed, sodium hydroxide is also produced.

What can be manufactured from sodium hydroxide?

[1 mark]

Tick (✓) **one** box.

Alloys ☐

Poly(ethene) ☐

Soap ☐

4.4.3.4 Electrolysis of aqueous solutions

Question 12 · continued

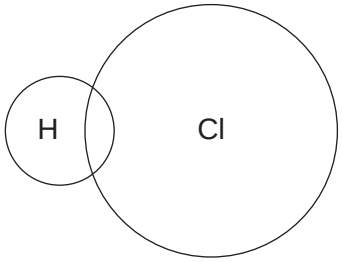
4 (d) (iv) The products chlorine and hydrogen react to form hydrogen chloride.

Hydrogen atoms have one electron in their outer shell. Chlorine atoms have seven electrons in their outer shell.

Complete **Figure 9** to show how the outer electrons are arranged in a molecule of hydrogen chloride (HCl).

[2 marks]

Figure 9



4 (d) (v) Which calculation shows the percentage of hydrogen in hydrogen chloride?

Relative atomic masses (A_r): H = 1; Cl = 35.5

Relative formula mass (M_r): HCl = 36.5

[1 mark]

Tick (✓) **one** box.

$\frac{35.5}{36.5} \times 100$ ☐

$\frac{1}{35.5} \times 100$ ☐

$\frac{1}{36.5} \times 100$ ☐

$\frac{1}{72.0} \times 100$ ☐

12

4.4.3.4 Electrolysis of aqueous solutions

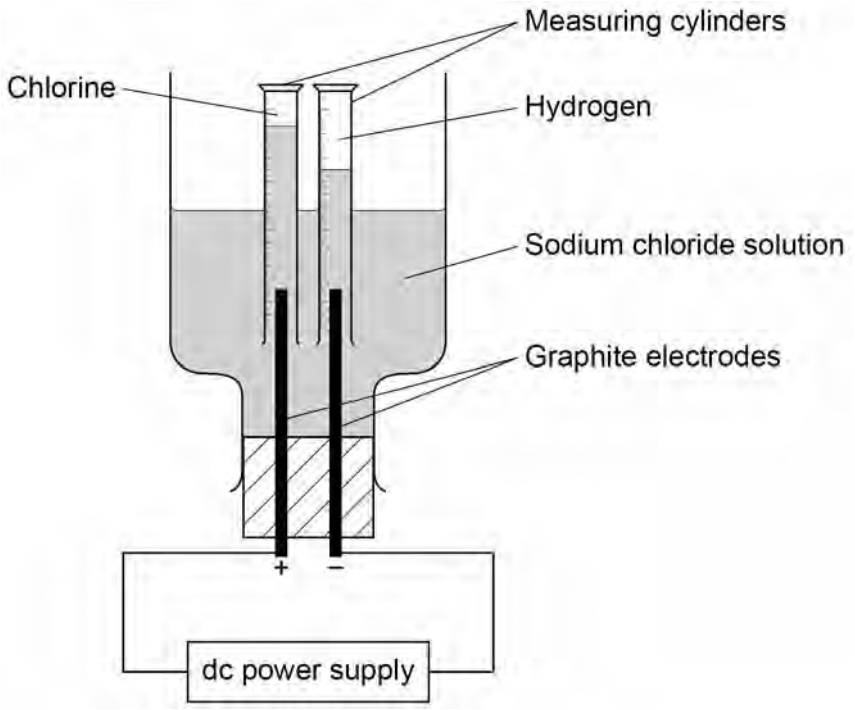
Question 13

June 2018 | 8462/1F | Original Q4

0 4 A student investigated the electrolysis of sodium chloride solution.

Figure 4 shows the apparatus.

Figure 4



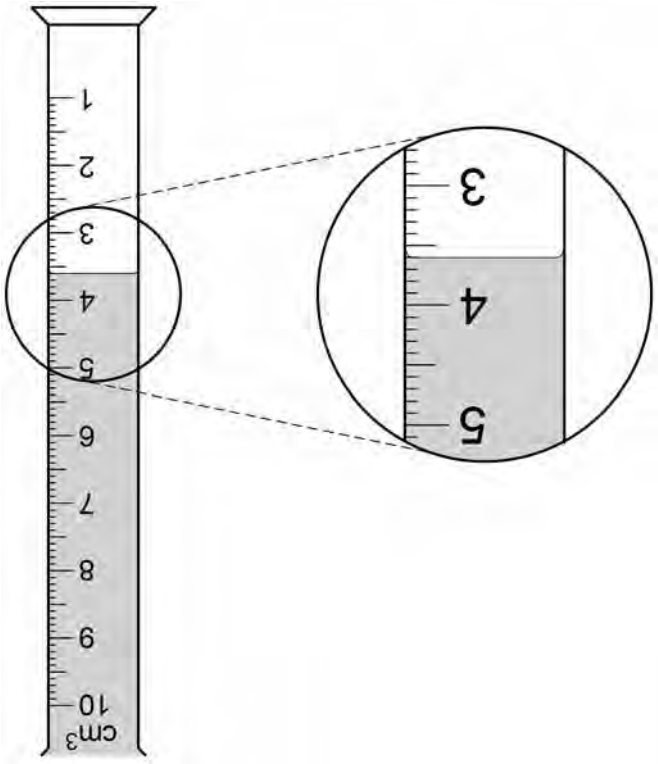
The student measured the volume of gas collected in each measuring cylinder every minute for 20 minutes.

4.4.3.4 Electrolysis of aqueous solutions

Question 13 · continued

0 4 . 1 **Figure 5** shows the volume of hydrogen gas collected in the measuring cylinder after 8 minutes.

Figure 5



What is the volume of hydrogen gas collected?

[1 mark]

Volume = _____ cm^3

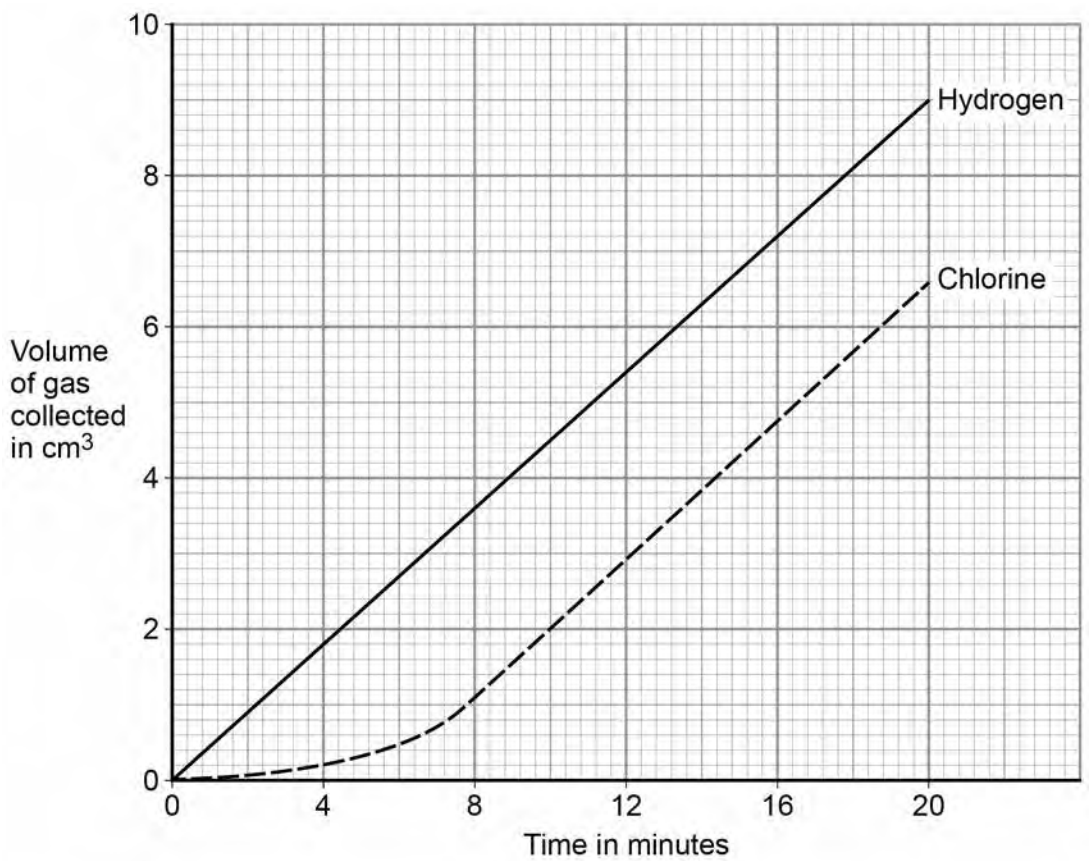
Question 4 continues on the next page

4.4.3.4 Electrolysis of aqueous solutions

Question 13 · continued

Figure 6 shows the results of the investigation.

Figure 6



0 4 . 2 Which of the lines on **Figure 6** show that the volume of gas collected is directly proportional to the time?

[1 mark]

Tick **one** box.

- Both lines ☐
- Chlorine line only ☐
- Hydrogen line only ☐
- Neither line ☐

4.4.3.4 Electrolysis of aqueous solutions

Question 13 · continued

0 4 . 3 Which of the lines on **Figure 6** show a positive correlation between the volume of gas collected and time?

[1 mark]

Tick **one** box.

- Both lines ☐
- Chlorine line only ☐
- Hydrogen line only ☐
- Neither line ☐

Question 4 continues on the next page

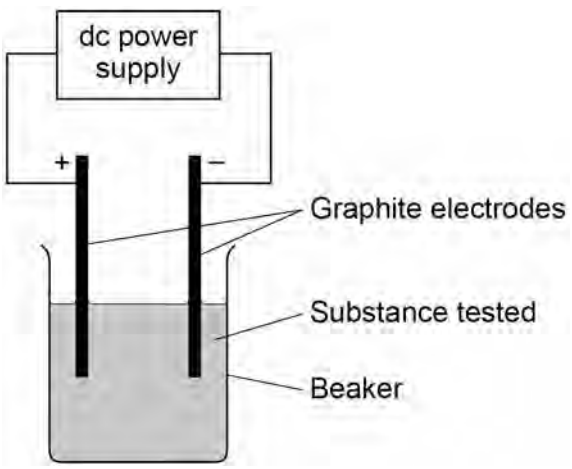
4.4.3.4 Electrolysis of aqueous solutions

Question 13 · continued

A teacher demonstrates the electrolysis of different substances using graphite electrodes.

Figure 7 shows the apparatus used.

Figure 7



0 4 . 4 Why can graphite conduct electricity?

[1 mark]

Tick **one** box.

Graphite exists in layers of atoms. ☐

Graphite has a giant structure. ☐

Graphite has a high melting point. ☐

Graphite has delocalised electrons. ☐

4.4.3.4 Electrolysis of aqueous solutions

Question 13 · continued

0 4 . 5 The teacher demonstrates the electrolysis of:

- molten zinc chloride
- potassium bromide solution.

Complete **Table 3** to predict the products.

Choose answers from the box.

[4 marks]

chlorine	**bromine**	**hydrogen**	**oxygen**	**potassium**	**zinc**

Table 3

Substance electrolysed	Product at cathode (negative electrode)	Product at anode (positive electrode)
Molten zinc chloride		
Potassium bromide solution		

4.4.3.4 Electrolysis of aqueous solutions

Question 14

November 2020 | 8462/1F | Original Q4

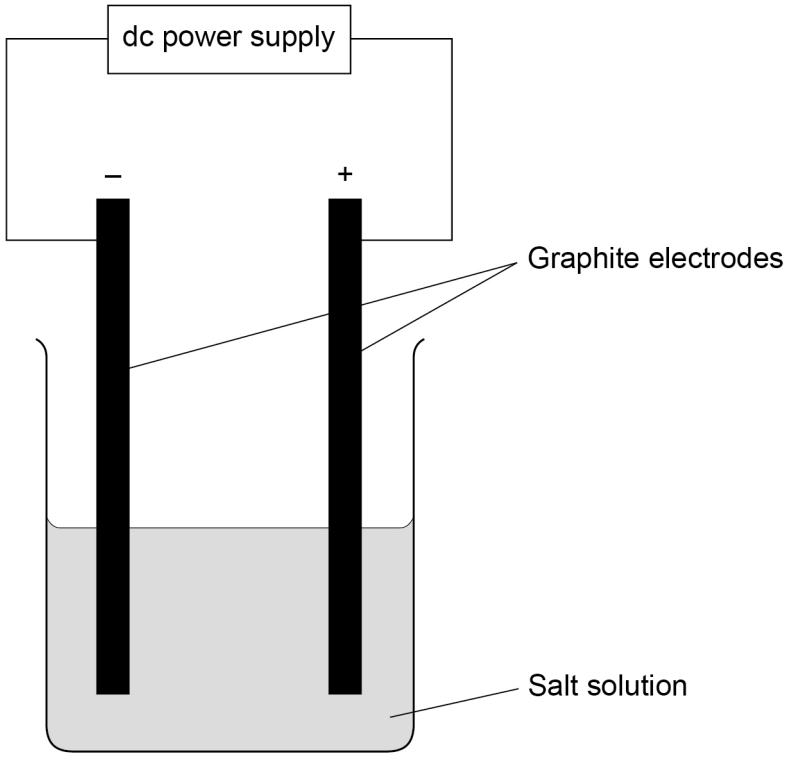
0 4 This question is about electrolysis.

A student investigated the hypothesis:

'The electrolysis of a salt solution produces a metal at the negative electrode and a gas at the positive electrode.'

Figure 4 shows the apparatus used.

Figure 4



0 4 . 1 What observation would be made at each electrode if the hypothesis is correct?

[2 marks]

Observation if metal produced at the negative electrode _____

_____

Observation if gas produced at the positive electrode _____

_____

4.4.3.4 Electrolysis of aqueous solutions

Question 14 · continued

Table 3 shows the student's results.

Table 3

Salt solution	Product at the negative electrode	Product at the positive electrode
Copper chloride	Copper	Chlorine
Potassium nitrate	Hydrogen	Oxygen
Silver nitrate	Silver	Oxygen

0 4 . 2 Which salt solution in **Table 3** does **not** match the student's hypothesis?

Give **one** reason why.

[2 marks]

Salt solution _____

Reason _____

_____

0 4 . 3 Give **two** reasons why graphite is used for the electrodes.

[2 marks]

1 _____

_____

2 _____

_____

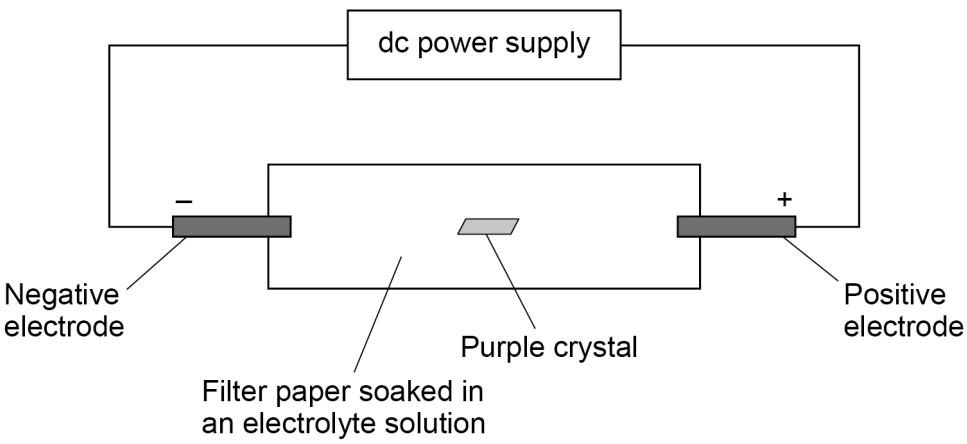
4.4.3.4 Electrolysis of aqueous solutions

Question 14 · continued

A different student investigated what happens during electrolysis.

Figure 5 shows the apparatus.

Figure 5



The purple crystal contained:

- colourless positive ions
- purple coloured negative ions.

The purple crystal dissolved in the electrolyte solution.

0 4 . 4 What happens to the purple coloured ions?

Give **one** reason for your answer.

[2 marks]

Tick (✓) **one** box.

The ions do not move. ☐

The ions move towards the negative electrode. ☐

The ions move towards the positive electrode. ☐

Reason _____

_____

8

4.4.3.4 Electrolysis of aqueous solutions

Question 15

November 2021 | 8462/1F | Original Q2

0 2 This question is about chemical cells and batteries.

0 2 . 1 Three different types of battery can be used to power a TV remote control.

Table 1 gives information about these batteries.

Table 1

	Zinc-carbon battery	Alkaline battery	Nickel-metal hydride battery
Cost of battery in £ (pounds)	0.17	0.50	1.50
Rechargeable?	No	No	Yes
Time before needing to replace or recharge in months	5	12	8

Give **one** advantage of each type of battery.

[3 marks]

Zinc-carbon _____

_____

Alkaline _____

_____

Nickel-metal hydride _____

_____

0 2 . 2 **Figure 3** shows a symbol printed on batteries.

Figure 3



This symbol shows that batteries should not be put in household waste.

Suggest why batteries should **not** be put in household waste.

[1 mark]

_____

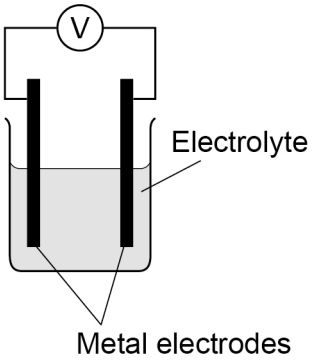
_____

4.4.3.4 Electrolysis of aqueous solutions

Question 15 · continued

Figure 4 shows a chemical cell.

Figure 4



0 2 . 3 The order of reactivity of three metals is shown below.

Iron	(Most reactive)
Tin	↑
Copper	(Least reactive)

Which combination of metal electrodes would give the highest voltage in the chemical cell in **Figure 4**?

[1 mark]

Tick (✓) **one** box.

Copper and iron ☐

Iron and tin ☐

Tin and copper ☐

0 2 . 4 The voltage produced by the cell in **Figure 4** depends on the type of electrodes and the type of electrolyte.

Suggest **one** other factor that could affect the voltage produced.

[1 mark]

4.4.3.4 Electrolysis of aqueous solutions

Question 15 · continued

0 2 . 5 Water is produced in a hydrogen fuel cell.

Complete the word equation to show the reaction that produces water in a hydrogen fuel cell.

[2 marks]

_____ + _____ → water

8

4.4.3.4 Electrolysis of aqueous solutions

Question 16

November 2021 | 8462/1F | Original Q7

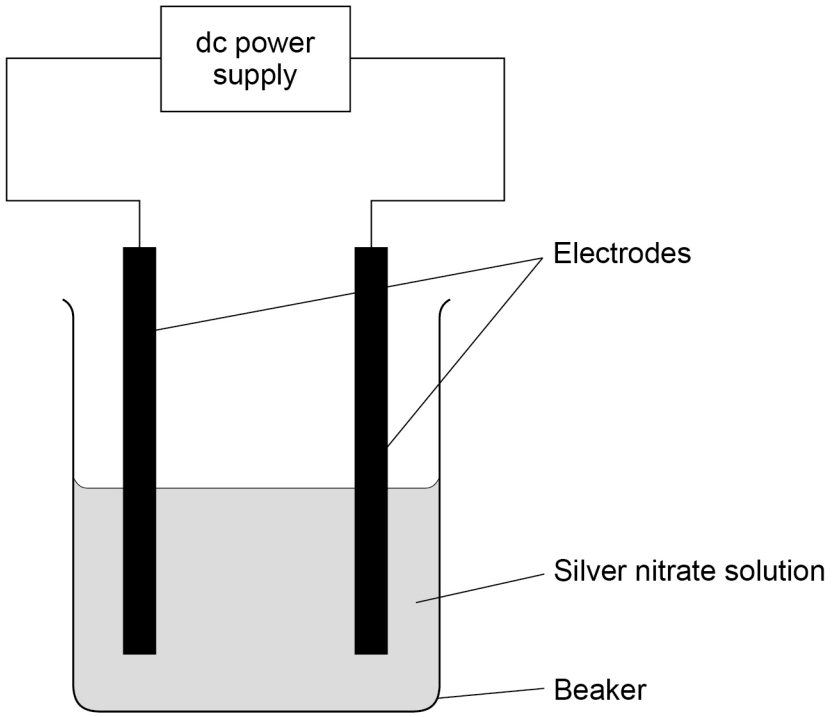
0 7 This question is about electrolysis.

Some students investigated the electrolysis of silver nitrate solution.

This electrolysis produces silver at the negative electrode.

Figure 11 shows the apparatus.

Figure 11



This is the method used.

1. Weigh the negative electrode.
2. Set up the apparatus shown in **Figure 11**.
3. Switch on the power supply.
4. Switch off the power supply after five 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.

4.4.3.4 Electrolysis of aqueous solutions

Question 16 · continued

0 7 . 1 Some silver did not stick to the negative electrode but fell to the bottom of the beaker.

The students needed to weigh this silver.

How could the students separate the silver from the silver nitrate solution?

[1 mark]

Tick (✓) **one** box.

By chromatography ☐

By crystallisation ☐

By distillation ☐

By filtration ☐

Table 5 shows the students' results.

Table 5

Time in minutes	Mass of silver in g
0	0.00
5	0.06
10	0.12
15	0.18
20	0.24
25	0.30

4.4.3.4 Electrolysis of aqueous solutions

Question 16 · continued

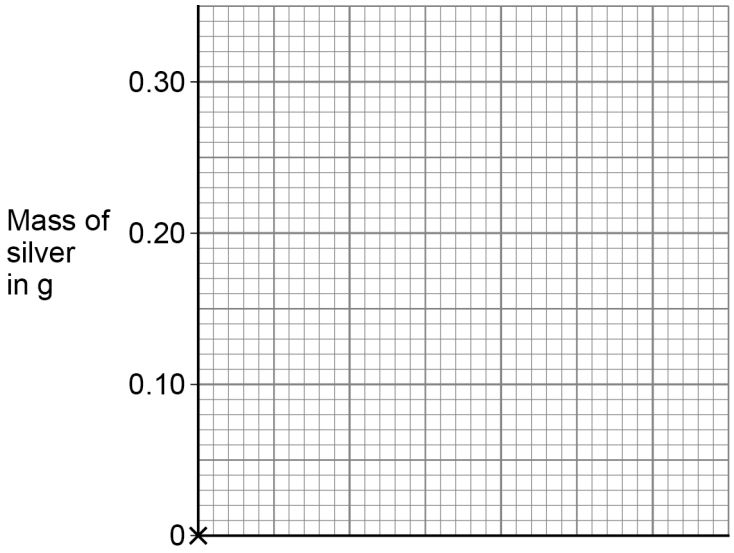
0 7 . 2 Draw a graph on **Figure 12**.

You should:

- use a suitable scale for the x-axis
- plot the data from **Table 5**
- draw a line of best fit.

[4 marks]

Figure 12



0 7 . 3 Determine the mass of silver that would be produced after 12 minutes.

Use **Figure 12**.

[1 mark]

Mass of silver = _____ g

Question 7 continues on the next page

4.4.3.4 Electrolysis of aqueous solutions

Question 16 · continued

0 7 . 4 A student investigated the electrolysis of two aqueous salt solutions.

Hydrogen is produced at the negative electrode when the metal in the salt solution is more reactive than hydrogen.

Complete **Table 6** to show what the student would **observe** at the negative electrode for each salt solution.

[2 marks]

Table 6

Salt solution	Observation at negative electrode
Copper sulfate	
Sodium chloride	

0 7 . 5 A teacher demonstrates the electrolysis of molten lead bromide.

The products at the electrodes are lead and bromine.

Why should the teacher do the demonstration in a fume cupboard?

[1 mark]

0 7 . 6 Two other molten compounds are electrolysed.

Complete **Table 7** to show the molten compounds and the products.

[3 marks]

Table 7

Molten compound electrolysed	Product at the negative electrode	Product at the positive electrode
Zinc chloride		
	Potassium	Iodine

12

4.4.3.4 Electrolysis of aqueous solutions

Question 17

June 2022 | 8462/1F | Original Q8

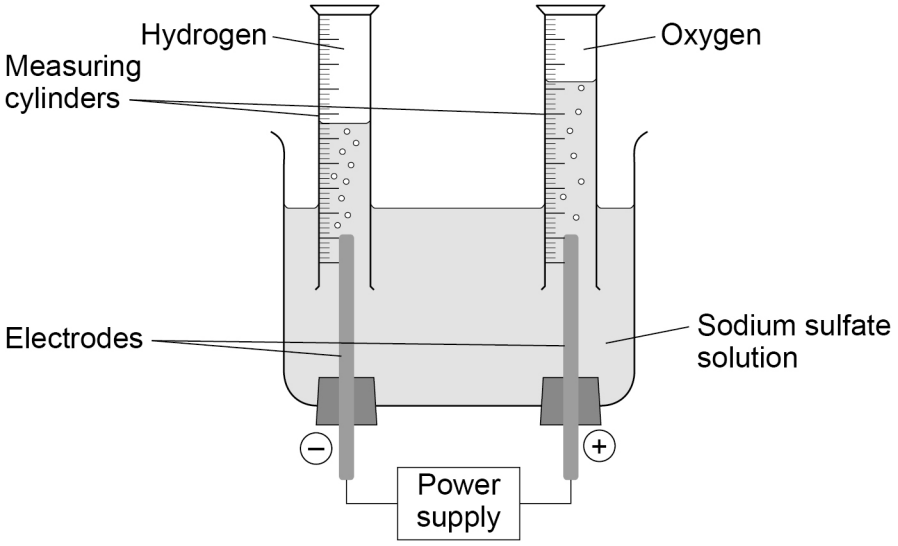
0 8 This question is about electrolysis.

Ionic compounds decompose when they are electrolysed.

A student electrolyses sodium sulfate solution.

Figure 13 shows the apparatus used.

Figure 13



0 8 . 1 Sodium sulfate solution contains:

- hydrogen ions
- hydroxide ions
- sodium ions
- sulfate ions.

Oxygen is produced at the positive electrode.

Which ions are discharged at the positive electrode to produce oxygen?

[1 mark]

Tick (✓) **one** box.

Hydrogen ions ☐

Hydroxide ions ☐

Sodium ions ☐

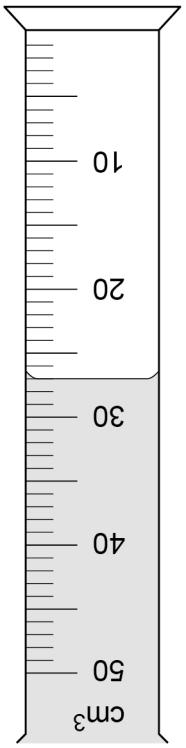
Sulfate ions ☐

4.4.3.4 Electrolysis of aqueous solutions

Question 17 · continued

0 8 . 2 **Figure 14** shows one of the measuring cylinders during the electrolysis.

Figure 14



What is the volume of gas in the measuring cylinder?

[1 mark]

Volume of gas = _____ cm^3

0 8 . 3 Ionic compounds can be electrolysed when molten or dissolved in water.

Why can ionic compounds **not** be electrolysed when solid?

You should answer in terms of ions.

[1 mark]

_____

_____

Question 17 · continued

0 8 . 4 **Table 7** shows the products of electrolysis of two molten compounds.

Table 7

Molten compound	Product at negative electrode	Product at positive electrode
Potassium iodide	Potassium	_____
Zinc bromide	_____	Bromine

Complete **Table 7**.

[2 marks]

0 8 . 5 The electrolysis of molten sodium chloride is used to extract sodium metal.

Why is sodium metal extracted by electrolysis instead of by reduction with carbon?

[1 mark]

Tick (✓) **one** box.

Carbon conducts electricity. ☐

Carbon is less reactive than sodium. ☐

Carbon reduction uses more energy. ☐

0 8 . 6 What is the state symbol for molten sodium chloride?

[1 mark]

Tick (✓) **one** box.

(aq) ☐ (g) ☐ (l) ☐ (s) ☐

4.4.3.4 Electrolysis of aqueous solutions

Question 17 · continued

0 8 . 7 Titanium can be produced from titanium oxide by electrolysis.

The equation for the reaction is:

$$TiO_2 \rightarrow Ti + O_2$$

Calculate the percentage atom economy for the production of titanium from titanium oxide by electrolysis.

Use the equation:

$$\text{Percentage atom economy} = \frac{\text{Relative atomic mass of desired product}}{\text{Relative formula mass of reactant}} \times 100$$

Relative atomic mass (A_r): Ti = 48

Relative formula mass (M_r): TiO_2 = 80

[2 marks]

Percentage atom economy = _____ %

9

4.4.3.4 Electrolysis of aqueous solutions

Question 18

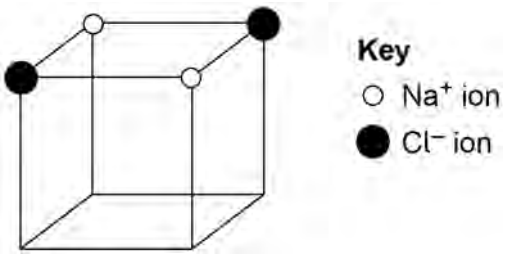
June 2023 | 8462/1F | Original Q7

0 7 This question is about ionic compounds and electrolysis.

Sodium chloride is an ionic compound.

0 7 . 1 **Figure 8** represents part of the structure of solid sodium chloride.

Figure 8



Complete **Figure 8**.

[2 marks]

0 7 . 2 Give **one** reason why molten sodium chloride conducts electricity.

Refer to ions in your answer.

[1 mark]

0 7 . 3 **Table 3** shows products of the electrolysis of two molten ionic compounds.

Complete **Table 3**.

[2 marks]

Table 3

Molten compound	Product at the negative electrode	Product at the positive electrode
Magnesium bromide	Magnesium	
Potassium chloride		Chlorine

4.4.3.4 Electrolysis of aqueous solutions

Question 18 · continued

0 7 . 4 Aluminium is extracted by electrolysis.

The electrolyte is a molten mixture of aluminium oxide and cryolite.

Why is a mixture used instead of pure aluminium oxide as the electrolyte?

[1 mark]

Tick (✓) **one** box.

- The mixture has a lower melting point than pure aluminium oxide. ☐
- The mixture has the same melting point as pure aluminium oxide. ☐
- The mixture has a higher melting point than pure aluminium oxide. ☐

0 7 . 5 Electrolysis of an aqueous solution of sodium sulfate produces hydrogen and oxygen.

What is the source of the hydrogen and the oxygen produced during the electrolysis of aqueous sodium sulfate solution?

[1 mark]

Tick (✓) **one** box.

- Air ☐
- Sulfate ions ☐
- Water ☐

Question 7 continues on the next page

Question 18 · continued

Electrolysis of an aqueous solution of sodium sulfate produces hydrogen and oxygen.

0 7 . 6 Why is hydrogen produced instead of sodium in the electrolysis of aqueous sodium sulfate solution?

[1 mark]

Tick (✓) **one** box.

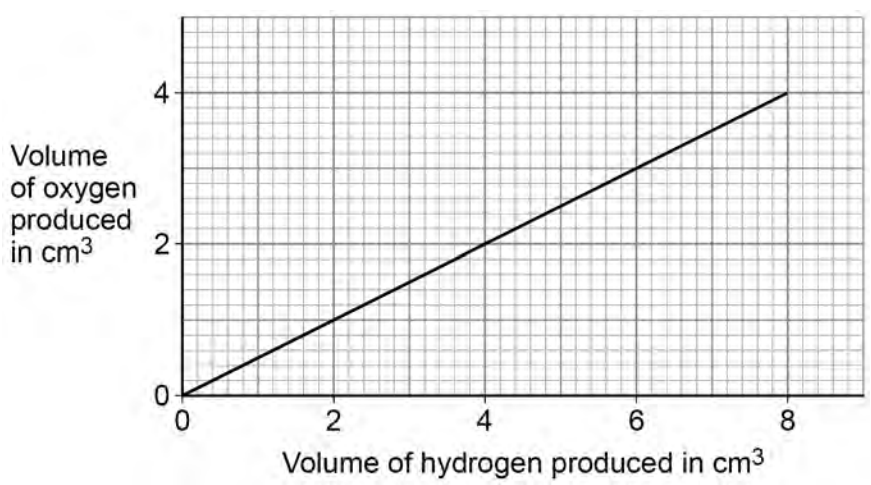
Hydrogen is less reactive than sodium. ☐

Hydrogen has the same reactivity as sodium. ☐

Hydrogen is more reactive than sodium. ☐

0 7 . 7 **Figure 9** shows the relationship between the volume of hydrogen and the volume of oxygen produced during the electrolysis.

Figure 9



Give **one** conclusion that can be made about the volume of hydrogen produced compared to the volume of oxygen produced.

[1 mark]

9

4.4.3.4 Electrolysis of aqueous solutions

Question 19

June 2024 | 8462/1F | Original Q7

0 7 This question is about chemical cells.

0 7 . 1 A student connects four 1.5 V cells in series to make a battery.

What is the total voltage produced by the battery?

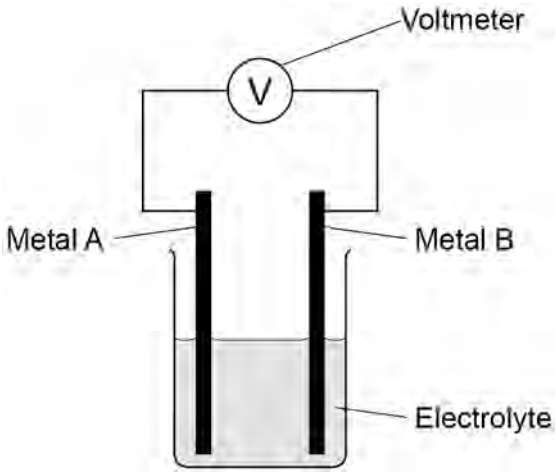
[1 mark]

Voltage = _____ V

A chemical cell can be made using two different metals in contact with an electrolyte.

Figure 14 shows a chemical cell.

Figure 14



0 7 . 2 Which is a suitable electrolyte for a chemical cell?

[1 mark]

Tick (✓) **one** box.

Pure water ☐

Solid lead bromide ☐

Sodium chloride solution ☐

4.4.3.4 Electrolysis of aqueous solutions

Question 19 · continued

0 7 . 3 A student made the hypothesis:

'The voltage produced by a cell depends on the difference in the reactivity of metal **A** and metal **B**.'

Plan an investigation to test this hypothesis.

Your plan should produce valid results.

Use **Figure 14**.

[6 marks]

8