AQA GCSE CHEMISTRY (HIGHER) · 8462

CHEMISTRY



EXAM QUESTION PACK

4.4.3 ELECTROLYSIS (PACK 3)

SCORE	PERCENTAGE
/146	%

STEMUP

These questions belong to AQA, not to us.

The examination questions, mark schemes and examiner comments in this pack were written and published by AQA. They are past assessment materials, reproduced here so that students can revise from them.

What we do not own

STEMUP is not affiliated with AQA and does not own, and makes no claim to own, any of the question, mark scheme or examiner report material in this pack. AQA has not endorsed, approved or been involved in the production of it. AQA and the qualification titles used here belong to their respective owners and appear for identification only.

Where to find the originals

AQA publishes its past papers, mark schemes and examiner reports. Always check the current specification at aqa.org.uk before you revise, because content and wording can change between series.

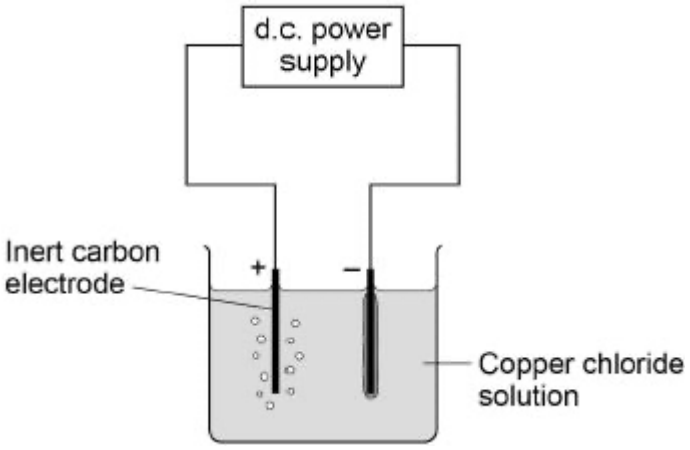
If you hold the rights to any material in this pack and would like it amended or removed, contact admin@stemup.co.uk and we will act on it.

Q1.

This question is about electrolysis.

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

The diagram below shows the apparatus.



(a) Which gas is produced at the positive electrode (anode)?

Tick **one** box.

carbon dioxide ☐

chlorine ☐

hydrogen ☐

oxygen ☐

(1)

(b) Copper is produced at the negative electrode (cathode).

What does this tell you about the reactivity of copper?

Tick **one** box.

Copper is less reactive than hydrogen ☐

Copper is less reactive than oxygen ☐

STEMUP.CO.UK

Copper is more reactive than carbon ☐

Copper is more reactive than chlorine ☐

(1)

The table below shows the student's results.

	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

(c) Determine the **mean** mass of copper produced after 3 minutes.

_____

_____

Mass = _____ mg

(1)

(d) Calculate the mass **X** of copper produced in **Experiment 2** after 5 minutes.

Use the table above.

_____

_____

_____

_____

Mass **X** = _____ mg

(2)

(e) 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.

_____

_____

_____

STEMUP.CO.UK

_____

_____

_____

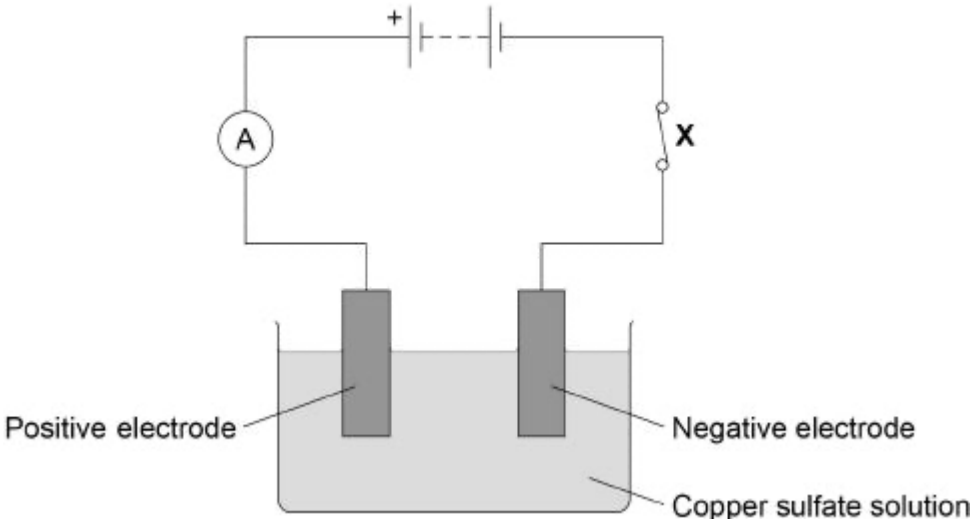
Mass = _____ g

(3)

(Total 8 marks)

Q2.

The diagram below shows the apparatus used to pass a current through copper sulfate solution.



(a) What is the name of component **X** in the diagram above?

Tick **one** box.

Ammeter ☐

Battery ☐

Fuse ☐

Switch ☐

(1)

(b) What is the name of the process happening in the diagram above?

Tick **one** box.

Combustion ☐

STEMUP.CO.UK

Crystallisation ☐

Distillation ☐

Electrolysis ☐

(1)

A student investigated how the concentration of copper sulfate solution affects the mass of copper deposited on the negative electrode.

(c) What are the independent and dependent variables in this investigation?

Draw **one** line from each type of variable to the correct description.

Type of variable	**Description**
Independent variable	Concentration of copper sulfate solution
	Distance between electrodes
Dependent variable	Mass of copper deposited
	Time circuit is switched on for

(2)

The table below shows the student's results.

Concentration of copper sulfate solution in g/dm^3	**Mass of copper deposited in grams**
30	0.04
60	0.08
90	0.12
120	0.07
150	0.20

(d) The result for the concentration of 120 g/dm^3 is anomalous.

What may have caused the anomalous result?

STEMUP.CO.UK

Tick **one** box.

Some copper fell off the electrode ☐

The circuit was switched on for too much time ☐

The concentration of the solution was too high ☐

(1)

(e) Predict the expected mass of copper deposited for the concentration of 120 g/dm^3

Use the table above.

Mass of copper = _____ g

(1)

(f) During the investigation copper ions move to the negative electrode.

Choose the answer from the box.

a negative charge	**a positive charge**	**no charge**

Copper ions move to the negative electrode because copper ions have

_____ .

(1)

(g) Solid copper sulfate does **not** conduct electricity.

What is the reason for this?

Tick **one** box.

The charge on the ions is too high ☐

The ions are too big ☐

The ions are too small ☐

The ions cannot move ☐

(1)

(h) In a different investigation, a student passed a current of 0.6 A through copper sulfate solution for 300 s

Calculate the charge flow through the solution.

STEMUP.CO.UK

Use the equation:

charge flow = current × time

_____

_____

_____

charge flow = _____ coulombs

(2)

(Total 10 marks)

Q3.

Two students investigated the electrolysis of copper sulfate solution.

When copper sulfate solution is electrolysed, copper is produced at the negative electrode.

(a) What substance is produced at the positive electrode when copper sulfate solution is electrolysed?

Tick **one** box.

Hydrogen ☐

Oxygen ☐

Sulfur ☐

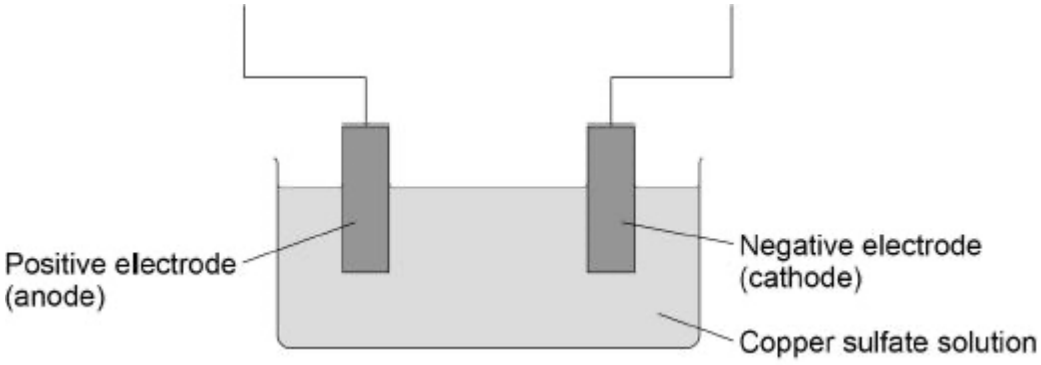
Sulfur dioxide ☐

(1)

(b) The students varied and measured the current in the circuit.

Complete the diagram below to show a circuit that could be used.

STEMUP.CO.UK



(3)

The students made the following hypothesis:

'The mass of copper deposited on the negative electrode will be directly proportional to the current.'

The table below shows the students' results.

Current in amps	**Mass of copper deposited on the negative electrode in grams**
0.12	0.024
0.24	0.047
0.36	0.057
0.48	0.095
0.60	0.118
0.72	0.142

(c) Student **A** said that the results did support the hypothesis.

Student **B** said that the results did **not** support the hypothesis.

Explain the extent to which the data in the table above supports the students' hypothesis.

STEMUP.CO.UK

_____

(4)

(d) Calculate the number of moles of copper deposited on the negative electrode when the current is 0.72 A

Give your answer in standard form.

Use the table above.

Relative atomic mass (A_r) of copper = 63.5

_____

_____

_____

Number of moles = _____

(2)

(e) What change to the investigation would increase the mass of copper deposited on the negative electrode?

Tick **one** box.

Decrease the concentration of copper sulfate solution ☐

Decrease the volume of copper sulfate solution ☐

Increase the distance between the electrodes ☐

Increase the time the circuit is switched on for ☐

(1)

(Total 11 marks)

Q4.

This question is about electrolysis.

(a) How many different elements are in the formula $AgNO_3$?

Tick **one** box.

2 ☐ 3 ☐ 5 ☐ 6 ☐

(1)

(b) How many atoms are in the formula $AgNO_3$?

Tick **one** box.

STEMUP.CO.UK

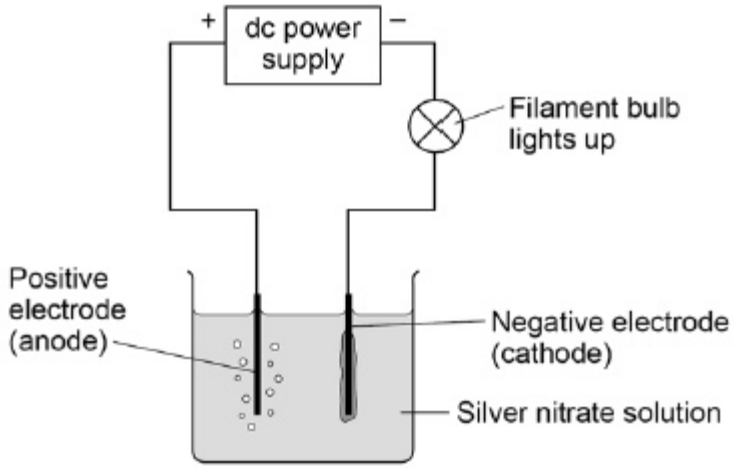
2 ☐ 3 ☐ 5 ☐ 6 ☐

(1)

An electric current is passed through silver nitrate solution.

Figure 1 shows the apparatus.

Figure 1



The solution contains four ions:

- Ag^+
- H^+
- NO_3^-
- OH^-

(c) Where do the H^+ and OH^- ions come from?

Tick **one** box.

Air ☐

Electrodes ☐

Silver nitrate ☐

Water ☐

(1)

(d) Ag^+ ions and H^+ ions are attracted to the negative electrode (cathode).

Give a reason why.

_____

_____

(1)

STEMUP.CO.UK

(e) Silver is produced at the negative electrode (cathode) and not hydrogen.

What does this tell you about the reactivity of silver?

Tick **one** box.

Silver is less reactive than hydrogen	☐
Silver is less reactive than oxygen	☐
Silver is more reactive than nitrate	☐
Silver is more reactive than water	☐

(1)

(f) The hydroxide ion (OH^-) is attracted to the positive electrode (anode).

The equation shows what happens at the positive electrode (anode).

$4OH^- \rightarrow 2H_2O + O_2 + 4e^-$

Name the gas produced at the positive electrode (anode).

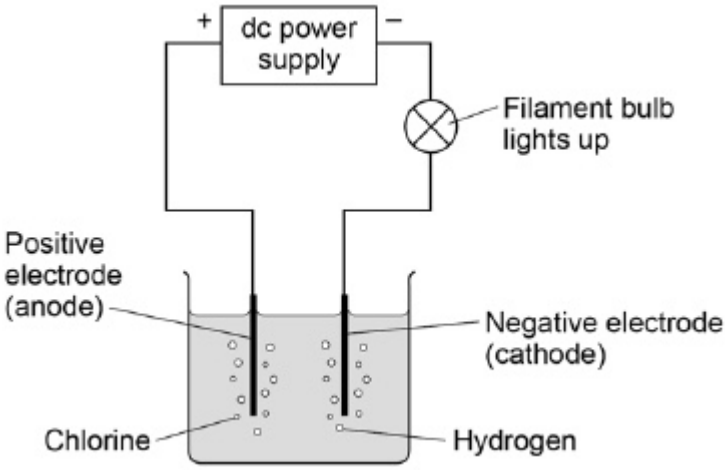
_____

(1)

(g) An electric current is passed through sodium chloride solution.

Figure 2 shows the apparatus.

Figure 2



After passing an electric current through sodium chloride solution one product is sodium hydroxide (NaOH) solution.

The presence of sodium hydroxide can be shown by adding an indicator.

Name an indicator.

STEMUP.CO.UK

Give the colour of the indicator in sodium hydroxide solution.

Indicator _____

Colour _____

(2)

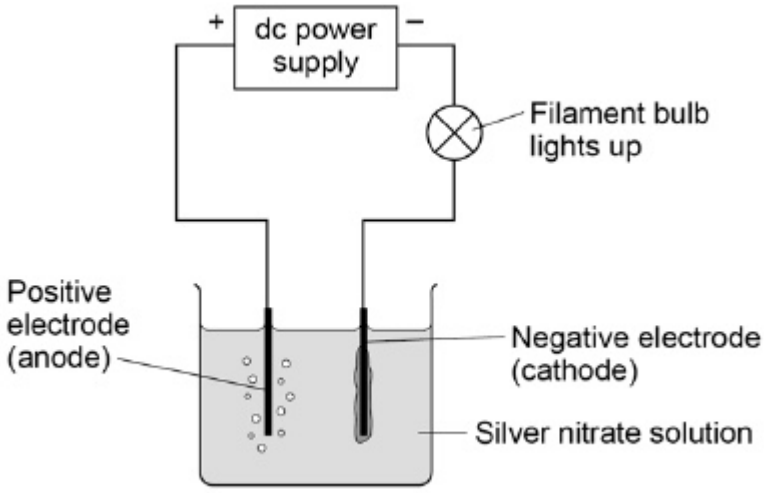
(Total 8 marks)

Q5.

This question is about electrolysis.

(a) **Figure 1** shows the apparatus used to electrolyse silver nitrate ($AgNO_3$) solution.

Figure 1



Name the product discharged at each electrode.

Write a half equation for the reaction at each electrode.

Product at negative electrode (cathode) _____

Half equation for negative electrode

_____

Product at positive electrode (anode) _____

Half equation for positive electrode

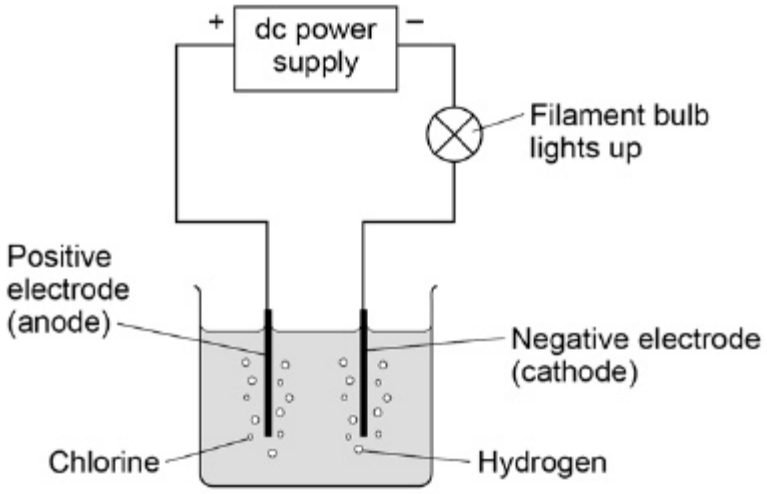
_____

(4)

(b) **Figure 2** shows the apparatus used to electrolyse sodium chloride (NaCl) solution.

Figure 2

STEMUP.CO.UK



Hydrogen and chlorine are produced.

Explain how another different product is formed in solution during this electrolysis.

(4)

(Total 8 marks)

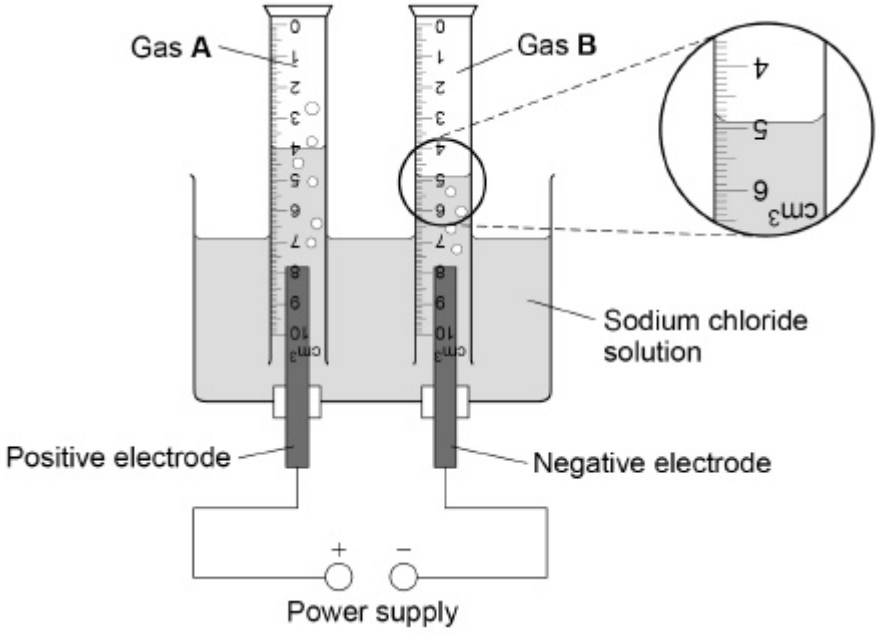
Q6.

A student investigated the electrolysis of sodium chloride solution.

Figure 1 shows the apparatus used.

Figure 1

STEMUP.CO.UK



(a) **Figure 1** shows the volume of gas **B** collected in 10 minutes.

What is the volume of gas **B**?

Volume of gas **B** = _____ cm^3

(1)

(b) The table shows the student's results using sodium chloride solution of concentration 30 g/dm^3

Experiment	**Volume of gas B collected in 10 minutes in cm^3**
1	2.2
2	2.2
3	2.0

Calculate the mean volume of gas **B** collected in 10 minutes.

_____

_____

Mean volume = _____ cm^3

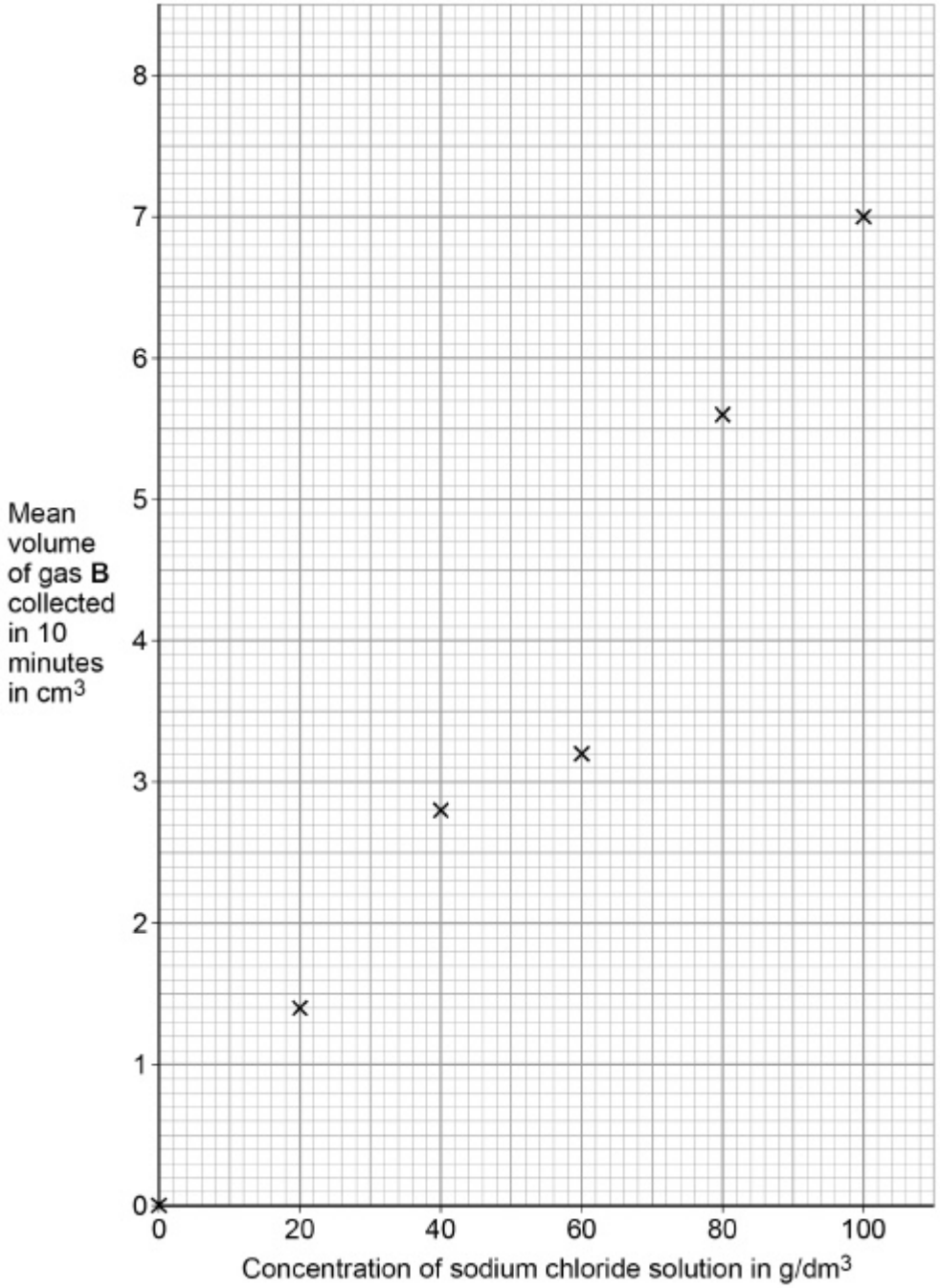
(2)

The student repeated the experiment using different concentrations of sodium chloride solution.

Figure 2 shows some of the student's results.

Figure 2

STEMUP.CO.UK



(c) One point on **Figure 2** is anomalous.

What is the concentration and volume of the anomalous point?

Give a reason for your choice.

Concentration _____ g/dm^3

Volume _____ cm^3

Reason _____

_____

(2)

(d) Describe the trend shown on **Figure 2**.

STEMUP.CO.UK

_____

_____

(1)

(e) Draw **one** line from each type of variable to the description of the variable in the experiment.

Type of variable	Description of variable in the experiment
	Concentration of sodium chloride solution
	Power supply
Dependent variable	
	Temperature of solution
Independent variable	
	Volume of gas collected
	Volume of sodium chloride solution

(2)

Sodium chloride solution contains sodium ions (Na^+) and chloride ions (Cl^-).

(f) Sodium chloride solution is electrolysed.

Explain why the sodium ions are attracted to the negative electrode.

_____

_____

_____

_____

(2)

(g) Complete the sentence.

Choose the answer from the box.

are too big	**are too small**	**cannot move**	**have delocalised electrons**

Solid sodium chloride does **not** conduct electricity because

the ions _____ .

STEMUP.CO.UK

(1)

(h) Which **two** gases are produced during the electrolysis of sodium chloride solution?

Tick **two** boxes.

Carbon dioxide ☐

Carbon monoxide ☐

Chlorine ☐

Hydrogen ☐

Nitrogen ☐

(2)

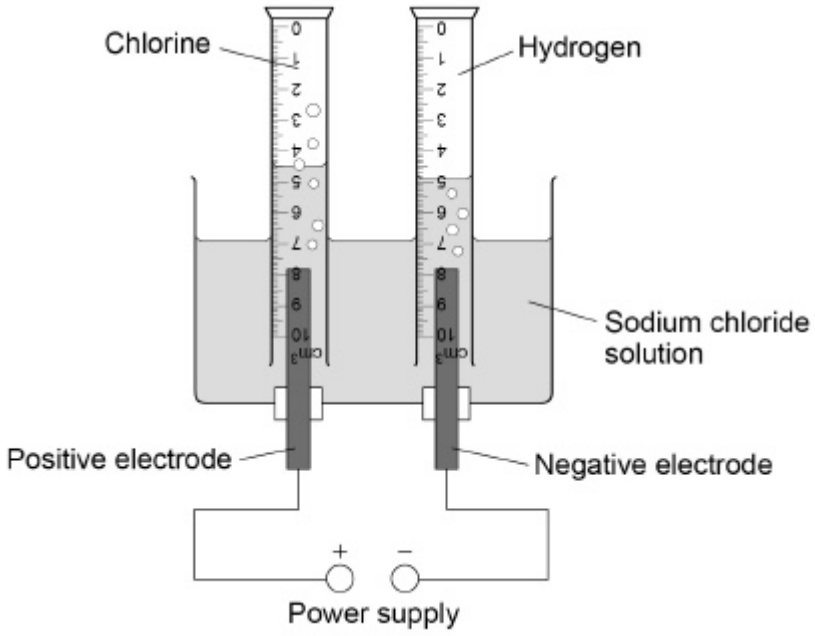
(Total 13 marks)

Q7.

A student investigated the electrolysis of different concentrations of sodium chloride solution.

Figure 1 shows the apparatus used.

Figure 1



The student recorded the volume of hydrogen gas produced in 10 minutes.

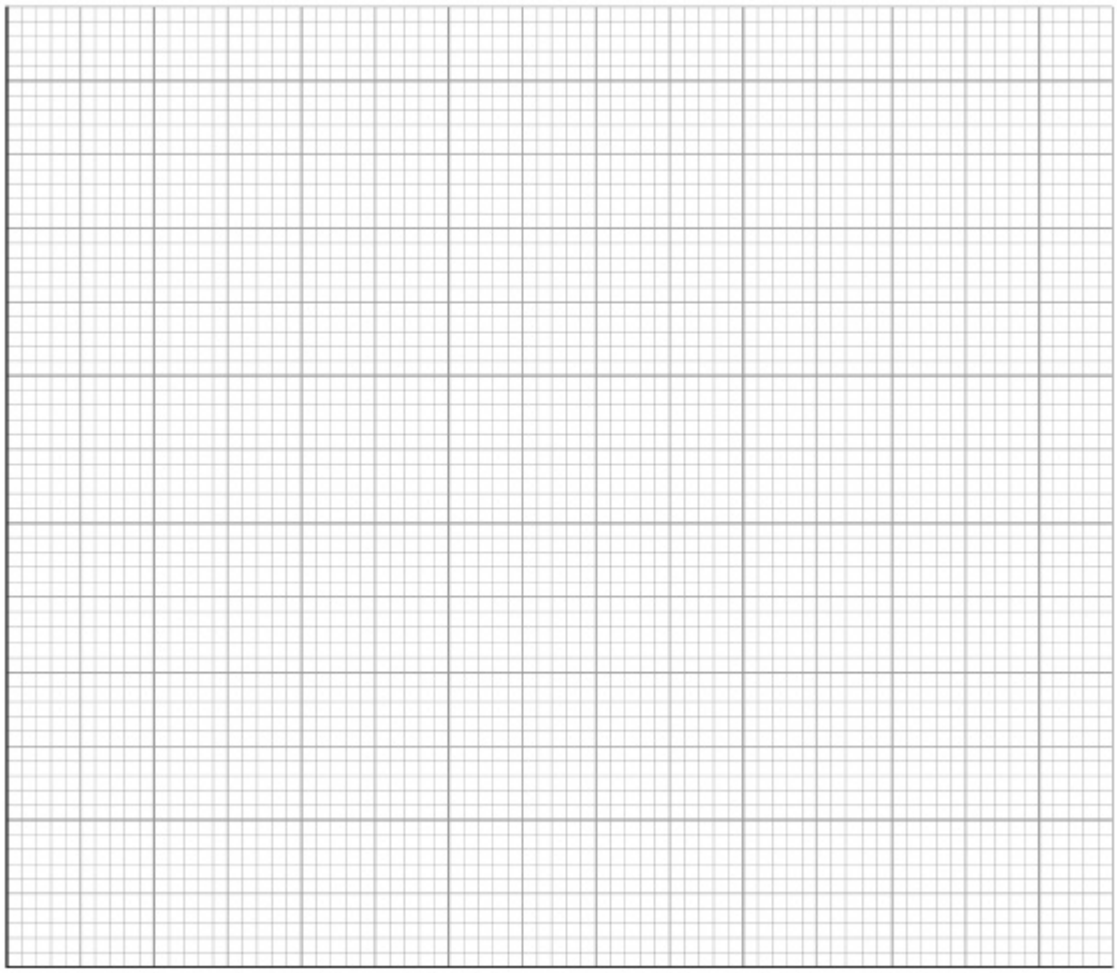
The table shows the student's results.

Concentration of sodium	Volume of hydrogen gas produced in 10 minutes in

STEMUP.CO.UK

chloride solution in g/dm^3	cm^3
0.0	0.0
14.6	1.3
29.3	2.1
43.9	3.9
58.5	5.2
73.1	6.5
87.8	7.8

Figure 2



(a) Plot the data from the table on **Figure 2**.

You should:
- label the x-axis and y-axis
- use suitable scales
- draw a line of best fit.

(4)

(b) Describe the trend on your graph in **Figure 2**.

STEMUP.CO.UK

(1)

(c) Give the dependent variable and the independent variable in the investigation.

Dependent _____

Independent _____

(2)

(d) Explain how chlorine gas is produced at the positive electrode.

(4)

(e) Sodium ions and hydrogen ions are attracted to the negative electrode.

Why is hydrogen gas produced at the negative electrode?

(1)

(f) The student made 50 cm^3 of a sodium chloride solution of concentration 29.25 g/dm^3

How many moles of sodium chloride did the student use to make 50 cm^3 of the solution?

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

You must show your working.

STEMUP.CO.UK

_____

_____

_____

_____

_____

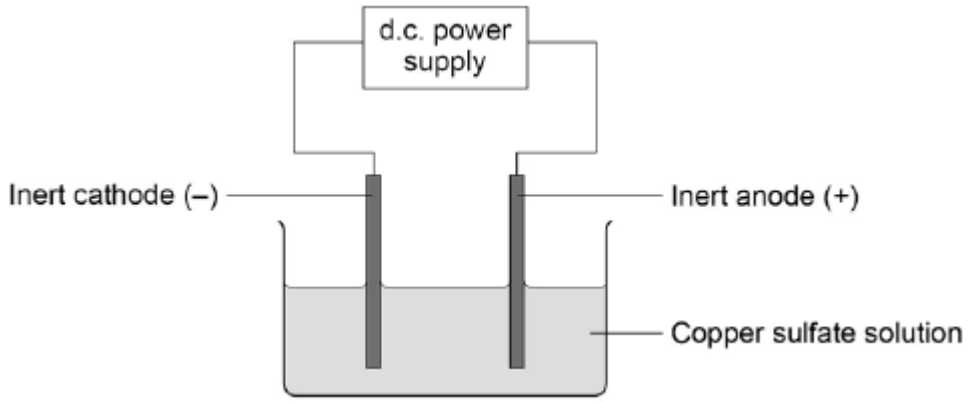
Number of moles = _____

(4)

(Total 16 marks)

Q8.

The figure below shows an apparatus to produce elements from a solution of an ionic compound.



(a) What is the name of the process in the figure?

Tick **one** box.

Combustion ☐

Crystallisation ☐

Distillation ☐

Electrolysis ☐

(1)

(b) The table below shows the products formed from three experiments using different compounds and the apparatus shown in the figure above.

Compound	State	Product at cathode	Product at anode

STEMUP.CO.UK

Copper chloride	Molten	Copper	Chlorine
Copper chloride	Aqueous solution	Copper	Chlorine
Potassium bromide	Molten	Potassium	Bromine

Use the table above to name the products formed at each electrode if using an aqueous solution of potassium bromide.

At cathode _____ At anode _____

(2)

(c) Explain why copper is formed at the cathode during the electrolysis of its salts.

(2)

(Total 5 marks)

Q9.

Copper can be produced from copper(II) sulfate solution by two different methods.

Method 1 – Electrolysis

(a) To produce copper by electrolysis a student has inert electrodes, a d.c. power supply, a switch and electrical wires for the external circuit.

Draw and label the apparatus set up to produce copper from copper(II) sulfate solution by electrolysis.

(2)

(b) Suggest why the colour of the copper(II) sulfate solution fades during the electrolysis.

(3)

(c) Explain how copper is produced from copper(II) sulfate solution by electrolysis.

STEMUP.CO.UK

(4)

Method 2 – Displacement

(d) The chemical equation for the displacement of copper using iron is:

$$CuSO_4 + Fe \rightarrow Cu + FeSO_4$$

Calculate the minimum mass of iron needed to displace all of the copper from 50 cm^3 of copper(II) sulfate solution.

The concentration of the copper(II) sulfate solution is 80 g $CuSO_4$ per dm^3.

Relative atomic masses (A_r): O = 16; S = 32; Fe = 56; Cu = 63.5

Give your answer to 2 significant figures.

Mass of iron = _____ g

(4)

(Total 13 marks)

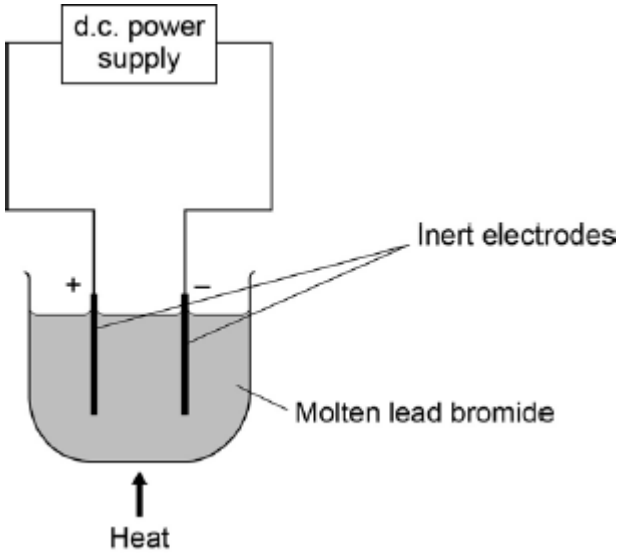
Q10.

This question is about the electrolysis of two compounds.

Figure 1 shows the electrolysis of molten lead bromide.

Figure 1

STEMUP.CO.UK



(a) The electrolyte contains lead ions (Pb^{2+}) and bromide ions (Br^-).

Complete the sentences.

Use words from the box.

atoms	**bromide ions**	**bromine**
lead	**molecules**	**oxygen**

At the positive electrode the gas produced is _____

At the negative electrode lead _____

gain electrons and _____ .

(3)

(b) A student measured the volumes of each gas produced during the electrolysis of water.

The table below shows the student's results.

Time in minutes	**Volume of gas produced in cm^3**	
	Hydrogen	**Oxygen**
0	0	0
2	11.2	5.4
4	20.1	11.4
6	32.5	17.6
8	40.0	23.7
10	60.9	30.0

STEMUP.CO.UK

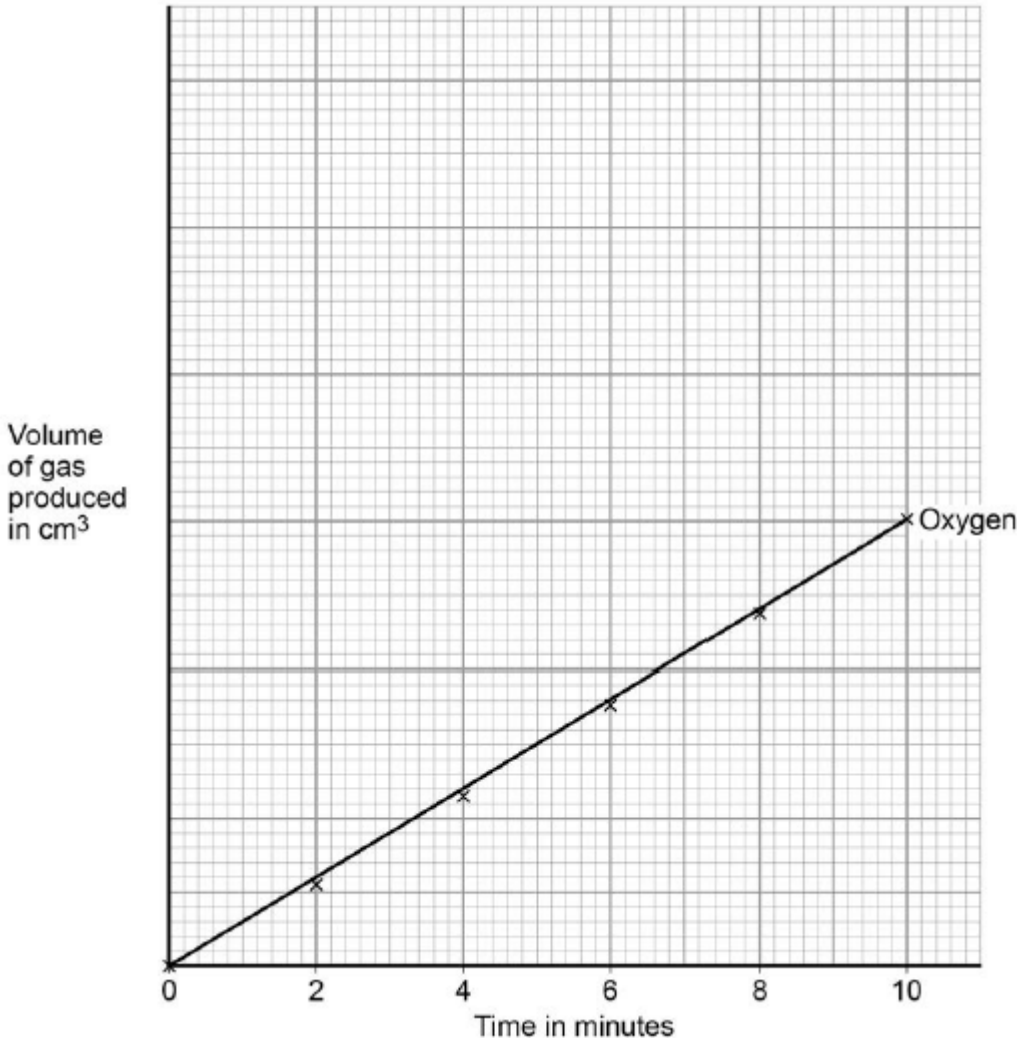
The student plotted a graph of the results for oxygen. **Figure 2** shows the graph.

The student did not put a scale on the *y* axis.

On the graph in **Figure 2**:

- complete the scale for the *y* axis
- plot the results for hydrogen
- include a line of best fit.

Figure 2



(3)

(c) Use the graph to calculate the mean volume of oxygen produced per second.

_____

_____

_____

_____

Mean volume of oxygen produced = _____ cm^3 / s

STEMUP.CO.UK

(3)
(Total 9 marks)

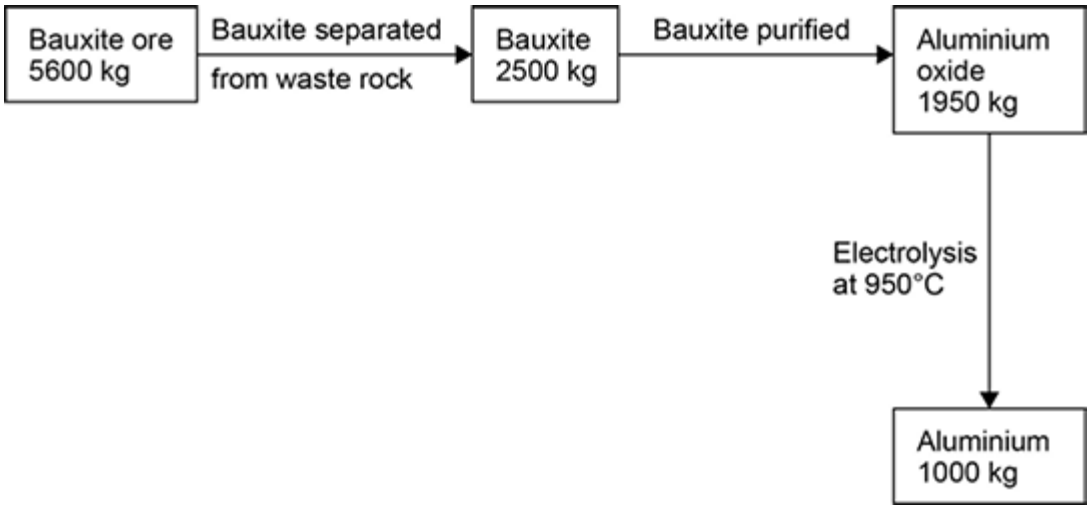
Q11.

Aluminium is produced from an ore called bauxite.

Bauxite contains aluminium oxide.

Look at **Figure 1**.

Figure 1



(a) Calculate the percentage of bauxite that is converted into aluminium oxide.

_____

_____

Percentage = _____

(2)

(b) Show by calculation that the mass of aluminium produced is less than that expected from 1 950 kg aluminium oxide (Al_2O_3).

You should state the difference in the mass of aluminium expected and the mass of aluminium produced to three significant figures.

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

_____

_____

_____

_____

_____

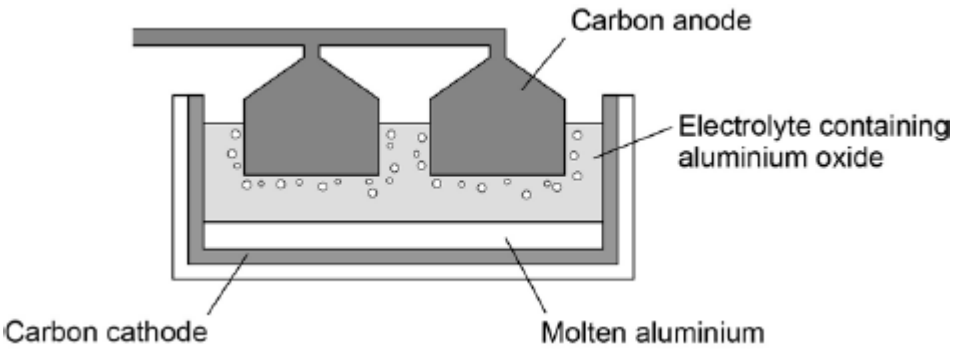
_____

STEMUP.CO.UK

(3)

(c) **Figure 2** shows an electrolysis cell used to extract aluminium.

Figure 2



Why does the carbon anode used in the electrolysis cell need to be continually replaced?

(3)

(d) In an electrolysis cell the current is 1.5×10^5 A, at a potential difference of 4V.

Calculate the energy transferred by the electrolysis cell in 24 hours.

Energy transferred = _____ J

(5)

(e) The half equation at the cathode is:

$Al^{3+} + 3e^- \longrightarrow Al$

Calculate the number of moles of electrons needed to produce 1 000 kg of aluminium.

Give your answer to three significant figures.

STEMUP.CO.UK

Relative atomic mass (A_r): Al = 27

Answer = _____ moles

(3)

(Total 16 marks)

Q12.

A student investigates a potassium salt, **X**.

She finds that salt **X**:

- has a high melting point
- does not conduct electricity when it is solid
- dissolves in water and the solution does conduct electricity.

(a) What is the type of bonding in salt **X**?

Tick **one** box.

Covalent	☐
Giant molecular	☐
Ionic	☐
Metallic	☐

(1)

(b) What is the name given to solutions that conduct electricity?

(1)

(c) Why does a solution of salt **X** in water conduct electricity?

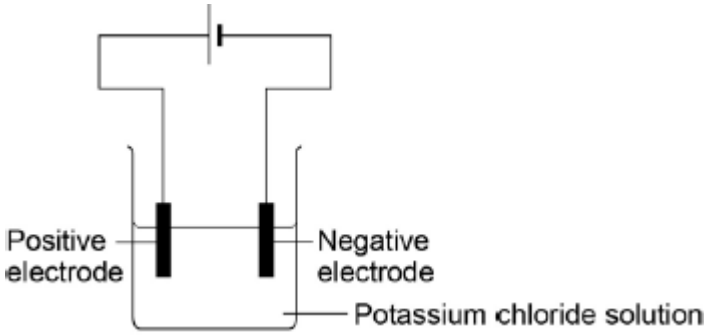
(1)

(d) The student electrolyses a solution of potassium chloride.

STEMUP.CO.UK

Figure 1 shows the apparatus she uses.

Figure 1



When the current is switched on, bubbles of hydrogen gas are given off at the negative electrode.

Explain why hydrogen is produced and **not** potassium.

_____

_____

_____

_____

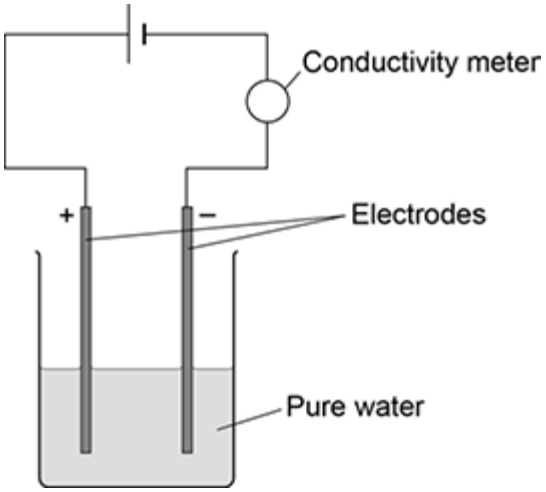
_____

(2)

(e) The student then compares the relative conductivity of different concentrations of potassium chloride.

Figure 2 shows the apparatus she uses.

Figure 2



This is the method used.

1. Add potassium chloride solution to the water one drop at a time.

STEMUP.CO.UK

2. Stir the mixture.

3. Record the reading on the conductivity meter.

The table below shows the student's results.

Number of drops of potassium chloride solution	Relative conductivity of solution
0	0
1	90
2	180
3	270
4	360
5	450
6	540

When there is no potassium chloride in the beaker no electrical charge flows.

Suggest why pure water does **not** conduct electricity.

_____

_____

_____

_____

(2)

(f) Describe the relationship shown in the table above.

_____

_____

_____

_____

(2)

(Total 9 marks)

Q64.

The Mary Rose was a wooden warship built in 1510. The Mary Rose sank in 1545 but was lifted from the sea bed in 1982. Scientists are now preserving the ship.

Metal objects found on the Mary Rose included some made from gold, some made from iron, but none made from aluminium.

STEMUP.CO.UK

(a) (i) Why is gold found in the Earth's crust as the element?

_____

_____

(1)

(ii) Iron is extracted from iron(III) oxide by reduction with carbon.

Complete and balance the symbol equation for the reaction.

___Fe_2O_3 + ___C $\longrightarrow$ _____ + _____

(2)

(iii) Scientists were not able to extract aluminium until the 19th century.

Explain why.

_____

_____

_____

_____

(2)

(b) The image shows the Mary Rose being supported on poles as it is preserved. As part of the preservation process the ship was sprayed with water for 12 years.



By Mary Rose Trust (MR Trust) [CC BY-SA 3.0] via Wikimedia Commons

The table gives information about two materials which could have been used to make the poles to support the Mary Rose.

Material	**Density in g / cm^3**	**Relative strength**	**Cost in £ per kg**
Steel	7.85	1	4
Titanium	4.51	3.9	4000

STEMUP.CO.UK

Compare the physical properties of the materials in the table above to suggest why the poles were made of titanium instead of steel.

_____

_____

(1)

(Total 6 marks)

Q65.

The table below shows information about three metals.

Metal	Mainly found as	% of metal in Earth's crust	Relative cost of 1 kg
Aluminium	Aluminium oxide, Al_2O_3	8.2	4.2
Gold	Gold	0.0000001	30000
Iron	Iron(III) oxide, Fe_2O_3	4.1	1

(a) Suggest why gold is a very expensive metal.

_____

_____

(1)

(b) Iron is extracted from iron oxide by reduction with carbon.

Aluminium cannot be extracted by reduction with carbon.

(i) What is the name of the process used to extract aluminium from aluminium oxide?

_____

(1)

(ii) Why is it more expensive to extract aluminium than iron?

_____

_____

(1)

(Total 3 marks)

Q66.

The table below shows information about three metals.

Metal	Mainly found as	% of metal in Earth's crust	Relative cost of 1 kg

STEMUP.CO.UK

Aluminium	Aluminium oxide, Al_2O_3	8.2	4.2
Gold	Gold	0.0000001	30000
Iron	Iron(III) oxide, Fe_2O_3	4.1	1

(a) Suggest why gold is a very expensive metal.

_____

_____

(1)

Iron is extracted from iron oxide by reduction with carbon.

Aluminium cannot be extracted by reduction with carbon.

(b) (i) What is the name of the process used to extract aluminium from aluminium oxide?

_____

(1)

(ii) Why is it more expensive to extract aluminium than iron?

_____

_____

_____

(1)

(c) Complete and balance the symbol equation for the reaction to produce iron from iron(III) oxide.

_____ + _____ → _____ + _____ CO_2

(2)

(Total 5 marks)

Q67.

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

Aluminium is used to make many items.

STEMUP.CO.UK



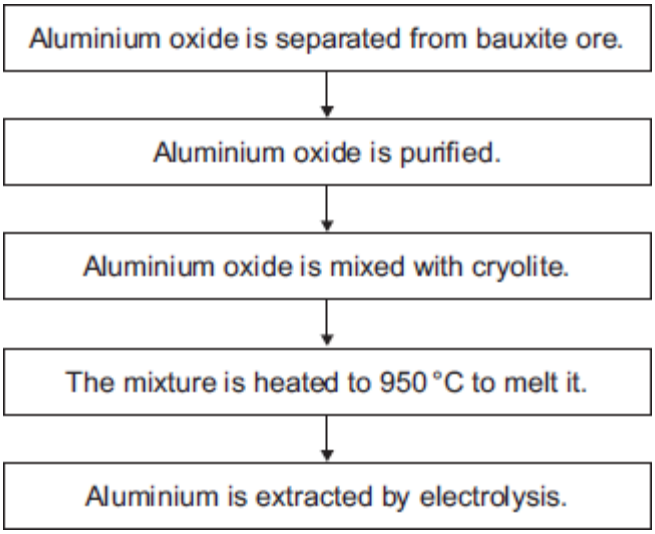




Window © Sergei Popov/iStock Airplane © Luminis/iStock
Pylon © afj1977/iStock Can © fotofermer/iStock
Car © tridland/iStock

Aluminium is extracted from aluminium ore. Aluminium ore is called bauxite, which is impure aluminium oxide.

The flow chart shows the main steps in the extraction of aluminium from aluminium ore.



Most aluminium is recycled.

Aluminium is recycled by melting scrap aluminium at 700 °C.

Use your own knowledge and the information given to answer the question.

Suggest why most aluminium is recycled.

STEMUP.CO.UK

(Total 6 marks)

STEMUP.CO.UK