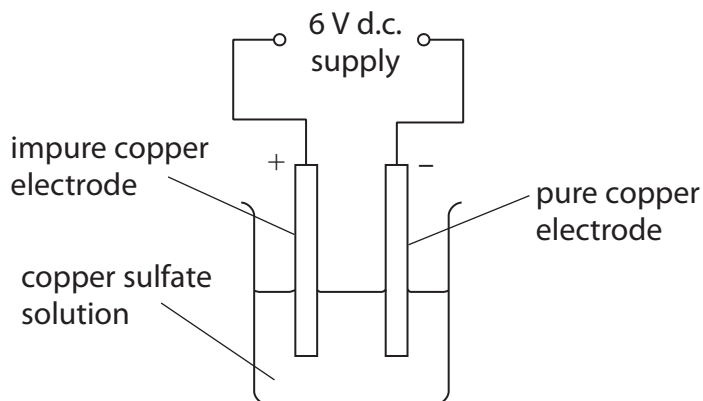


1 (a) Impure copper is purified by electrolysis using the apparatus shown.



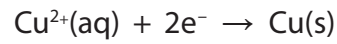
(i) Give the name of the electrode which is made of pure copper.

(1)

(ii) Describe how each electrode will have changed at the end of the electrolysis process.

(2)

(iii) Complete the sentence by putting a cross (☒) in the box next to your answer.



This half equation shows the process of

(1)

- A** displacement
- B** oxidation
- C** redox
- D** reduction

(iv) Copper sulfate solution is the electrolyte used in this electrolysis process.

Explain how copper sulfate solution conducts electricity.

(2)

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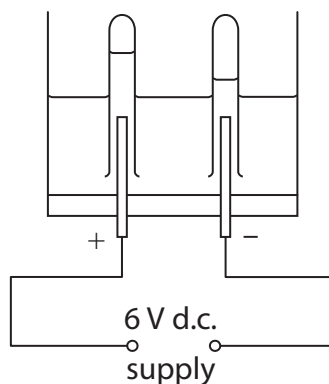
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(b) Sodium sulfate solution is electrolysed in the apparatus shown.



Sodium sulfate solution contains sodium ions, Na^+ , sulfate ions, SO_4^{2-} , hydrogen ions, H^+ , and hydroxide ions, OH^- .

Hydrogen is produced at one electrode and oxygen is produced at the other electrode.

Explain how these products are formed from the ions in the electrolysis process, indicating how you would identify the products.

You may give ionic equations in your answer.

(6)

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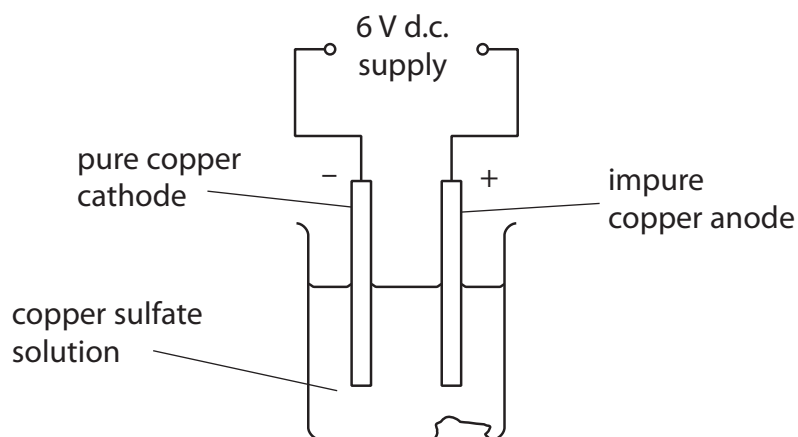
(Total for Question 1 = 12 marks)

2 (a) Some metal objects are electroplated to improve their appearance.

Give another reason why some metal objects are electroplated.

(1)

(b) Copper sulfate solution was electrolysed using copper electrodes.
The mass of each electrode was determined before it was placed in the solution.



The electrolysis was carried out for a period of time.
The electrodes were removed, washed, dried and their masses redetermined.

The table shows the masses of the electrodes before and after electrolysis.

	mass of electrode before electrolysis / g	mass of electrode after electrolysis / g	change in mass
mass of impure copper anode	40.0	35.0	5.0 g decrease
mass of pure copper cathode	10.0	14.8	4.8 g increase

Explain these results.

(3)

(c) In an electrolysis experiment, oxide ions, O^{2-} , form oxygen gas, O_2 .

Write the balanced half equation for the reaction.

(2)

*d) Sodium chloride is an ionic compound.

It contains sodium ions, Na^+ , and chloride ions, Cl^- .

When molten sodium chloride is electrolysed, sodium metal and chlorine gas are formed.

Describe how the sodium ions and chloride ions in solid sodium chloride are converted into sodium and chlorine by electrolysis.

(6)

(Total for Question 2 = 12 marks)

3 Electrolysis occurs when solutions of some compounds are decomposed by passing direct electric current through them.

(a) Sodium chloride solution was electrolysed.
The reaction produced chlorine and hydrogen.
The remaining solution contained sodium hydroxide, NaOH.

(i) State a hazard associated with chlorine gas. (1)

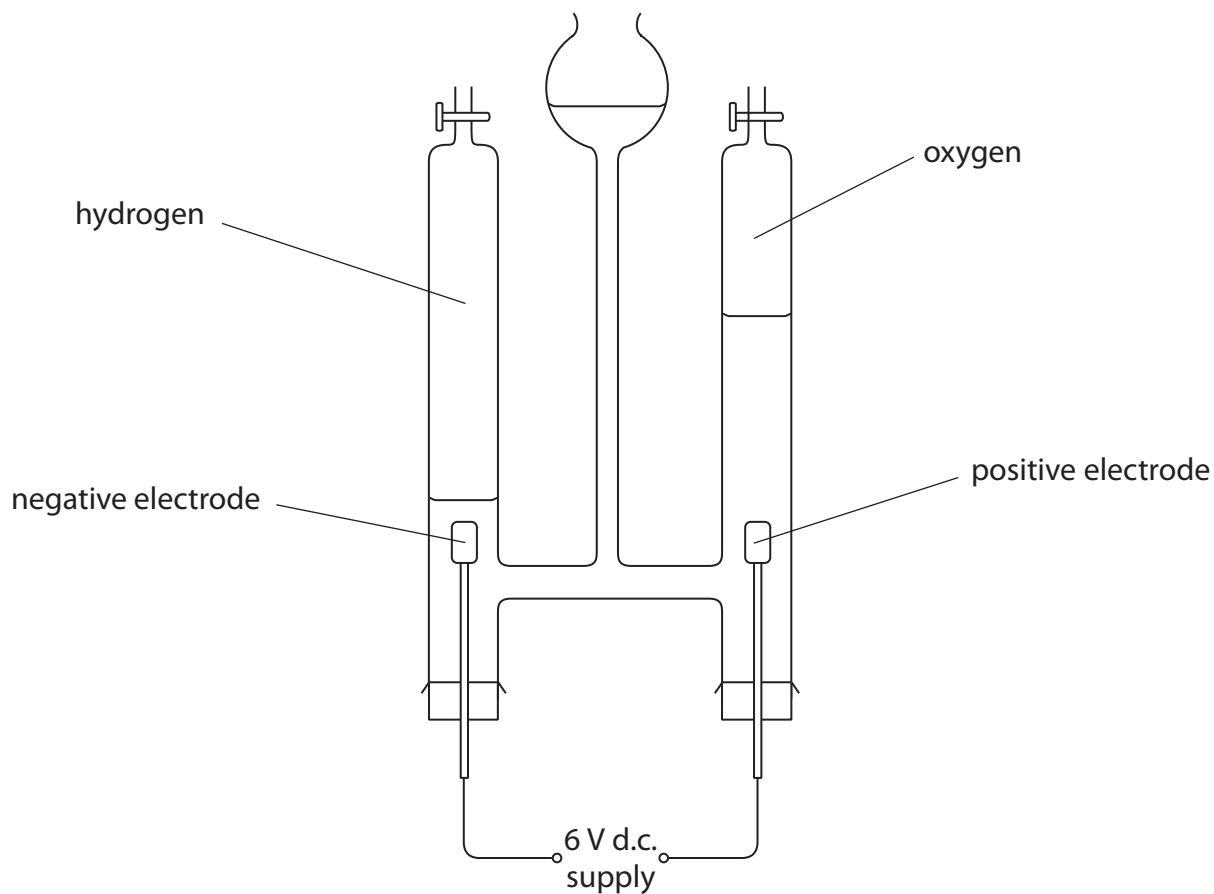
(ii) Describe a test that can be used to identify a sample of gas as chlorine. (2)

(iii) State a use of chlorine. (1)

(iv) Complete and balance the equation for the overall reaction taking place when sodium chloride solution is electrolysed. (2)



*(b) Water was decomposed by electrolysis in the apparatus shown.



The water decomposed into hydrogen and oxygen.
After five minutes, the volumes of hydrogen and oxygen in the tubes were measured.

Two further experiments were carried out changing only one factor in each experiment. All other factors were kept the same.

The table shows the conditions and results of all three experiments.

experiment	time / minutes	current / amps	volume of hydrogen / cm ³	volume of oxygen / cm ³
1	5	0.50	20.0	10.0
2	10	0.50	40.0	20.0
3	5	0.75	30.0	15.0

Use these results of electrolysis to compare the volumes of hydrogen and oxygen formed and to show the effect of changing the time and the current on the volumes of these gases.

(6)

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(Total for Question 3 = 12 marks)

4 (a) Complete the sentence by putting a cross (☒) in the box next to your answer.

When dilute hydrochloric acid reacts with copper oxide one of the products is

(1)

- A copper
- B copper hydroxide
- C copper chlorate
- D copper chloride

(b) Chlorine is manufactured by electrolysis.

Explain what is meant by **electrolysis**.

(2)

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(c) Chlorine gas reacts with sodium hydroxide solution to form sodium chlorate(I), NaOCl, sodium chloride and water.

Write the balanced equation for this reaction.

(3)

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***(d)** Sulfur is an impurity in some fossil fuels.

Explain how the presence of sulfur in fossil fuels can lead to damage to the environment and how the amount of damage can be reduced.

(6)

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(Total for Question 4 = 12 marks)