

Electrolysis

Question Paper

Level	GCSE
Subject	Chemistry
Exam Board	Edexcel IGCSE
Module	Single Award (Paper 2C)
Topic	Principles of Chemistry
Sub-Topic	Electrolysis
Booklet	Question Paper

Time Allowed: 48 minutes

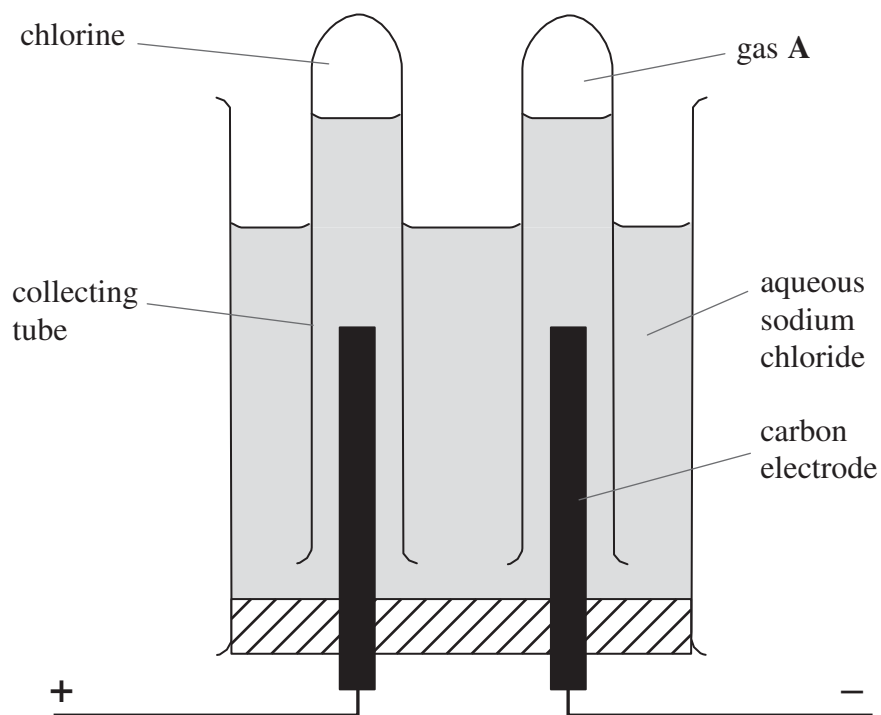
Score: /40

Percentage: /100

Grade Boundaries:

A*	A	B	C	D	E	U
>85%	75%	70%	60%	55%	50%	<50%

1 The apparatus shown can be used to electrolyse aqueous sodium chloride in the laboratory.



(a) Gases are evolved at both electrodes.

(i) Describe a chemical test to show that the gas evolved at the positive electrode is chlorine.

(2)

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(ii) Identify gas A.

(1)

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(b) Some of the solution formed after the electrolysis was tested with the indicator phenolphthalein. The indicator turned pink

Explain this result.

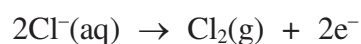
(1)

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(c) The equation for the reaction taking place at the positive electrode is:



Ten faradays (10 F) of electricity were passed through an aqueous solution of sodium chloride.

(i) Calculate the amount, in moles, of chlorine formed.

(1)

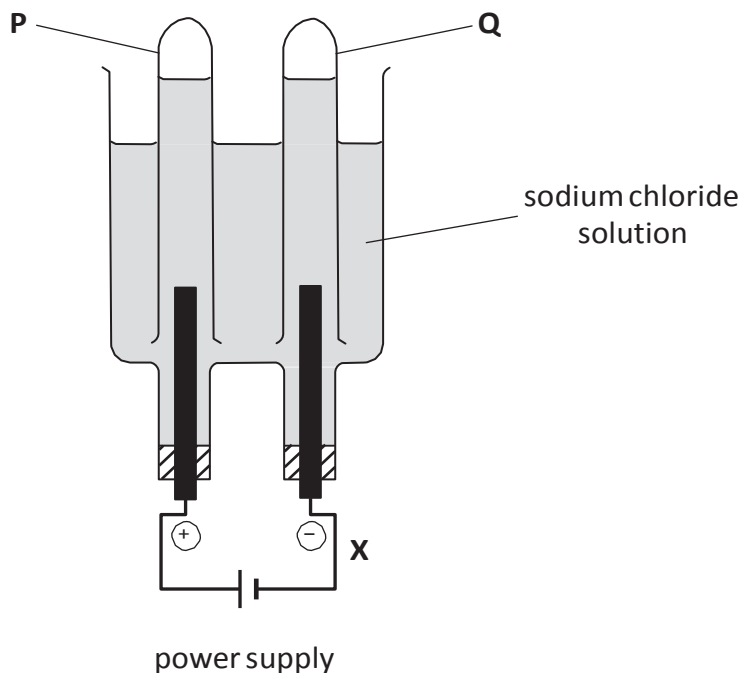
(ii) Calculate the volume of chlorine formed.

(One mole of a gas occupies 24 dm³ at this temperature and pressure)

(2)

(Total for Question 1 = 7 marks)

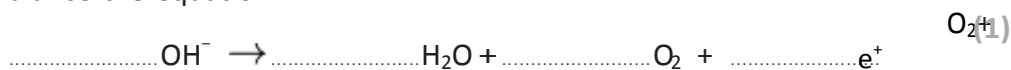
- 2 The diagram shows how sodium chloride solution can be electrolysed and the products of electrolysis collected.



- (a) (i) Draw an arrow on the diagram to show the direction of electron flow at point **X**. (1)
- (ii) The diagram shows one of the gases being collected in test tube **Q**. Identify this gas. (1)

- (iii) When the concentration of the sodium chloride solution is low, the gas collected in test tube **P** is mostly oxygen. The formation of this gas can be represented by an ionic half-equation.

Balance the equation.



- (b) When the concentration of sodium chloride solution is high, the gas that collects in test tube **P** is mostly chlorine. The equation for its formation is:



In one experiment, the volume of chlorine gas collected was 18 cm³.

- (i) Calculate the amount, in moles, of chlorine gas in 18 cm³.

(The volume of 1 mol of a gas at room temperature and pressure is 24 000 cm³)

(2)

Amount = mol

- (ii) Calculate the quantity of electricity, in coulombs, needed to produce this volume of chlorine gas.

(1 faraday = 96 500 coulombs)

(2)

Quantity = C

- (c) Chlorine reacts with potassium bromide solution. The equation for this reaction is:



This reaction can be described as both a displacement reaction and a redox reaction.

- (i) Identify the element that is displaced in this reaction.

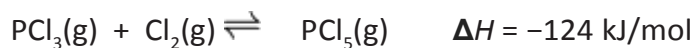
(1)

- (ii) State the meaning of the term **redox**.

(1)

(d) Chlorine is used in the manufacture of phosphorus pentachloride, PCl_5

The equation for the reaction is:



(i) What does the \rightleftharpoons symbol indicate about this reaction?

(1)

(ii) Predict and explain the effect of increasing the pressure on the equilibrium position of this reaction.

(2)

Prediction

Explanation

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(Total for Question 2 = 12 marks)

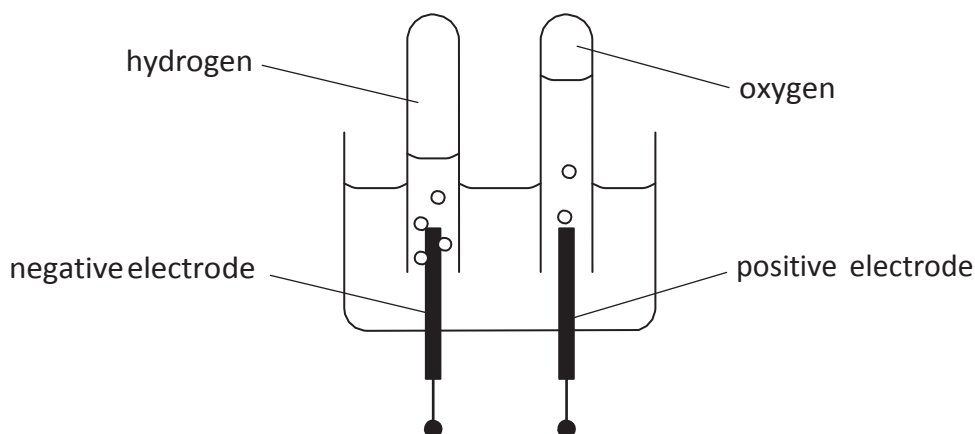
- 3 (a) The table shows some results of the electrolysis of aqueous solutions using inert electrodes. The solutions were electrolysed under the same conditions.

Use the information given to complete the table.

(3)

Solution	Product at the negative electrode	Product at the positive electrode	Substance left in solution at the end of the electrolysis
copper(II) sulfate	copper	oxygen	sulfuric acid
potassium sulfate	hydrogen	oxygen	potassium sulfate
silver nitrate	silver	oxygen	nitric acid
silver sulfate		oxygen	sulfuric acid
potassium nitrate	hydrogen		

- (b) Water can be decomposed by electrolysis using this apparatus.



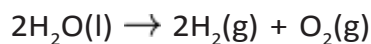
- (i) Suggest a suitable element for the inert electrodes.

(1)

- (ii) Suggest why a small amount of dilute acid is added to the water before it is electrolysed.

(1)

(c) (i) The overall equation for the decomposition of water is



Use this equation to explain why the volume of hydrogen collected should be twice that of the volume of oxygen.

(1)

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(ii) The volume of oxygen collected is always slightly less than expected, even though there are no leaks in the apparatus.

Suggest a reason for this.

(1)

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(d) The equation represents the formation of hydrogen gas at the negative electrode.



During electrolysis, 482 500 coulombs were passed through the solution.

Calculate the amount, in moles, of hydrogen gas formed.

[One faraday = 96 500 coulombs]

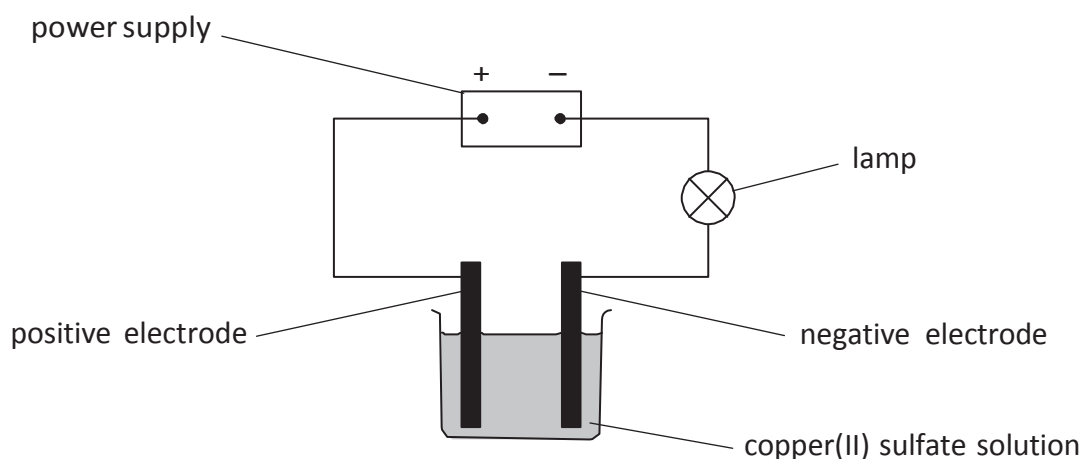
(2)

Amount of hydrogen gas formed = mol

(Total for Question 3 = 9 marks)

- 4 Most experiments involving electrolysis use inert electrodes, which do not take part in the reactions. However, in some experiments the electrodes do take part in the reactions.

A student investigates the electrolysis of copper(II) sulfate solution using copper electrodes which do take part in the reaction. She uses this apparatus.



She uses this method.

- t weigh two clean strips of copper
- t use one strip as the positive electrode and the other as the negative electrode
- t after electrolysis wash the strips of copper with ethanol (a liquid that boils at 78 °C)
- t dry the strips of copper and reweigh them

The ionic half-equations for the reactions at the electrodes are



- (a) Suggest why the copper strips would dry more quickly when washed with ethanol rather than with water.

(1)

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

	Positive electrode	Negative electrode
Mass of electrode before electrolysis in g	8.78	7.95
Mass of electrode after electrolysis in g	8.46	8.25

The table shows that the decrease in mass of the positive electrode was 0.32 g.

(i) Calculate the increase in mass, in grams, of the negative electrode.

(1)

Increase in mass = g

(ii) The ionic half-equations show that the increase in mass of the negative electrode should be the same as the decrease in mass of the positive electrode.

Suggest two reasons why the increase in mass of the negative electrode in the student's experiment was less than expected.

(2)

1

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2

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(c) Another student investigated the effect of changing the electrical charge, in faradays, passed during the electrolysis.

He wanted to find how this affected the increase in mass of the negative electrode.

One faraday is the electrical charge of one mole of electrons.

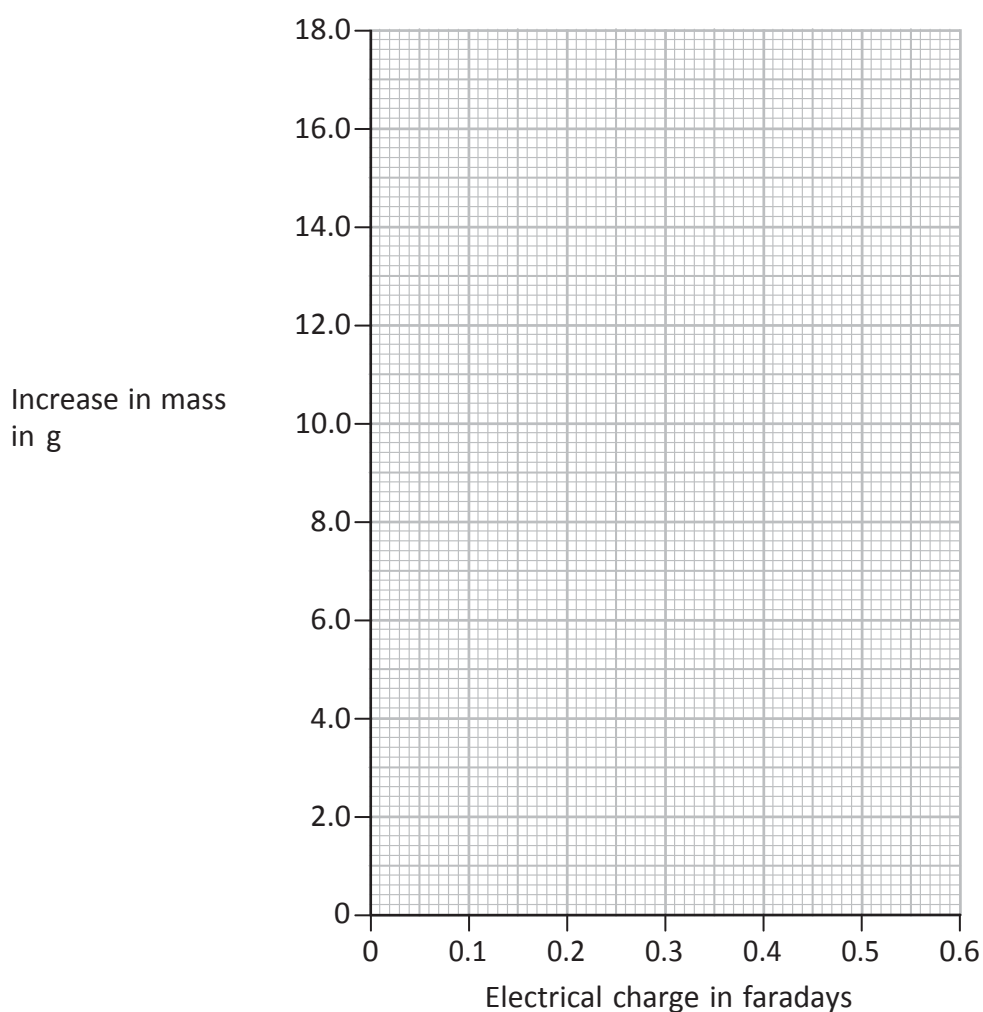
His results are shown in the table.

Experiment	1	2	3	4	5	6	7	8	9
Electrical charge in faradays	0.10	0.15	0.20	0.25	0.30	0.35	0.40	0.45	0.50
Increase in mass in g	3.20	4.80	7.40	8.00	9.60	11.20	12.80	14.40	16.00

(i) On the grid, plot a graph of increase in mass against electrical charge.

Draw a straight line of best fit. Start your line at the origin (0,0).

(3)



(ii) Draw a circle around the anomalous result.

(1)

(iii) Suggest why the straight line should go through the origin.

(1)

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(iv) Explain why the graph shows that the increase in mass is directly proportional to the electrical charge passed.

(1)

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(v) Use your graph to estimate the increase in mass, in grams, of the copper electrode that would be produced by passing an electrical charge of 0.55 faradays.

(2)

Increase in mass = g

(Total for Question 4 = 12 marks)
