Cambridge Assessment International Examination

Chemistry

O Level Topical Paper 4

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CONTENT
O LEVEL CHEMISTRY TOPICAL P4

I am a teacher. It's how I define myself.

A good teacher isn't someone who gives the answers out to their Students but is understanding of needs and challenges and gives tools to help other people succeed.
That's the way I see myself, so whatever it is that I will do, it'll have to do a lot with teaching.

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3 Stoichiometry

1 5070/41/M/J/21/Q5

A student investigates a solid metal carbonate using two different methods.

Method **1**.

The student:

- measures the mass of an empty test-tube
- adds some metal carbonate to the test-tube and measures the mass again
- heats the test-tube strongly then lets it cool
- measures the mass of the test-tube and contents again
- heats the test-tube a second time then lets it cool
- measures the mass of the test-tube and contents again
- heats the test-tube a third time then lets it cool
- measures the mass of the test-tube and contents again.

The student's results are shown in the table.

	mass / g
empty test-tube	59.14
test-tube and metal carbonate before heating	63.34
test-tube and contents after first heating	61.78
test-tube and contents after second heating	61.14
test-tube and contents after third heating	61.14

(a) (i) Calculate the mass of metal carbonate used.

mass ..... g [1]

(ii) Calculate the total change in mass of the contents of the test-tube after heating.

change in mass ..... g [1]

(b) Explain why the student heats the metal carbonate three times.

.....

..... [1]

(c) The metal in the metal carbonate is represented by **M**.

The equation for the reaction is shown.

$$\mathbf{M}CO_3(s) \rightarrow \mathbf{M}O(s) + CO_2(g)$$

(i) Explain why there is a change in mass during heating.

..... [1]

(ii) The M_r of carbon dioxide is 44.

Use your answer to **(a)(ii)** to calculate the number of moles of carbon dioxide made in the reaction.

number of moles of carbon dioxide ..... [1]

(iii) Use the equation to calculate the number of moles of metal carbonate used in the experiment.

number of moles of metal carbonate ..... [1]

(iv) Use your answers to **(a)(i)** and **(c)(iii)** to calculate the mass of **one** mole of the metal carbonate.

mass of one mole of metal carbonate ..... g [1]

(v) Calculate the A_r of metal **M**.
[A_r: C,12; O,16]

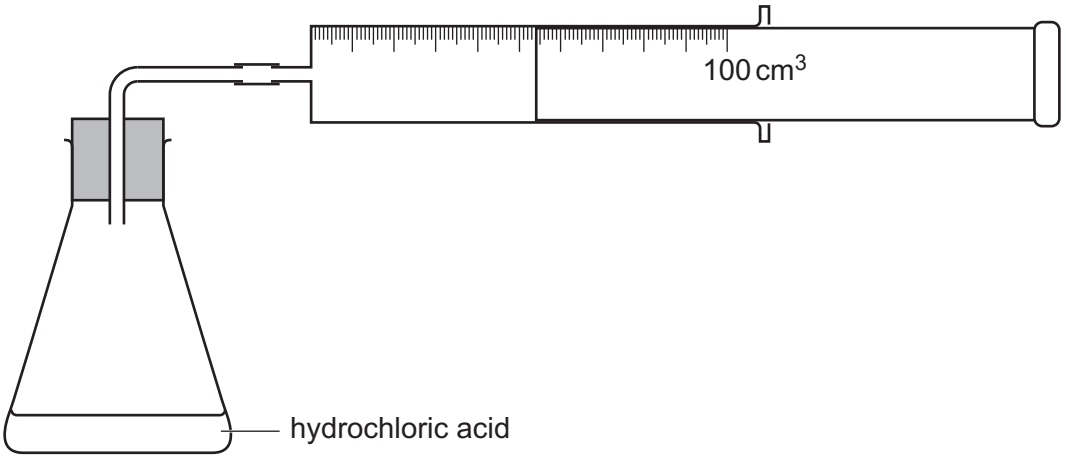
A_r of metal **M** ..... [2]

(vi) Due to an issue with question 5(c)(vi), the question has been removed from the question paper.

(d) Method **2**.

The student:

- measures 0.20 g of metal carbonate
- sets up the apparatus shown in the diagram
- removes the bung and quickly adds the metal carbonate
- replaces the bung
- measures the total volume of gas collected when all of the metal carbonate has reacted.



(i) Name the apparatus used to collect the carbon dioxide.

..... [1]

(ii) State the volume of carbon dioxide collected.

..... cm^3 [1]

(iii) Calculate the number of moles of carbon dioxide collected.
[One mole of any gas at room temperature and pressure occupies 24 dm^3.]

..... mol [1]

(iv) The student uses this information to calculate the relative atomic mass, A_r, of **M**.

Suggest a reason why method **2** is less accurate than method **1**.

.....

.....

..... [1]

(v) Identify a hazard in method **2** and suggest a safety precaution to reduce the risk associated with this hazard.

hazard .....

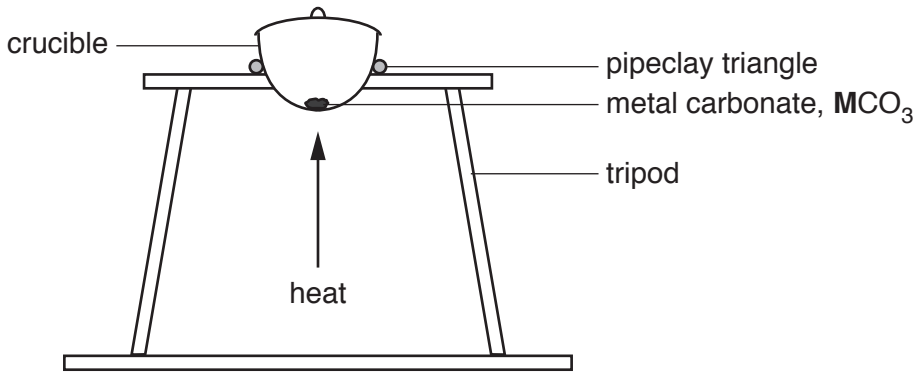
precaution .....
[2]

---

2 5070/42/M/J/18/Q8

A scientist needs to identify the metal ion in a metal carbonate, **M**CO_3.

MCO_3 is heated in a crucible for three minutes. The **M**CO_3 decomposes to form the solid metal oxide, **M**O, and carbon dioxide gas.



(a) Give **two** reasons why it is important that a lid is placed loosely on the crucible.

1 .....

2 .....
[2]

(b) Complete the table of results.

mass of crucible and lid / g	mass of crucible, lid and **M**CO_3 before heating / g	mass of crucible, lid and contents after heating / g	mass of **M**CO_3 before heating / g	mass of carbon dioxide gas formed / g
10.1	12.6	11.7		

[2]

(c) The crucible is heated for another three minutes. The mass of the crucible, lid and contents is 11.5 g.

Explain why this is different from the value in the table.

.....

.....

..... [1]

(d) The total mass of carbon dioxide, CO_2, formed is 1.1 g.

Calculate the number of moles of CO_2 formed.

[M_r: CO_2, 44]

..... moles [1]

(e) The equation for the decomposition of the metal carbonate is shown.

$$\mathbf{M}CO_3 \rightarrow \mathbf{M}O + CO_2$$

Using the equation and your answers to **(b)** and **(d)**, calculate the relative formula mass of **M**CO_3.

relative formula mass ..... [1]

(f) Calculate the relative atomic mass, A_r, of metal **M**.

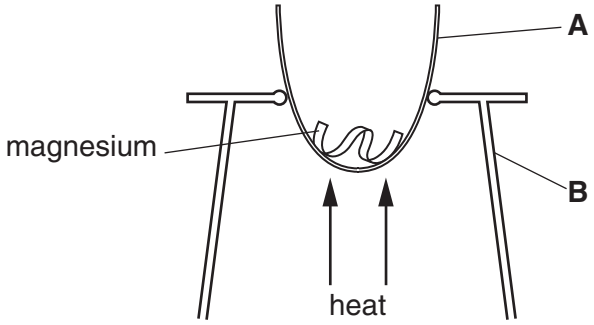
[A_r: C, 12; O, 16]

A_r of metal **M** ..... [1]

3 5070/41/M/J/17/Q1

A student does an experiment to convert magnesium into magnesium oxide, MgO.

A 0.36 g sample of magnesium is heated strongly for several minutes using the apparatus shown.



(a) Name apparatus **A** and **B**.

A .....

B ..... [2]

Magnesium is converted into a white powder, MgO. The expected mass of MgO is 0.60 g.

The student found that 0.55 g of MgO is produced in the experiment.

(b) Suggest one reason why the mass of MgO is lower than expected and suggest how the expected result may be achieved.

.....

.....

.....[2]

(c) The student does a similar experiment using 0.36 g of zinc instead of 0.36 g of magnesium.

Explain why he is wrong to expect that the mass of zinc oxide will also be 0.60 g.
[A_r: Mg, 24; Zn, 65]

.....

.....

.....[2]

(d) Suggest a safety item that the student should use when doing this experiment.

.....[1]

1 (a)(i)	Mass of carbonate = 4.20(g)	**1**
(a)(ii)	Mass lost = 2.20 (g)	**1**
(b)	To make sure the reaction is complete / to obtain constant mass	**1**
(c)(i)	Gas leaves the apparatus / gas escapes (from the apparatus)	**1**
(c)(ii)	0.05 (mols)	**1**
(c)(iii)	0.05 (mols)	**1**
(c)(iv)	4.20 / 0.05 = 84	**1**
(c)(v)	M + 12 + (3 × 16) = 84 M = 84 – 60 = 24	**2**
(c)(vi)	Question Removed	
(d)(i)	Gas syringe	**1**
(d)(ii)	54 (cm^3)	**1**
(d)(iii)	0.00225 (mols)	**1**
(d)(iv)	Gas lost / escapes / leaves the flask (when adding acid) / low resolution on scale of syringe	**1**
(d)(v)	**M1** Acid corrosive (1) **M2** Wear safety goggles / avoid contact with eyes (1)	**2**

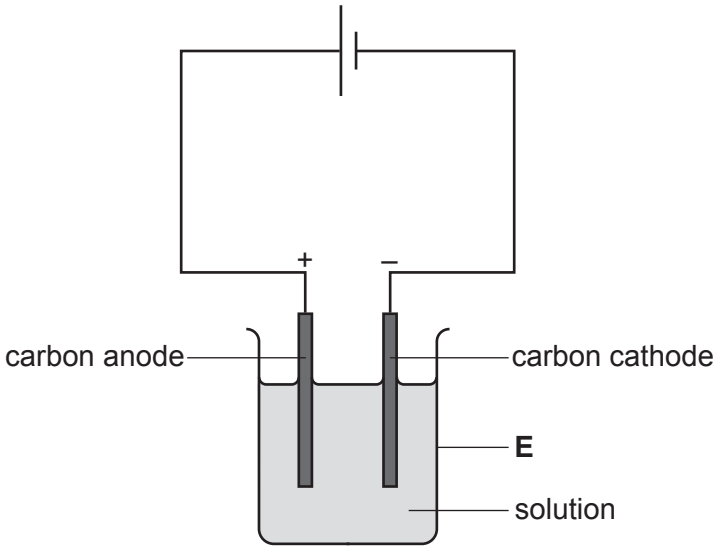
2 (a)	**M1** prevent **solid / MCO_3 / MO** escaping (1) **M2** allow **gas** or **carbon dioxide** to escape / to prevent pressure building up (1)	**2**
(b)	<table><tr><td>10.1</td><td>12.6</td><td>11.7</td><td>**2.5**</td><td>**0.9**</td></tr></table> 1 mark for each correct value (2)	**2**
(c)	not all solid had decomposed / (more) gas is produced / (more) carbon dioxide is produced	**1**
(d)	(1.1 / 44 =) **0.025** (moles)	**1**
(e)	(M_r = 2.5 / 0.025) = **100**	**1**
(f)	(100 – 60) = **40**	**1**

3 (a)	**A** – crucible (1) **B** – tripod (1)	**2**
(b)	Escape of MgO / (white) powder / smoke out of top of crucible (1) Place a lid on crucible / cover crucible (1) **OR** The magnesium has not been heated long enough / not enough air gets in / magnesium has not been completely burned (1) Heat contents for a longer time / to constant mass (1)	**2**
(c)	Atomic mass of zinc is greater (or reverse argument) (1) Fewer moles of zinc heated in 0.36 g / requires fewer moles of oxygen / less oxygen (1)	**2**
(d)	Safetygoggles / safety glasses	**1**

4 Electrochemistry

1 5070/42/O/N/22/Q2

A student electrolyses two aqueous solutions using the apparatus shown.



(a) Name apparatus **E**.

..... [1]

(b) Complete the table.

	anode (+)		cathode (–)	
solution	name of product	observation	name of product	observation
aqueous potassium iodide	iodine		hydrogen	
dilute sulfuric acid	oxygen			bubbles of colourless gas

[4]

(c) Describe the test used to identify oxygen gas.

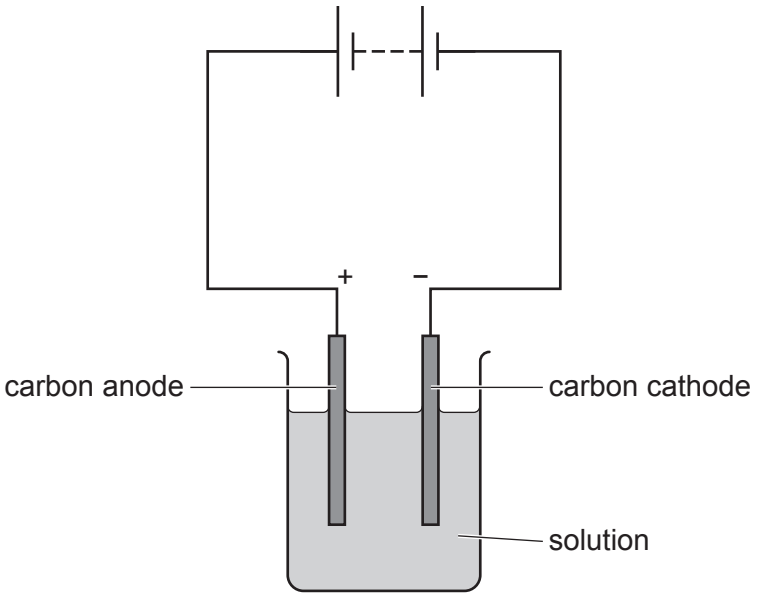
test .....

observation .....

[2]

2 5070/41/O/N/22/Q2

A student electrolyses two aqueous solutions using the apparatus shown.



(a) Complete the table.

	anode (+)		cathode (–)	
solution	name of product	observation	name of product	observation
aqueous copper(II) sulfate	oxygen			
concentrated aqueous sodium chloride	chlorine		hydrogen	

[5]

(b) (i) Describe the test used to identify chlorine gas.

test .....

observation .....

[2]

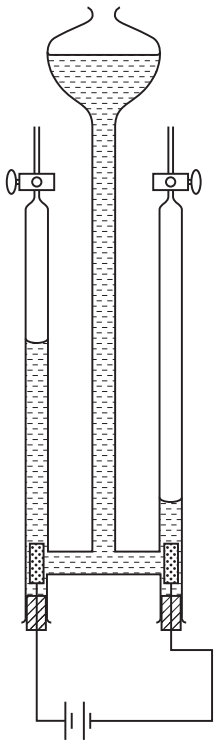
(ii) Chlorine gas is toxic.

Describe a safety precaution that the student should take because of this hazard.

..... [1]

3 5070/42/M/J/22/Q4

The apparatus shown is used for the electrolysis of dilute sulfuric acid to produce hydrogen gas and oxygen gas.



(a) The electrodes are made of platinum.
Give the name of each electrode.

positive electrode .....

negative electrode .....
[2]

(b) The equation for the reaction at the positive electrode is shown.

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

(i) Give the equation for the reaction at the negative electrode.

..... [2]

(ii) Describe tests used to identify the gases produced.

oxygen

test .....

observations .....

.....

hydrogen

test .....

observations .....
[4]

4 5070/41/O/N/20/Q4

A student wants to electroplate a metallic spoon with a layer of copper.

Plan how the student does the experiment.

You should:

- state what needs to be done to the spoon before electrolysis
- include a labelled diagram of the apparatus
- give the names of the substances used.

.....

.....

.....

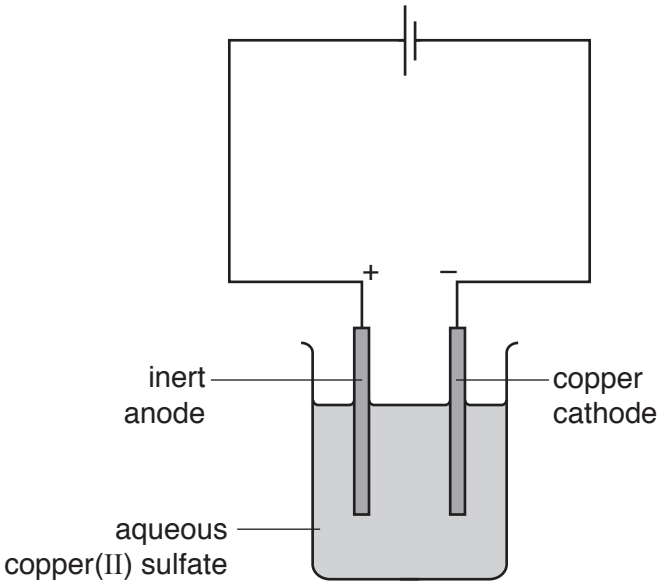
.....

.....

..... [5]

5 5070/42/O/N/19/Q6

A student passes an electric current through an electrolyte of aqueous copper(II) sulfate using an inert anode and a copper cathode.



(a) Bubbles of gas are observed at the anode.

Name the gas given off at the anode. Give a test and observation to identify the gas.

name .....

test .....

observation .....

[2]

(b) A layer of copper is deposited at the copper cathode. A student wants to find the mass of copper deposited.

The student removes the cathode after 5 minutes.

(i) What should the student do to the cathode before weighing it?

..... [1]

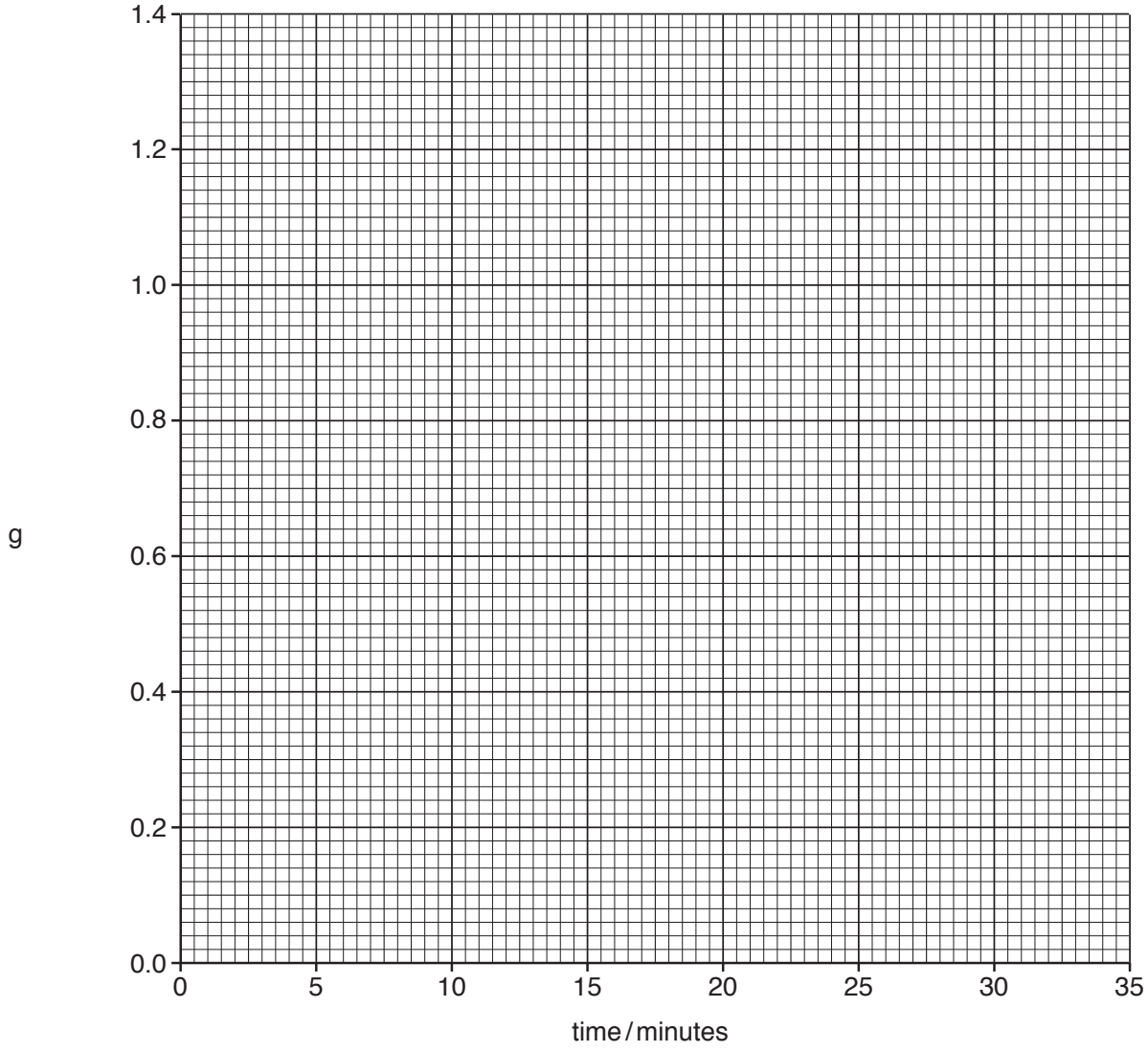
(ii) The student weighs the cathode. Which essential measurement is missing from the experimental method?

..... [1]

(c) After the student weighed the cathode she replaced it in the circuit and continued the experiment. She determined the mass of copper deposited at five-minute intervals.

time / minutes	mass of copper deposited / g
0	0.00
5	0.28
10	0.54
15	0.62
20	1.12
25	1.20
30	1.20
35	1.20

(i) Plot the results in the table on the grid. Use the points to draw two intersecting straight lines of best-fit.



[4]

(ii) Draw a circle around the anomalous point. [1]

(d) (i) Use your graph to determine how long it takes for 0.80 g of copper to be deposited.

..... minutes [1]

(ii) Use your graph to determine how long it takes for all the copper to be deposited.

..... minutes [1]

(e) What is the colour of the electrolyte:

- at the start of the experiment

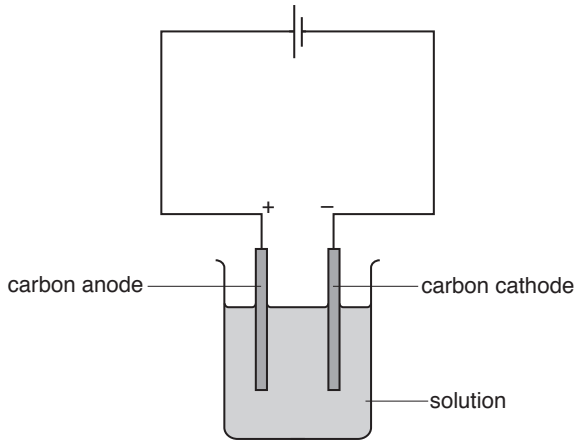
  .....

- when **all** the copper has been deposited at the cathode?

  ..... [2]

6 5070/41/O/N/19/Q1

A student electrolyses three solutions using the apparatus shown.



(a) Complete the table.

	anode (+)		cathode (–)	
solution	name of product	observation	name of product	observation
aqueous copper(II) sulfate	oxygen	bubbles of colourless gas	copper	
aqueous potassium iodide		brown liquid		
dilute sulfuric acid		bubbles of colourless gas		bubbles of colourless gas

[6]

(b) Give a test and observation to identify oxygen gas.

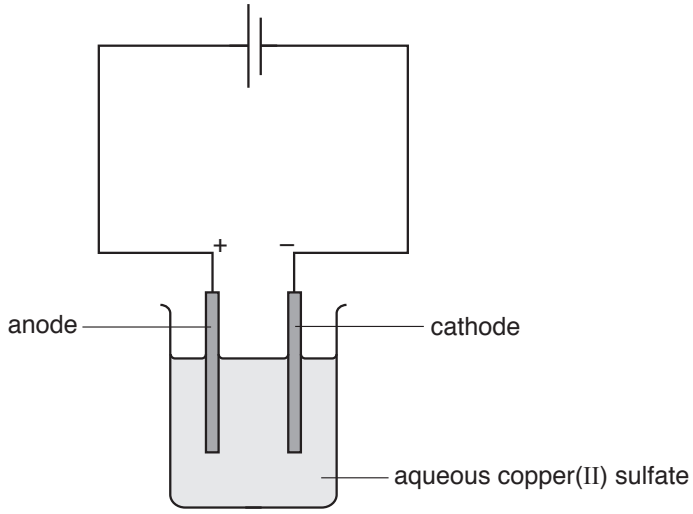
test .....

observation .....

[2]

7 5070/42/M/J/19/Q3

The apparatus shown is used for the electrolysis of aqueous copper(II) sulfate.



(a) Inert graphite electrodes are used for the electrolysis.

(i) Describe what is seen at each electrode during the electrolysis.

cathode .....

anode .....
[2]

(ii) Give a test and observation to identify the product at the anode.

test .....

observation .....
[2]

(iii) Describe what happens to the colour of the solution during the electrolysis. Explain your answer.

description .....

explanation .....

.....
[2]

(b) The electrolysis is repeated using copper electrodes in place of the inert graphite electrodes.

(i) Describe what happens to the colour of the solution during this electrolysis.

.....

..... [1]

(ii) State what happens to the mass of each electrode during this electrolysis.
Explain your answer.

mass of cathode .....

mass of anode .....

explanation .....

.....
[3]

(iii) Suggest a practical use for the electrolysis of aqueous copper(II) sulfate.

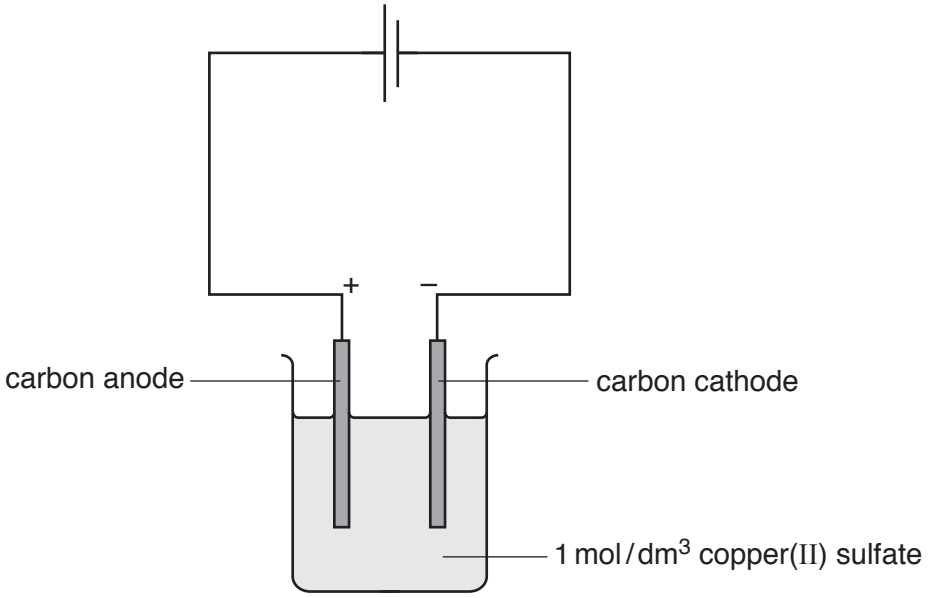
..... [1]

8 5070/41/M/J/19/Q6

A student does an electrolysis experiment to investigate how the length of time an electric current is passed through 1 mol / dm^3 copper(II) sulfate affects the mass of the cathode.

He weighs a carbon electrode to use as a cathode and records its mass.

He sets up the apparatus shown.



The student:

- passes a current of 2 amps through the circuit for 5 minutes
- removes the cathode, dries it and weighs it
- records the new mass of the cathode
- replaces the cathode into the circuit.

This process is repeated until the current has been passed for a total of 25 minutes.

The results are shown in the table.

time the current is passed / min	mass of cathode / g	increase in mass / g
0	4.63	0.00
5	4.82	0.19
10	5.01	
15	5.20	0.57
20	5.39	
25	5.58	0.95

(a) Complete the table by calculating the missing increases in mass. [1]

(b) (i) Describe the appearance of the cathode when the current has been passed for 25 minutes.

..... [1]