Cambridge Assessment International Education

Cambridge O Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

CHEMISTRY **5070/42**

Paper 4 Alternative to Practical **October/November 2020**

1 hour

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.

INFORMATION

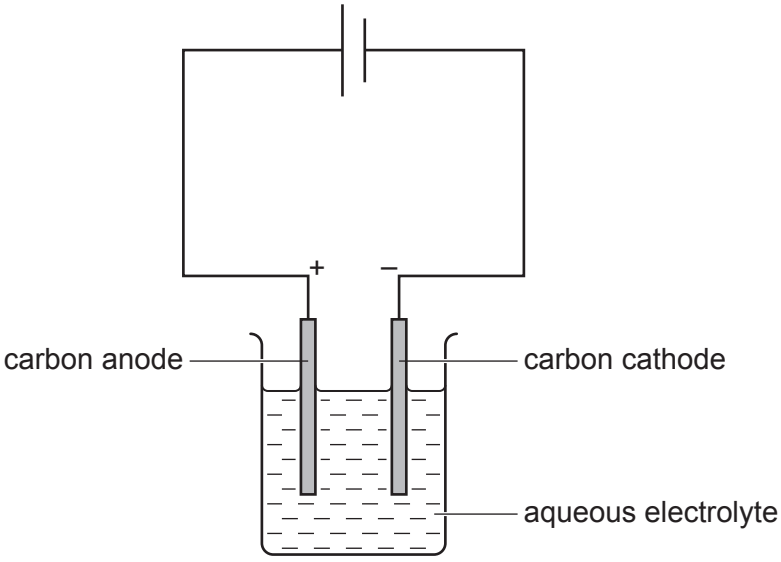
- The total mark for this paper is 60.
- The number of marks for each question or part question is shown in brackets [ ].

This document has **16** pages. Blank pages are indicated.

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[Turn over

1 A student investigates two different aqueous electrolytes using the apparatus shown.



(a) Complete the table.

	anode (+)		cathode (–)	
aqueous electrolyte	name of product	observation	name of product	observation
dilute sulfuric acid			hydrogen	bubbles of colourless gas
aqueous copper(II) sulfate		bubbles of colourless gas		

[5]

(b) State the test and its observation to identify hydrogen gas.

test .....

observation ..... [1]

[Total: 6]

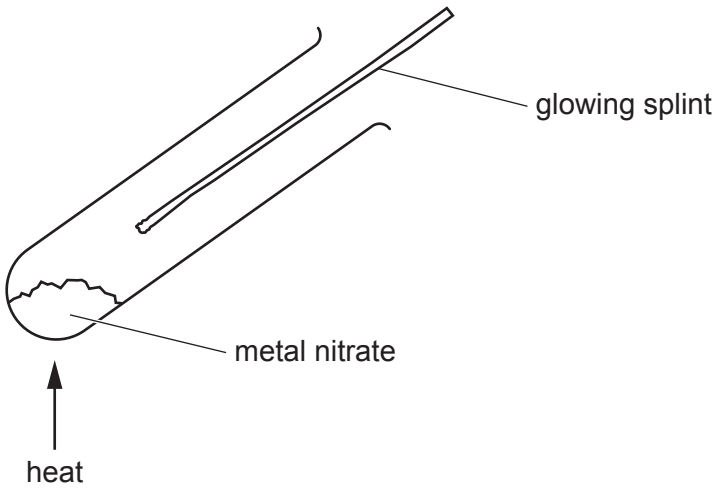
2 When solid Group I nitrates are heated they decompose and give off a gas. The gas relights a glowing splint.

(a) Name the gas that relights a glowing splint.

..... [1]

A student investigates the rate of decomposition of four Group I nitrates.

The student heats each of the nitrates separately with a Bunsen burner. The student measures the time taken for a glowing splint to relight for each nitrate.



(b) It is important to control the amount of heat supplied by the Bunsen burner.

Suggest **two** ways the amount of heat supplied is kept constant.

1 .....

2 ..... [2]

(c) Suggest a variable, involving the metal nitrate, that should be controlled.

..... [1]

(d) Each experiment is repeated two more times. The results are shown in the table.

	time taken for glowing splint to relight / s			
metal nitrate	experiment 1	experiment 2	experiment 3	average time
lithium nitrate	100	150	100	
potassium nitrate	150	300	320	
rubidium nitrate	400	450	410	
sodium nitrate	200	200	240	

(i) Use the times in the table to calculate an average time for each metal nitrate. Do **not** use any anomalous times. Write your answers in the table. [2]

(ii) Which metal nitrate decomposes the fastest? Use information from the table to explain your answer.

metal nitrate .....

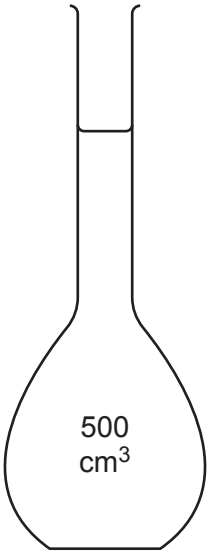
explanation ..... [2]

[Total: 8]

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3 A student is provided with solution **K**, which is aqueous sodium hydroxide, NaOH. The student determines the concentration of **K** by titration.

The student measures 25.0 cm^3 of **K** and transfers it to apparatus **A**.



A

(a) Name a piece of apparatus used to measure 25.0 cm^3 accurately.

..... [1]

(b) Name apparatus **A**.

..... [1]

The student makes up the 25.0 cm^3 sample of **K** to 500 cm^3 with distilled water. This is solution **L**.

The student transfers 25.0 cm^3 of **L** into a conical flask and adds two drops of methyl orange indicator.

Solution **M** is 0.0500 mol/dm^3 sulfuric acid, H_2SO_4.

M is put into a burette and run into the conical flask until the indicator changes colour and the end-point is reached.

(c) Why is it wrong to wash out the burette with distilled water immediately before filling it with **M**?

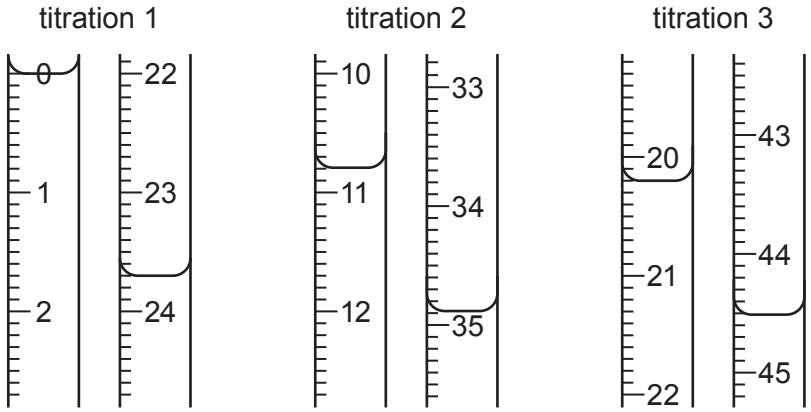
..... [1]

(d) What is the colour change of the methyl orange indicator at the end-point?

The colour changes from ..... to ..... [1]

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(e) The student does three titrations. The diagrams show parts of the burette with the liquid levels at the beginning and end of each titration.



Use the diagrams to complete the table.

titration number	1	2	3
final burette reading / cm^3			
initial burette reading / cm^3			
volume of **M** / cm^3			
best titration results (✓)			

Summary

Tick (✓) the best titration results in the table.

Use the ticked results to calculate the average volume of **M**.

..... cm^3 [4]

(f) Solution **M** is 0.0500 mol / dm^3 sulfuric acid, H_2SO_4.

Calculate the number of moles of H_2SO_4 in the average volume of **M** used in the titration.

..... mol [1]

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(g) Dilute sulfuric acid reacts with aqueous sodium hydroxide as shown.

$$H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2H_2O$$

Calculate the number of moles of NaOH in 25.0 cm^3 of **L**.

..... mol [1]

(h) Calculate the number of moles of NaOH in 500 cm^3 of **L**.

..... mol [1]

(i) Calculate the number of moles of NaOH in 25.0 cm^3 of **K**.

..... mol [1]

(j) Calculate the concentration of NaOH in **K**.

Give your answer to **three** significant figures.

..... mol/dm^3 [1]

(k) Between each titration, the student washes the conical flask with water. A second student repeats the experiment but uses **L** instead of water to wash the conical flask.

State **and** explain whether the second student's titration volume of dilute sulfuric acid would be smaller, larger or unchanged compared with the first student's volume of dilute sulfuric acid.

.....

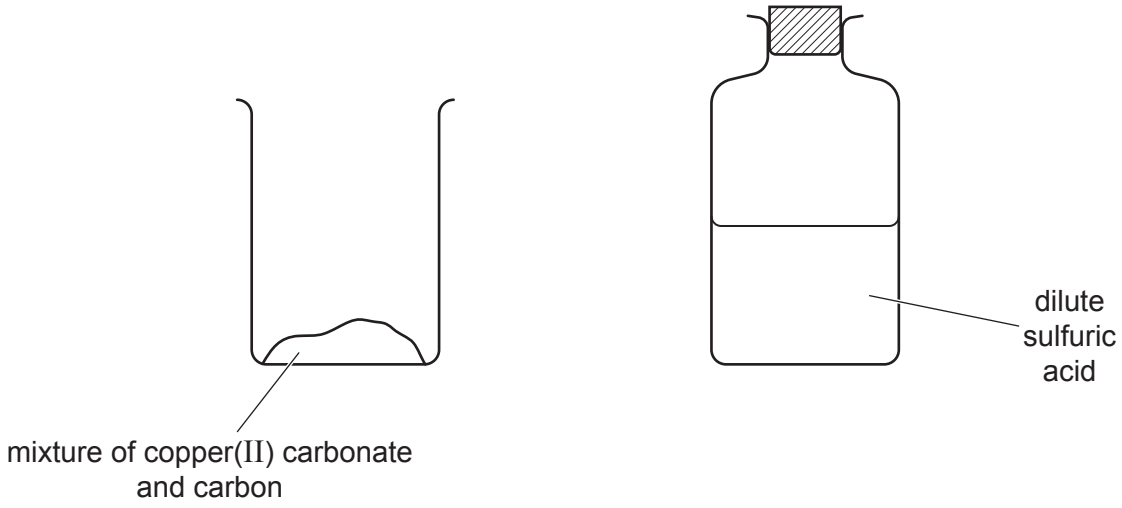
.....

..... [2]

[Total: 15]

4 You are provided with a mixture of copper(II) carbonate and carbon.

Both copper(II) carbonate and carbon are solids. They are both insoluble in water. Copper(II) carbonate reacts with dilute sulfuric acid and forms an aqueous solution. Carbon does not react with or dissolve in dilute sulfuric acid.



Use this information to plan an experiment to produce a sample of **pure carbon** from the mixture.

You are provided with the mixture of copper(II) carbonate and carbon as well as dilute sulfuric acid and distilled water. You have access to the apparatus normally found in a school chemistry laboratory. No other chemicals are available.

Your plan should include details of how to:

- separate the carbon
- purify the carbon.

Chemical equations are not required.

.....

.....

.....

.....

.....

.....

..... [4]

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5 A solid mixture **R** contains two cations and one anion. The table shows the tests that a student does on **R**.

Complete the table.

Identify any gases that are formed in the tests.

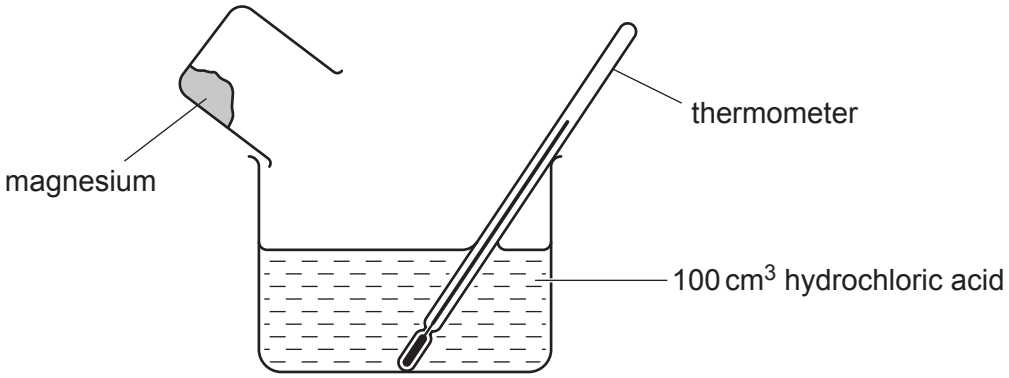
test	observation	conclusion	
(a) **R** is dissolved in water. The solution is divided into three portions for tests **(b)**, **(c)** and **(d)**.	A coloured solution is formed.	....	[1]
(b) **(i)** To a portion of the solution from **(a)**, aqueous ammonia is added until a change is seen.	....	**R** contains Cr^{3+} or Fe^{2+} ions.	[1]
(ii) An excess of aqueous ammonia is added to the mixture from **(b)(i)**.	....	**R** contains Cr^{3+} or Fe^{2+} ions.	[1]
(c) **(i)** To a portion of the solution from **(a)**, aqueous sodium hydroxide is added until a change is seen.	....	**R** contains Cr^{3+} or Fe^{2+} ions.	[1]
(ii) An excess of aqueous sodium hydroxide is added to the mixture from **(c)(i)**.	....	**R** contains Cr^{3+} ions.	[2]
(iii) The mixture from **(c)(ii)** is warmed and the gas formed is tested with damp red litmus paper.	The gas turns damp red litmus paper blue.	....	[2]
(d)	....	**R** contains SO_4^{2-} ions.	[3]

[Total: 11]

6 A student investigates the temperature rise when different masses of magnesium are added to dilute hydrochloric acid.

In each experiment the student:

- pours 100 cm^3 of dilute hydrochloric acid into a beaker
- places a thermometer into the acid
- records the temperature of the acid
- adds a known mass of magnesium to the acid and stirs the mixture
- records the highest temperature reached.



(a) (i) The temperature rise with each mass of magnesium is less than expected. Give one reason for this.

.....

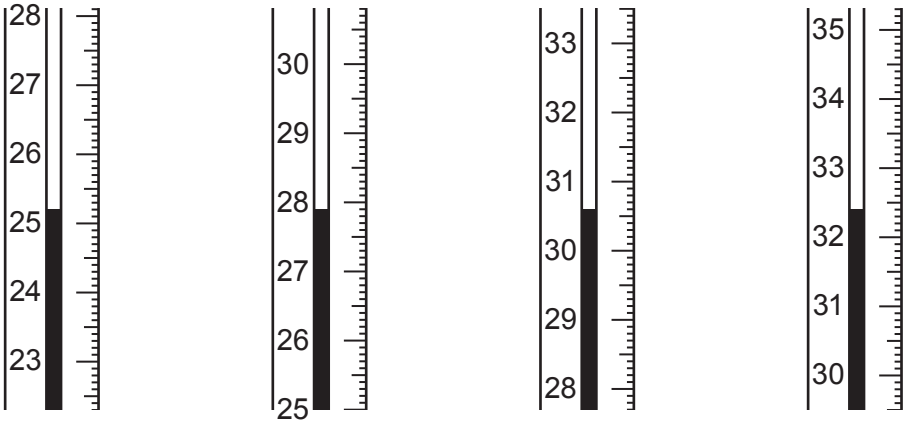
..... [1]

(ii) State **two** changes that can be made to the apparatus so that the temperature rise for each mass of magnesium is closer to the expected value for each mass.

1 .....

2 ..... [2]

The diagrams show parts of the thermometer stem giving the highest temperature recorded using different masses of magnesium.



0.20 g Mg | 0.30 g Mg | 0.40 g Mg | 0.50 g Mg

(b) Use the thermometer readings to complete the following table.

mass of magnesium / g	initial temperature of hydrochloric acid / °C	highest temperature of hydrochloric acid / °C	temperature rise / °C
0.10	20.0	22.6	2.6
0.20	20.0		
0.30	20.0		
0.40	20.0		
0.50	20.0		
0.60	20.0	32.4	12.4
0.70	20.0	32.4	12.4

[2]

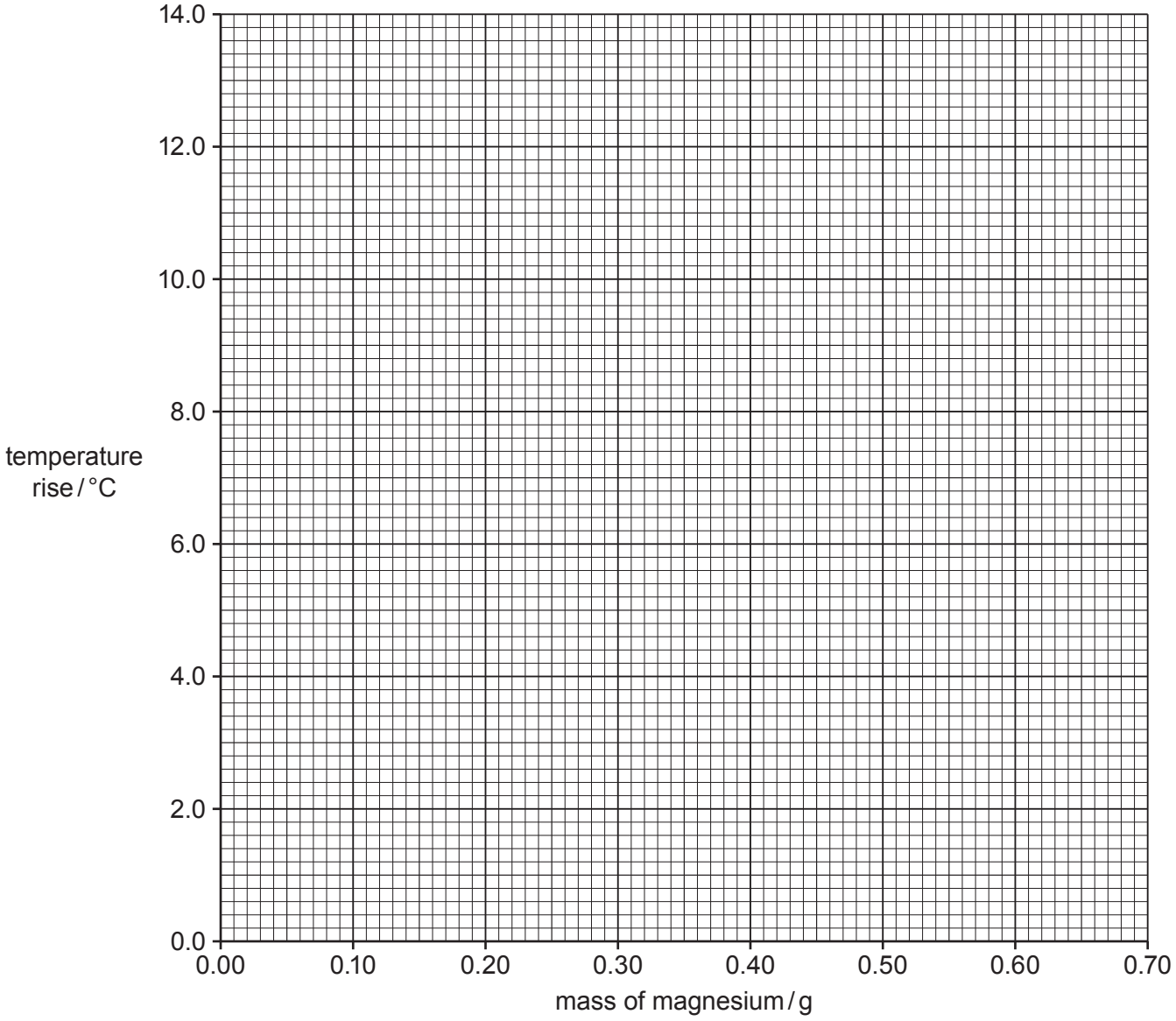
(c) What evidence in the table shows that the reaction is exothermic?

..... [1]

(d) Plot the temperature rise against the mass of magnesium on the grid.

Draw a straight line through the first four points.

Draw another straight line through the last three points. Extend both straight lines so that they cross.



[3]

(e) Use your graph to answer the questions. In each case assume that magnesium is added to 100 cm^3 of dilute hydrochloric acid at 20.0 °C.

(i) What is the temperature rise when 0.35 g of magnesium is used?

..... °C [1]

(ii) What is the highest temperature when 0.15 g of magnesium is used?

..... °C [1]

(iii) What mass of magnesium is used to give a highest temperature of 26.0 °C?

..... g [1]

(iv) What is the **minimum** mass of magnesium that reacts with all of the hydrochloric acid?

..... g [1]

(f) **(i)** Use your answer to **(e) (iv)** to calculate the number of moles of magnesium that reacts with 100 cm^3 of dilute hydrochloric acid.

[A_r: Mg, 24]

..... mol [1]

(ii) Magnesium reacts with dilute hydrochloric acid.

$$Mg + 2HCl \rightarrow MgCl_2 + H_2$$

Calculate the concentration, in mol / dm^3, of the hydrochloric acid.

..... mol / dm^3 [2]

[Total: 16]

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