Cambridge O Level

Cambridge Assessment International Education
Cambridge Ordinary Level

CANDIDATE NAME

CENTRE NUMBER | CANDIDATE NUMBER

5467371621

CHEMISTRY **5070/41**

Paper 4 Alternative to Practical **October/November 2019**

1 hour

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
Write your answers in the spaces provided in the Question Paper.
Electronic calculators may be used.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

This document consists of **12** printed pages and **4** blank pages.

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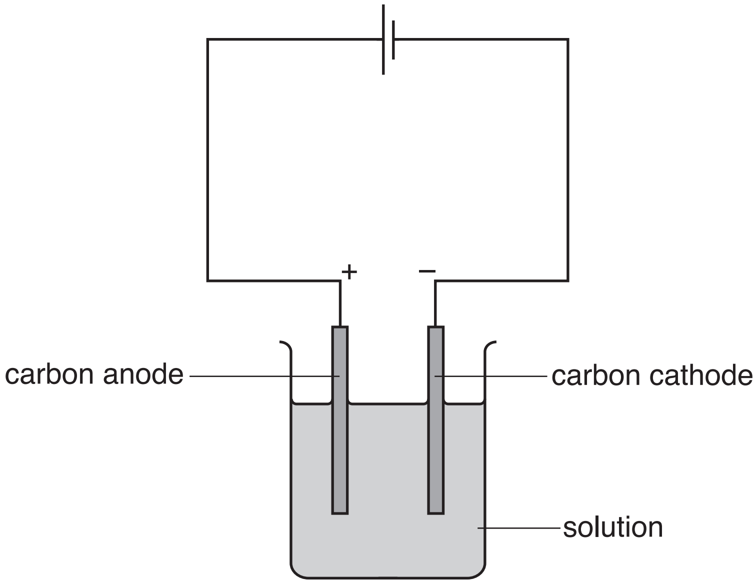
1 A student electrolyses three solutions using the apparatus shown.



(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 ....

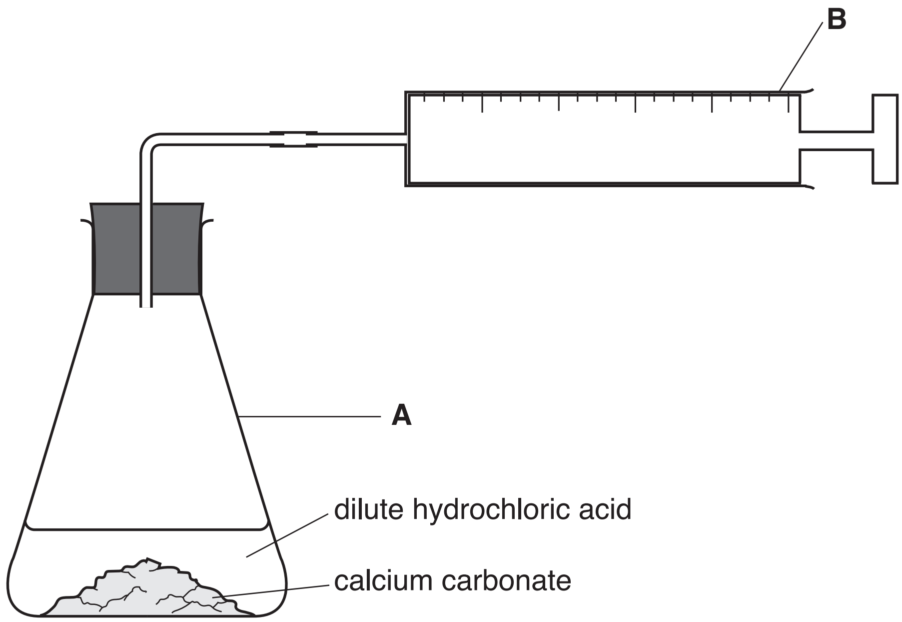
observation ....
[2]

[Total: 8]

2 Calcium carbonate reacts with dilute hydrochloric acid.

$$CaCO_3(s) \ + \ 2HCl(aq) \ \rightarrow \ CaCl_2(aq) \ + \ CO_2(g) \ + \ H_2O(l)$$

A student investigates the rate of this reaction at three different temperatures using the apparatus shown.



In each experiment the student adds dilute hydrochloric acid to an excess of calcium carbonate. The volume of carbon dioxide in **B** is recorded every 30 seconds.

(a) What is meant by *an excess* of calcium carbonate?

....

.... [1]

(b) Name the two pieces of apparatus, **A** and **B**.

A ....

B ....

[2]

(c) The student does experiment **1** at 20 °C.

Name a piece of apparatus that can be used to keep the temperature constant.

.... [1]

(d) The student does two more experiments:

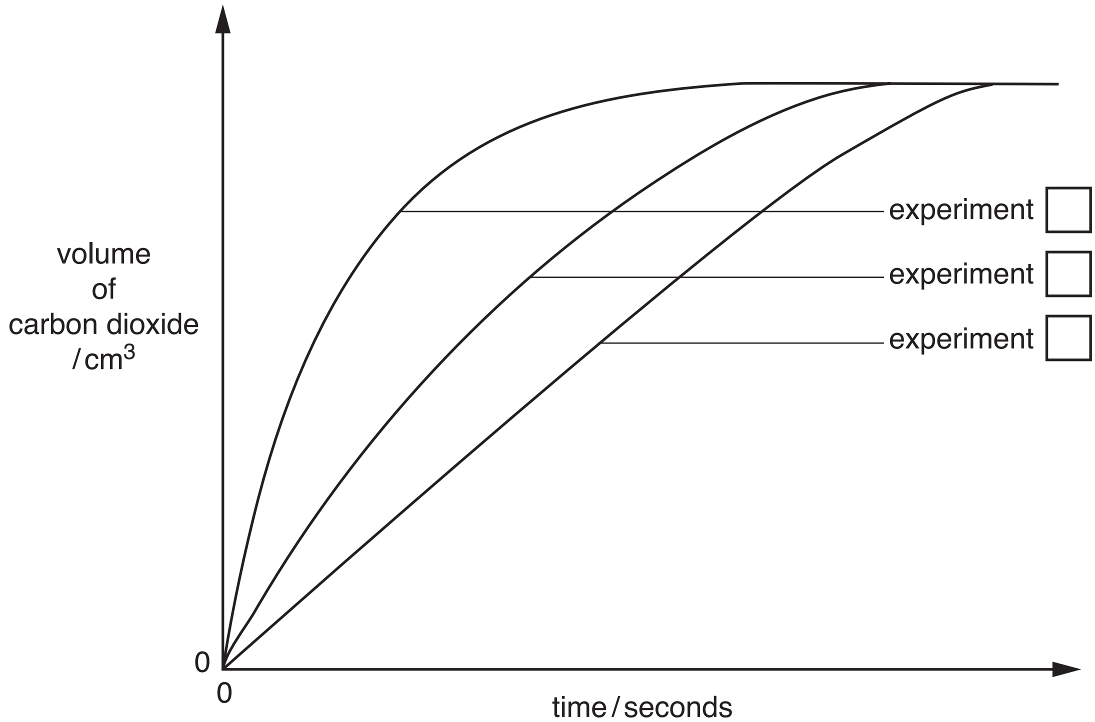
- experiment **2** at 40 °C
- experiment **3** at 60 °C.

Suggest two variables that the student keeps constant so that temperature is the only variable that affects the rate of reaction.

1 ....

2 ....
[2]

(e) The student plots a graph of the results.



(i) Describe how the graphs are used to decide which experiment has the fastest rate.

....

.... [1]

(ii) Write a number in each box on the graph to identify experiments **1**, **2** and **3**. [1]

(iii) State how the graph shows that the reactions stop.

.... [1]

(iv) Why do the reactions stop?

.... [1]

[Total: 10]

3 Carbon and copper(II) oxide are both black solids. Copper(II) oxide reacts with dilute sulfuric acid to form an aqueous solution. Carbon does not react with or dissolve in dilute sulfuric acid. Neither carbon nor copper(II) oxide dissolve in water.

A mixture contains carbon and copper(II) oxide only.

Plan an experiment to produce **a sample of pure carbon** from the mixture.

You may use:

- dilute sulfuric acid
- distilled water
- any of the apparatus usually found in a chemistry laboratory.

No other chemicals are available.

Your plan should include details of:

- how to dissolve the copper(II) oxide in the dilute sulfuric acid
- how to separate the carbon
- how to purify the carbon
- observations occurring at each stage of the process.

Chemical equations are not required.

....

....

....

....

....

....

....

....

....

....

....
[5]

4 A student is provided with three solutions:

- aqueous zinc sulfate
- aqueous copper(II) sulfate
- aqueous calcium nitrate.

The student tests the three aqueous solutions by adding each reagent shown in the table.

Record the observations in the table.

Write 'no reaction' where appropriate.

	reagents			
solutions	aqueous sodium hydroxide	aqueous sodium hydroxide in excess	aqueous barium nitrate and dilute nitric acid	aluminium and aqueous sodium hydroxide + heat
aqueous zinc sulfate				
aqueous copper(II) sulfate				
aqueous calcium nitrate				name of gas .... test for gas .... result of test ....

[10]

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5 Solution **J** is bleach.

A student does an experiment to determine the concentration of sodium chlorate(I), $NaClO$, in **J**.

The student transfers 25.0 cm^3 of **J** to a conical flask using a pipette.

(a) Why does the student use a pipette instead of a measuring cylinder to measure 25.0 cm^3 of **J**?

.... [1]

(b) Which other piece of apparatus could be used to measure 25.0 cm^3 of **J**?

.... [1]

The student adds an excess of aqueous sodium iodide and an excess of hydrochloric acid to the conical flask. A reaction occurs to form iodine. This is solution **K**.

The amount of iodine produced can be determined by titration with aqueous sodium thiosulfate, $Na_2S_2O_3$, with a suitable indicator.

Solution **L** is 0.0500 mol / dm^3 $Na_2S_2O_3$.

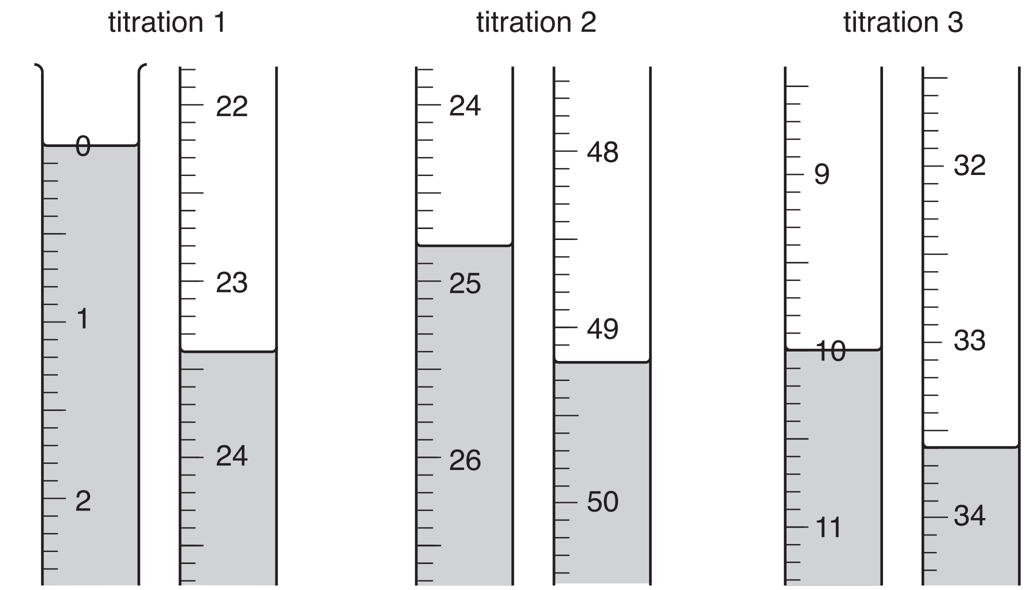
L is put into a burette and run into the conical flask until the end-point is reached.

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

....

.... [1]

(d) Three titrations are done. 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 **L** / cm^3			
best titration results (✓)			

Summary

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

Use these best results to calculate the average volume of **L**.

.... cm^3
[4]

(e) Calculate the number of moles of $Na_2S_2O_3$ in the average volume of **L**, 0.0500 mol / dm^3 $Na_2S_2O_3$, used in the titration.

.... moles [1]

(f) Use the equation to calculate the number of moles of I_2 in 25.0 cm^3 of **K**.

$$2Na_2S_2O_3 + I_2 \rightarrow Na_2S_4O_6 + 2NaI$$

.... moles [1]

(g) Use the equation to calculate the number of moles of NaC*l*O that produces the number of moles of I_2 calculated in **(f)**.

$$NaClO + 2NaI + 2HCl \rightarrow I_2 + 3NaCl + H_2O$$

.... moles [1]

(h) Calculate the M_r of NaC*l*O.

[A_r: Na, 23; C*l*, 35.5; O, 16]

.... [1]

(i) Use your answers to **(g)** and **(h)** to calculate the mass of NaC*l*O in 25.0 cm^3 of **J**.

.... g [1]

(j) Calculate the concentration of NaC*l*O in **J**

(i) in g/dm^3

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

(ii) in mol/dm^3.

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

[Total: 14]

6 When zinc is added to aqueous iron(II) sulfate, the temperature of the mixture increases.

The equation for the reaction is shown.

$$Zn(s) + FeSO_4(aq) \rightarrow ZnSO_4(aq) + Fe(s)$$

(a) A student transfers 25.0 cm^3 of 2.0 mol / dm^3 iron(II) sulfate into a beaker. The temperature of this solution is 22.0 °C.

The student then adds excess zinc to the aqueous iron(II) sulfate and starts a timer. The student stirs the mixture with a thermometer and measures the temperature at 1 minute intervals. The results are shown.

time / minutes	temperature / °C
1.0	31.6
2.0	30.3
3.0	29.9
4.0	27.6
5.0	26.3
6.0	25.0

(i) As soon as the zinc is added to the aqueous iron(II) sulfate, the temperature of the mixture increases.

What can you deduce about the reaction from this information?

.... [1]

(ii) Why do the temperature readings in the table decrease from 1.0 to 6.0 minutes?

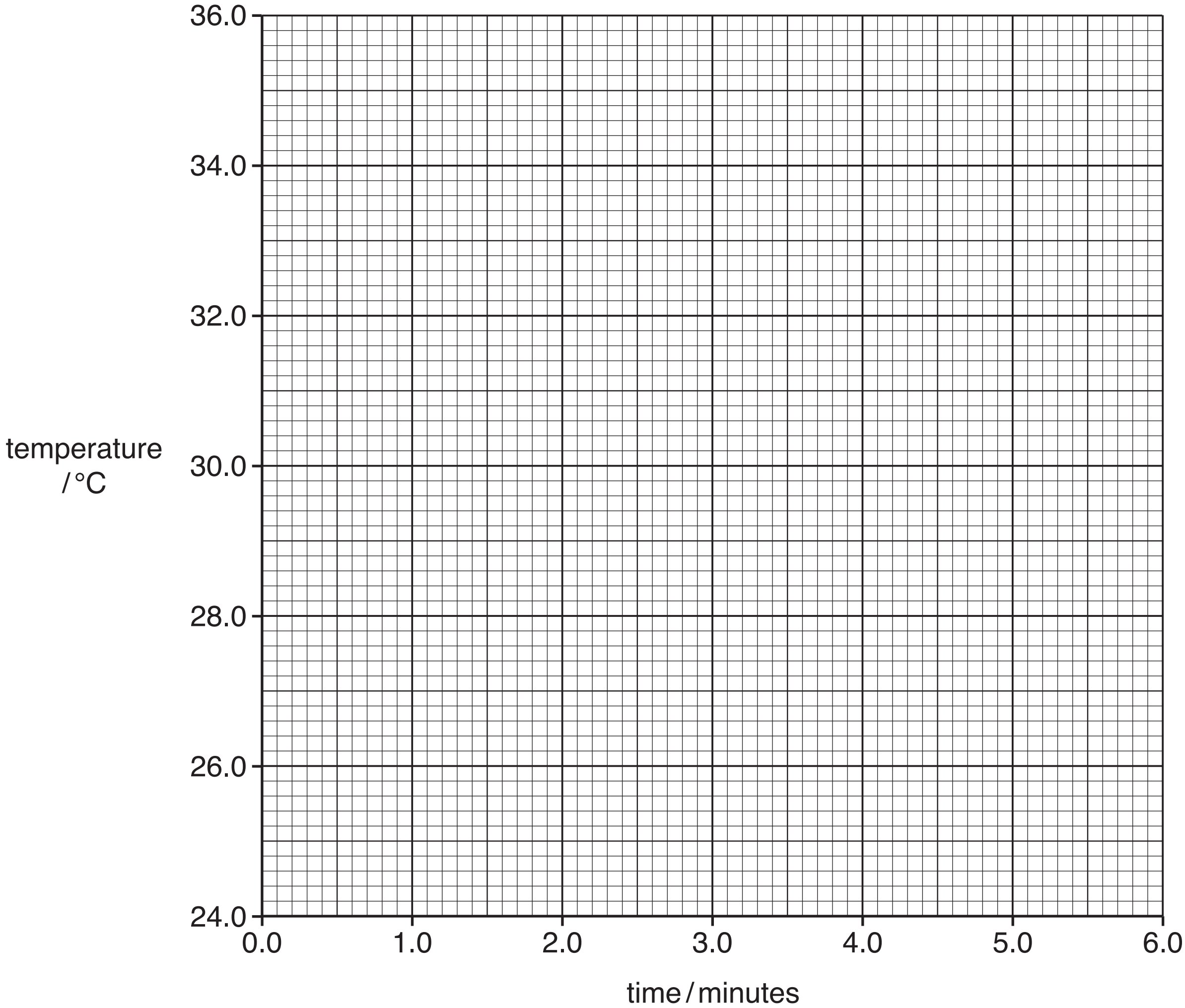
....

.... [1]

(iii) If the student had continued to measure the temperatures after 6.0 minutes, suggest the lowest temperature that would be reached.

.... [1]

(b) (i) Plot the results from the table on the grid. Draw a straight line of best-fit. Extend the line until it intersects with the *y*-axis.



[3]

(ii) On the grid, draw a circle around the anomalous point. [1]

(c) (i) Use your graph to determine the temperature of the mixture at a time of 2.5 minutes.

.... °C [1]

(ii) Use your graph to determine the time at which the temperature of the mixture would be 30.0 °C.

.... minutes [1]

(d) (i) Use your graph to determine the temperature of the mixture at 0.0 minutes. This figure represents the maximum temperature that the mixture reaches in the reaction.

.... °C [1]

(ii) The initial temperature of the aqueous iron(II) sulfate was 22.0 °C. Calculate the maximum temperature rise after the zinc is added.

.... °C [1]

(e) The student uses $25.0\,cm^3$ of $2.0\,mol/dm^3$ iron(II) sulfate and an excess of zinc.

(i) Calculate the number of moles of iron(II) sulfate in $25.0\,cm^3$ of $2.0\,mol/dm^3$ iron(II) sulfate.

.... moles [1]

(ii) The heat produced in the reaction in kJ/mol is calculated using the expression shown.

$$\text{heat produced} = \frac{25 \times 4.2 \times \text{maximum temperature rise}}{1000 \times \text{moles of iron(II) sulfate}}$$

Use this expression and your answers to **(d)(ii)** and **(e)(i)** to calculate the heat produced in the reaction in kJ/mol.

.... kJ/mol [1]

[Total: 13]

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