Cambridge Assessment International Education

Cambridge O Level

CANDIDATE NAME		
CENTRE NUMBER		CANDIDATE NUMBER

1025131291

CHEMISTRY **5070/41**

Paper 4 Alternative to Practical **May/June 2021**

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. Any blank pages are indicated.

DC (MS/JG) 305887/5

1 A student uses dilute sulfuric acid and copper(II) carbonate to make a pure dry sample of blue copper(II) sulfate crystals.

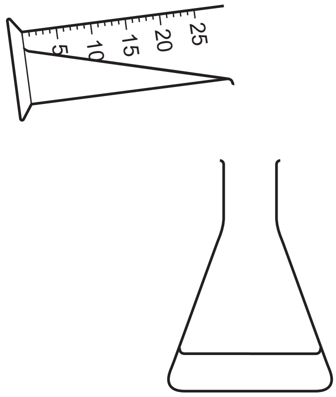
Dilute sulfuric acid is colourless.
Copper(II) carbonate is an insoluble green powder.

The equation for the reaction is shown.

$$H_2SO_4(aq) \quad + \quad CuCO_3(s) \quad \longrightarrow \quad CuSO_4(aq) \quad + \quad CO_2(g) \quad + \quad H_2O(l)$$

(a) The student:

- uses one of the pieces of apparatus shown in the diagram to measure 20 cm^3 of dilute sulfuric acid
- pours the dilute sulfuric acid into the other piece of apparatus as shown in the diagram.



(i) Name the apparatus the student uses to measure the acid.

.... [1]

(ii) Name the apparatus into which the student pours the acid.

.... [1]

(b) The student adds solid copper(II) carbonate to the dilute sulfuric acid until the reaction is finished and the copper(II) carbonate is in excess.

Describe two observations which show that the reaction is finished and the copper(II) carbonate is in excess.

reaction is finished ....

....

copper(II) carbonate is in excess ....

....
[2]

(c) The student filters the reaction mixture through filter paper in a filter funnel.

Describe the appearance of the residue on the filter paper and the filtrate after filtration is complete.

appearance of the residue on the filter paper

....

appearance of the filtrate

....
[2]

[Total: 6]

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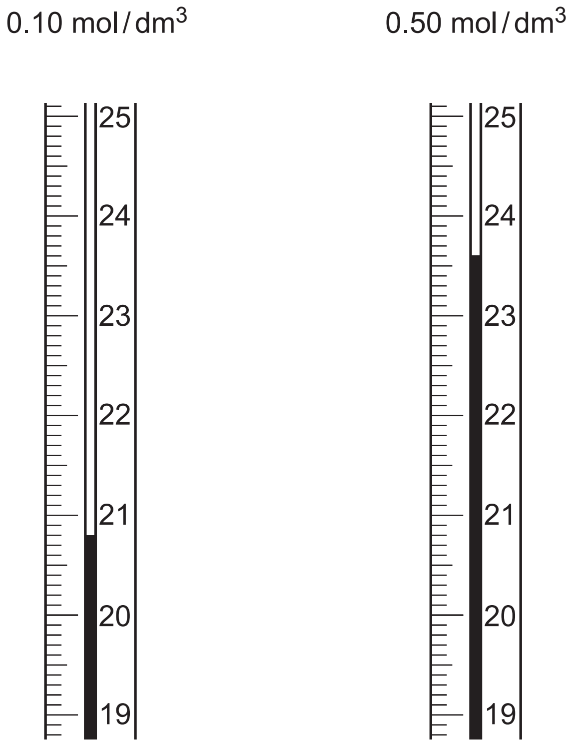
2 A student investigates the effect of concentration on the energy change in a neutralisation reaction.

The student:

- measures 25.0 cm^3 of aqueous sodium hydroxide, NaOH(aq), into a beaker
- measures the temperature of this solution
- adds 25.0 cm^3 of 0.10 mol / dm^3 hydrochloric acid, HC*l*(aq), to the beaker
- stirs the mixture
- measures and records the highest temperature of the solution in the beaker
- repeats the experiment with different concentrations of hydrochloric acid.

(a) The diagram shows the highest temperatures reached for 0.10 mol / dm^3 and 0.50 mol / dm^3 HC*l*(aq).



The initial temperature of NaOH(aq) and the HC*l*(aq) for all experiments is 20.0 °C.

Record the highest temperatures and the temperature changes in the table.

concentration of HC*l*(aq) in mol / dm^3	highest temperature in °C	temperature change in °C
0.10		
0.50		

[2]

Another student repeats the experiment for eight different concentrations of $HCl(aq)$ and records the temperature changes.

The results are shown in the table.

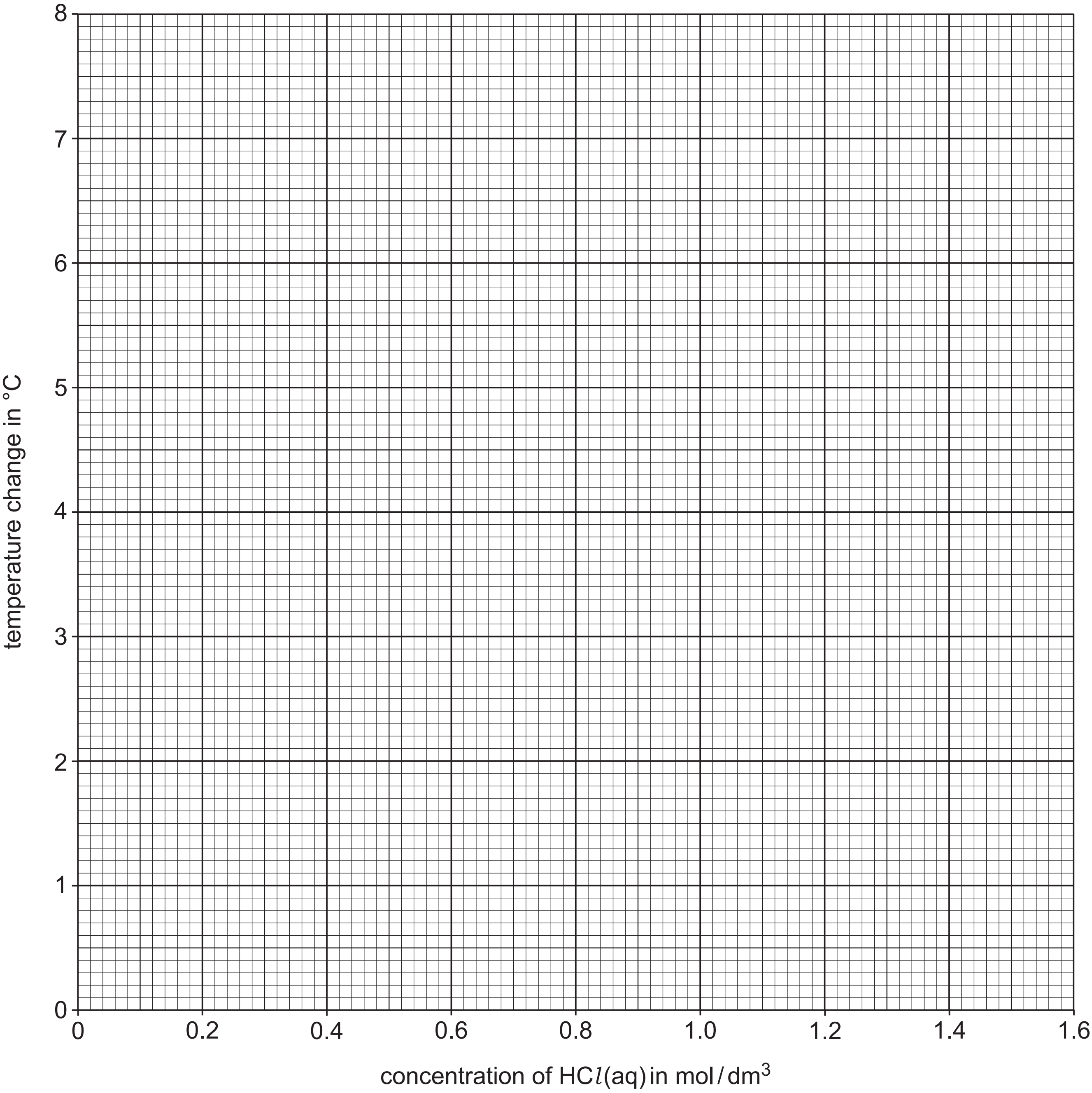
concentration of $HCl(aq)$ in mol/dm^3	temperature change in °C
0.10	0.6
0.30	2.0
0.50	3.4
0.70	2.6
0.90	6.2
1.30	6.9
1.50	6.9
1.60	6.9

(b) The temperature change for $0.70\,mol/dm^3$ $HCl(aq)$ is anomalous.

Suggest what the student should do to check that this temperature change is anomalous.

.... [1]

(c) Plot the points of temperature change (*y*-axis) against concentration of HC*l*(aq) (*x*-axis) on the grid.



[2]

(d) Draw one straight line of best fit for concentrations up to 0.90 mol / dm^3 and a second straight line through the other three points.

Extend both straight lines until they intersect. [2]

(e) Use the graph to determine the concentration of $HCl(aq)$ which gives a temperature change of 5.4 °C.

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

(f) Use the graph to determine the temperature change for 1.40 mol / dm^3 $HCl(aq)$.

temperature change .... °C [1]

(g) Use the graph to determine the minimum concentration of $HCl(aq)$ that neutralises all the NaOH(aq).

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

(h) A major source of error in this experiment is heat loss.

Suggest how the student can reduce the heat loss.

....

.... [1]

[Total: 11]

3 A student does a series of tests on a mixture of ionic compounds in aqueous solution.

Complete the table.

Name any gases formed and describe the tests used to identify these gases.

tests	observations	conclusions	
(a) aqueous ammonia is added to the mixture	a green precipitate forms which is insoluble in excess aqueous ammonia	....	[1]
(b) aqueous sodium hydroxide is added to the mixture	a green precipitate is formed which is soluble in excess aqueous sodium hydroxide	....	
the mixture is warmed	a gas is also produced which turns damp red litmus paper blue	....	[3]
(c) excess dilute nitric acid is added to the mixture	....	.... CO_3^{2-} ions are in the mixture	
followed by aqueous silver nitrate	....	I^- ions are in the mixture	[4]
(d)	....	SO_4^{2-} ions are in the mixture	[3]

[Total: 11]

4 A mixture of aqueous iron(III) nitrate and aqueous sodium thiosulfate is purple.

A reaction takes place in the mixture.

When the reaction is complete the solution turns from purple to colourless.

Plan experiments to show that aqueous copper(II) sulfate increases the rate of this reaction.

You are provided with

- aqueous iron(III) nitrate
- aqueous sodium thiosulfate
- aqueous copper(II) sulfate
- the apparatus normally found in a school laboratory.

Your answer should include

- a method which includes the names of the apparatus you would use and the variables you would control
- the measurements you need to make during your experiment
- the results you expect
- an explanation of how the results show that copper(II) sulfate increases the rate of the reaction.

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

.... [9]

5 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]

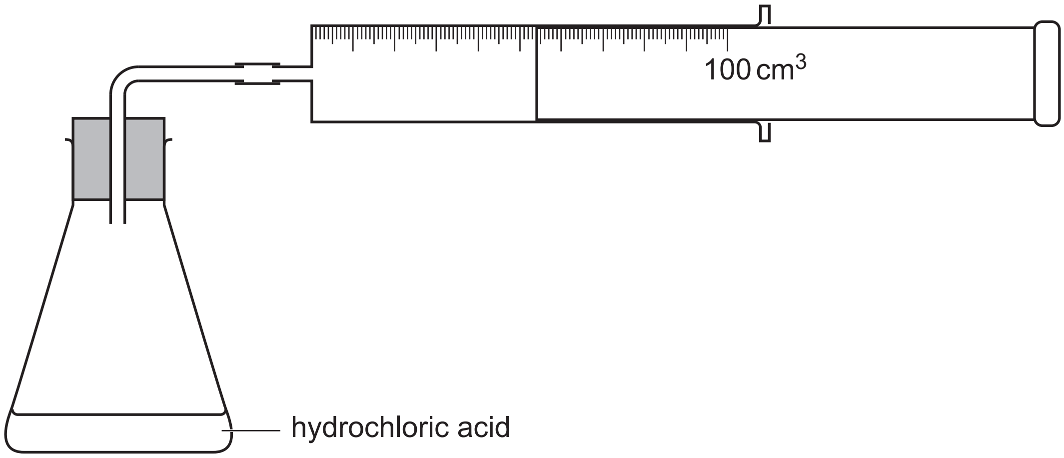
A_r of metal **M** .... [2]

(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]

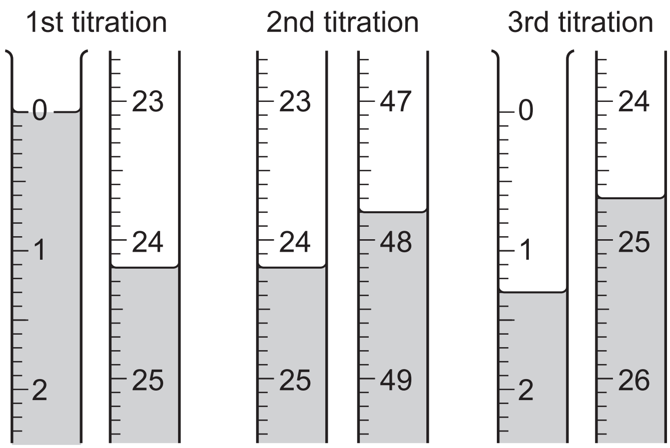
[Total: 16]

6 A student determines the concentration of dilute sulfuric acid, $H_2SO_4(aq)$, by titrating it with aqueous sodium hydroxide, NaOH(aq).

The student:

- transfers $10.0\,cm^3$ of $0.100\,mol/dm^3$ NaOH(aq) into a flask
- adds a few drops of methyl orange indicator to the flask
- fills a burette with $H_2SO_4(aq)$
- adds $H_2SO_4(aq)$ to the flask until the indicator changes colour.

The diagrams show parts of the burette with the liquid levels at the beginning and end of each titration.



(a) Use the diagrams to complete the table.

titration number	1	2	3
final burette reading / cm^3			
initial burette reading / cm^3			
volume of acid added / cm^3			
best titration result (✓)			

Tick (✓) the best titration results.
Use these results to calculate the average volume of $H_2SO_4(aq)$ required to neutralise the NaOH(aq).

.... cm^3 [4]

(b) Calculate the number of moles of NaOH in 10.0 cm^3 of 0.100 mol / dm^3 NaOH(aq).

.... mol [1]

(c) The equation for the reaction between NaOH and H_2SO_4 is shown.

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

Calculate the number of moles of H_2SO_4 that react with 10.0 cm^3 of 0.100 mol / dm^3 NaOH(aq).

.... mol [1]

(d) Calculate the concentration of the H_2SO_4(aq) in mol / dm^3. Give your answer to **three** significant figures.

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

[Total: 7]