Cambridge Assessment International Education

Cambridge O Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

CHEMISTRY **5070/42**

Paper 4 Alternative to Practical **October/November 2025**

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 40.
- The number of marks for each question or part question is shown in brackets [ ].
- Notes for use in qualitative analysis are provided in the question paper.

This document has **16** pages. Any blank pages are indicated.

[Turn over

1 A student investigates the rate of a reaction.

Fig. 1.1 shows the apparatus the student uses.

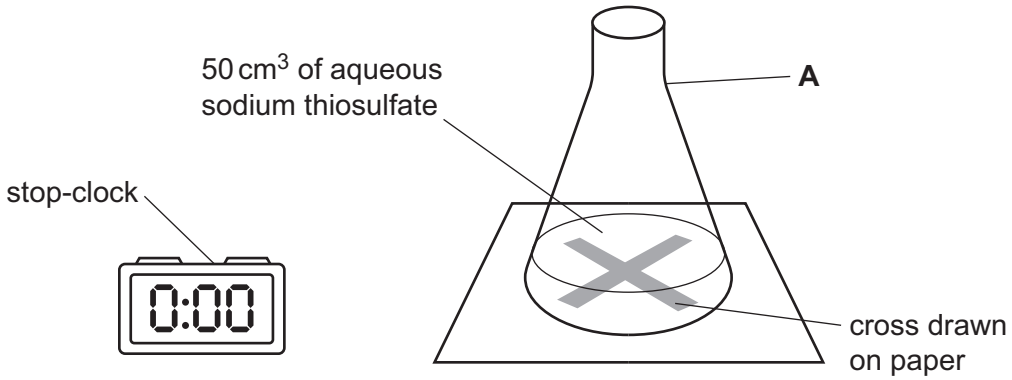

Fig. 1.1

(a) State the name of the piece of apparatus labelled **A** in Fig. 1.1.

..... [1]

(b) The student adds a fixed volume and concentration of dilute hydrochloric acid to **A**, swirls the mixture in **A** and places it back on the cross.

- The mixture in the flask slowly turns cloudy.
- The student records the time taken for the solution to become so cloudy that the cross is no longer visible through the mixture.

State the name of a piece of apparatus needed which is **not** shown in Fig. 1.1.

..... [1]

(c) The student repeats the experiment with the same fixed volume and concentration of dilute hydrochloric acid and with increasing concentrations of aqueous sodium thiosulfate, using a new cross drawn on paper for each experiment.

Explain why drawing a new cross on paper in each experiment reduces the accuracy of the results.

.....

..... [2]

(d) The student then:

- uses the same cross drawn on paper
- repeats the experiment with the same fixed volume and concentration of dilute hydrochloric acid and with increasing concentrations of aqueous sodium thiosulfate.

Suggest the effect of increasing the concentration of aqueous sodium thiosulfate on the time taken for the cross to become no longer visible.

..... [1]

(e) Sulfur dioxide gas is produced during this reaction.

Sulfur dioxide causes breathing difficulties in humans.

Suggest **one** precaution necessary in this investigation to avoid breathing difficulties.

.....

..... [1]

[Total: 6]

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2 A student investigates the temperature changes when an acid neutralises aqueous potassium hydroxide.

The ionic equation for the reaction is shown.

$$H^+ + OH^- \rightarrow H_2O$$

The reaction is exothermic.

The temperature change is used to determine the concentration of hydrogen ions in an acid.

X is an acid of concentration 0.80 mol / dm^3
Y is 2.0 mol / dm^3 potassium hydroxide

The student:

step 1 fills the burette with **Y**
step 2 stands a plastic cup inside a beaker
step 3 uses a volumetric pipette to put 25.0 cm^3 of **X** into the plastic cup
step 4 measures the initial temperature of **X** and records it in Table 2.1
step 5 adds 5.0 cm^3 of **Y** from the burette to the plastic cup
step 6 stirs the mixture for 30 seconds and records in Table 2.1 the temperature of the mixture
step 7 repeats steps 5 and 6 until a total of 40.0 cm^3 of **Y** is added.

Fig. 2.1 on page 6 shows two of the thermometer readings in °C during the experiment.

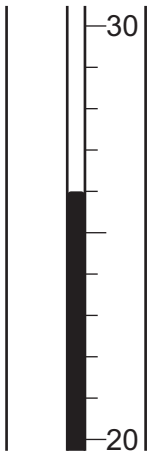
(a) Complete Table 2.1.

You should:

- record the student's results for 10.0 cm^3 and 35.0 cm^3 using Fig. 2.1
- subtract the initial temperature of **X** from each temperature recorded to determine the temperature change.

All temperatures and temperature changes should be recorded to +/– 0.5 °C.

30 seconds after adding 10.0 cm^3 of **Y**



30 seconds after adding 35.0 cm^3 of **Y**

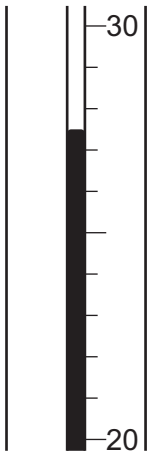


Fig. 2.1

Table 2.1

volume of **Y** / cm^3	temperature / °C	temperature change / °C
0.0	20.5	0.0
5.0	23.5	
10.0		
15.0	29.5	
20.0	31.5	
25.0	30.5	
30.0	29.0	
35.0		
40.0	26.5	

[4]

(b) Plot a graph of the temperature change (*y*-axis) against the volume of **Y** (*x*-axis) on Fig. 2.2.

Draw a line of best fit through the points where the temperature change is increasing.

Draw a line of best fit through the points where the temperature change is decreasing.

Extend both lines so that they cross.

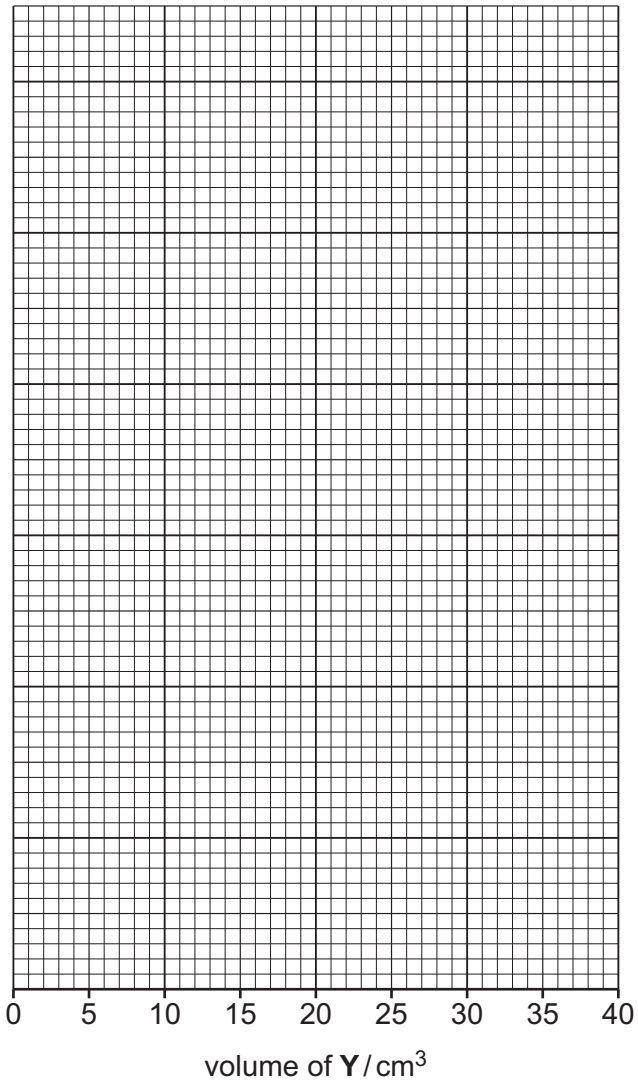


Fig. 2.2

[5]

(c) Find the point on the graph where the two lines cross.

Determine the volume of **Y** at this point.

volume of **Y** ..... cm^3 [1]

(d) **Y** is 2.0 mol / dm^3 potassium hydroxide.

The formula of potassium hydroxide is KOH.

Calculate the number of moles of hydroxide ions, OH^-, in the volume of **Y** in **(c)**.

number of moles ..... [1]

(e) The volume of **Y** in **(c)** is the volume needed to completely neutralise 25.0 cm^3 of **X**.

Use your answer to **(d)** to calculate the concentration of hydrogen ions, H^+, in **X**.

$$H^+ + OH^- \rightarrow H_2O$$

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

(f) Suggest why 25 cm^3 of **X** is measured using a volumetric pipette and **not** a measuring cylinder.

.....

..... [1]

(g) Suggest why the mixture is stirred in step 6.

.....

..... [1]

[Total: 14]

Question 3 starts on page 10.

3 A student does a series of tests using aqueous solution **P** and aqueous solution **Q**.

(a) The tests the student does on **P** are shown in Table 3.1.

Some of the observations for these tests are also shown.

Table 3.1

test number	test	observations
1	flame test	orange-red flame
2	add aqueous ammonia	

(i) Describe how the student does a flame test.

.....

.....

..... [2]

(ii) Describe **one** observation expected in test 2 based on the observation in test 1.

..... [1]

(iii) Describe **one** additional test to confirm the identity of the cation in **P**.

Include the result of a positive test.

test .....

.....

result .....

[3]

(iv) Identify the cation in **P**.

cation ..... [1]

(b) Solution **Q** is acidic.

The tests the student does on **Q** are shown in Table 3.2.

Some of the observations for these tests are also shown.

Table 3.2

test number	test	observations
3	add five drops of universal indicator	colour change
4	add a piece of magnesium ribbon	magnesium ribbon disappears
5	add dilute nitric acid followed by aqueous barium nitrate	white precipitate

(i) Describe the expected colour change in test 3.

..... [1]

(ii) A gas is produced in test 4.

Predict **one** other observation made by the student in test 4.

..... [1]

(iii) Predict the identity of the gas produced in test 4.

..... [1]

(iv) Describe a test to confirm the identity of this gas.

Include the result of a positive test.

test .....

result .....

[2]

(v) **Q** contains one cation and one anion.

Identify the cation and the anion in **Q**.

cation ..... anion ..... [2]

[Total: 14]

4 The reaction between a metal and dilute sulfuric acid is exothermic.

Plan an experiment to determine which metal, magnesium or zinc, releases more thermal energy per gram of metal when reacting with excess dilute sulfuric acid.

You are provided with magnesium powder, zinc powder, dilute sulfuric acid and common laboratory apparatus. No other chemicals should be used.

Your plan should include:

- the apparatus needed
- the method to use and the measurements to take
- how the measurements are used to determine which metal releases more thermal energy per gram.

You may draw a diagram to help answer the question.

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[6]

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Notes for use in qualitative analysis

Tests for anions

anion	test	test result
carbonate, CO_3^{2-}	add dilute acid, then test for carbon dioxide gas	effervescence, carbon dioxide produced
chloride, Cl^- [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	white ppt.
bromide, Br^- [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	cream ppt.
iodide, I^- [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	yellow ppt.
nitrate, NO_3^- [in solution]	add aqueous sodium hydroxide, then aluminium foil; warm carefully	ammonia produced
sulfate, SO_4^{2-} [in solution]	acidify with dilute nitric acid, then add aqueous barium nitrate	white ppt.
sulfite, SO_3^{2-}	add a small volume of acidified aqueous potassium manganate(VII)	the acidified aqueous potassium manganate(VII) changes colour from purple to colourless

Tests for aqueous cations

cation	effect of aqueous sodium hydroxide	effect of aqueous ammonia
aluminium, Al^{3+}	white ppt., soluble in excess, giving a colourless solution	white ppt., insoluble in excess
ammonium, NH_4^+	ammonia produced on warming	–
calcium, Ca^{2+}	white ppt., insoluble in excess	no ppt. or very slight white ppt.
chromium(III), Cr^{3+}	green ppt., soluble in excess	green ppt., insoluble in excess
copper(II), Cu^{2+}	light blue ppt., insoluble in excess	light blue ppt., soluble in excess, giving a dark blue solution
iron(II), Fe^{2+}	green ppt., insoluble in excess, ppt. turns brown near surface on standing	green ppt., insoluble in excess, ppt. turns brown near surface on standing
iron(III), Fe^{3+}	red-brown ppt., insoluble in excess	red-brown ppt., insoluble in excess
zinc, Zn^{2+}	white ppt., soluble in excess, giving a colourless solution	white ppt., soluble in excess, giving a colourless solution

Tests for gases

gas	test and test result
ammonia, NH_3	turns damp red litmus paper blue
carbon dioxide, CO_2	turns limewater milky
chlorine, Cl_2	bleaches damp litmus paper
hydrogen, H_2	'pops' with a lighted splint
oxygen, O_2	relights a glowing splint
sulfur dioxide, SO_2	turns acidified aqueous potassium manganate(VII) from purple to colourless

Flame tests for metal ions

metal ion	flame colour
lithium, Li^+	red
sodium, Na^+	yellow
potassium, K^+	lilac
calcium, Ca^{2+}	orange-red
barium, Ba^{2+}	light green
copper(II), Cu^{2+}	blue-green