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Cambridge Assessment International Education

Cambridge O Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

2958952175

CHEMISTRY **5070/41**

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.

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1 A student separates petroleum.

Fig. 1.1 shows how the student assembles the apparatus.

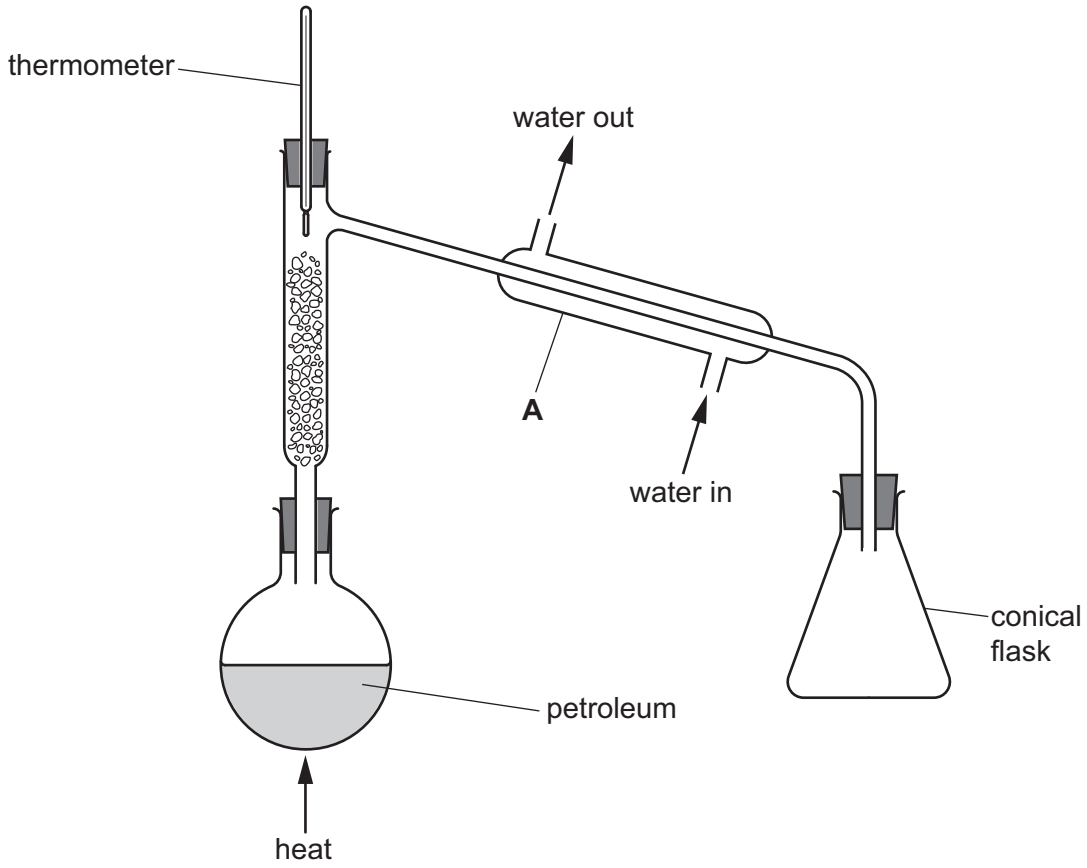

Fig. 1.1

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

..... [1]

(b) The student makes a mistake when assembling the apparatus.

Describe this mistake.

.....

..... [1]

(c) When it is correctly assembled, the apparatus shown in Fig. 1.1 is used to separate petroleum into useful substances.

(i) State the name of this separation process.

..... [1]

(ii) State the property of these substances that allows them to be separated.

..... [1]

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(d) State the name of the piece of apparatus the student uses to safely heat the petroleum in Fig. 1.1.

Explain why this piece of apparatus is suitable.

piece of apparatus .....

explanation .....

.....

[2]

[Total: 6]

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2 A student investigates the temperature changes when an acid neutralises aqueous sodium 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 1.60 mol / dm^3 sodium hydroxide solution
Y is an acid of concentration 2.00 mol / dm^3

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.

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(a) Complete Table 2.1.

You should:

- record the student's results for 5.0 cm^3 and 30.0 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.

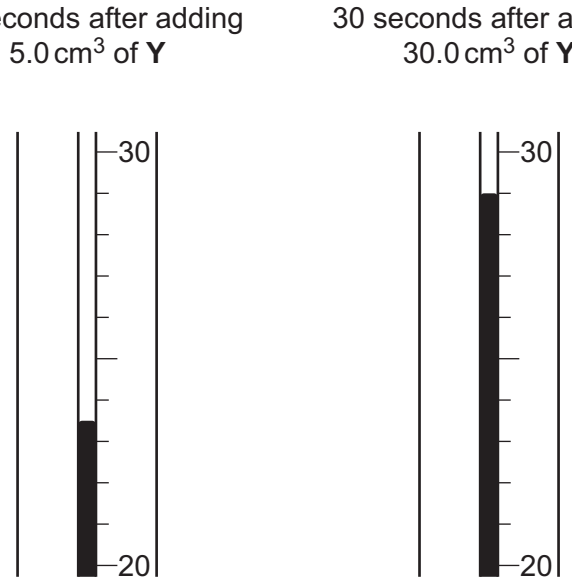

Fig. 2.1

Table 2.1

volume of **Y** / cm^3	temperature / °C	temperature change / °C
0.0	20.5	0.0
5.0		
10.0	26.0	
15.0	29.5	
20.0	31.5	
25.0	30.5	
30.0		
35.0	27.5	
40.0	26.5	

[4]

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(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.

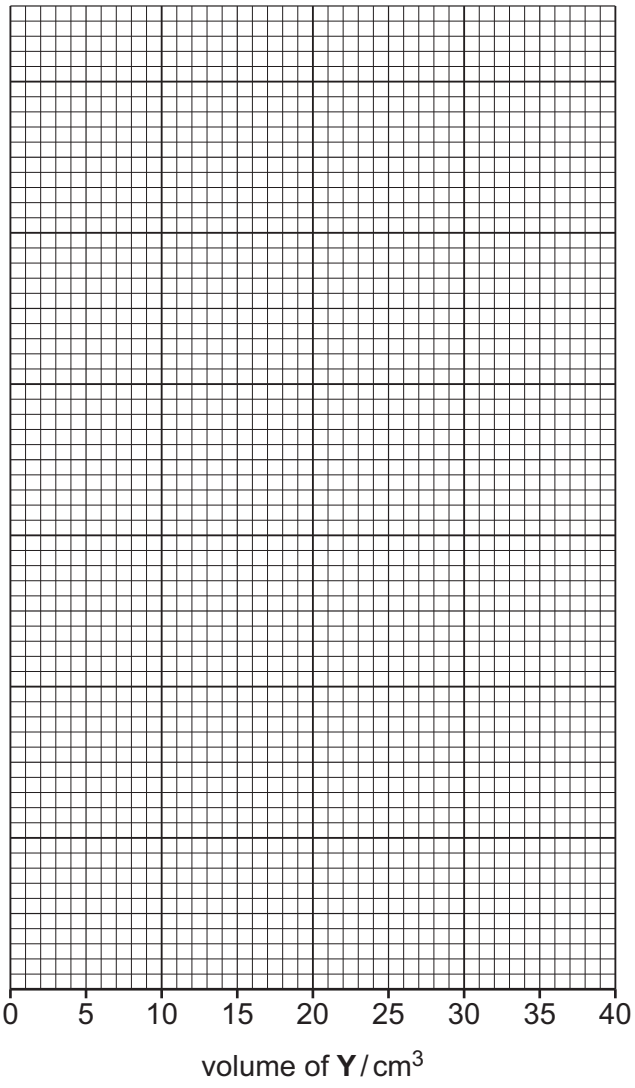

Fig. 2.2

[5]

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

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

volume ..... cm^3 [1]

(d) **X** is 1.60 mol / dm^3 sodium hydroxide solution.

The formula of sodium hydroxide is NaOH.

Calculate the number of moles of hydroxide ions, OH^-, in 25.0 cm^3 of **X**.

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 answers to **(c)** and **(d)** to calculate the concentration of hydrogen ions, H^+, in **Y**.

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

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

(f) Suggest why **Y** is added to **X** using a burette and **not** a measuring cylinder.

.....

..... [1]

(g) Suggest why the temperatures are recorded after 30 seconds and **not** immediately after mixing.

.....

..... [1]

[Total: 14]

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Question 3 starts on page 10.

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

(a) Solution **Q** is acidic. Solution **Q** contains one cation and one anion.

The tests the student does on **Q** are shown in Table 3.1.

Some of the observations for these tests are also shown.

Table 3.1

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

(i) Describe the expected colour change in test 1.

..... [1]

(ii) A gas is produced in test 2.

Predict **one** other observation made by the student in test 2.

..... [1]

(iii) Predict the identity of the gas produced in test 2.

..... [1]

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

Include the result of a positive test.

test .....

result .....

[2]

(v) Identify the cation and the anion in **Q**.

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

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(b) The tests the student does on **R** are shown in Table 3.2.

Some of the observations for these tests are also shown.

Table 3.2

test number	test	observations
4	flame test	blue-green flame
5	add aqueous ammonia drop by drop until a change is seen add excess aqueous ammonia	light blue precipitate blue precipitate dissolves

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

.....

.....

..... [2]

(ii) Describe **one** additional observation expected in test 5 based on the observations in tests 4 and 5.

..... [1]

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

Include the result of a positive test.

test .....

.....

result .....

[3]

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

cation ..... [1]

[Total: 14]

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4 Alcohols are used as fuels to heat water.

Plan an experiment to determine which alcohol, methanol or ethanol, releases more thermal energy per gram of alcohol burned.

Your plan should describe the use of an alcohol burner, as shown in Fig. 4.1, to heat water. You should use water, methanol, ethanol and common laboratory apparatus. No other chemicals should be used.

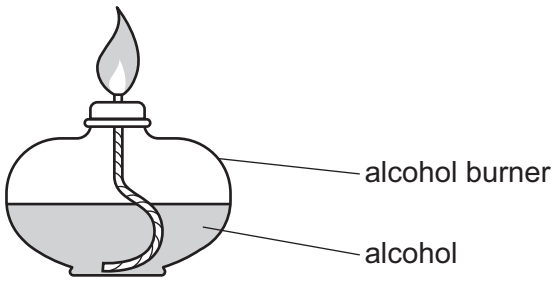

Fig. 4.1

Your plan should include:

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

You may draw a diagram to help answer the question.

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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

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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

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