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CHEMISTRY **5070/42**

Paper 4 Alternative to Practical **May/June 2026**

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. Do **not** use correction fluid or tape.
- 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 Figure 1.1 shows the apparatus a student uses to separate a mixture of three different alkanes.

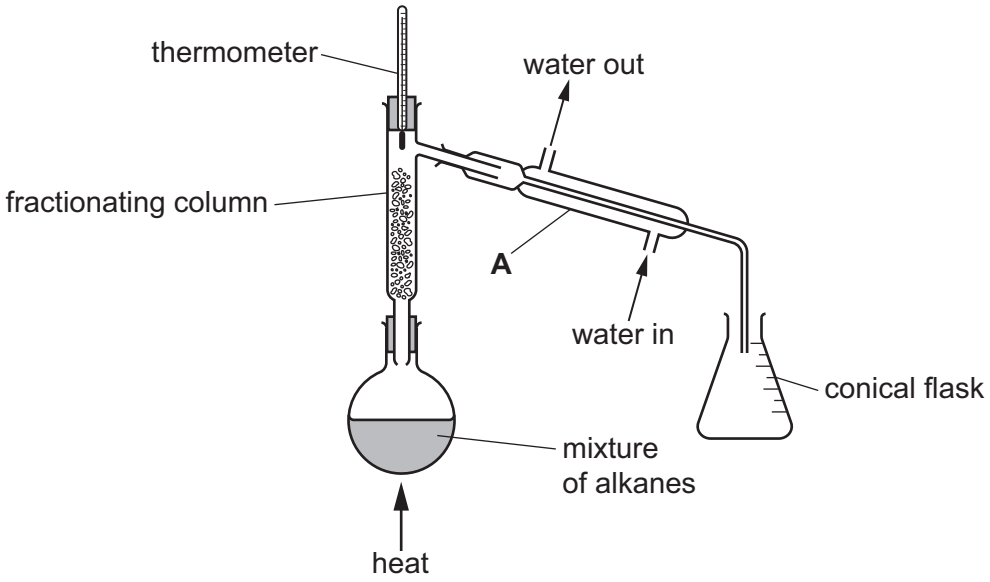

Figure 1.1

(a) (i) State the name of apparatus **A**.

.....

..... [1]

(ii) Explain how apparatus **A** works.

.....

..... [1]

(b) State the property that allows the alkanes to be separated by this method.

..... [1]

(c) Describe how the three different alkanes are obtained from the mixture.

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..... [3]

[Total: 6]

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2 A student investigates the effect of concentration on the rate of reaction between calcium carbonate and dilute hydrochloric acid.

calcium carbonate + hydrochloric acid → calcium chloride + water + carbon dioxide

(a) The student does five experiments using 2.00 mol / dm^3 hydrochloric acid, **B**.

Experiment 1

The student:

- uses a measuring cylinder to add 50 cm^3 of **B** to a conical flask
- puts the conical flask on a piece of black paper
- adds 1 g of calcium carbonate to the flask
- **immediately** starts the stop-watch
- observes the reaction by looking down into the flask from above
- stops the stop-watch when the reaction is complete
- records in Table 2.1 the time taken for the reaction to complete.

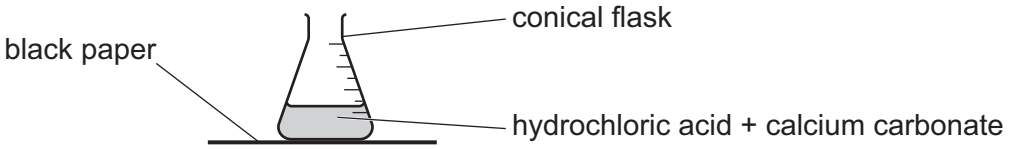

Figure 2.1

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Experiments 2–5

The student repeats the experiment four times but instead of 50 cm^3 of **B** uses different volumes of **B** and distilled water as shown in Table 2.1.

Table 2.1

experiment	volume of B /cm^3	volume of distilled water /cm^3	time taken /s
1	50	0	7
2	40	10	28
3	35	15	56
4	30	20	130
5	20	30	320

(i) Suggest an observation that shows when the reaction is complete.

.....

..... [1]

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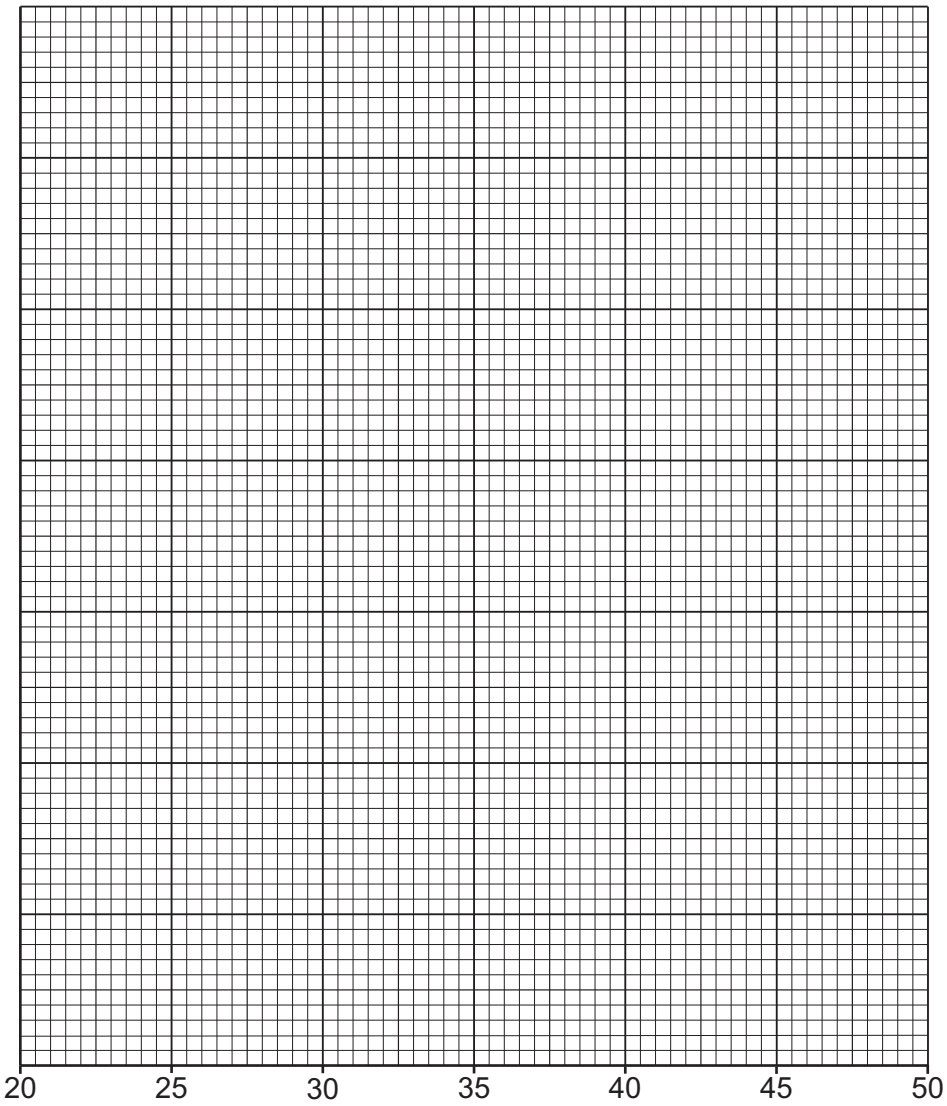
(ii) Plot on the grid the time taken (*y*-axis) against volume of **B** (*x*-axis).

Label the axes.



[3]

(iii) Draw a curve of best fit. [1]

(iv) Use the graph to deduce the time taken when 25 cm^3 of **B** and 25 cm^3 of distilled water are used.

time ..... s [1]

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(b) Measuring the mass of the calcium carbonate and the precision of the stop-watch are sources of inaccuracy in these experiments.

Suggest two **other** sources of inaccuracy in these experiments.

Suggest an improvement that reduces each of these sources of inaccuracy.

source of inaccuracy .....

.....

improvement .....

.....

source of inaccuracy .....

.....

improvement .....

.....

[4]

(c) **(i)** The concentration of hydrochloric acid in **B** is 2.00 mol / dm^3.

Calculate the concentration of the hydrochloric acid in the flask before the calcium carbonate is added in experiment 3.

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

(ii) State the relationship between the **concentration** of hydrochloric acid and the **rate** of reaction.

Explain how the data in Table 2.1 shows this relationship.

relationship .....

.....

explanation .....

.....

.....

[3]

[Total: 14]

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3 A student investigates a pink solid, **C**, which contains two cations and one anion.

(a) The student:

- puts some **C** into a boiling tube
- clamps the boiling tube as shown in Figure 3.1
- heats **C**
- observes any changes that take place.

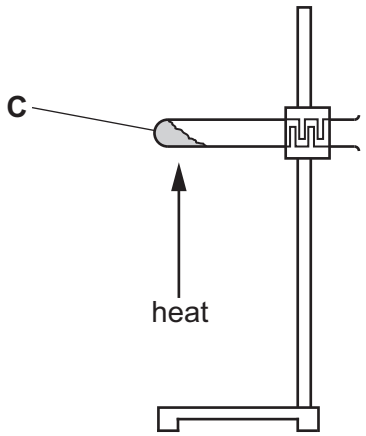

Figure 3.1

(i) Suggest a possible safety hazard and a precaution to take to minimise the hazard when using the apparatus in Figure 3.1.

hazard .....

precaution .....

.....

[2]

(ii) State the name of the piece of apparatus used to heat solid **C**.

..... [1]

(iii) **C** turns into a yellow solution that becomes a yellow solid on further heating.

State **two** conclusions made from these observations.

1 .....

.....

2 .....

.....

[2]

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(iv) Ammonia gas is given off when **C** is heated with aqueous sodium hydroxide.

Describe the effect of ammonia gas on damp red and damp blue litmus papers.

Suggest a conclusion about solid **C** that is made from these observations.

damp red litmus .....

damp blue litmus .....

conclusion .....

.....

[3]

(b) The student dissolves **C** in water. A pale yellow aqueous solution of **C** is formed.

The student determines the pH of aqueous **C** but does not use a pH meter.

(i) Describe how the student determines the pH of aqueous **C**.

.....

..... [1]

(ii) Aqueous **C** has a pH of 2.

Describe the observation the student makes when determining this pH.

..... [1]

(iii) A few drops of aqueous sodium hydroxide are added to aqueous **C**.

Excess aqueous sodium hydroxide is then added.

The student concludes that iron(III) ions are present in **C**.

Describe the observations that the student makes.

.....

.....

.....

..... [2]

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(iv) Dilute nitric acid and aqueous barium nitrate are added to aqueous **C**.

The student thinks that a yellow precipitate is formed. The mixture is left for five minutes to allow the precipitate to settle. The student then sees that the precipitate is white, **not** yellow.

Explain why the precipitate appears yellow at first but is seen to be white after it settles.

.....

..... [1]

(v) State a conclusion that is made from the observations in **3(b)(iv)**.

.....

..... [1]

[Total: 14]

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4 Aqueous ammonia is an alkaline solution that is used to clean surfaces.

The higher the concentration of aqueous ammonia, the better it is at cleaning surfaces.

A student investigates three different samples of aqueous ammonia.

Plan an investigation to determine the **concentration** of ammonia in each of the three samples.

Your plan should describe the use of common laboratory apparatus, dilute hydrochloric acid, a suitable indicator and the three samples of aqueous ammonia.

No other chemicals should be used.

Your plan should include:

- the apparatus needed
- the method to use
- how to use the results to show which sample is the best at cleaning surfaces.
  You do **not** need to show any calculations.

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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