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Cambridge Assessment International Education

Cambridge O Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

6134907894

CHEMISTRY **5070/42**

Paper 4 Alternative to Practical **May/June 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 **12** pages.

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1 A student investigates how the solubility of solid potassium nitrate varies with temperature.

The student:

step 1 puts 100 cm^3 of water into a beaker at room temperature
step 2 measures the mass of the beaker of water
step 3 adds some potassium nitrate to the water
step 4 stirs the mixture until all the potassium nitrate dissolves
step 5 repeats steps 3 and 4 until a small amount of undissolved solid remains in the beaker
step 6 measures the mass of the beaker of water and potassium nitrate
step 7 repeats steps 1 to 6 using water at different temperatures
step 8 calculates the mass of potassium nitrate dissolved in the water at each temperature.

(a) (i) The student does **not** make an important measurement.

State the measurement that the student needs to make.

..... [1]

(ii) The student's results are shown in Table 1.1.

Table 1.1

temperature / °C	mass of potassium nitrate dissolved in 100 cm^3 of water / g
15	26.4
room temperature	31.7
35	54.9
55	
75	152.4
95	225.3

Estimate the mass of potassium nitrate dissolved in 100 cm^3 of water at 55 °C.

mass ..... g [1]

(iii) The student observes that when the solution made at 75 °C is left at room temperature a solid appears in the beaker.

Explain why.

.....

.....

..... [2]

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(b) Suggest why the student does **not** do the experiment at 115 °C.

..... [1]

(c) Explain why the method the student uses gives a higher value for the solubility than the true value.

.....

..... [1]

[Total: 6]

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2 Solid **W** is an impure organic acid, H_3A.

A student determines the mass of H_3A in a sample of **W** by titration with 0.100 mol / dm^3 sodium hydroxide, NaOH.

The student:

step 1 places the sample of **W** in a beaker
step 2 uses a measuring cylinder to add 100 cm^3 of distilled water to the beaker
step 3 stirs the mixture until the solid is fully dissolved
step 4 labels this mixture **X**
step 5 pipettes 25.0 cm^3 of NaOH into a conical flask and adds five drops of thymolphthalein indicator
step 6 fills the burette with **X**
step 7 adds **X** to the conical flask until the solution just changes colour
step 8 repeats this titration two more times.

(a) Explain why it is important to use distilled water and **not** tap water for the experiment.

.....

..... [1]

(b) Fig. 2.1 shows the initial and final burette readings for titration 1.

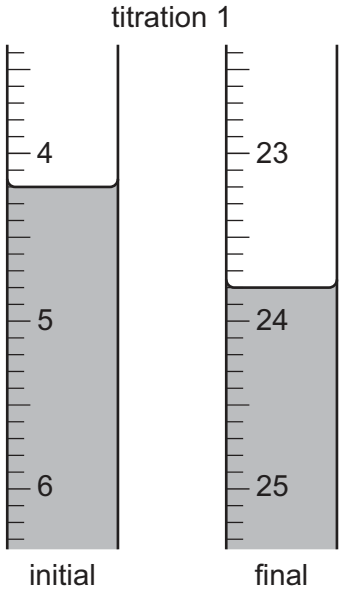

Fig. 2.1

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(i) Table 2.1 shows some of the student's results.

Complete Table 2.1 by:

- writing the initial and final readings for titration 1
- calculating the volume of **X** used in each titration
- ticking (✓) the best titration results.

Table 2.1

	titration 1	titration 2	titration 3
final burette reading / cm^3		19.2	38.6
initial burette reading / cm^3		0.1	19.3
volume used / cm^3			
best titration results (✓)			

[3]

(ii) Use the best titration results (✓) to calculate the average volume of **X** used.

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

(c) Calculate the number of moles of NaOH in 25 cm^3 of 0.100 mol / dm^3 NaOH.

number of moles ..... [1]

(d) The equation for the reaction between H_3A and NaOH is shown.

$$H_3A + 3NaOH \rightarrow Na_3A + 3H_2O$$

Calculate the number of moles of H_3A that react with 25.0 cm^3 of 0.100 mol / dm^3 NaOH.

number of moles ..... [1]

(e) Calculate the number of moles of H_3A in the sample of **W**.

number of moles ..... [1]

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(f) The relative molecular mass of H_3A is 210.

Calculate the mass of H_3A in the sample of **W**.

mass ..... g [1]

(g) In step 2 a measuring cylinder is used to add 100 cm^3 of distilled water to the beaker.

Explain why using the measuring cylinder makes the volume of distilled water used inaccurate. Suggest an improvement.

explanation .....

.....

improvement .....

[2]

(h) Before the student does step 6 the burette is rinsed with distilled water and then with **X**.

(i) Explain why the burette is rinsed with distilled water.

..... [1]

(ii) Suggest and explain the effect on the titration results if the burette is **not** rinsed with **X** after rinsing with distilled water.

effect .....

explanation .....

.....

[2]

[Total: 14]

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3 A student investigates solid **A** and aqueous solution **B**.

Solid **A** is a metal carbonate. Solution **B** contains only one cation and one anion.

The student does a flame test on solid **A**.

(a) (i) Describe how to do a flame test on a solid.

.....

.....

..... [2]

(ii) The student observes a blue-green colour in the flame.

Identify the cation present in **A**.

..... [1]

(b) The student adds dilute hydrochloric acid to **A**.

An aqueous solution **C** and a colourless gas are formed.

(i) Describe the observations the student makes. Describe the chemical test and the positive result used to identify the gas formed.

observations .....

.....

.....

test .....

result .....
[5]

(ii) Explain how the student knows when the reaction has finished.

.....

..... [1]

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(c) Explain how the student uses aqueous ammonia to confirm the metal ion present in **C**.

Include the observations you expect.

.....

.....

.....

.....

..... [4]

(d) The student does tests on **B**. The results are shown in Table 3.1.

Table 3.1

test	observation
adds dilute nitric acid and aqueous barium nitrate	colourless solution formed
adds dilute nitric acid and aqueous silver nitrate	cream precipitate formed
adds aqueous sodium hydroxide and aluminium foil then warms the mixture	colourless solution formed

Identify the anion in **B**.

..... [1]

[Total: 14]

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4 **Q** is a mixture of solid copper(II) carbonate and solid lead sulfate.

Lead sulfate is insoluble in water and does **not** react with dilute sulfuric acid.

Copper(II) carbonate is insoluble in water. It reacts with dilute sulfuric acid to form copper(II) sulfate solution.

Plan an investigation to obtain pure copper(II) sulfate crystals and pure lead sulfate solid from **Q**.

Your plan should describe the use of common laboratory apparatus, dilute sulfuric acid and **Q**. No other chemicals should be used.

Your plan should include:

- the apparatus needed
- the preparation of copper(II) sulfate solution
- the method to obtain pure copper(II) sulfate crystals
- the method to obtain pure lead sulfate solid
- how to test that the lead sulfate is pure.

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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