* 0000800000001 *

Cambridge Assessment International Education

Cambridge O Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

* 7 0 9 1 2 4 2 5 2 9 *

CHEMISTRY **5070/42**

Paper 4 Alternative to Practical **October/November 2024**

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. Any blank pages are indicated.

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[Turn over

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1 A student does an experiment to make pure hydrated copper(II) sulfate crystals, $CuSO_4•5H_2O$.

(a) The student makes aqueous copper(II) sulfate by reacting a dilute acid with excess copper(II) oxide.

Name the acid.

.... [1]

(b) Fig. 1.1 shows the apparatus the student uses to crystallise the aqueous copper(II) sulfate.

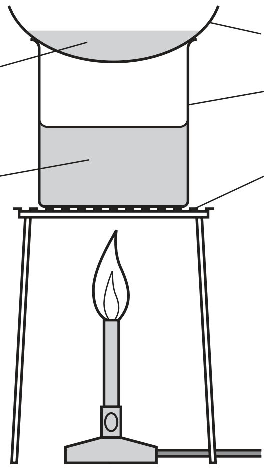

Fig. 1.1

(i) Name apparatus **X**.

.... [1]

(ii) Describe how the student decides when to stop heating the aqueous copper(II) sulfate.

....

.... [1]

(iii) Suggest why apparatus **X** is heated with a water bath and **not** heated directly using the Bunsen burner.

....

....

.... [2]

(iv) Describe the final step needed to produce pure hydrated copper(II) sulfate crystals.

.... [1]

[Total: 6]

2 A student titrates four samples of aqueous sodium carbonate with 0.500 mol / dm^3 dilute hydrochloric acid, HCl(aq).

In titration 1 the student:

- rinses and fills a burette with 0.500 mol / dm^3 HCl(aq)
- adds 25.0 cm^3 of aqueous sodium carbonate to a conical flask
- adds methyl orange indicator to the conical flask
- adds HCl(aq) from the burette while swirling the flask, adding drop by drop near the end-point, until the solution just changes colour.

The student repeats the titration three more times.

(a) Fig. 2.1 shows the burette readings for two of the titrations.

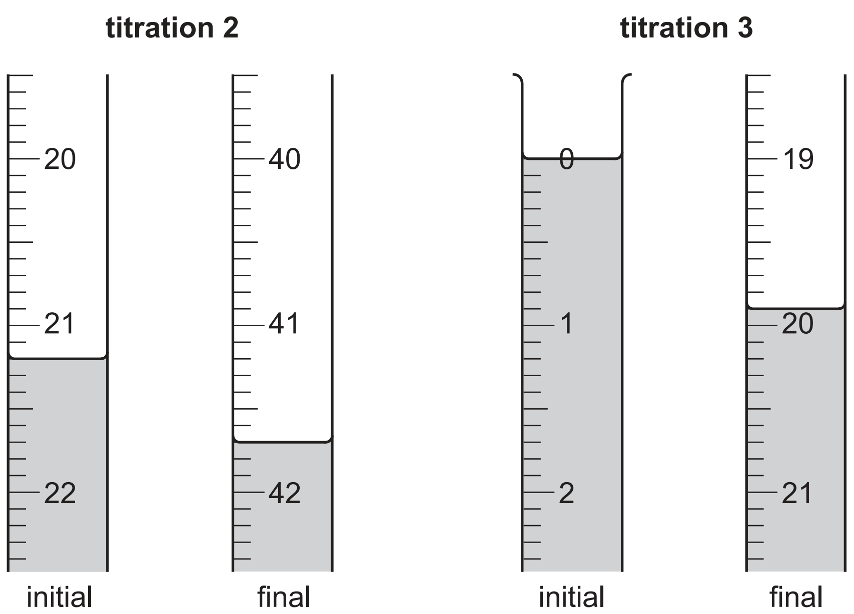

Fig. 2.1

Record the burette readings in Table 2.1.

Complete Table 2.1.

Table 2.1

	titration number			
	1	2	3	4
final burette reading / cm^3	21.1			40.4
initial burette reading / cm^3	0.2			20.3
volume of HCl(aq) used / cm^3	20.9			
best titration results (✓)				

[3]

(b) Tick (✓) the two best titration results in Table 2.1. [1]

(c) Use the ticked (✓) titration results in Table 2.1 to calculate the average volume of HCl(aq) needed to neutralise 25.0 cm^3 of the aqueous sodium carbonate.

volume .... cm^3 [1]

(d) Use your answer from **(c)** to calculate the number of moles of HCl in the average volume of HCl(aq) needed to neutralise 25.0 cm^3 of the aqueous sodium carbonate.

number of moles .... [1]

(e) The equation for the reaction between hydrochloric acid and sodium carbonate is:

$$2HCl + Na_2CO_3 \rightarrow 2NaCl + H_2O + CO_2$$

Use your answer from **(d)** to calculate the concentration of the aqueous sodium carbonate.

Give your answer to **three** significant figures.

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

(f) The student is provided with 150 cm^3 of the aqueous sodium carbonate.

Use your answer to **(e)** to calculate the mass of Na_2CO_3 in 150 cm^3 of this solution.

[A_r: C, 12; O, 16; Na, 23]

mass .... g [3]

(g) State why the conical flask is swirled while HCl(aq) is added from the burette.

.... [1]

(h) State why the HCl(aq) is added drop by drop near the end-point.

.... [1]

[Total: 14]

3 A student investigates solution **P** and solution **Q**.

(a) Solution **P** is colourless and contains sodium ions.

(i) Describe how to do a flame test on solution **P** to confirm the identity of this cation.

....

....

....

.... [3]

(ii) Solution **P** contains an anion composed of nitrogen and oxygen.

Describe a test to identify the anion in solution **P**.

test ....

....

....

observations ....

....

identity of anion ....
[6]

(b) The tests the student does on solution **Q** are shown in Table 3.1.

Some of the observations for these tests are also shown.

Table 3.1

	tests on solution **Q**	observations
1	Add drops of aqueous ammonia to solution **Q** until a change is seen. Then add excess aqueous ammonia.	green precipitate insoluble in excess
2	Add drops of aqueous sodium hydroxide to solution **Q** until a change is seen. Then add excess aqueous sodium hydroxide.	green precipitate soluble in excess, giving a green solution
3	Add aqueous silver nitrate to solution **Q**.	white precipitate
4	Add dilute nitric acid to solution **Q**. Then add aqueous barium nitrate.	

(i) Identify the cation in solution **Q** using the observations from tests 1 **and** 2.

.... [1]

(ii) Test 3 is incomplete.

Describe what else must be done in test 3 to ensure that the white precipitate observed leads to a valid conclusion about the anion in solution **Q**.

.... [1]

(iii) The student completes test 3 correctly. The observation remains the same.

Identify an anion in solution **Q**.

.... [1]

(iv) The ion identified in **(iii)** is the only anion in solution **Q**.

Describe the expected observation from test 4.

.... [1]

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

Describe the observation when solution **Q** is added to sodium carbonate.

.... [1]

[Total: 14]

4 Muntz metal is an alloy that contains zinc and copper.

Zinc reacts with dilute sulfuric acid. Copper does **not** react with dilute sulfuric acid.

Plan an investigation to find the percentage by mass of zinc in a powdered sample of Muntz metal which contains only zinc and copper.

Your plan must include the use of common laboratory apparatus, Muntz metal and dilute sulfuric acid. No other chemicals should be used.

Your plan must include:

- the apparatus needed
- the method to use and the measurements to take
- procedures to ensure that the percentage determined is as accurate as possible
- how the measurements are used to determine the percentage by mass of zinc in the sample of Muntz metal.

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