Cambridge Assessment International Education

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CANDIDATE NAME

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CHEMISTRY **0620/61**

Paper 6 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 **12** pages.

DC (SL/SW) 347001/4

1 Hot concentrated hydrochloric acid reacts with solid manganese(IV) oxide to make chlorine gas. Chlorine gas is toxic and more dense than air. Concentrated hydrochloric acid is corrosive.

Fig. 1.1 shows the apparatus used to make and collect a sample of chlorine gas.

There is **one** error in the way the apparatus has been set up in Fig. 1.1.

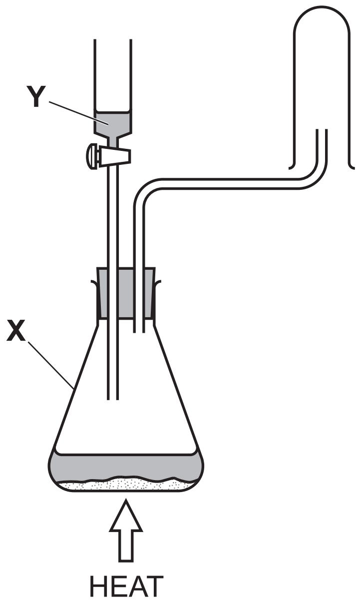

Fig. 1.1

(a) Name the item of apparatus labelled **X** in Fig. 1.1.

.... [1]

(b) Identify the substance labelled **Y** in Fig. 1.1.

.... [1]

(c) Name an item of apparatus that can be used to heat **X** in Fig. 1.1.

.... [1]

(d) There is **one** error in the way the apparatus has been set up.

Describe a change that needs to be made to the apparatus in Fig. 1.1 to correct this error.

....

.... [1]

(e) Explain why this experiment should be carried out in a fume cupboard.

....

.... [1]

[Total: 5]

2 A student investigates the reaction between dilute hydrochloric acid and aqueous sodium hydroxide.

The student does five experiments.

Experiment 1

- Fill a burette with aqueous sodium hydroxide.
- Run some of the aqueous sodium hydroxide out of the burette so that the level of the aqueous sodium hydroxide is on the burette scale.
- Record the initial burette reading.
- Use a volumetric pipette to add 25.0 cm^3 of dilute hydrochloric acid to a conical flask.
- Stand the conical flask on a white tile.
- Add five drops of thymolphthalein indicator to the conical flask.
- Slowly add aqueous sodium hydroxide from the burette to the conical flask, while swirling the flask, until the solution just changes colour. This is the end-point.
- Record the final burette reading.

Experiment 2

- Empty the conical flask and rinse it with distilled water.
- Refill the burette with aqueous sodium hydroxide.
- Run some of the aqueous sodium hydroxide out of the burette so that the level of the aqueous sodium hydroxide is on the burette scale.
- Record the initial burette reading.
- Use the volumetric pipette to add 25.0 cm^3 of dilute hydrochloric acid to the conical flask.
- Add 0.25 g of sodium hydrogencarbonate to the conical flask and swirl the flask.
- Stand the conical flask on the white tile.
- Add five drops of thymolphthalein indicator to the conical flask.
- Slowly add aqueous sodium hydroxide from the burette to the conical flask, while swirling the flask, until the solution just changes colour. This is the end-point.
- Record the final burette reading.

Experiment 3

- Repeat Experiment 2 using 0.50 g of sodium hydrogencarbonate instead of 0.25 g.

Experiment 4

- Repeat Experiment 2 using 1.00 g of sodium hydrogencarbonate instead of 0.25 g.

Experiment 5

- Repeat Experiment 2 using 1.50 g of sodium hydrogencarbonate instead of 0.25 g.

(a) Use the information in the descriptions of Experiments 1 to 5 and the burette diagrams in Fig. 2.1 and Fig. 2.2 to complete Table 2.1.

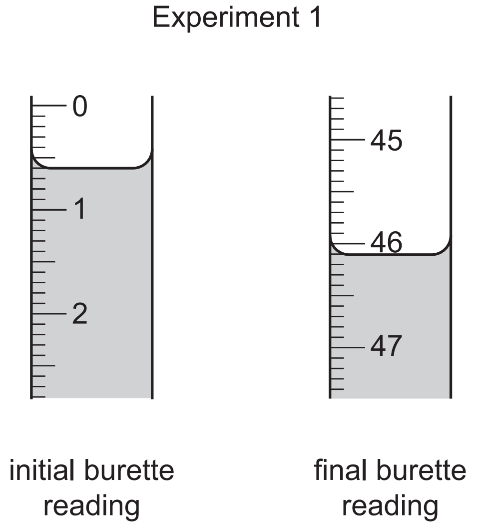

Fig. 2.1

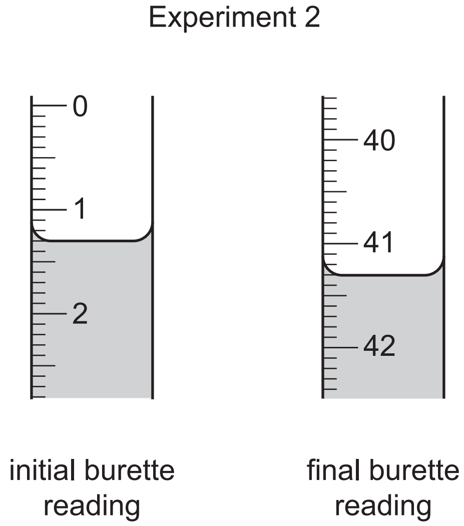

Fig. 2.2

Table 2.1

	Experiment 1	Experiment 2	Experiment 3	Experiment 4	Experiment 5
volume of dilute hydrochloric acid / cm^3					
mass of sodium hydrogencarbonate / g	0.00	0.25	0.50	1.00	1.50
final burette reading / cm^3			36.0	24.1	13.5
initial burette reading / cm^3			1.4	0.3	0.5
volume of aqueous sodium hydroxide added to reach the end-point / cm^3					13.0

[5]

(b) Complete a suitable scale on the *y*-axis and plot the results from Experiments 1 to 5 in Table 2.1 on Fig. 2.3. Draw a straight line of best fit.

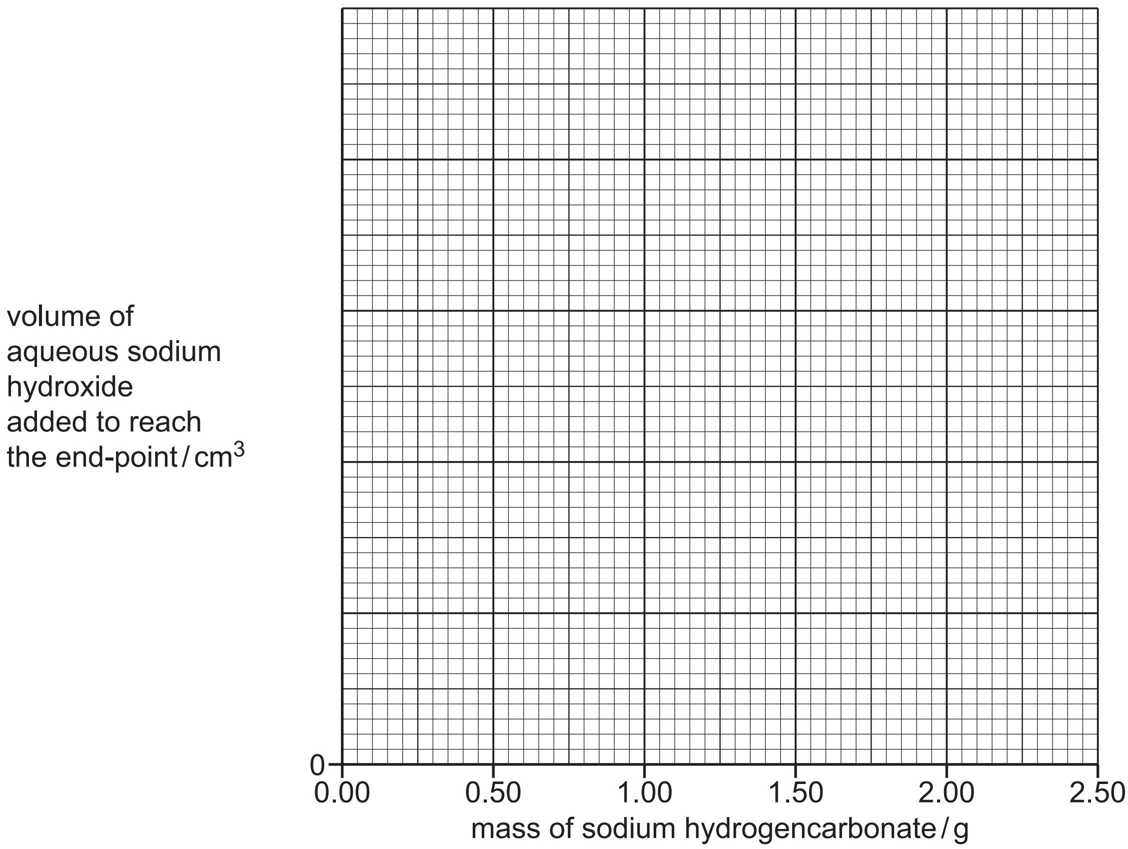

Fig. 2.3

[4]

(c) The sodium hydrogencarbonate added in Experiments 2 to 5 neutralises some of the dilute hydrochloric acid in the conical flask. The sodium hydroxide used in the titration neutralises the remaining dilute hydrochloric acid.

Extrapolate the line on your graph in Fig. 2.3 and deduce the mass of sodium hydrogencarbonate needed to neutralise **all** of the dilute hydrochloric acid in the conical flask.

Show clearly **on Fig. 2.3** how you worked out your answer.

mass of sodium hydrogencarbonate = ...

[3]

(d) **(i)** Explain why a volumetric pipette is used rather than a measuring cylinder to measure the volume of dilute hydrochloric acid used in each experiment.

....

.... [1]

(ii) Explain why it is **not** possible to use a volumetric pipette instead of the burette to measure the volume of aqueous sodium hydroxide added in each experiment.

....

.... [1]

(e) The conical flask is placed on a white tile to make the colour change of the indicator at the end-point more visible.

Explain why universal indicator is **not** a suitable indicator for this titration.

....

....

....

.... [2]

(f) Draw a line **on Fig. 2.3** to show the results you would expect if the investigation was repeated using aqueous sodium hydroxide with twice the concentration.

Label your line **F**. [2]

[Total: 18]

3 A student tests two solids: solid **J** and solid **K**.

Tests on solid J

Solid **J** is lithium chloride.

Record the expected observations.

(a) The student carries out a flame test on solid **J**.

(i) State the colour the Bunsen burner flame becomes during the flame test.

.... [1]

(ii) The student uses a roaring Bunsen burner flame to carry out the flame test.

State why a yellow Bunsen burner flame is **not** suitable for a flame test.

....

.... [1]

(b) The student dissolves the remaining solid **J** in distilled water to form solution **J**.

The student divides solution **J** into two portions.

(i) To the first portion of solution **J**, the student adds about 1 cm^3 of dilute nitric acid followed by a few drops of aqueous silver nitrate.

observations ....

.... [1]

(ii) To the second portion of solution **J**, the student adds aqueous sodium hydroxide until it is in excess.

observations ....

.... [1]

Tests on solid K

Table 3.1 shows the tests and the student's observations for solid **K**.

Table 3.1

tests	observations
test 1 Heat about half of solid **K** in a boiling tube until there is no further change. Hold anhydrous cobalt(II) chloride paper at the mouth of the boiling tube.	condensation forms at the top of the boiling tube the anhydrous cobalt(II) chloride paper changes colour from blue to pink
test 2 The remaining solid **K** is dissolved in distilled water to form solution **K**. Solution **K** is divided into three portions. To the first portion of solution **K**, add aqueous ammonia dropwise and then in excess.	a green precipitate forms the precipitate remains when excess aqueous ammonia is added
test 3 To the second portion of solution **K**, add 1 cm^3 of dilute nitric acid followed by a few drops of aqueous barium nitrate.	a white precipitate forms
test 4 To the third portion of solution **K**, add 3 cm^3 of aqueous sodium carbonate. Test any gas given off.	effervescence is seen and a green precipitate forms the gas turns limewater milky

(c) State the conclusion that can be made from the observations in **test 1**.

.... [1]

(d) Two different cations can give the observations in **test 2**.

(i) Identify the **two** possible cations that the observations in **test 2** show could be in solid **K**.

....

.... [2]

(ii) Describe an additional test that can be carried out on solution **K** to confirm which of the two cations you have identified in **(d)(i)** is in solid **K**.

Explain how the result of this test shows which of these two cations is in solid **K**.

test ....

....

explanation ....

.... [2]

(e) Identify the gas given off in **test 4**.

.... [1]

(f) Identify the anion in solid **K**.

.... [1]

[Total: 11]

4 When a solid metal is added to an aqueous salt of a less reactive metal, a reaction takes place. The reaction is exothermic, and the temperature of the reaction mixture increases. The larger the difference in reactivity of the two metals, the more exothermic the reaction.

Cobalt, manganese and nickel are three metals which are all more reactive than copper and react with aqueous copper(II) sulfate. The temperature of the reaction mixture increases during each reaction.

Plan an investigation to find the order of reactivity of the three metals cobalt, manganese and nickel.

Your plan should include how you can use the results to find the order of reactivity of the three metals cobalt, manganese and nickel.

You are provided with powdered samples of cobalt, manganese and nickel, aqueous copper(II) sulfate and common laboratory apparatus.

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.... [6]

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