Cambridge Assessment International Education

Cambridge IGCSE™ (9–1)

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

0153715490

CHEMISTRY **0971/62**

Paper 6 Alternative to Practical **May/June 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.

1 When a mixture of calcium hydroxide and ammonium chloride is heated, ammonia gas is made.

calcium hydroxide + ammonium chloride → calcium chloride + water + ammonia

Ammonia gas is soluble in water and toxic. Ammonia gas reacts with hot copper(II) oxide to make nitrogen.

ammonia + copper(II) oxide → copper + water + nitrogen

A student makes nitrogen using the apparatus shown in Fig. 1.1.

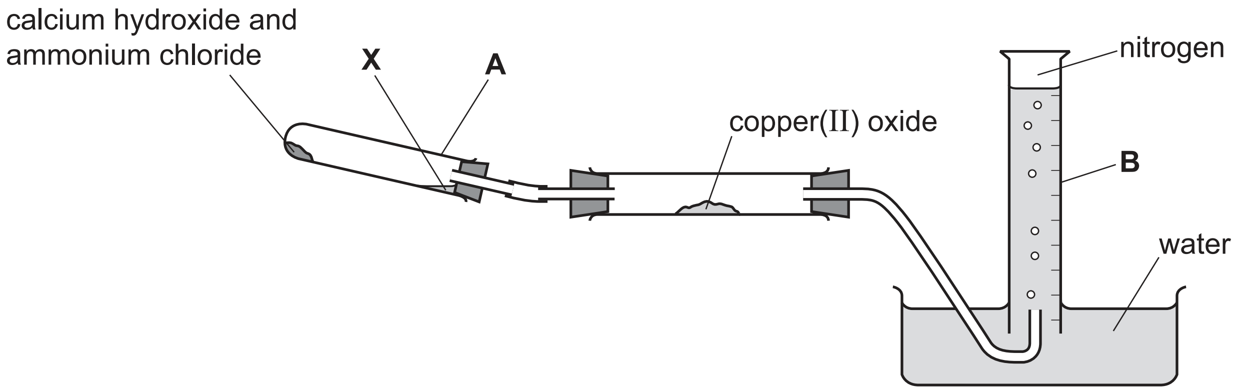

Fig. 1.1

(a) Name the items of apparatus labelled **A** and **B** in Fig. 1.1.

A ....

B ....
[2]

(b) The apparatus needs to be heated in two places.

On Fig. 1.1, draw arrows in **two** places to show where the apparatus should be heated during the experiment. [2]

(c) During the reaction, a colourless liquid collects at the point marked **X** in Fig. 1.1.

Suggest the identity of the colourless liquid.

.... [1]

(d) Some of the ammonia gas passes over the copper(II) oxide without reacting.

Suggest why none of this ammonia gas is collected in the item of apparatus labelled **B** in Fig. 1.1.

....

.... [1]

(e) The student does not collect the first few bubbles of gas.

Suggest why the first few bubbles of gas are **not** collected.

....

.... [1]

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

....

.... [1]

[Total: 8]

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2 A student investigates the reaction between aqueous aluminium chloride and two aqueous solutions of sodium hydroxide, solution **F** and solution **G**. Solution **F** and solution **G** have different concentrations.

The student does three experiments.

Experiment 1

- Rinse a burette with distilled water and then with aqueous aluminium chloride.
- Rinse a conical flask with distilled water.
- Fill the burette with aqueous aluminium chloride. Run some of the aqueous aluminium chloride out of the burette so that the level of the aqueous aluminium chloride is on the burette scale.
- Record the initial burette reading.
- Use a measuring cylinder to pour 25 cm^3 of solution **F** into the conical flask.
- Stand the conical flask on a black or dark-coloured sheet of paper.
- Slowly add aqueous aluminium chloride from the burette to the conical flask, while swirling the flask, until the mixture in the conical flask just starts to become cloudy.
- Record the final burette reading.

Experiment 2

- Refill the burette with aqueous aluminium chloride. Run some of the aqueous aluminium chloride out of the burette so that the level of the aqueous aluminium chloride is on the burette scale.
- Record the initial burette reading.
- Rinse the conical flask with distilled water.
- Rinse the measuring cylinder with distilled water and then with solution **G**.
- Use the measuring cylinder to pour 25 cm^3 of solution **G** into the conical flask.
- Stand the conical flask on a black or dark-coloured sheet of paper.
- Slowly add aqueous aluminium chloride from the burette to the conical flask, while swirling the flask, until the mixture in the conical flask just starts to become cloudy.
- Record the final burette reading.

Experiment 3

- Refill the burette with aqueous aluminium chloride. Run some of the aqueous aluminium chloride out of the burette so that the level of the aqueous aluminium chloride is on the burette scale.
- Record the initial burette reading.
- Rinse the conical flask with distilled water.
- Use the measuring cylinder to pour 25 cm^3 of solution **G** into the conical flask.
- Add 5 drops of thymolphthalein indicator to the conical flask.
- Stand the conical flask on a **white tile**.
- Slowly add aqueous aluminium chloride from the burette to the conical flask, while swirling the flask, until the thymolphthalein indicator changes colour.
- Record the final burette reading.

(a) Use the burette diagrams in Fig. 2.1, Fig. 2.2 and Fig. 2.3 to record the readings for Experiments 1, 2 and 3 in Table 2.1 and complete Table 2.1.

Experiment 1

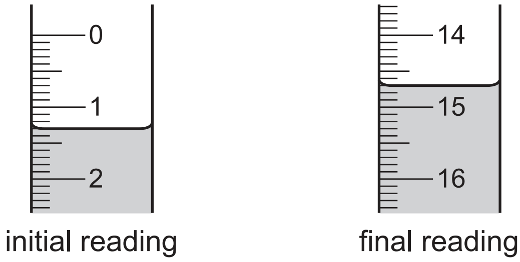

Fig. 2.1

Experiment 2

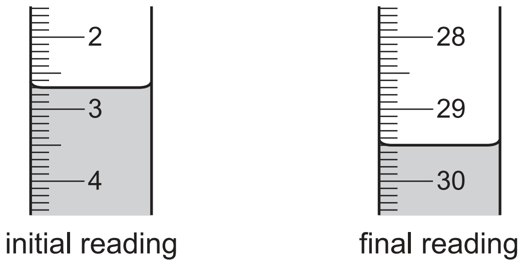

Fig. 2.2

Experiment 3

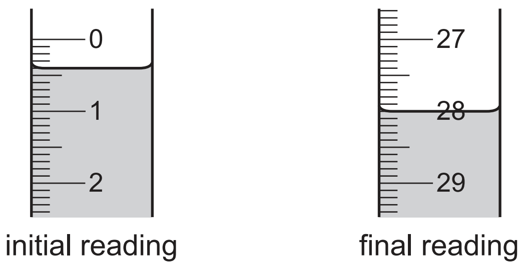

Fig. 2.3

Table 2.1

	Experiment 1	Experiment 2	Experiment 3
final burette reading / cm^3			
initial burette reading / cm^3			
volume of aqueous aluminium chloride added / cm^3			

[4]

(b) In Experiment 3, the aqueous sodium hydroxide in the conical flask is alkaline. At the end-point, the mixture in the flask is no longer alkaline.

State the colour change seen at the end-point in Experiment 3.

from .... to .... [1]

(c) State why the conical flask is swirled as solution **F** is added in Experiment 1.

....

.... [1]

(d) Suggest why the conical flask is placed on black or dark-coloured paper in Experiments 1 and 2.

....

.... [1]

(e) **(i)** Explain why the measuring cylinder is rinsed between Experiment 1 and Experiment 2.

.... [1]

(ii) Explain why the measuring cylinder does **not** need rinsing between Experiment 2 and Experiment 3.

.... [1]

(f) Compare the concentration of solution **F** used in Experiment 1 with the concentration of solution **G** used in Experiment 2.

Explain your answer.

....

....

.... [3]

(g) Calculate the volume of aqueous aluminium chloride required when Experiment 1 is carried out with 10 cm^3 of aqueous sodium hydroxide instead of 25 cm^3.

.... [2]

(h) In all three experiments it is more accurate to measure the volume of the aqueous sodium hydroxide using a volumetric pipette instead of a measuring cylinder.

Explain why it is **not** possible to use a volumetric pipette to measure the volume of aqueous aluminium chloride in these experiments.

....

.... [1]

[Total: 15]

3 A student tests two substances: solid **H** and solution **I**.

Tests on solid H

Solid **H** is barium carbonate.

Complete the expected observations.

(a) **(i)** The student adds an excess of dilute nitric acid to the sample of solid **H** in a boiling tube and tests any gas produced.

observations ....

....

.... [2]

(ii) Identify the gas made in **(a)(i)**.

.... [1]

The solution produced in **(a)(i)** is solution **J**. The student divides solution **J** into four approximately equal portions.

(b) The student carries out a flame test on the first portion of solution **J**.

observations .... [1]

(c) To the second portion of solution **J**, the student adds a few drops of acidified aqueous potassium manganate(VII).

observations ....

.... [1]

(d) To the third portion of solution **J**, the student adds a few drops of dilute sulfuric acid.

observations ....

.... [1]

(e) To the fourth portion of solution **J**, the student adds about 1 cm depth of dilute nitric acid followed by a few drops of aqueous barium nitrate.

observations ....

.... [1]

Tests on solution I

Table 3.1 shows the tests and the student's observations for solution **I**.

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

Table 3.1

tests	observations
test 1 To the first portion of solution **I** in a boiling tube, add 2 cm^3 of aqueous sodium hydroxide and warm the mixture. Test any gas produced, using damp red litmus paper.	damp red litmus paper turns blue
test 2 To the second portion of solution **I** in a boiling tube, add 1 cm^3 of dilute nitric acid followed by a few drops of aqueous silver nitrate.	a white precipitate forms

(f) **(i)** Identify the gas produced in **test 1**.

.... [1]

(ii) State what is observed when the gas produced in **test 1** is tested using damp blue litmus paper.

.... [1]

(g) Identify solution **I**.

....

.... [2]

[Total: 11]

4 Bismuth is a metal that has a reactivity similar to that of copper. The ore bismite contains the compound bismuth(III) oxide, Bi_2O_3.

Bismuth(III) oxide is insoluble in water and reacts with dilute acids to form an aqueous solution of a salt. The ore bismite contains no other compounds that are insoluble in water and no other compounds that react with acids to form aqueous solutions.

Describe how you could obtain a sample of bismuth metal starting with a large lump of the ore bismite.

You have access to common laboratory apparatus and chemicals.

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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