Cambridge Assessment International Education

Cambridge O Level

CANDIDATE NAME

CENTRE NUMBER | | | | | |

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3010358971

CHEMISTRY **5070/42**

Paper 4 Alternative to Practical **May/June 2023**

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 **16** pages. Any blank pages are indicated.

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[Turn over

1 A student investigates the rusting of iron.

Fig. 1.1 shows the apparatus the student uses.

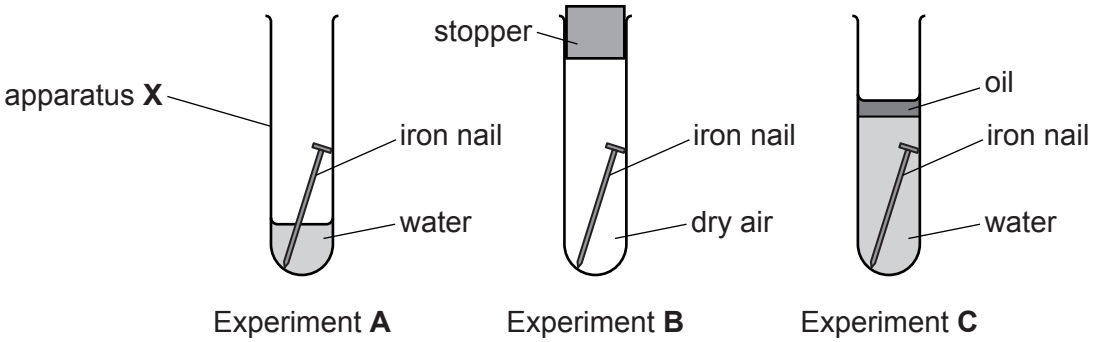


Fig. 1.1

(a) Name apparatus **X**.

..... [1]

(b) State why a stopper is used in Experiment **B**.

.....

..... [1]

(c) State why the water in Experiment **C** is boiled before use.

.....

..... [1]

(d) State why a layer of oil is used in Experiment **C**.

.....

..... [1]

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(e) The experiments are left for one week.

Predict in which of the experiments the nail will have rusted.

.....

.....

Explain your prediction.

.....

.....

[2]

[Total: 6]

2 Aqueous ammonia is a solution of ammonia gas.

A student titrates two samples of aqueous ammonia, **A** and **B**, with 0.500 mol / dm^3 hydrochloric acid.

The student does four titrations, two with **A** and two with **B**.

The student:

Step 1. rinses and fills a burette with 0.500 mol / dm^3 hydrochloric acid
Step 2. uses a volumetric pipette to add 25.0 cm^3 of **A** to a conical flask
Step 3. adds five drops of methyl orange indicator to the conical flask
Step 4. places the conical flask on a white tile
Step 5. adds 0.500 mol / dm^3 hydrochloric acid from the burette while swirling the contents of the flask, adding drop by drop near the end-point, until the solution just changes colour
Step 6. empties the conical flask and rinses it with distilled water
Step 7. repeats steps 2 to 6
Step 8. repeats steps 2 to 7 using aqueous ammonia **B** instead of aqueous ammonia **A**.

(a) Fig. 2.1 shows the burette readings for the two titrations with **A**.

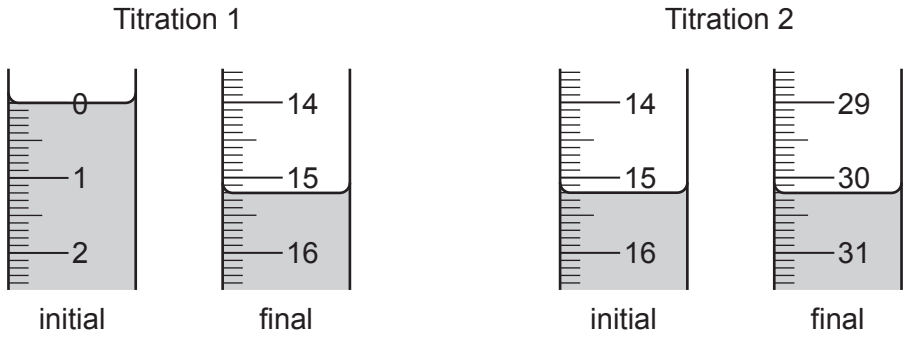


Fig. 2.1

Record the burette readings in Table 2.1.

Complete Table 2.1 with the volume used in each titration.

Table 2.1

	Titration 1	Titration 2
final burette reading / cm^3		
initial burette reading / cm^3		
volume used / cm^3		

[3]

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(b) Fig. 2.2 shows the burette readings for one of the titrations with **B**.

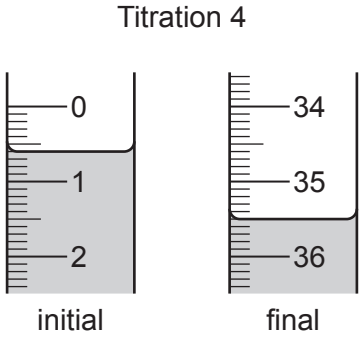


Fig. 2.2

Record the burette readings for Titration 4 in Table 2.2.

Complete Table 2.2 with the volume used in each titration.

Table 2.2

	Titration 3	Titration 4
final burette reading / cm^3	34.9	
initial burette reading / cm^3	0.2	
volume used / cm^3		

[1]

(c) Explain why the student uses a white tile in these titrations.

..... [1]

(d) Calculate the mean volume of 0.500 mol / dm^3 hydrochloric acid needed to neutralise 25.0 cm^3 of **A** and of **B**.

mean volume of acid needed for solution **A** ..... cm^3

mean volume of acid needed for solution **B** ..... cm^3

[1]

(e) The equation for the reaction between hydrochloric acid and aqueous ammonia is shown.

$$HCl + NH_3 \rightarrow NH_4Cl$$

Use the mean volume of acid needed to neutralise 25.0 cm^3 of **A** in **(d)** to calculate the concentration of ammonia in **A**.

Give your answer to an appropriate number of significant figures.

concentration ..... mol/dm^3 [2]

(f) Calculate the volume of ammonia gas measured at room temperature and pressure, r.t.p., dissolved in 25.0 cm^3 of **A**.

The volume of one mole of any gas at r.t.p. is 24 dm^3.

volume ..... dm^3 [2]

(g) Use your answers to **(d)** and **(f)** to calculate the volume of ammonia gas measured at r.t.p. dissolved in 25.0 cm^3 of **B**.

volume ..... dm^3 [1]

(h) The student rinses the burette with 0.500 mol/dm^3 hydrochloric acid immediately before it is filled.

Explain why the student should **not** rinse the burette with distilled water immediately before it is filled with 0.500 mol/dm^3 hydrochloric acid.

.....

.....

..... [2]

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(i) Suggest why universal indicator is **not** suitable for use in these titrations.

..... [1]

[Total: 14]

3 A student investigates solution **W** and solid **X**.

(a) Solution **W** is green in colour and contains Fe^{2+} ions.

(i) Describe how **W** can be shown to contain Fe^{2+} ions.

.....

..... [2]

(ii) Excess **W** is added to acidified aqueous potassium manganate(VII).

Describe the colour change seen.

from ..... to ..... [2]

(iii) Describe the observations made when a few drops of aqueous ammonia and then an excess of aqueous ammonia are added to the mixture from **(ii)**.

a few drops .....

an excess .....
[2]

(b) Solid **X** is a shiny grey metal.

The tests the student does on **X** are shown in Table 3.1.

Some of the observations for these tests are also shown.

Table 3.1

	tests on solid **X**	observations
1	Add excess dilute acid to **X** in a test-tube. The gas produced is tested.	solid disappears solution remains colourless and becomes warmer
2	Add dilute nitric acid, then add aqueous silver nitrate to some of the solution from test 1.	solution remains colourless
3	Add dilute nitric acid, then add aqueous barium nitrate to some of the solution from test 1.	white precipitate

(i) Predict the identity of the gas produced in test 1.

Describe how the student tests the gas to confirm its identity.

gas .....

test .....

observation to confirm gas .....

[3]

(ii) The observations for test 1 are incomplete.

State one **other** observation that the student makes for test 1.

..... [1]

(iii) State the conclusion you can make from test 2.

..... [1]

(iv) State the conclusion you can make from test 3.

..... [1]

(v) Identify the acid used in test 1.

..... [1]

(vi) Suggest the identity of metal **X**.

..... [1]

[Total: 14]

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4 Baking soda is used to make bread rise. When baking soda is heated, it decomposes and carbon dioxide gas is released.

Baking soda also decomposes gradually when it is stored. The longer the baking soda is stored, the less carbon dioxide it releases when it is heated.

Plan an investigation to show which of two different samples of baking soda has been stored for longer.

Your plan should include the use of common laboratory apparatus and the two samples of baking soda. No other chemicals should be used.

Your plan should include:

- the apparatus needed
- the method to use
- the measurements to take
- the variables to control
- how to use the results to determine which sample has been stored for longer.

You may draw a diagram to help you 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

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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
copper(II), Cu^{2+}	blue-green
calcium, Ca^{2+}	orange-red
barium, Ba^{2+}	light green

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