Cambridge Assessment International Education

Cambridge O Level

CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER				

0091627422

CHEMISTRY **5070/42**

Paper 4 Alternative to Practical **October/November 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.

© UCLES 2023

BLANK PAGE

1 A student investigates the electrolysis of concentrated aqueous sodium chloride.

Fig. 1.1 shows the apparatus the student uses.

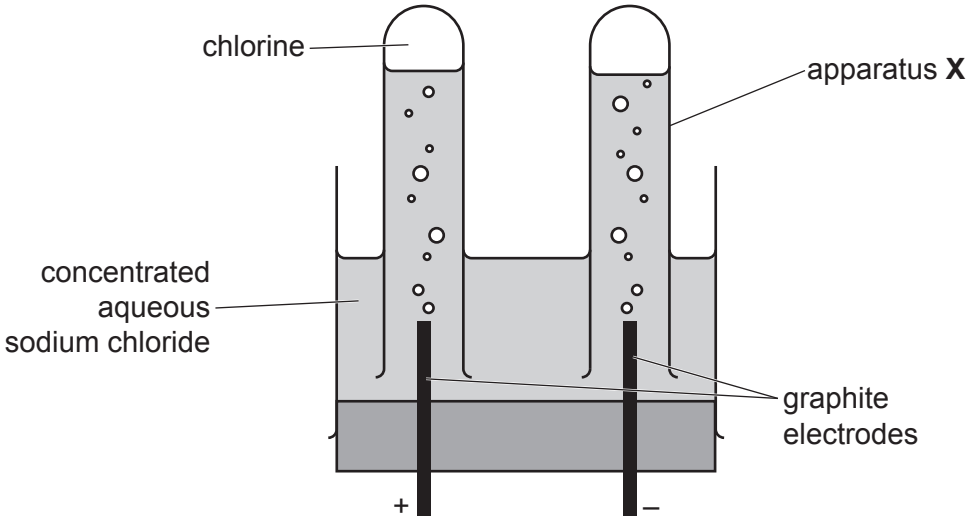


Fig. 1.1

(a) Name apparatus **X**.

..... [1]

(b) Give a reason why iron electrodes are **not** used during this electrolysis.

..... [1]

(c) Chlorine gas is produced at the anode during this electrolysis.

Describe and explain **one** safety precaution the student takes during this electrolysis.

safety precaution .....

explanation .....
[2]

(d) A different gas is produced at the cathode during this electrolysis.

Name the gas produced.

Describe a test and its result to confirm the identity of the gas.

name of gas .....

description of test and result .....

.....
[2]

[Total: 6]

2 Sulfuric acid, H_2SO_4, is neutralised when it is added to aqueous sodium hydroxide, NaOH.

$$H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2H_2O$$

The reaction is exothermic.

P is 1.25 mol / dm^3 aqueous sodium hydroxide.
Q is dilute sulfuric acid.

A student determines the concentration of sulfuric acid in **Q**.

The student does six experiments.

The student:

Step 1. uses a volumetric pipette to add 25.0 cm^3 of **P** to a plastic cup
Step 2. uses a measuring cylinder to add 20 cm^3 of distilled water to the plastic cup
Step 3. stirs the mixture in the cup with a thermometer and records its temperature to the nearest 0.5 °C
Step 4. uses a burette to add 5.0 cm^3 of **Q** to the plastic cup and stirs
Step 5. records the highest temperature reached
Step 6. empties the plastic cup and rinses it with water
Step 7. repeats steps 1–6 using five different volumes of distilled water and **Q** so that the total volume in the cup is always 50 cm^3.

The student's results are in Table 2.1.

Table 2.1

experiment number	volume of **P** / cm^3	volume of water / cm^3	volume of **Q** / cm^3	initial temperature / °C	highest temperature reached / °C	temperature rise / °C
1	25.0	20	5.0	23.0	25.5	
2	25.0	15	10.0	24.5	29.5	5.0
3	25.0	10		25.0	32.5	7.5
4	25.0	7	18.0	25.0	33.0	8.0
5	25.0	5	20.0	25.5	33.5	8.0
6	25.0		25.0	24.5	32.5	8.0

(a) Complete Table 2.1 by filling in the three missing values.

[3]

© UCLES 2023

(b) Parts of the thermometer used in Experiment 3 are shown in Fig. 2.1.

The liquid levels inside the thermometer are missing.

Complete Fig. 2.1 by drawing in the liquid level to show:
- the initial temperature in Experiment 3
- the highest temperature reached in Experiment 3.

[1]

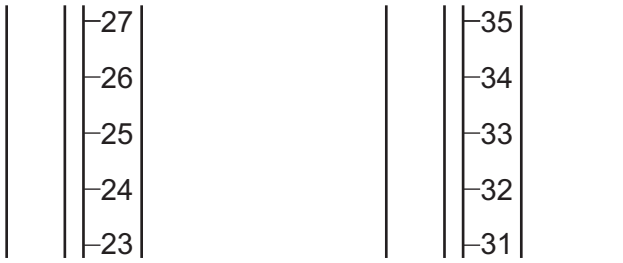


Fig. 2.1

(c) Draw a graph of temperature rise against volume of **Q** on the grid in Fig. 2.2.

You should:
- plot the point (0,0) as there is no temperature rise when no **Q** is added
- plot the temperature rises and volumes of **Q** from Table 2.1
- draw a straight line of best fit for the first four points
- draw a straight line of best fit for the last three points
- extend the lines so that they intersect.

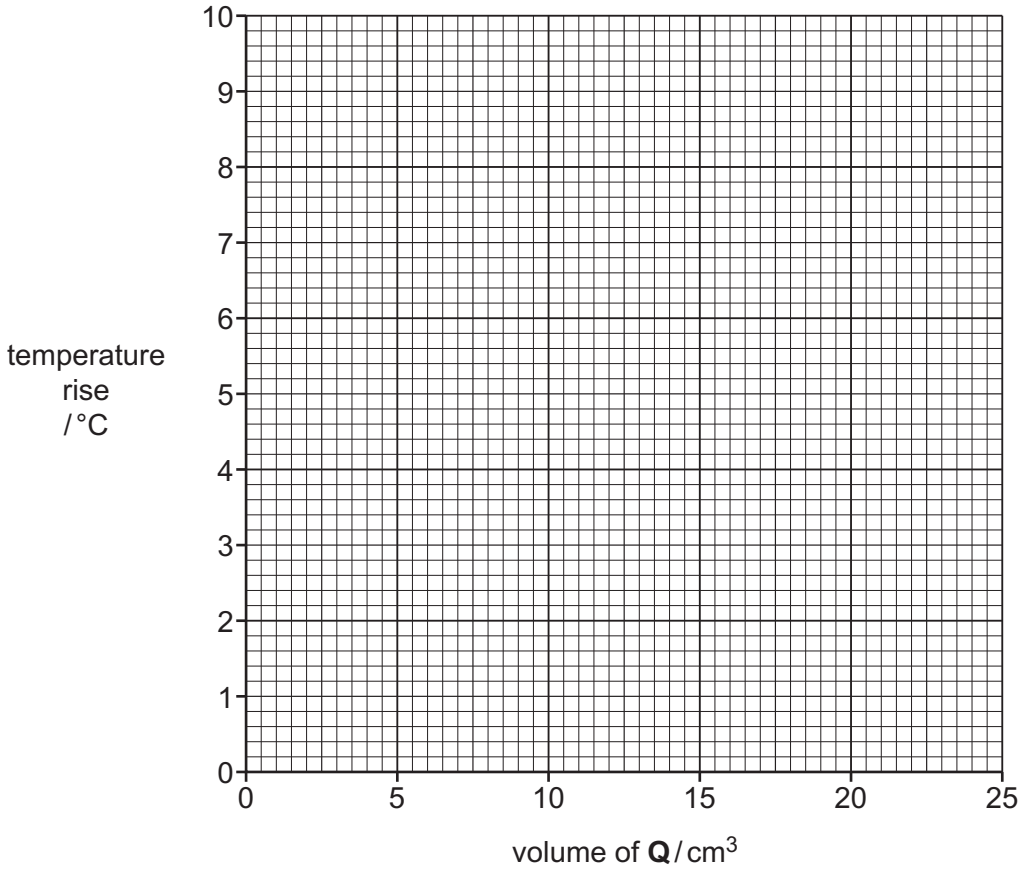


Fig. 2.2

[3]

(d) The point where the two lines intersect indicates the volume of **Q** that exactly neutralises 25.0 cm^3 of **P**.

Determine the volume of **Q** where the two lines on the graph intersect.

volume of **Q** ..... cm^3 [1]

(e) **P** is 1.25 mol/dm^3 aqueous sodium hydroxide.

Use your answer to **(d)** to calculate the concentration of sulfuric acid in **Q**.

$$2NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O$$

concentration of sulfuric acid in **Q** ..... mol/dm^3 [2]

(f) Describe and explain what happens to the gradient of the straight line for the first four points on the graph if a metal cup is used instead of a plastic cup.

.....

.....

..... [2]

(g) A burette may be used instead of a measuring cylinder to measure the volume of water in these experiments.

Suggest how this improves the experiments.

.....

..... [1]

(h) State the dependent variable in this set of experiments.

..... [1]

[Total: 14]

© UCLES 2023

BLANK PAGE

3 A student investigates solid **Y** and solution **Z**.

(a) Solid **Y** is white and contains carbonate ions.

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

Some of the observations for these tests are also shown.

Table 3.1

	tests on solid **Y**	observations
1	Add excess dilute sulfuric acid to **Y** in a boiling tube.	effervescence solid disappears
2	Add aqueous sodium hydroxide to the solution from test 1 until a change is seen.	white precipitate
3	Add more aqueous sodium hydroxide to the mixture from test 2 until a further change is seen.	white precipitate dissolves

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

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

gas .....

test and observation .....

.....

[2]

(ii) The solution produced in test 1 contains an anion.

Name a reagent that reacts with this anion to form a white precipitate when added to the solution produced in test 1 after the addition of dilute nitric acid.

..... [1]

© UCLES 2023

(iii) The observations for test 3 are incomplete.

State **one** other observation the student makes in test 3.

..... [1]

(iv) Solid **Y** contains only one cation. The student cannot identify the cation from the observations in Table 3.1.

Use Table 3.1 to name the **two** cations which could be present in **Y**.

.....

..... [2]

(v) Describe an additional test the student does on the solution produced in test 1 to identify the cation in **Y**.

.....

.....

..... [2]

(b) Solution **Z** contains **one** cation and **one** anion. The cation contains two non-metals.

(i) The student adds aqueous sodium hydroxide to **Z** in a boiling tube.

Describe how the student completes this test to identify the cation in **Z**.

.....

.....

..... [3]

(ii) The student adds dilute nitric acid and then aqueous silver nitrate to **Z**.

A precipitate is formed. It is difficult to tell if the precipitate is white or cream in colour.

Describe how the student uses separate aqueous solutions of a chloride and a bromide to decide the colour of the precipitate.

.....

.....

..... [2]

(iii) The student adds dilute nitric acid and then aqueous barium nitrate to **Z**.

Predict the expected observation.

..... [1]

[Total: 14]

4 Copper(II) sulfate is a salt used to kill pests on plant leaves.

Copper(II) sulfate is prepared by neutralising dilute sulfuric acid with solid copper(II) oxide.

Plan an experiment to prepare pure dry crystals of copper(II) sulfate.

Your plan should include the use of:

- common laboratory apparatus
- dilute sulfuric acid
- solid copper(II) oxide.

No other chemicals should be used.

Your plan should include:

- the apparatus needed
- the method to use.

You may draw a diagram to help answer the question.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

[6]

BLANK PAGE

BLANK PAGE

BLANK PAGE

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

© UCLES 2023

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

Permission to reproduce items where third-party owned material protected by copyright is included has been sought and cleared where possible. Every reasonable effort has been made by the publisher (UCLES) to trace copyright holders, but if any items requiring clearance have unwittingly been included, the publisher will be pleased to make amends at the earliest possible opportunity.

To avoid the issue of disclosure of answer-related information to candidates, all copyright acknowledgements are reproduced online in the Cambridge Assessment International Education Copyright Acknowledgements Booklet. This is produced for each series of examinations and is freely available to download at www.cambridgeinternational.org after the live examination series.

Cambridge Assessment International Education is part of Cambridge Assessment. Cambridge Assessment is the brand name of the University of Cambridge Local Examinations Syndicate (UCLES), which is a department of the University of Cambridge.

© UCLES 2023