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Cambridge Assessment International Education

Cambridge O Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

5113876523

CHEMISTRY **5070/41**

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

[Turn over

1 A teacher investigates the electrolysis of molten lead(II) bromide.

Lead(II) bromide is a solid at room temperature.

Fig. 1.1 shows the apparatus the teacher uses.

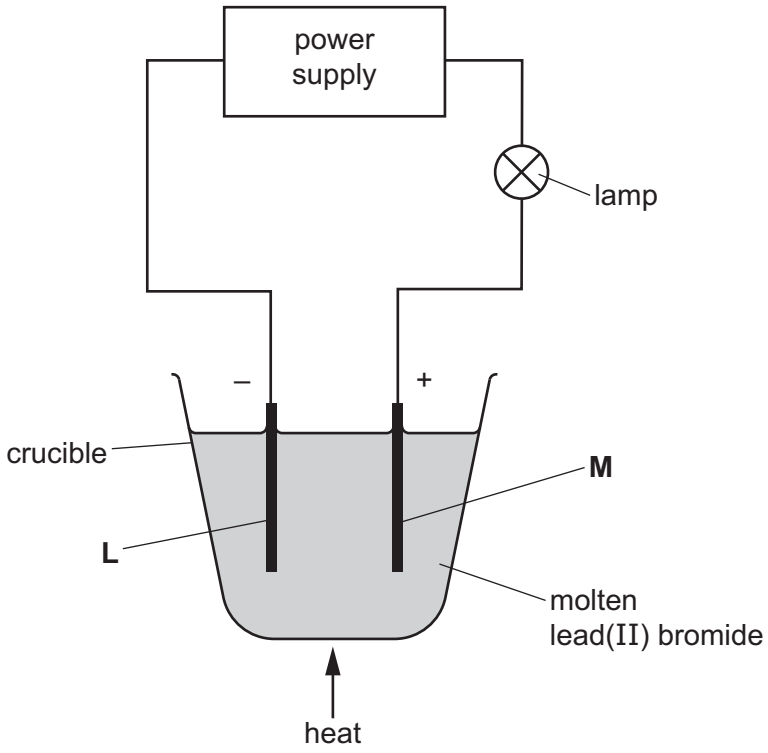

Fig. 1.1

(a) Name the pieces of apparatus labelled **L** and **M**.

Suggest the material from which **L** and **M** are made.

name .....

material .....

[2]

(b) Describe the appearance of the products at **L** and at **M**.

appearance of product at **L** .....

appearance of product at **M** .....

[2]

(c) The teacher stops heating and allows the lead(II) bromide to cool.

Explain why the lamp goes out.

.....

.....

..... [2]

[Total: 6]

2 A student titrates four samples of 0.800 mol / dm^3 aqueous sodium hydroxide, NaOH(aq), with aqueous ethanedioic acid.

In titration 1 the student:

- rinses and fills a burette with aqueous ethanedioic acid
- uses a volumetric pipette to add 25.0 cm^3 of NaOH(aq) to a conical flask
- adds thymolphthalein indicator to the conical flask
- places the conical flask on a white tile
- adds aqueous ethanedioic acid 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.

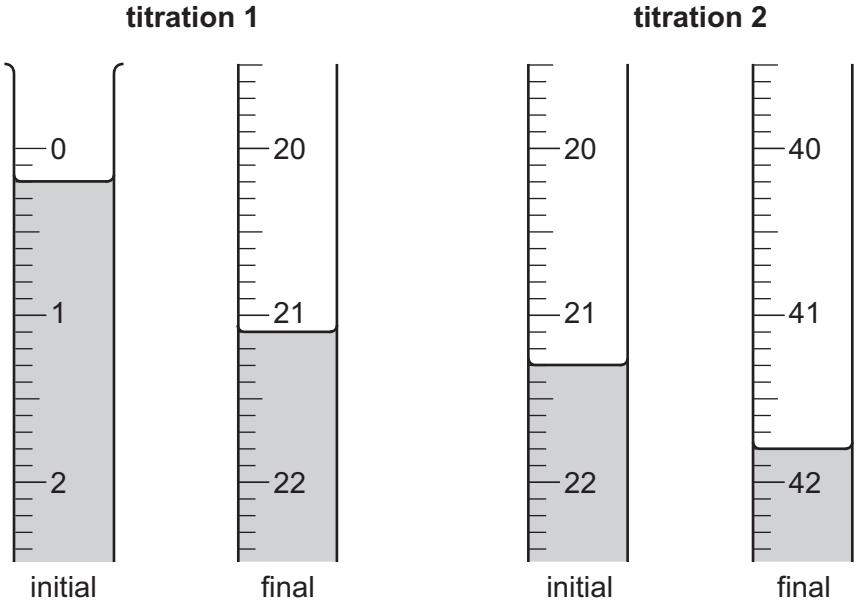

Fig. 2.1

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			20.1	40.4
initial burette reading / cm^3				20.5
volume of ethanedioic acid added / cm^3			20.1	
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 aqueous ethanedioic acid needed to neutralise 25.0 cm^3 of the aqueous sodium hydroxide.

volume ..... cm^3 [1]

(d) Calculate the number of moles of NaOH in 25.0 cm^3 of 0.800 mol/dm^3 NaOH(aq).

number of moles ..... [1]

(e) One mole of ethanedioic acid is neutralised by two moles of sodium hydroxide.

Use your answers to **(c)** and **(d)** to calculate the concentration, in mol/dm^3, of ethanedioic acid.

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

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

(f) The formula of ethanedioic acid is $C_2H_2O_4 \cdot nH_2O$.

(i) 100 cm^3 of the aqueous ethanedioic acid contains 6.3 g of $C_2H_2O_4 \cdot nH_2O$.

Use your answer from **(e)** to calculate the relative formula mass, M_r, of $C_2H_2O_4 \cdot nH_2O$.

M_r ..... [2]

(ii) Use your answer from **(f)(i)** to deduce the value of n in $C_2H_2O_4 \cdot nH_2O$.

Give your answer to the nearest whole number.

[A_r: H, 1; C, 12; O, 16]

n ..... [1]

(g) State why the conical flask is placed on a white tile before aqueous ethanedioic acid is added from the burette.

..... [1]

(h) State why a measuring cylinder is **not** used to measure 25.0 cm^3 of NaOH(aq) in this experiment.

..... [1]

[Total: 14]

Question 3 starts on page 8.

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

(a) Solid **Y** is a white powder.

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 acid to **Y** in a boiling tube. The gas produced is tested using limewater.	colourless solution formed limewater becomes milky
2	Add dilute nitric acid to some of the solution from test 1. Then add aqueous barium nitrate.	 white precipitate
3	Add aqueous sodium hydroxide drop by drop to some of the solution from test 1 until a change is seen. Then add excess aqueous sodium hydroxide.	white precipitate soluble in excess giving a colourless solution
4	Add aqueous ammonia drop by drop to some of the solution from test 1 until a change is seen. Then add excess aqueous ammonia.	white precipitate soluble in excess giving a colourless solution

(i) Describe how the gas is passed through limewater in test 1.

You may draw a labelled diagram to help answer the question.

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[1]

(ii) Describe two **other** observations the student makes in test 1.

1. .....

2. .....

[2]

(iii) Identify the gas produced in test 1.

..... [1]

(iv) **Y** contains one anion. Use the observations from test 1 to identify this anion.

..... [1]

(v) Use the observations from test 2 to identify the dilute acid used in test 1.

..... [1]

(vi) Identify the cation in **Y** using the observations from tests 3 **and** 4.

..... [1]

(b) Solution **Z** is colourless.

(i) The student thinks that **Z** contains Cu^{2+} ions.

State why the student is **not** correct.

..... [1]

(ii) Solution **Z** contains K^+ ions.

Describe how to do a flame test on solution **Z** to confirm the identity of this cation.

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..... [3]

(iii) Solution **Z** contains ions of a Group VII element.

Describe a test and the possible results to identify which Group VII ion is present in **Z**.

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..... [3]

[Total: 14]

Question 4 starts on page 12.

4 Argentan is an alloy containing only zinc, nickel and copper.

Zinc and nickel both react with dilute hydrochloric acid. Copper does **not** react with dilute hydrochloric acid.

Plan an investigation to find the percentage by mass of copper in a powdered sample of argentan.

Your plan must include the use of common laboratory apparatus, argentan and dilute hydrochloric 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 copper in the sample.

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