Cambridge Assessment International Education

Cambridge O Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

14921511121

CHEMISTRY **5070/42**

Paper 4 Alternative to Practical **May/June 2022**

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 60.
- The number of marks for each question or part question is shown in brackets [ ].

This document has **16** pages. Any blank pages are indicated.

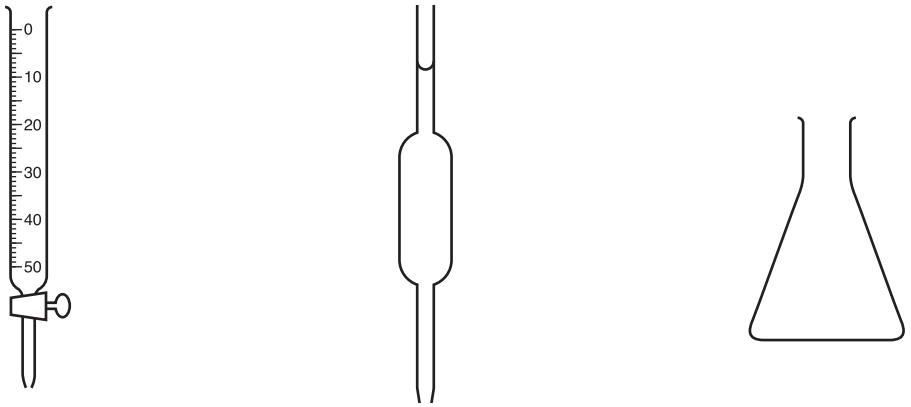
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1 A student determines the concentration of aqueous potassium manganate(VII), $KMnO_4$, by titration with a solution of ethanedioic acid, $H_2C_2O_4$.

An equation to represent this reaction is shown.

$$2KMnO_4 + 5H_2C_2O_4 + 6H^+ \rightarrow 2Mn^{2+} + 10CO_2 + 8H_2O + 2K^+$$

(a) Diagrams of some of the pieces of apparatus the student uses are shown.



A **B** **C**

Name the three pieces of apparatus.

A .....

B .....

C .....

[3]

(b) The student:

- records the mass of a sample of solid ethanedioic acid
- dissolves the solid in distilled water and makes the solution up to 250 cm^3
- uses apparatus **B** to transfer 25.0 cm^3 of the solution of $H_2C_2O_4$ into apparatus **C**
- adds 10.0 cm^3 of dilute sulfuric acid to apparatus **C**
- fills apparatus **A** with the solution of $KMnO_4$
- titrates the colourless solution of $H_2C_2O_4$ with the solution of $KMnO_4$ until the end-point is reached
- repeats the titration three more times.

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(i) Suggest why sulfuric acid is added to apparatus **C**.

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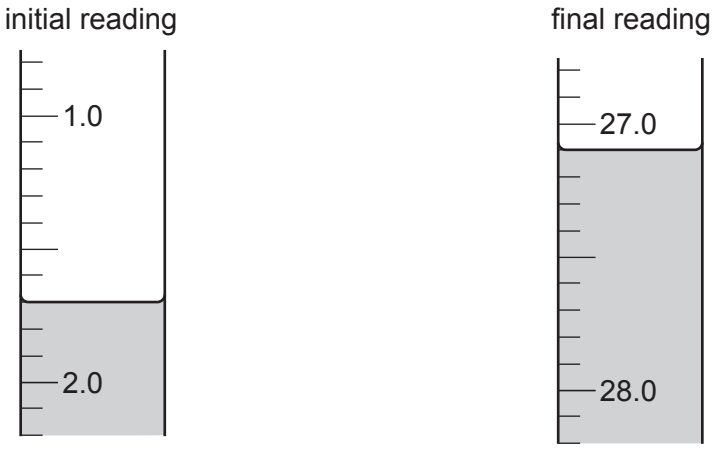
..... [1]

(ii) State the colour change at the end-point.

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

(iii) The diagrams show parts of apparatus **A** with the liquid levels at the beginning and the end of titration **1**.

titration **1**



Record the values in the results table.

Complete the results table.

titration	1	2	3	4
final reading / cm^3		24.8	25.9	24.9
initial reading / cm^3		0.0	0.8	
volume used / cm^3		24.8		24.6
best titration results (✓)				

[3]

(iv) Tick (✓) the best titration results in the table.

Use the ticked values to calculate the average volume of $KMnO_4(aq)$ added in cm^3.

average volume of $KMnO_4(aq)$ added ..... cm^3 [1]

(c) Another student repeats the experiment using the same method.

This student uses 1.08 g of ethanedioic acid to make up the 250 cm^3 solution of $H_2C_2O_4$.

The student obtains an average titration volume of 24.55 cm^3.

(i) Calculate the number of moles of ethanedioic acid in 25.0 cm^3 of the $H_2C_2O_4(aq)$.

Show your working.

[M_r: $H_2C_2O_4$, 90]

..... mol [2]

(ii) During the reaction, two moles of $KMnO_4$ react with five moles of $H_2C_2O_4$.

Calculate the number of moles of $KMnO_4$ in 24.55 cm^3 of the aqueous potassium manganate(VII).

..... mol [1]

(iii) Calculate the concentration, in mol / dm^3, of the $KMnO_4(aq)$.

..... mol / dm^3 [1]

(iv) Calculate the concentration, in g / dm^3, of the $KMnO_4(aq)$.

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

[M_r: $KMnO_4$, 158]

..... g / dm^3 [1]

[Total: 14]

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2 **(a)** A solution contains one cation and two different anions.

The table shows the tests a student does on this solution.

Complete the table.

Name any gases formed.

test	observations	conclusions
(i) To 1 cm depth of the solution in a test-tube, add a small volume of aqueous sodium hydroxide. Then add more aqueous sodium hydroxide until it is in excess.	....	The cation might be Al^{3+}. The cation could also be ..... .
(ii) To 1 cm depth of the solution in a boiling tube, add a small volume of aqueous ammonia. Then add more aqueous ammonia until it is in excess.	....	The cation is Al^{3+}.
(iii) To 1 cm depth of the solution in a test-tube add nitric acid and warm until no further change is seen.	A gas is evolved that decolourises acidified potassium manganate(VII) solution.	The gas is ..... . One of the anions is ..... .
(iv) To the solution from **(iii)** add aqueous silver nitrate.	A yellow precipitate forms.	The other anion is ..... .

[4]

[2]

[2]

[1]

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(b) A mixture of solids contains barium sulfate and sodium chloride only.

Barium sulfate is insoluble in water. Sodium chloride is soluble in water.

Describe how to separate the mixture to obtain pure barium sulfate and pure crystals of sodium chloride.

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..... [6]

[Total: 15]

3 A student measures the temperature change during the reaction between HC*l*(aq) and aqueous sodium hydroxide, NaOH(aq).

$$NaOH(aq) + HCl(aq) \rightarrow NaCl(aq) + H_2O(l)$$

(a) The student:

- uses a measuring cylinder to add 25 cm^3 of 1.50 mol / dm^3 NaOH(aq) to a glass beaker
- records the temperature of the NaOH(aq)
- adds 4.0 cm^3 of the HC*l*(aq) to the beaker and records the highest temperature reached
- adds further 4.0 cm^3 portions of the HC*l*(aq), and records the highest temperature reached each time.

The student's results are shown.

total volume of HC*l*(aq) / cm^3	0	4.0	8.0	12.0	16.0	20.0	24.0	28.0	32.0
temperature / °C	24.5	25.0	28.5	30.5	32.5	32.5	31.5	30.5	29.5

(i) Name the type of reaction that takes place between HC*l*(aq) and NaOH(aq).

..... [1]

(ii) Name a piece of apparatus that can improve the accuracy of the volume of NaOH(aq) added to the beaker.

..... [1]

(iii) Name the piece of apparatus used to add the 4.0 cm^3 portions of HC*l*(aq).

..... [1]

(iv) Explain why the glass beaker is **not** the most suitable piece of apparatus for this experiment.

Suggest an improvement.

explanation .....

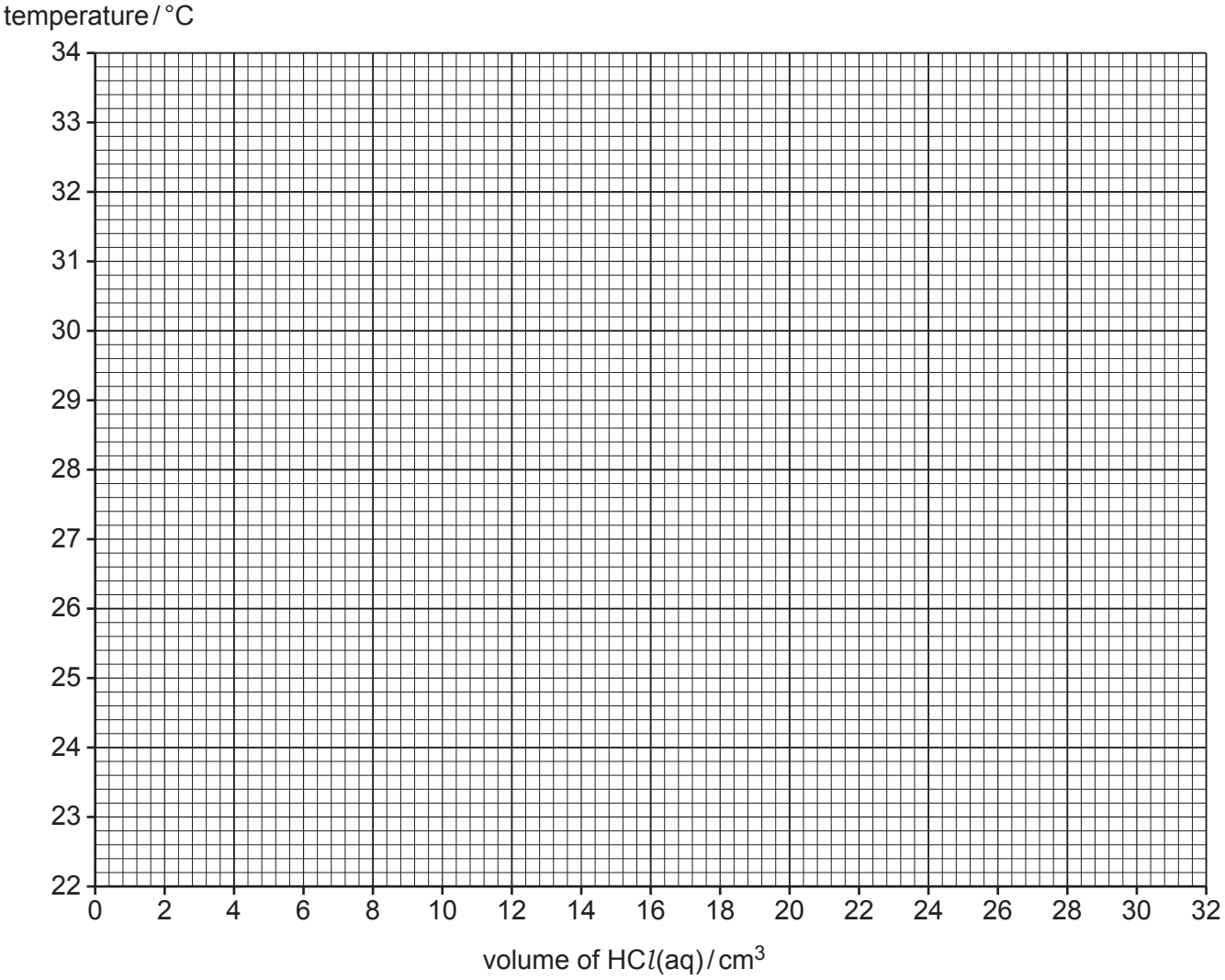
.....

improvement .....

.....

[2]

(v) Plot the values of temperature against total volume of HC*l*(aq) on the grid.



[2]

(vi) Circle the anomalous point on the grid. [1]

(vii) Draw a straight line of best fit through the points from 0 to 16 cm^3. [1]

(viii) Draw a straight line of best fit through the points from 20 to 32 cm^3.

Extrapolate both lines so that they intersect. [2]

(ix) Use the intersection to determine the minimum volume of HC*l*(aq) needed to react with all of the NaOH(aq).

volume of HC*l*(aq) ..... cm^3 [1]

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[Turn over

(x) Use the intersection to determine the temperature change, ΔT, due to the reaction.

ΔT ..... °C [1]

(xi) The heat change during this reaction is calculated using the expression shown.

heat change = mass of solution × specific heat capacity × temperature change

1.0 cm^3 of this solution has a mass of 1.0 g.

Determine the value used for the mass of solution in the calculation of this heat change.

mass ..... g [1]

(b) The actual heat change of this reaction is much greater than the value calculated using the expression in **(a)(xi)**.

Suggest a reason for this difference.

.....

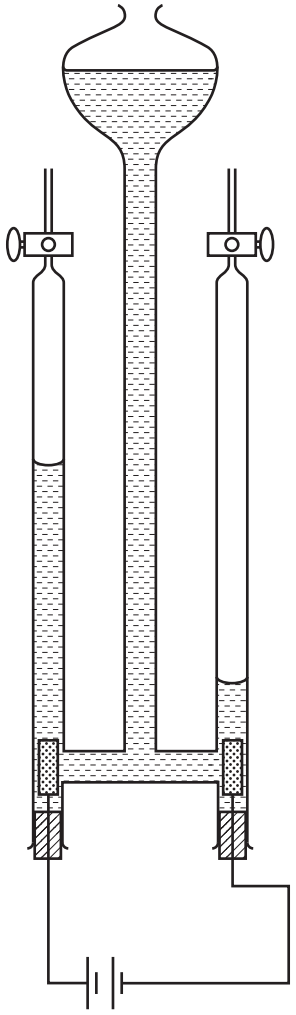
..... [1]

[Total: 15]

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4 The apparatus shown is used for the electrolysis of dilute sulfuric acid to produce hydrogen gas and oxygen gas.



(a) The electrodes are made of platinum.

Give the name of each electrode.

positive electrode .....

negative electrode .....

[2]

(b) The equation for the reaction at the positive electrode is shown.

$$4OH^- \longrightarrow O_2 + 2H_2O + 4e^-$$

(i) Give the equation for the reaction at the negative electrode.

..... [2]

(ii) Describe tests used to identify the gases produced.

oxygen

test .....

observations .....

.....

hydrogen

test .....

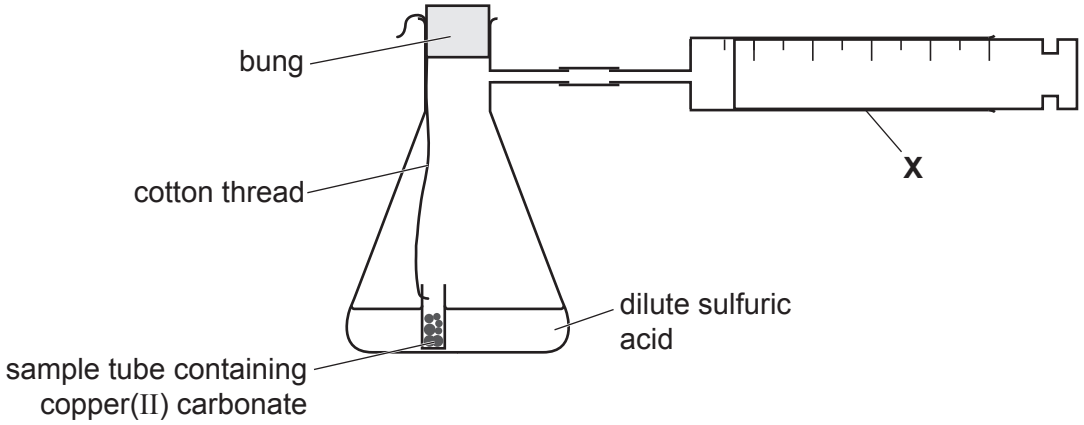
observations .....

[4]

[Total: 8]

5 A student uses the apparatus shown to investigate the rate of reaction between excess copper(II) carbonate and dilute sulfuric acid.

$$CuCO_3(s) + H_2SO_4(aq) \rightarrow CuSO_4(aq) + CO_2(g) + H_2O(l)$$



(a) Identify the piece of apparatus labelled **X**.

..... [1]

(b) The student starts the reaction by tipping the sample tube so that the copper(II) carbonate and acid come into contact.

Explain why this method is used instead of adding the copper(II) carbonate to the acid and then replacing the bung.

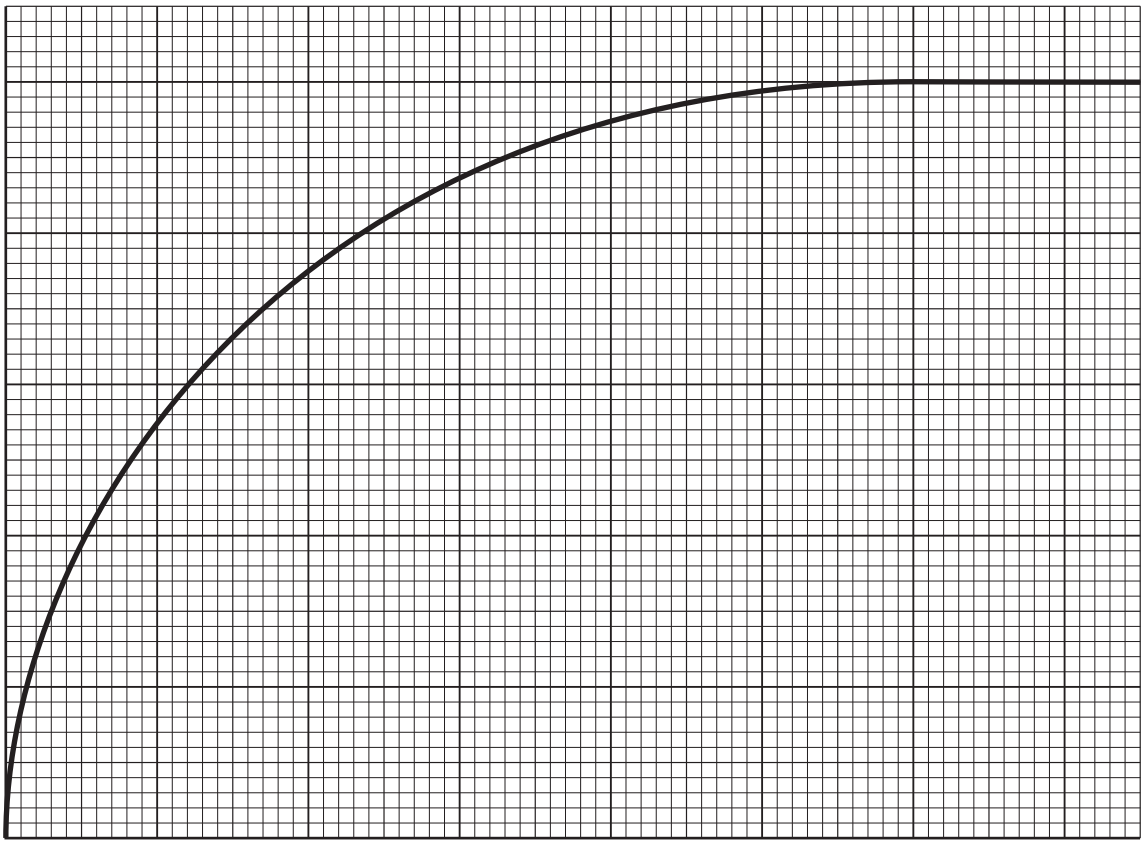
.....

..... [1]

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(c) The student takes a reading on apparatus **X** every 10 seconds until the reaction has stopped.

The student plots a graph of the results.



(i) Give the labels for each axis of the graph.

horizontal axis .....

vertical axis .....

[1]

(ii) List three things the student **sees** happening in the flask during the reaction.

1 .....

2 .....

3 .....

[3]

(iii) Use the graph to explain what happens to the rate of reaction during the reaction.

.....

.....

.....

..... [2]

[Total: 8]

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