



CANDIDATE
NAME

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CENTRE
NUMBER

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CANDIDATE
NUMBER

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5070/42

May/June 2022

1 hour

You must answer on the question paper.

No additional materials are needed.

- 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.

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

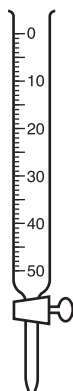
This document has **16** pages. Any blank pages are indicated.

- 1 A student determines the concentration of aqueous potassium manganate(VII), KMnO_4 , by titration with a solution of ethanedioic acid, $\text{H}_2\text{C}_2\text{O}_4$.

An equation to represent this reaction is shown.



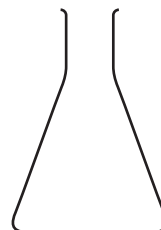
- (a) Diagrams of some of the pieces of apparatus the student uses are shown.



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 $\text{H}_2\text{C}_2\text{O}_4$ 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 $\text{H}_2\text{C}_2\text{O}_4$ with the solution of KMnO_4 until the end-point is reached
- repeats the titration three more times.

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

.....
 [1]

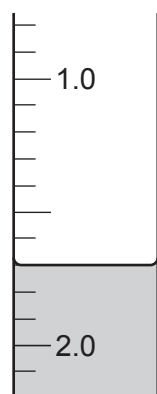
- (ii) State the colour change at the end-point.

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

initial reading



final reading



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 KMnO₄(aq) added in cm³.

average volume of KMnO₄(aq) added cm³ [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 cm³ solution of H₂C₂O₄.

The student obtains an average titration volume of 24.55 cm³.

- (i) Calculate the number of moles of ethanedioic acid in 25.0 cm³ of the H₂C₂O₄(aq).

Show your working.

[*M_r*: H₂C₂O₄, 90]

..... mol [2]

- (ii) During the reaction, two moles of KMnO₄ react with five moles of H₂C₂O₄.

Calculate the number of moles of KMnO₄ in 24.55 cm³ of the aqueous potassium manganate(VII).

..... mol [1]

- (iii) Calculate the concentration, in mol/dm³, of the KMnO₄(aq).

..... mol/dm³ [1]

- (iv) Calculate the concentration, in g/dm³, of the KMnO₄(aq).

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

[*M_r*: KMnO₄, 158]

..... g/dm³ [1]

[Total: 14]

- 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	[4]
(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+}.	[2]
(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	[2]
(iv) To the solution from (iii) add aqueous silver nitrate.	A yellow precipitate forms.	The other anion is	[1]

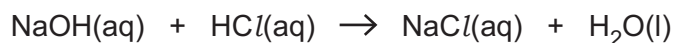
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Describe how to separate the mixture to obtain pure barium sulfate and pure crystals of sodium chloride.

[6]

[Total: 15]

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



(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 HCl(aq) to the beaker and records the highest temperature reached
- adds further 4.0 cm^3 portions of the HCl(aq) , and records the highest temperature reached each time.

The student's results are shown.

total volume of $\text{HCl(aq)}/\text{cm}^3$	0	4.0	8.0	12.0	16.0	20.0	24.0	28.0	32.0
temperature/ $^{\circ}\text{C}$	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 HCl(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 HCl(aq) .

..... [1]

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

Suggest an improvement.

explanation

.....

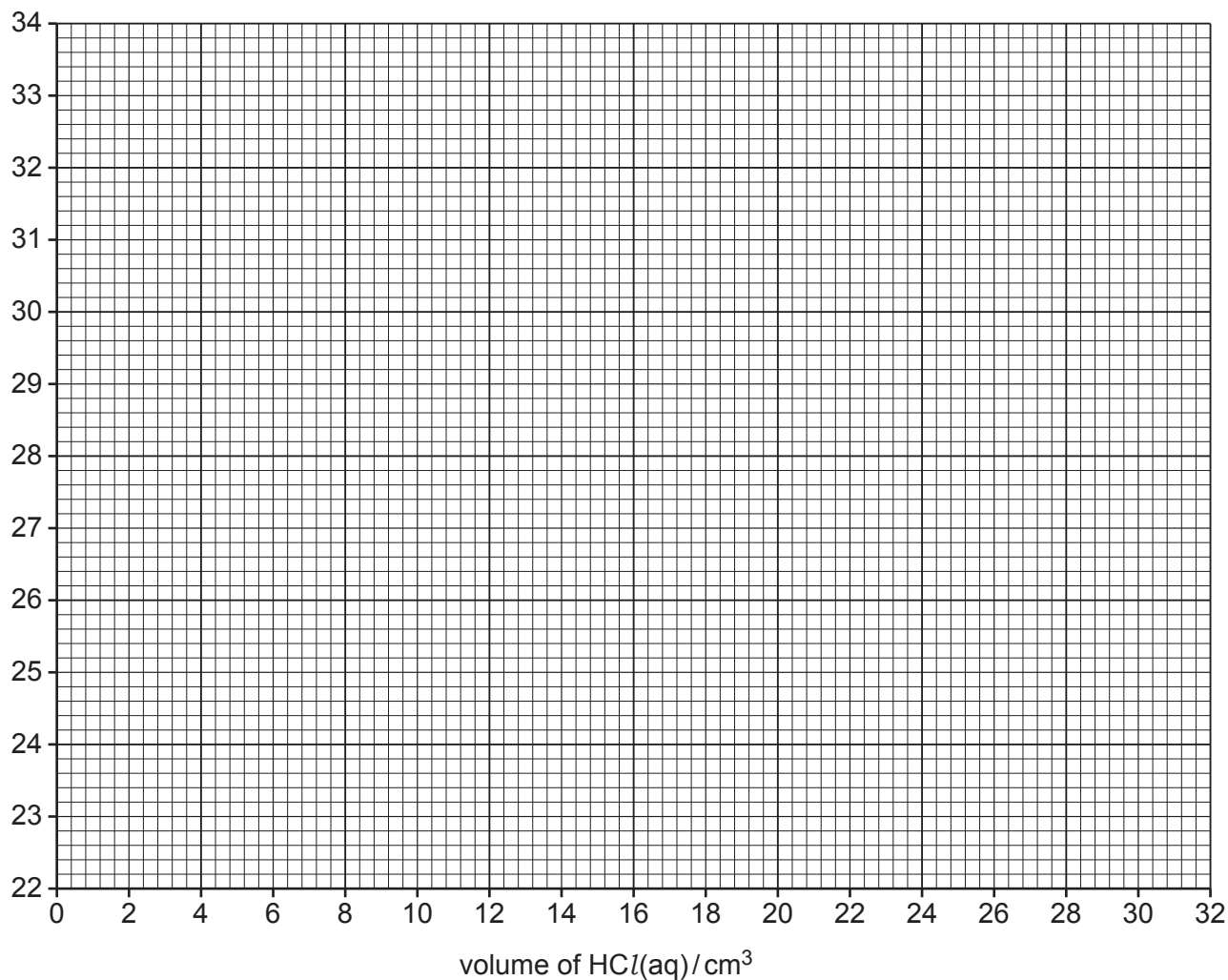
improvement

.....

[2]

(v) Plot the values of temperature against total volume of HCl(aq) on the grid.

temperature / $^{\circ}\text{C}$



[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 HCl(aq) needed to react with all of the NaOH(aq) .

volume of HCl(aq) cm^3 [1]

- (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 $\times$ specific heat capacity $\times$ temperature change

1.0 cm³ 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.

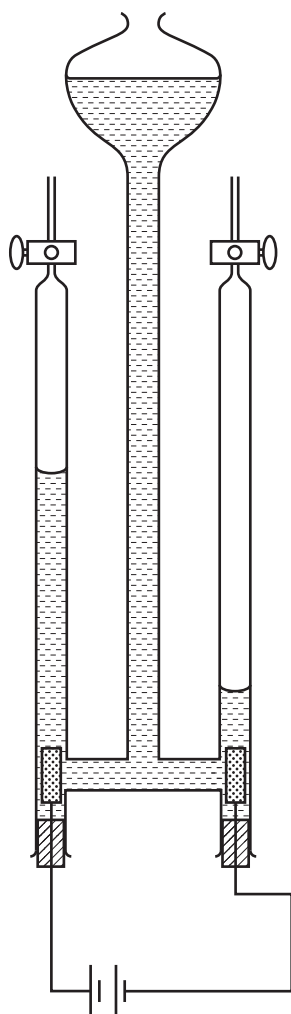
.....

..... [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.



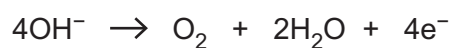
- (a) The electrodes are made of platinum.

Give the name of each electrode.

positive electrode

negative electrode [2]

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



- (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

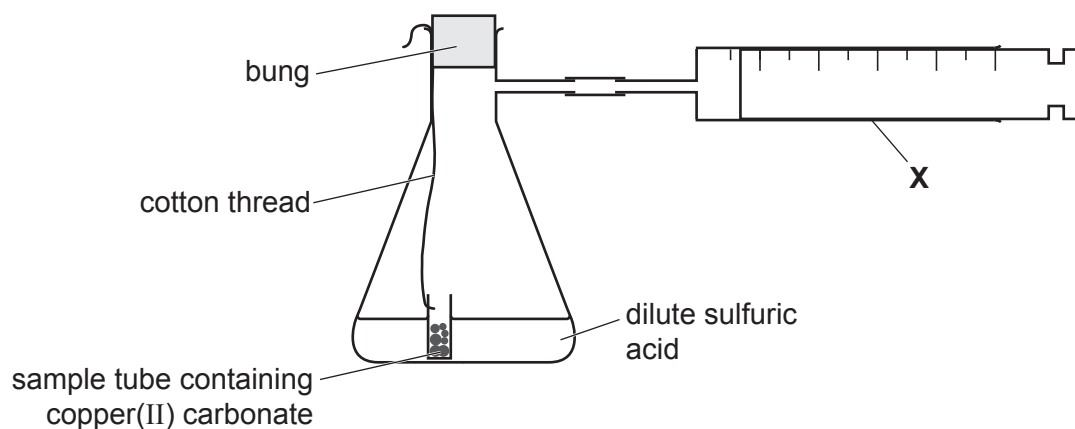
test

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.



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

..... [1]

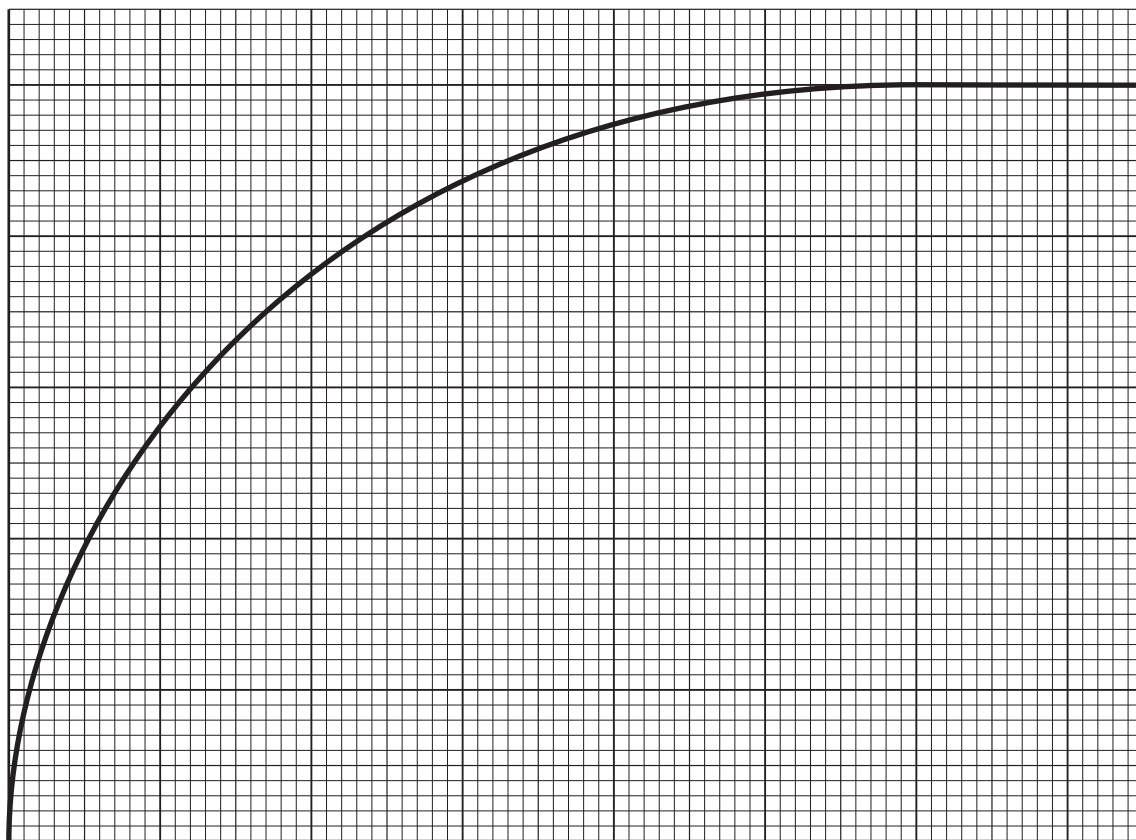
- (b) The student starts the reaction by tipping the sample tube so that the copper(II) carbonate and acid come into contact.

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

.....
 [1]

- (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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