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SECONDARY 4

G3 Express Exam Paper

G3 Pure Chem Practical (Paper 3)

1	Assumption English	Prelim
2	Christ Church	Prelim
3	Hua Yi Sec	Prelim
4	Junyuan Sec	Prelim
5	Kuo Chuan	Prelim
6	Maris Stella	Prelim
7	Pasir Ris Sec	Prelim
8	Paya Lebar MGS	Prelim
9	Presbyterian High	Prelim
10	Seng Kang Sec	Prelim
11	Tanjong Katong Girls	Prelim
12	Woodgrove Sec	Prelim
13	Xinmin Sec	Prelim
14	Yishun Town	Prelim
15	Zhonghua Sec	Prelim

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Name: ()

**ASSUMPTION ENGLISH SCHOOL
PRELIMINARY EXAMINATION 2025**

**CHEMISTRY
6092 / 03**



**ASSUMPTION
ENGLISH**

A Montfortian Gabrielite Education Institution

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LEVEL: Sec 4 Express

DATE: 26 August 2025

CLASS: Sec 4/1

DURATION: 1 hour 50 minutes

Additional Materials provided: NIL

INSTRUCTIONS TO CANDIDATES

Do not open this booklet until you are told to do so.

Write your NAME and INDEX NUMBER at the top of this page.

Write in dark blue or black pen on both sides of the paper.

You may use a soft pencil for any diagrams, graphs, tables or rough working.

Do not use staples, paper clips, highlighters, glue or correction fluid.

Answer **ALL** questions in the spaces provided.

The number of marks is given in brackets [] at the end of each question or part question.

Qualitative Analysis Notes are printed on page 13.

For Examiner's use:	
Total	/ 40

This Question Paper consists of 13 printed pages including this page.

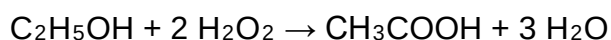
[Turn over

Answer **all** questions in the spaces provided.

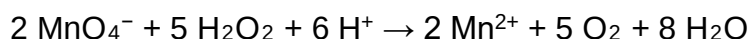
1 Ethanol is the main component of wine.

You are going to use titration to determine the concentration of ethanol in a sample of wine.

Fenton's reagent is a mixture of hydrogen peroxide and trace amounts of iron(II) sulfate. The iron(II) sulfate acts as a catalyst for this reaction. When excess Fenton's reagent is added to ethanol, the ethanol is oxidised to form ethanoic acid and water according to the chemical equation.



The amount of unreacted Fenton's reagent can be found by titration with acidified potassium manganate(VII). The ionic equation for the reaction is shown.



Read all the instructions carefully before starting the experiments in Question 1.

Instructions

P is 0.2 mol/dm³ aqueous potassium manganate(VII).

Q is a solution containing ethanoic acid and unreacted Fenton's reagent which is formed by adding 100 cm³ of 0.2 mol/dm³ Fenton's reagent to 5 cm³ of wine.

R is dilute sulfuric acid.

- (a) (i)** Fill a burette with **P**. As the colour of the solution is intense, you should obtain burette readings by reading the top of the meniscus.

Use a pipette to transfer 25.0 cm³ of **Q** into a conical flask.

Use a measuring cylinder to measure and transfer 20.0 cm³ of **R** into the same conical flask.

Add **P** from the burette to the flask. At first, the purple colour disappears rapidly. At the end point, one drop of **P** produces a permanent pale pink colour that does not disappear on swirling.

Record your titration results in the space provided. Repeat the titration as many times as you consider necessary to achieve consistent results.

Results

[5]

- (ii) From your titration results, obtain the average volume of **P** to be used in your calculations. Show clearly how you obtained this volume.

average volume of **P** = [1]

- (b) (i) Calculate the number of moles of potassium manganate(VII) used to react with the unreacted Fenton's reagent in **Q**.

number of moles of potassium manganate(VII) = [1]

- (ii) Use your answer from (b)(i) and the equation for the reaction to calculate the number of moles of unreacted Fenton's reagent in **Q**.

number of moles of unreacted Fenton's reagent in **Q** = [1]

- (iii) Use your answer from **(b)(ii)** to calculate the volume of unreacted Fenton's reagent in **Q**.

volume of unreacted Fenton's reagent in **Q** = [1]

- (iv) Use your answer from **(b)(iii)** to calculate the volume of Fenton's reagent that reacted with ethanol.

volume of Fenton's reagent that reacted with ethanol = [1]

- (v) Use your answer from **(b)(iv)** to calculate the concentration of ethanol in the sample of wine.

concentration of ethanol in the sample of wine = [4]

- (c) Potassium manganate(VII) is unreactive to the ethanoic acid in Q. However, at extremely high temperatures, Potassium manganate(VII) can also oxidise ethanoic acid.

Describe how your calculated concentration of ethanol would change if the experiment was conducted at high temperatures.

.....
.....
.....
..... [2]

- (d) Identify one source of error for this experiment and suggest an improvement that would avoid this source of error.

source of error
.....
improvement
..... [2]

[Total: 18]

2 Read all the instructions carefully before starting the experiments in Question 2.

You are provided with a sample of dilute acid **X**, and a stoppered boiling tube containing salt **Y**.

Instructions

- (a)** Carry out the following tests. You should test and identify any gases evolved. Record your observations in the table.

The volumes given below are approximate and should be estimated rather than measured.

If no observable change is observed for a test, write 'no observable change'.

test	observations
Add about 2 cm depth of X into a clean test-tube. Add a few drops of barium nitrate.	[1]
Add about 2 cm depth of X into a clean test-tube. Add a few drops of silver nitrate.	[1]
Add about 2 cm ³ of X into the boiling tube containing Y . Add an equal volume of aqueous sodium hydroxide. Gently warm the mixture.	[3]

- (b)** Deduce the formulae of acid **X** and salt **Y**.

X is **Y** is [1]

[Total: 6]

3 Read all the instructions carefully before starting the experiments in Question 3.

You are given the same acid **X** from Question 2.

You are also provided with 5 stoppered test-tubes containing **Z** which is copper(II) carbonate.

It is known that **X** and **Z** react to form carbon dioxide gas. The evolution of carbon dioxide gas causes visible bubbling to occur in the reaction flask.

You will investigate the relationship between the rate of reaction and the concentration of **X**. The rate of reaction can be estimated by measuring the time taken for effervescence in the reaction flask to stop.

Experiment 1

- Use a 10 cm³ measuring cylinder to measure 10.0 cm³ of **X**.
- Pour **X** into the test-tube containing **Z** and immediately start the stopwatch. Stir the solution constantly using a glass rod.
- Stop the stopwatch as soon as you can no longer see visible effervescence in the test-tube. Record the time to the nearest second in the results table on page 8.
- Empty the contents of the test-tube into the WASTE container provided.

Experiment 2

- Use a 10 cm³ measuring cylinder to measure 8.0 cm³ of deionised water. Add 2.0 cm³ of **X** to make the total volume 10.0 cm³.
- Pour the mixture of **X** and water into another test-tube containing **Z** and immediately start the stopwatch. Stir the solution constantly using a glass rod.
- Stop the stopwatch as soon as you can no longer see visible effervescence in the test-tube. Record the time to the nearest second in the results table on page 8.
- Empty the contents of the test-tube into the WASTE container provided.

Experiments 3 to 5

- Choose 3 further volumes of **X** between 2.0 cm³ and 10.0 cm³ and deionised water. Record the volumes you have chosen in the results table provided on page 8.
- Follow the instructions for Experiment 2 for each pair of volumes you have chosen. You should use a fresh test-tube of **Z** in each experiment.

(a) (i) Results

experiment	volume of X / cm ³	volume of water / cm ³	reaction time / s	rate of reaction / s ⁻¹
1	10.0	0.0		
2	2.0	8.0		
3				
4				
5				

[2]

- (ii)** Calculate the rate of reaction in each experiment using the following equation.

$$\text{rate of reaction} = \frac{1000}{\text{reaction time}}$$

Record each rate in the results table above to three significant figures. [1]

- (b)** Visual observation of effervescence to determine the endpoint of the reaction is convenient but unreliable to accurately determine the rate of reaction.

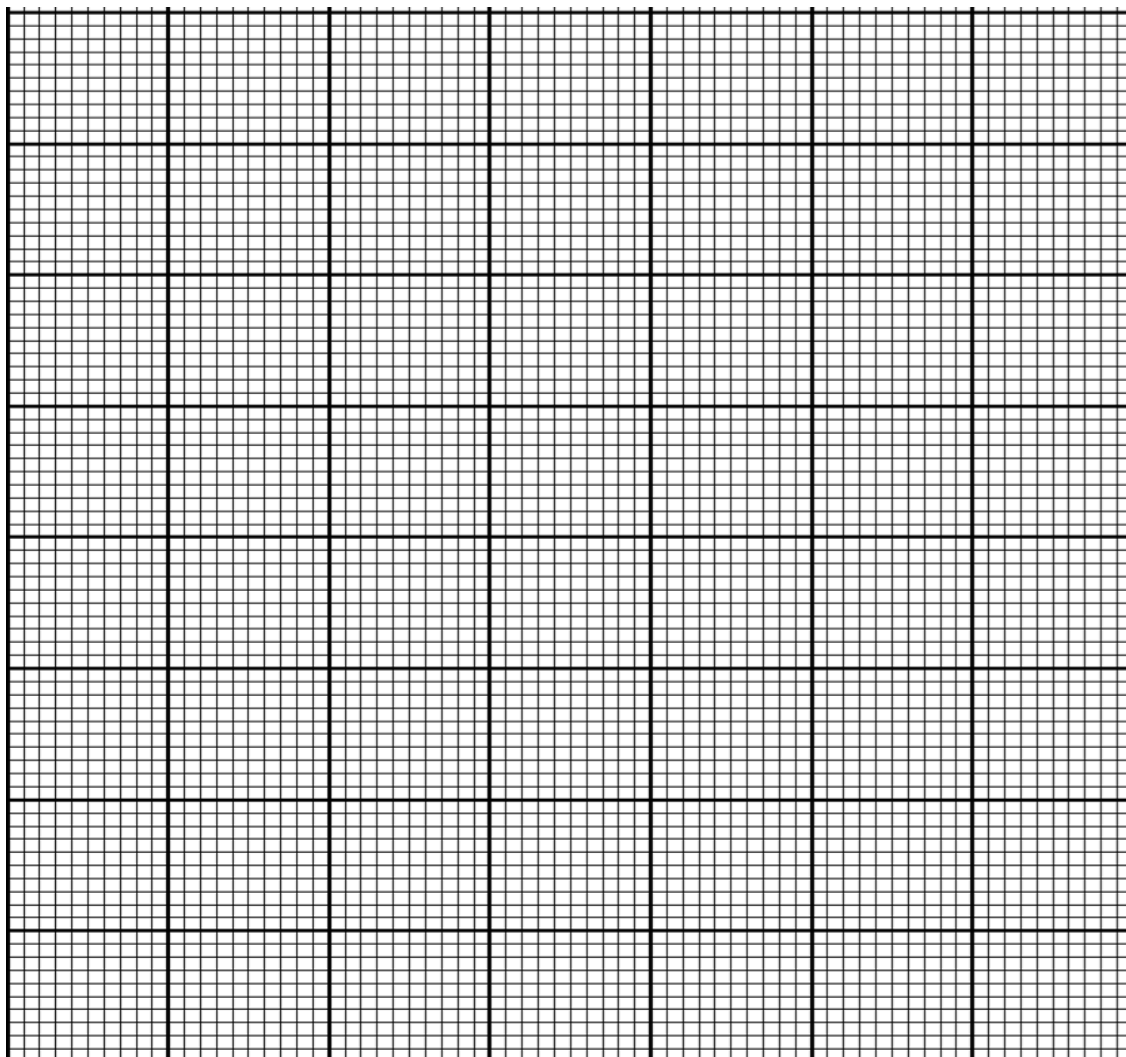
Suggest **one** alternative method of determining the endpoint of the reaction that would improve the accuracy of the results.

.....

 [1]

- (c) (i) Use your results from (a) to plot a graph of rate against volume of **X** on the grid. You should include the origin (0,0).

Draw a line of best fit. Circle anomalous points, if any.



[4]

- (ii) Use your graph to determine the rate of reaction if the volume of **X** used is 2.5 cm³. Show clearly on the graph how you obtained your answer.

rate = s⁻¹ [1]

- (d) From your results, describe the relationship between concentration of X and rate of reaction.

Explain your answer using your graph and ideas about collisions between reacting particles.

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..... [2]

[Total: 11]

- 4 Brass is an alloy containing copper and zinc. It is commonly used to make household tools like screws.

Outline a method you could use to determine the percentage by mass of zinc in a brass screw. Show clearly how you can use the experimental results to calculate the percentage by mass of zinc.

You can assume all the apparatus and chemicals normally found in the school laboratory are available.

You should include a relevant chemical equation in your answer. You may also choose to include a labelled diagram if it helps your explanation.

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[Total: 5]

– End of Paper –

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NOTES FOR QUALITATIVE ANALYSIS

Test for anions

<i>anion</i>	<i>test</i>	<i>test results</i>
carbonate (CO_3^{2-})	add dilute acid	effervescence, carbon dioxide produced
chloride (Cl^-) [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	white 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.

Test for aqueous cations

<i>cation</i>	<i>effect of aqueous sodium hydroxide</i>	<i>effect of aqueous ammonia</i>
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.
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	green ppt., insoluble in excess
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

Test for gases

<i>gas</i>	<i>test and test result</i>
ammonia (NH_3)	turns damp red litmus paper blue
carbon dioxide (CO_2)	gives white ppt. with limewater (ppt. dissolves with excess CO_2)
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 aqueous acidified potassium manganate(VII) from purple to colourless





Assumption English School
4E Chemistry 6092
2025 Prelim Paper 3 – Preparation List & Mark Scheme

Class: 4/1 (Total: **38 students**)

Question 1

chemical	per candidate	identity
P	150 cm ³ (in capped container)	0.20 mol/dm ³ KMnO ₄
Q	150 cm ³ (in capped container)	0.20 mol/dm ³ H ₂ O ₂
R	100 cm ³ (in capped container)	1.0 mol/dm ³ H ₂ SO ₄

Apparatus	Quantity (per student)
Burette (50 cm ³)	1
Pipette (25 cm ³)	1
Pipette filler	1
Conical flask (250 cm ³)	2
Filter funnel	1
White tile	1
Retort stand and clamp	1
Measuring Cylinder (25.0 cm ³)	1

Standardisation of solutions

25.0 cm³ of **Q** should react with between 15.00 cm³ and 16.00 cm³ of **P**.

SEE NEXT PAGE FOR APPARATUS AND CHEMICALS FOR QUESTION 2

Question 2 & 3

Apparatus / Chemical	Quantity	Unit	Remarks
Acid X Identity: 2.0 mol/dm ³ sulfuric acid	80 cm ³	capped container	
Solid Y Identity: ammonium carbonate	1	boiling tube	Stoppered with a rubber bung; About 5 spatulas
Salt Z Identity: copper(II) carbonate	5	test-tube	Stoppered with a rubber bung; About 0.10g each
Common bench apparatus & reagents			
Test tube rack	2		1 rack to hold the 5 stoppered test-tubes of Z
Test tubes and Boiling tubes	1	Set	1 boiling tube to contain solid Y
Bench Reagents - To include sodium hydroxide - To include barium nitrate - To include silver nitrate - To include limewater/calcium hydroxide (freshly prepared)	1	Set	 Islandwide Delivery Whatsapp Only 88680031 www.kiasuExamPaper.com
Distilled water	1	bottle	
Litmus paper	1	Set	
Bunsen burner	1		
Cleaning cloth	1		
Additional apparatus			
Safety goggles	1		
Test tube holder	1		
Teat pipette	3		
Spatula	2		
Lighter	1		
Glass rod	1		
Delivery tube	1		For boiling tube
Stopwatch	1		
10 cm ³ measuring cylinder	1		
Waste beaker (250 cm ³)	1		Labelled "Waste"

2025 4E Chemistry 6092 Prelim – Mark Scheme

Qn	Skill		1	2	3	
1(a)(i)	MMO, PDO					
		Final burette reading/cm ³	16.00	15.50	15.50	
		Initial burette reading/cm ³	0.00	0.00	0.00	
		Volume of P used/cm ³	16.00	15.70	15.70	
		Results selected		✓	✓	
		<u>Results table</u> H(eadings) Correct headings and units A(ccuracy) All burette readings recorded to nearest 0.05 cm³ <u>Titration results</u> R(esults) Average titre within 0.20 cm³ of supervisor's value scores- 2 mark Average titre within 0.30 cm³ of supervisor's average value scores – 1 mark C(onsistency) At least two titre values are within 0.20 cm³ of each other				[1] [1] [2] [1]
1(a)(ii)	MMO	clear working must be shown. Units and volume to 2 d.p. (Expected teacher's reading: 15.70 cm³)				[1]
1(b)(i)	ACE	No. of moles of potassium manganate(VII) = $0.2 \times 15.70/1000$ = 0.00314 mol				[1]
1(b)(ii)	ACE	MnO ₄ ⁻ : H ₂ O ₂ 2 : 5 No. of moles of excess Fenton's reagent = $5/2 \times 0.00314$ = 0.00785 mol [allow ecf from 1(b)(i)]				[1]
1(b)(iii)	ACE	Volume of excess Fenton's reagent = $0.00785 \div 0.2$ = 0.03925 dm ³ = 39.3 cm ³ [allow ecf from 1(b)(ii)]				[1]
1(b)(iv)	ACE	Volume of Q used = $100 - 39.25$ = 60.75 cm ³ = 60.8 cm ³ [allow ecf from 1(b)(iii)]				[1]

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1(b)(v)	ACE	No. of moles of H_2O_2 $= 60.75/1000 \times 0.2$ $= 0.01215 \text{ mol}$ No. of moles of ethanol $= 0.01225 / 2$ $= 0.006075 \text{ mol}$ Concentration of ethanol $= 0.006075 / (5/1000)$ $= 1.215 \text{ mol/dm}^3$ $= 1.22 \text{ mol/dm}^3$ [allow ecf from 1(b)(iv)] U(nits) Correct units across (b) A(ccuracy) 3 s.f. across (b)	[1] [1]								
1(c)	ACE	At higher temperatures, KMnO_4 reacts with ethanoic acid. Volume of KMnO_4 used in titration increases so volume of excess H_2O_2 calculated increases Calculated volume of H_2O_2 used decreases so concentration of ethanol calculated decreases	[1] [1]								
1(d)	ACE	<table border="1"> <tr> <th>Source of error</th> <th>Mitigation</th> </tr> <tr> <td>Poor precision of measuring cylinder</td> <td>Use burette instead</td> </tr> <tr> <td>Colour change for endpoint can be subjective</td> <td>Use a colourimeter instead</td> </tr> </table>	Source of error	Mitigation	Poor precision of measuring cylinder	Use burette instead	Colour change for endpoint can be subjective	Use a colourimeter instead	[1] - source [1] - solution		
Source of error	Mitigation										
Poor precision of measuring cylinder	Use burette instead										
Colour change for endpoint can be subjective	Use a colourimeter instead										
2(a)	MMO	<table border="1"> <tr> <th>test</th> <th>observations</th> </tr> <tr> <td>Add about 2 cm depth of X into a clean test-tube. Add a few drops of barium nitrate.</td> <td>White ppt formed [1]</td> </tr> <tr> <td>Add about 2 cm depth of X into a clean test-tube. Add a few drops of silver nitrate.</td> <td>No observable change [1]</td> </tr> <tr> <td>Add about 2 cm³ of X into the boiling tube containing Y. Add aqueous sodium hydroxide slowly with shaking until no further change is seen. Gently warm the mixture.</td> <td>Solid Y dissolves to form a colourless solution [1] Effervescence, gas evolved forms a white ppt in limewater [1] Upon warming, gas evolved turns damp red litmus paper blue [1]</td> </tr> </table>	test	observations	Add about 2 cm depth of X into a clean test-tube. Add a few drops of barium nitrate.	White ppt formed [1]	Add about 2 cm depth of X into a clean test-tube. Add a few drops of silver nitrate.	No observable change [1]	Add about 2 cm ³ of X into the boiling tube containing Y. Add aqueous sodium hydroxide slowly with shaking until no further change is seen. Gently warm the mixture.	Solid Y dissolves to form a colourless solution [1] Effervescence, gas evolved forms a white ppt in limewater [1] Upon warming, gas evolved turns damp red litmus paper blue [1]	[5]
test	observations										
Add about 2 cm depth of X into a clean test-tube. Add a few drops of barium nitrate.	White ppt formed [1]										
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2(b)	ACE	X: H_2SO_4 Y: $(\text{NH}_4)_2\text{CO}_3$	[1]								

		reject: name	
3(a)(i)	MMO, PDO	3 additional pairs of B and water that add up to 10.0cm^3 - Accuracy of time (nearest s), volume (1 d.p.) Each bullet point – [1]	[2]
3(a)(ii)	ACE	All values calculated correctly to 3 s.f.	[1]
3(b)	ACE	Use a gas syringe to measure the volume of gas collected and stop the time when the volume of gas stops increasing. OR Measure the change in mass of the test-tube and stop the time when the mass stops decreasing.	[1]
3(c)(i)	PDO	- Scale (appropriate scale: graph takes about 70%); - Line (straight line of best fit) - Axis & labels (y-axis: rate / s^{-1}; x-axis: volume of X added/ cm^3) - Points (all points plotted correctly including origin); Each bullet point- [1]	[4]
3(c)(ii)	ACE	Value that correspond to graph for volume of X = 2.5 cm^3 reached AND must show dotted lines on graph from intersection point to y-axis	[1]
3(d)	ACE	The <u>higher the concentration of X the faster the rate of reaction</u>. This can be seen by the <u>graph being a straight line/ positive (constant) gradient of graph (for straight line graphs)</u> OR <u>increasing gradient of graph (if graph is a curve)</u>. When the concentration of X is higher, there are <u>more reactant particles per unit volume</u>, thus <u>frequency of effective collisions is higher</u> and hence rate is faster.	[1] [1]

4	P	<u>Equation</u> $\text{Zn} + \text{HX} \rightarrow \text{ZnX}_2 + \text{H}_2$ Correct balanced equation for chosen acid – [1m] <u>Method</u> <u>Using an electronic balance</u>, measure the mass of the brass screw (<u>m</u> g) - Use a measuring cylinder/burette/pipette to measure <u>excess</u> (named) acid into <u>named reaction flask</u> (e.g. conical flask, boiling tube, round bottomed flask) <u>Add</u> the brass screw to acid All points – [1m] - Connect a <u>gas syringe</u> to the reaction flask. - Measure the <u>maximum amount of gas</u> collected (<u>v</u> cm³) Both points – [1m] - Calculate the <u>number of moles</u> of hydrogen gas collected using formula <u>(v/1000)/24</u> - Use the <u>mole ratio</u> of zinc : hydrogen to find the number of moles of zinc (<u>n</u> mol). Both points – [1m] - Find the <u>mass of zinc</u> in the screw using the formula <u>n x Ar</u> - Calculate the <u>% by mass</u> of zinc in the screw using the formula <u>n/m x 100%</u> Both points – [1m]	[5] KIASU ExamPaper Islandwide Delivery Whatsapp Only 88660031 www.KiasuExamPaper.com 
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CHRIST CHURCH SECONDARY SCHOOL
2025 PRELIMINARY EXAMINATION
FOUR EXPRESS

CANDIDATE NAME		CLASS										
CENTRE NUMBER	<table border="1"><tr><td>S</td><td></td><td></td><td></td><td></td></tr></table>	S					INDEX NUMBER	<table border="1"><tr><td></td><td></td><td></td><td></td></tr></table>				
S												

CHEMISTRY

Paper 3 Practical

6092/03

28 July 2025

1 hour 50 minutes

Candidates answer on the Question Paper.

Additional Materials: As listed in the confidential instructions

READ THESE INSTRUCTIONS FIRST

Write your Centre number, index number, name and class in the spaces at the top of this page.

Write in dark blue or black pen.

You may use an HB pencil for any diagrams, graphs.

Do not use staples, paper clips, highlighters, glue or correction fluid.

Answer **all** questions in the spaces provided on the Question Paper.

The use of an approved scientific calculator is expected, where appropriate.

You may lose marks if you do not show your working or if you do not use appropriate units.

Qualitative analysis notes are printed on page 12.

At the end of the examination, fasten all your work securely together.

The number of marks is given in brackets [] at the end of each question or part question.

Shift
Laboratory

For Examiner's Use	
1	
2	
3	
Total	40

This document consists of **11** printed pages and **1** blank page.

- 1** An oxyacid of phosphorus has the formula, H_3PO_3 .

You are required to find, by experiment, the number of moles of sodium hydroxide that react with 1 mole of this acid.

P is 0.0984 mol/dm^3 sodium hydroxide.

Q is a solution containing 5.04 g of the oxyacid of phosphorus, H_3PO_3 , in 1 dm^3 of solution.

Read all the instructions carefully before starting the experiments in Question 1.

Instructions

- (a) (i)** Fill the burette with solution **Q**.

Pipette 25.0 cm^3 of **P** into a flask and titrate with **Q**, using the indicator provided.

Record your titration results in the space provided below, repeating the titration as many times as you consider necessary to achieve consistent results.

Results

[5]

- (ii)** From your titration results, obtain an average volume of **Q** to be used in your calculations. Show clearly how you obtained this volume.

average volume of **Q** [1]

- (b) (i) **P** is 0.0984 mol/dm³ sodium hydroxide.

Calculate the number of moles of sodium hydroxide in 25.0 cm³ of **P**.

no. of moles of sodium hydroxide in 25.0 cm³ of **P** [1]

- (ii) **Q** is an aqueous solution of H₃PO₃ with a concentration of 5.04 g/dm³.

Calculate the molar concentration, in mol/dm³, of H₃PO₃ in **Q**.

[Ar: H, 1; P, 31; O, 16]

concentration of H₃PO₃ in **Q** [2]

- (iii) Hence, using your answer from **(b)(i)** and **(b)(ii)**, calculate the number of moles of sodium hydroxide which react with 1 mole of H₃PO₃.

no. of moles of sodium hydroxide [2]

- (iv) Using your answer to **(b)(iii)**, write an equation for the reaction of the oxyacid of phosphorus, H₃PO₃, with sodium hydroxide.

..... [1]

- (c) Using your results in (a)(ii), describe briefly how a pure and dry sample of the salt formed from the reaction of the oxyacid of phosphorus, H_3PO_3 , with sodium hydroxide can be obtained.

.....

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.....

.....

[3]

- (d) A student repeated the experiment. When preparing solution **Q**, the student accidentally measured 5.04 g of the oxyacid of sulfur, H_2SO_3 , instead and dissolved it in 1 dm³ of solution.

The number of moles of sodium hydroxide which react with 1 mole of H_2SO_3 is the same as the number of moles of sodium hydroxide which react with 1 mole of H_3PO_3 .

Describe and explain the effect this would have on the titration results recorded in (a)(i).

[A_r: H, 1; S, 32; O, 16]

.....

.....

.....

.....

[2]

[Total: 17]

2 You are provided with two solids, **R** and **S**.

You will carry out the following tests on the two solids, recording your observations at each stage. You should test and identify any gases evolved.

Read the instructions carefully before starting the experiments.

(a) Tests on Solid R

	test	observations
(i)	Using a spatula, place approximately half of the solid R sample in a boiling tube. With a measuring cylinder, add about 8 cm³ of dilute sulfuric acid to the boiling tube.	[2]
	Filter the reaction mixture from (a)(i) . The filtrate is solution T .	
(ii)	Pour about 1 cm depth of solution T into a test-tube. Add aqueous sodium hydroxide dropwise and then in excess.	[2]
(iii)	Place the remaining solid R in a hard-glass boiling tube. Heat the solid strongly until no further change is seen. Then, stop the heating and leave the solid to cool.	[2]

(iv) Identify the gas given off in (a)(i).

..... [1]

(v) Explain why it is **not** possible to identify the cation contained in solution **T** from your observations in (a)(ii).

.....
 [1]

(vi) Suggest an additional test that can be done on solution **T** that would allow you to identify the cation contained in solution

.....
 [1]

(b) Tests on Solid S

Place solid **S** in a boiling tube. With a measuring cylinder, add about 15 cm³ of distilled water to the boiling tube. Stopper the boiling tube and shake to dissolve the solid to form solution **S**.

Divide this volume of solution **S** into three approximately equal portions in three test-tubes.

	test	observations
(i)	Add the first portion of solution S to the aqueous chlorine provided in a test-tube.	[1]
(ii)	To the second portion of solution S , add about 1 cm depth of dilute nitric acid followed by a few drops of aqueous silver nitrate.	[1]

(iii)	To the third portion of solution S , add aqueous sodium hydroxide dropwise and then in excess.	[2]
-------	---	-----

(iv) Use evidence from the observations above to identify solid **S**.

Identity:

Evidence:

.....

.....

..... [3]

[Total: 16]

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- 3 (a)** You are provided with a rusty iron nail. The mass of the nail is between 0.10 to 0.20 g.

Outline a method you would use to determine the mass of rust in the iron nail.

You can assume all the apparatus and reagents normally found in a school laboratory are available. You may wish to include one or more labelled diagrams as part of your answer.

In your method, you should include the measurements you would take and explain how you would use your results to determine the mass of rust in the iron nail.

[illegible]

[4]

- (b) A separate experiment was carried out on a similar rusty nail to determine how the mass of the nail changes as time proceeds.

At 1-minute intervals, the mass of the rusty iron nail is measured.

The results are shown in the table.

time / min	mass of the rusty nail / g
0	0.17
1	0.11
2	0.07
3	0.06
4	0.06

Use these results to plot a suitable graph on the grid in the next page. Draw a line of best fit, using all of the plotted points.



[3]

[Total: 7]

END OF PAPER

NOTES FOR QUALITATIVE ANALYSIS

Test for anions

<i>anion</i>	<i>test</i>	<i>test result</i>
carbonate (CO_3^{2-})	add dilute acid	effervescence, carbon dioxide produced
chloride (Cl^-) [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	white 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.

Test for aqueous cations

<i>cation</i>	<i>effect of aqueous sodium hydroxide</i>	<i>effect of aqueous ammonia</i>
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.
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	green ppt., insoluble in excess
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

Test for gases

<i>gas</i>	<i>test and test result</i>
ammonia (NH_3)	turns damp red litmus paper blue
carbon dioxide (CO_2)	gives white ppt. with limewater (ppt. dissolves with excess CO_2)
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 aqueous acidified potassium manganate(VII) from purple to colourless





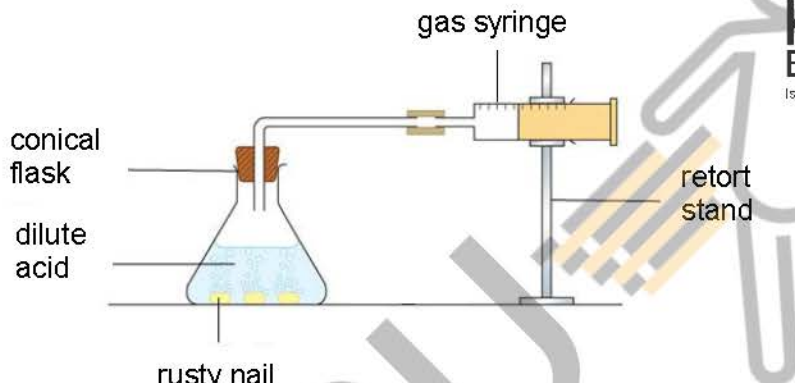


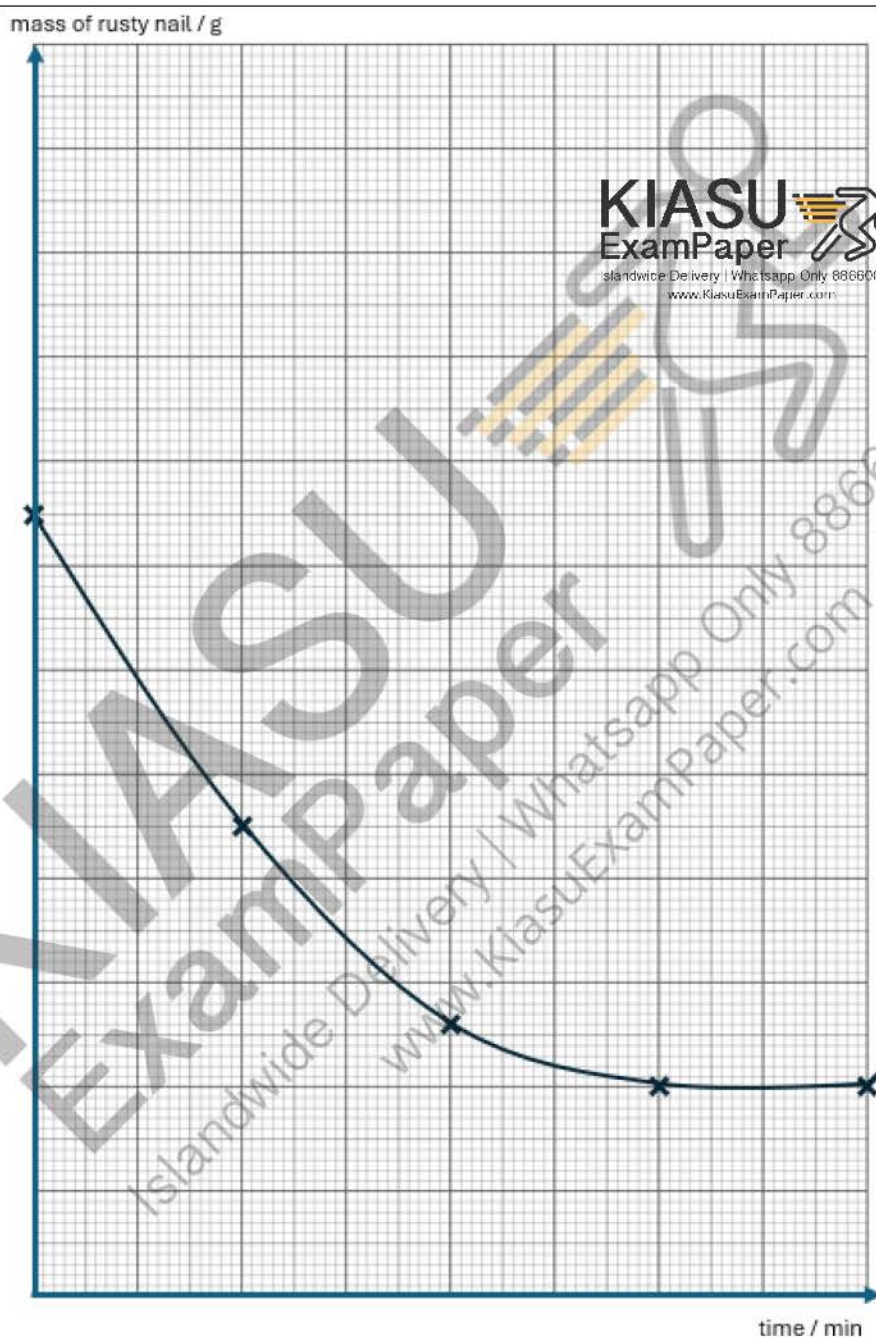
Marking Scheme

Paper 3 6092/03

1ai	PDO	<i>Results table:</i> Records initial burette readings, final burette readings and volume added with correct headings and units in a titration table All burette readings for all accurate titres in titration table are recorded to nearest 0.05 cm³ <i>Titration results</i> Accuracy For the average titre (of consistent readings) within 0.20 cm³ of supervisor's average value score 2 marks For the average titre (of consistent readings) within 0.30 cm³ of supervisor's average value score 1 marks Concordance At least two titre values are within 0.20 cm³ (using uncorrected titres) (teacher's result) <table border="1"> <tr> <td>Titration number</td> <td>1</td> <td>2</td> <td>3</td> </tr> <tr> <td>Final burette reading / cm³</td> <td></td> <td></td> <td></td> </tr> <tr> <td>Initial burette reading / cm³</td> <td></td> <td></td> <td></td> </tr> <tr> <td>Volume of Q used / cm³</td> <td></td> <td></td> <td></td> </tr> <tr> <td>Best titration results (✓)</td> <td></td> <td></td> <td></td> </tr> </table>	Titration number	1	2	3	Final burette reading / cm ³				Initial burette reading / cm ³				Volume of Q used / cm ³				Best titration results (✓)				T 1 D 1 R 2 C 1	[5]
Titration number	1	2	3																					
Final burette reading / cm ³																								
Initial burette reading / cm ³																								
Volume of Q used / cm ³																								
Best titration results (✓)																								
1aii	MMO	Appropriate average volume of Q in 2d.p. from closest titre values (titres should be identified either in the table by a tick, or in a calculation). <u>Teacher's result: 19.5 – 20.5 cm³</u>	1	[1]																				
1bi	ACE	No of moles of NaOH = $25/1000 \times 0.0984 = \underline{0.00246 \text{ mol}}$	1	[1]																				
1bii	ACE	Concentration, in mol/dm ³ , of H ₃ PO ₃ in Q $= 5.04 / 82$ $= 0.061463 \text{ mol/dm}^3$ $= \underline{0.0615 \text{ mol/dm}^3}$	1 1	[2]																				
1biii	ACE	No of moles of H ₃ PO ₃ in 20.1 cm ³ of Q $= [1aii] / 1000 \times 0.061463$ $= x \text{ mol}$ Since no of moles of NaOH that reacted = 0.00246 mol, No of moles of sodium hydroxide that react with 1 mole of H ₃ PO ₃ $= 0.00246 / x$ $= 2.00 \text{ mol (Accept: 1.95 – 2.05)}$	1 1	[2]																				
1biv	ACE	$2 \text{ NaOH} + \text{H}_3\text{PO}_3 \rightarrow \text{Na}_2\text{HPO}_3 + 2 \text{ H}_2\text{O}$	1	[1]																				
1c	MMO	Repeat the titration <u>without the indicator</u> , <u>using 25.0cm³ of P and the volume of Q found in (a)(ii).</u> Transfer the salt solution produced to an evaporating dish.	1 1	[3]																				

		Heat the salt solution until <u>saturated solution is formed</u> . <u>Cool the solution</u> to allow crystallisation.		
		Filter to obtain crystals, wash with cool distilled water and <u>pat dry</u> crystals with filter paper.	1	
1d	ACE	There would be <u>no change</u> to the titration results.		[2]
		<u>M_r of H_2SO_3 is also 82 / the mole concentration of the acid is the same as H_3PO_3</u>	1	
		<i>Accept calculations to show that the mole concentration is the same.</i>		
		<u>Number of moles</u> of hydroxide that react with 1 mole of H_2SO_3 is <u>the same</u> as that of H_3PO_3 / the number of moles of H_2SO_3 <u>required for neutralisation</u> is the same as that of H_3PO_3 .	1	
			[Total: 17]	
2ai	MMO PDO	Any TWO from below - effervescence, gas forms a white precipitate when bubbled into limewater - solid dissolves to form a colourless solution - solution becomes warm	2	[2]
2aii	MMO PDO	White precipitate forms Dissolves in excess to form a colourless solution	1 1	[2]
2aiii	MMO PDO	Any TWO from below ☐ solid turns yellow ☐ condensation/ water droplets at top of tube ☐ turns white again (when cooled)	2	[2]
2aiv	ACE	Carbon dioxide	1	[1]
2av	ACE	Zinc and / or aluminium (ions) give the same result	1	[1]
2avi	ACE	Add aqueous ammonia	1	[1]
2bi	MMO PDO	White precipitate forms	1	[1]
2bii	MMO PDO	White precipitate forms	1	[1]
2biii	MMO PDO	White precipitate forms Insoluble in excess	1 1	[2]
2biv	ACE	Calcium chloride / $CaCl_2$	1	[3]
		From (b)(ii), white precipitate formed with acidified silver nitrate shows presence of chloride ions.	1	
		From (b)(iii), white precipitate that is insoluble in excess sodium hydroxide shows the presence of calcium ions.	1	
		(Evidence must specify the test itself)		
			[Total: 16]	

3a	P	<u>Labelled diagram</u>  Procedure (accept lesser details if they can be complemented with the labelled diagram): 1. Measure the mass of the rusty nail using an electronic balance, M g. 2. Add the rusty nail into a conical flask and add excess dilute acid to the conical flask. 3. Stopper the conical flask immediately with a delivery tube connected to a calibrated gas syringe. 4. Measure the maximum volume of gas collected in the syringe, V cm³. 5. Calculate the mass of rust using the following method: $\text{Fe} + 2\text{H}^+ \rightarrow \text{Fe}^{2+} + \text{H}_2$ No. of moles of hydrogen = $(V/24000)$ mol No. of moles of iron = $(V/24000)$ mol Mass of iron = $(V/24000) \times 56 = (7V/3000)$ g Mass of rust = $M - (7V/3000)$ g	2	[4]
3b	P	Correct scale Correct points plotted Correct line of best fit with all points	1 1 1	[3]



[Total: 7]





HUA YI SECONDARY SCHOOL

PRELIMINARY EXAM 2025

4-G3

NAME

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CLASS

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INDEX
NUMBER

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CHEMISTRY

6092/03

PAPER 3 Practical

13 August 2025

1 hour 50 minutes

Additional Materials: Nil

READ THESE INSTRUCTIONS FIRST

Write your Name, Class, and Index Number on all the work you hand in.
Give details of the practical shift and laboratory where appropriate, in the boxes provided.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, highlighters, glue, or correction fluid.

Answer **all** questions.
Write your answers in the spaces provided.

The use of an approved scientific calculator is expected, where appropriate.
You may lose marks if you do not show your working or if you do not use appropriate units.
Qualitative Analysis Notes are printed on page 13.
The number of marks is given in brackets [] at the end of each question or part question.

Shift
Laboratory

For Examiner's Use	
1	
2	
3	
4	
Total	

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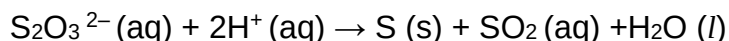
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Setter: Ms Chiang Wai Kit

[Turn Over

- 1 The ionic equation for the reaction between sodium thiosulfate and hydrochloric acid is:



The solid sulfur formed causes the reaction mixture to become cloudy and opaque.

In this experiment, you will investigate the relationship between the concentration of sodium thiosulfate and the rate of reaction.

Very small amounts of SO_2 gas may be produced in this reaction. Take care not to inhale any gas. The reaction products should be disposed off into the container labelled WASTE immediately following each experiment.

Read all the instructions below carefully before starting the experiment in Question 1.

Instructions

X is 0.10mol/dm^3 sodium thiosulfate, $\text{Na}_2\text{S}_2\text{O}_3$.

Y is 2.00mol/dm^3 hydrochloric acid, HCl .

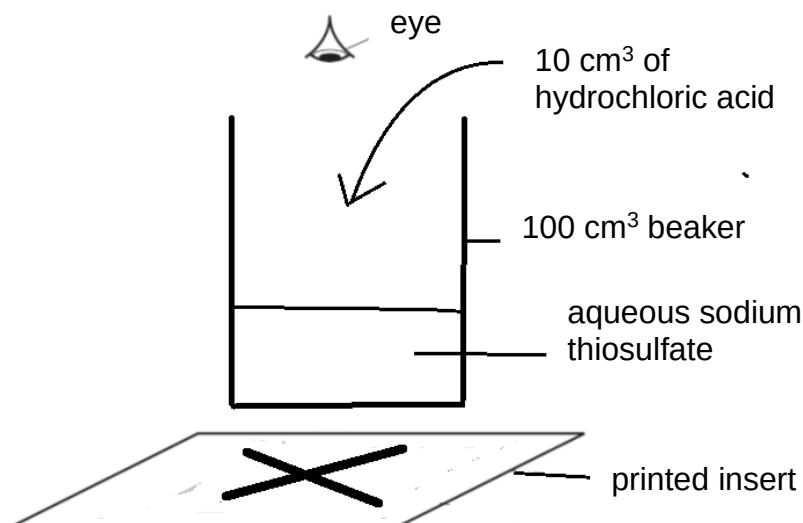
Complete the table with your results in the 'Results section' on page 4.

- Relative rate can be calculated using the expression:

$$\text{relative rate} = \frac{1000}{\text{reaction time}}$$

- Leave your answers to 3 significant figures.

You are going to carry out five experiments using the apparatus shown.



(a) Experiment 1

- Put **X** into the burette labelled **X**.
- Fill the burette with **X**.
- Transfer 25.00 cm³ of **X** into a 100 cm³ beaker.
- Place the beaker on the printed insert (Refer to diagram on page 2).
- Use the 25 cm³ measuring cylinder to measure 10.0 cm³ of **Y**.
- Add **Y** to the 25.00 cm³ **X** in the beaker and immediately start the stopwatch.
- Stir the mixture once.
- Look vertically down through the solution in the beaker at the print on the insert.
- Stop the stopwatch as soon as the print on the insert is no longer visible.
- Record the reaction time to the nearest second.
- Rinse the beaker with water.
- Dry the beaker with the paper towels provided so that it is ready to be used in **Experiment 2**.

Experiment 2

- Transfer 12.50 cm³ of **X** into the 100 cm³ beaker.
- Fill the burette labelled 'water' with distilled water.
- Transfer 12.50 cm³ of distilled water into the 100 cm³ beaker.
- Place the beaker on the printed insert.
- Use the 25 cm³ measuring cylinder to measure 10.0 cm³ of **Y**.
- Add the **Y** to the solution in the beaker and immediately start the stopwatch. Stir the mixture once.
- Look vertically down through the solution in the beaker at the print on the insert.
- Stop the stopwatch as soon as the print on the insert is no longer visible. Record the reaction time to the nearest second.
- Rinse the beaker with water.
- Dry the beaker with the paper towels provided so that it is ready to be used in the next experiment.

Experiment 3-5

- Carry out three further experiments to investigate how reaction times change with different volumes of **X**. **Do not** use a volume of **X** less than 12.50 cm³.

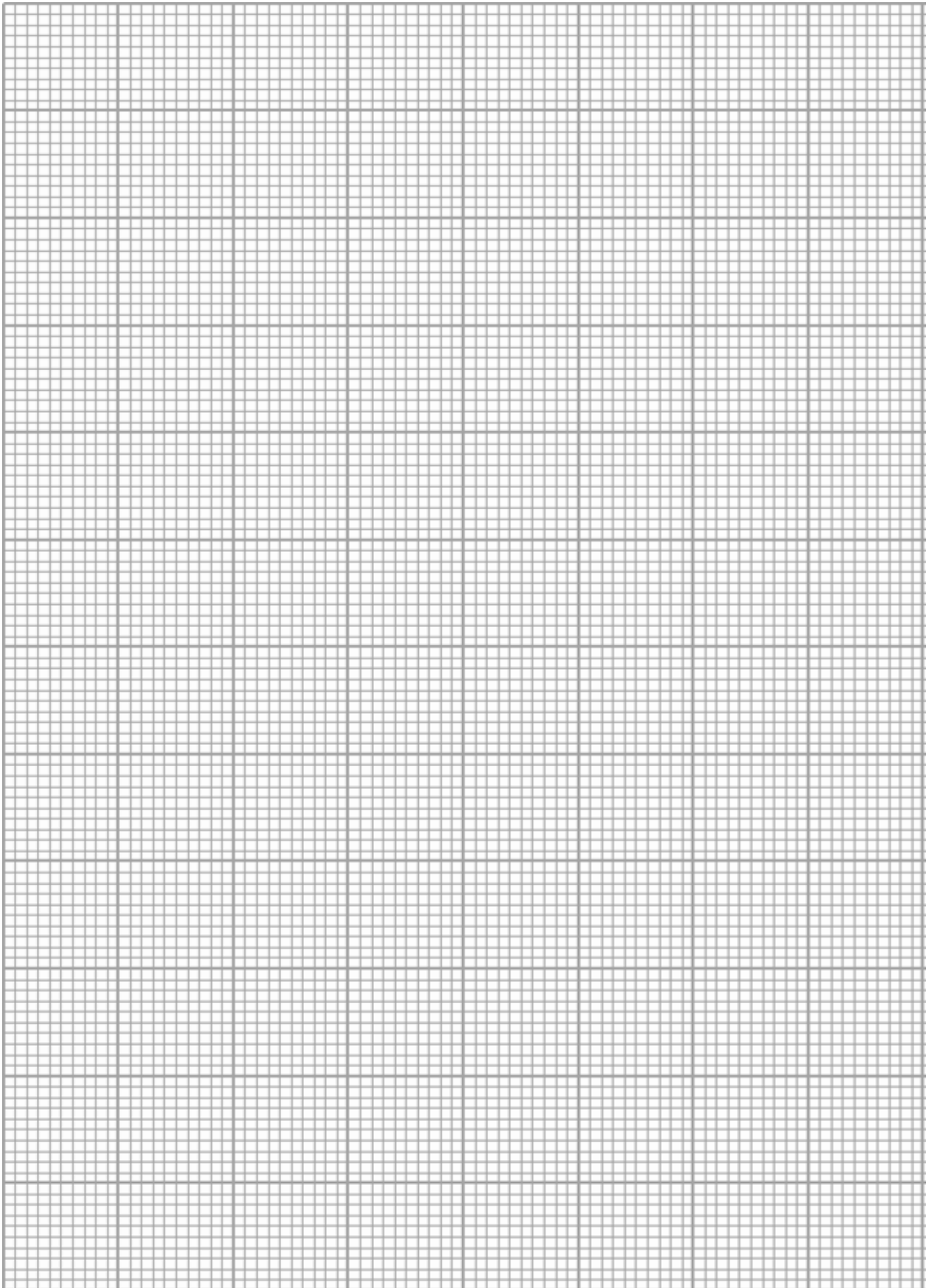
Results

volume of X used / cm ³	volume of distilled water used / cm ³	reaction time / s	relative rate
25.00	0.00		
12.50	12.50		

[5]

- (b) Plot a graph, on the given grid, of relative rate (y-axis) against volume of **X** (x-axis). The graph **should not** include the origin.

Draw a curve of best fit using all the plotted points.



[4]

- (c) Use your graph to predict the reaction time if an experiment is carried out using 23.50 cm³ of **X** and distilled water.

Show clearly on the graph how you obtained your answer.

reaction time = s [2]

- (d) The final instruction for each experiment is to rinse and dry the beaker.

State the effect on the reaction time of **not** drying the beaker before carrying out each of **Experiments 2–5**.

Explain your answer.

.....

..... [2]

- (e) A student repeats **Experiment 1** but uses a 250 cm³ beaker in place of the 100 cm³ beaker. All other conditions remain the same.

State whether each statement below is correct.

Explain your answers.

- (i) The student records a longer time for this experiment because the 250 cm³ beaker is used.

.....

..... [1]

- (ii) A longer time is recorded because the rate of production of sulfur is slower.

.....

..... [1]

[Total:15]

2 Acids react with carbonates to produce carbon dioxide gas.

This reaction can be used to determine the concentration of acid, using the mass of carbon dioxide released.

You will determine the concentration of sulfuric acid in **P**.

P is sulfuric acid.

Q is sodium carbonate, Na_2CO_3 .

- (a)** Carry out the following experiment and record all results in the space provided.

Instructions

Pre-Reaction:

- Use the 25 cm^3 measuring cylinder to transfer 25.0 cm^3 of **P** into the conical flask.
- Weigh the flask with the acid. Record the mass.
- Weigh the container with **Q**. Record the mass.
- Carefully transfer all of **Q** into the acid in the conical flask.
- Swirl the contents of the flask and leave the flask to stand with occasional swirling until the fizzing stops.

Post-Reaction:

- Weigh the container with any residual **Q**. Record the mass.
- Weigh the flask and contents when the fizzing has stopped. Record the mass.
- Record your results in an appropriate format in the space provided.

(b) Results

[2]

Calculations

(c) (i) In the space provided, calculate

- the mass of **Q** added to the flask

mass of **Q** added =

- the total mass of flask + acid + **Q**.

total mass of flask + acid + **Q** added =

- the mass of carbon dioxide given off during the experiment.

mass of carbon dioxide given off = [3]

(ii) Calculate the amount, in mol, of carbon dioxide given off in the reaction.

amount of CO_2 =mol [1]

(ii) The sodium carbonate, **Q**, was in excess in the reaction with sulfuric acid.
Show by calculation that the sodium carbonate was in excess. Use your answer in **(c)(i)**.

[3]

- (iii) Calculate the concentration, in mol/dm³, of sulfuric acid in **Q**.

concentration of H₂SO₄ = [1]

- (c) (i) A student does not have a conical flask and uses a small beaker for the reaction.

Explain why a conical flask is better.

.....

..... [1]

- (ii) Two students made suggestions of how they thought the experiment in **(a)** could be adapted to determine the concentration of sulfuric acid, **P**, by using other reactions. In each case their teacher told them that this method was not suitable.

Explain, in each case, why the method is not suitable. Do **not** consider factors based on quantities of any reagent.

Student 1 suggested using magnesium in place of sodium carbonate.

.....

..... [1]

Student 2 suggested using calcium carbonate in place of sodium carbonate.

.....

..... [1]

[Total:13]

- 3 Metal carbonates generally decompose on heating, liberating carbon dioxide and leaving behind an oxide of the metal.

Outline a method you could use to determine the reactivities of **2** metals, iron and copper based on the action of heat on their carbonates.

You are **only** provided with samples of their carbonates. You can assume all the apparatus and reagents normally found in a school laboratory are available.

You should include in your answer:

- the measurements you would take **using 1 g of carbonate for each experiment**
- explain how your results would show the reactivities of the metals.

You may wish to use a labelled diagram to illustrate your answer.

.....

.....

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.....

.....

[5]

[Total: 5]

- 4 In this experiment you will perform tests to deduce the ions present in salt **T**.

You are provided with a solution of salt **T**, labelled **solution T**.

Read all the instructions carefully before starting the experiments in Question 4.

Instructions

- (a) Carry out the following tests. You should test and identify any gases evolved. Record your observations in the table.

The volume given below are approximate and should be estimated rather than measured unless instructed otherwise.

test	observations
Test 1 Add about 1 cm depth of solution T into a clean test-tube. To this test-tube add aqueous sodium hydroxide slowly with shaking until no further changes are seen.	[1]
Test 2 Add about 1 cm depth of solution T into a clean test-tube. To the same test-tube, acidify with nitric acid and then add barium nitrate.	[1]
Test 3 Add about 1 cm depth of solution T into a clean test-tube. To this test-tube add about 1 cm depth of dilute sulfuric acid followed by 2 cm depth of aqueous potassium manganate (VII). Shake the test-tube. To the same test-tube, add aqueous ammonia slowly with shaking until no further changes are seen.	[3]

(b) Using your observations, deduce the ions present in salt **T**. Justify your deductions.

(i) ion:

justification:

..... [1]

(ii) ion:

justification:

..... [1]

[Total: 7]

QUALITATIVE ANALYSIS NOTES**Test for anions**

<i>anion</i>	<i>test</i>	<i>test result</i>
carbonate (CO_3^{2-})	add dilute acid	effervescence, carbon dioxide produced
chloride (Cl^-) [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	white 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.

Test for aqueous cations

<i>cation</i>	<i>effect of aqueous sodium hydroxide</i>	<i>effect of aqueous ammonia</i>
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.
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	green ppt., insoluble in excess
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

Test for gases

<i>gas</i>	<i>test and test result</i>
ammonia (NH_3)	turns damp red litmus paper blue
carbon dioxide (CO_2)	gives white ppt. with limewater (ppt. dissolves with excess CO_2)
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 aqueous acidified potassium manganate(VII) from purple to colourless

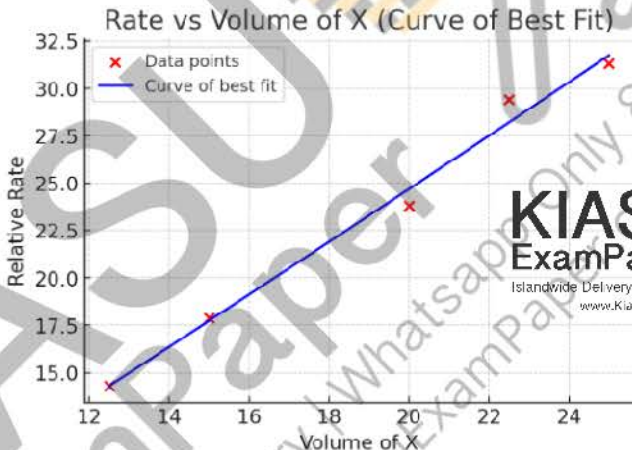
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2025 4E Chemistry Prelim P3 Marking Scheme

Question	Skill	Indicative material	Mark	Total																								
1a	MMO	Results table: <table border="1"> <thead> <tr> <th>volume of X used/ cm³</th> <th>volume of distilled water used / cm³</th> <th>reaction time /s</th> <th>relative rate</th> </tr> </thead> <tbody> <tr> <td>25.00</td> <td>0.00</td> <td>32</td> <td></td> </tr> <tr> <td>22.50</td> <td>2.50</td> <td>34</td> <td></td> </tr> <tr> <td>20.00</td> <td>5.00</td> <td>42</td> <td></td> </tr> <tr> <td>15.00</td> <td>10.00</td> <td>56</td> <td></td> </tr> <tr> <td>12.50</td> <td>12.50</td> <td>70</td> <td></td> </tr> </tbody> </table>	volume of X used/ cm ³	volume of distilled water used / cm ³	reaction time /s	relative rate	25.00	0.00	32		22.50	2.50	34		20.00	5.00	42		15.00	10.00	56		12.50	12.50	70			[5]
volume of X used/ cm ³	volume of distilled water used / cm ³	reaction time /s	relative rate																									
25.00	0.00	32																										
22.50	2.50	34																										
20.00	5.00	42																										
15.00	10.00	56																										
12.50	12.50	70																										
	PDO	Precision of data recorded: - all volumes recorded to 2 dp with the final digit being 0 or 5 cm³ - all times to the nearest second 3 additional volumes chosen with intervals not less than 2.00 cm³ AND no volume less than 12.50 cm³ AND water added in each additional experiment to make total volume of FA 1 and water equal to 25.00 cm³ All relative rates correctly calculated using $1000 / \text{time}$ to 3 significant figures.	1																									
	MMO	Reaction time decreases as volume of FA 1 increases for all five experiments Examiner corrects times (if necessary) to the nearest second for Experiments 1 and 2 and calculates ratio $t_{12.5} / t_{25}$ to 2 dp Award [1] for ratio between 1.50–2.60 [1]	1																									

b	MMO	Axes unambiguously labelled (relative) rate or s⁻¹ on y-axis AND volume / X / (sodium) thiosulfate / Na₂S₂O₃ / cm³ on x-axis AND some numbers for scales	1	[1]
	MMO	All points recorded in the table are accurately plotted. All points recorded plotted correctly to within half a small square AND in the correct small square or on the line if it should be on the line AND minimum of 4 experiment points plotted	1 1	[2]
	MMO	Line of best fit drawn 	1	[1]
c	ACE	2 dotted lines drawn on the graph – vertical from 23.50 on the x-axis to the line of best fit and horizontal from the line to the y-axis. [1] Correctly uses time = 1000 / (relative) rate [1] From the graph, reaction rate = 31.6 Reaction rate = 1000/ reaction time 31.6 = 1000/ reaction time Reaction time = 31.65 ~ 32	2	[2]
d	ACE	Time taken will be longer extra water would lower the concentration / dilute (FA 1 or reactants)	1 1	[2]

e(i)	ACE	The student is correct (that time would be greater) AND the depth (of solution / ppt / mixture) is less/ there is a need for more sulfur to be produced to obscure the insert.	1	[1]										
e (ii)	ACE	The student is not correct / (The rate of production of sulfur is the same. AND (the solution) concentrations have not changed / the frequency of effective collisions remains the same / more sulfur is required to obscure the insert.	1	[1]										
[Total:15]														
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2	MMO	Table with correct headings and units all shown in space given. Headings • (Mass of) flask + acid P [I] • (Mass of) container + Q [II] • (Mass of) container (empty/with residue) [III] • (Mass of) flask and contents after reaction (owtte) [IV] • (Mass of) carbon dioxide / mass loss Units: / g, (g), in g or g next to each value. [M1] All four specified (I- IV) balance readings shown AND All balance readings given either to 2 or to 3 dp [M2] <table border="1" data-bbox="453 1341 1177 1655"> <tr> <td>Mass of) flask + acid P</td> <td>137.09 g [I]</td> </tr> <tr> <td>(Mass of) container + Q</td> <td>10.76 g [II]</td> </tr> <tr> <td>(Mass of) container empty/with residue Q</td> <td>4.68 g [III]</td> </tr> <tr> <td> </td> <td> </td> </tr> <tr> <td>(Mass of) flask and contents after reaction (owtte) 4</td> <td>142.24 g [IV]</td> </tr> </table>	Mass of) flask + acid P	137.09 g [I]	(Mass of) container + Q	10.76 g [II]	(Mass of) container empty/with residue Q	4.68 g [III]			(Mass of) flask and contents after reaction (owtte) 4	142.24 g [IV]		[5]
Mass of) flask + acid P	137.09 g [I]													
(Mass of) container + Q	10.76 g [II]													
(Mass of) container empty/with residue Q	4.68 g [III]													
(Mass of) flask and contents after reaction (owtte) 4	142.24 g [IV]													
		Correctly calculates • the mass of Q added to the flask • the total mass of flask + acid + Q. • the mass of carbon dioxide given off during the experiment.												

		<table border="1"> <tr> <td>(Mass of) Q added</td> <td>$10.76 - 4.68 = 6.08 \text{ g}$</td> </tr> <tr> <td>(Mass of) flask + acid + Q (added)</td> <td>$139.05 + 6.08 = 143.17 \text{ g}$</td> </tr> <tr> <td>Mass of CO_2 formed</td> <td>Mass of CO_2 formed = $143.17 - 142.24 = 0.93 \text{ g}$</td> </tr> </table> Correctly calculates mass of Q (II – III) AND Correctly calculates total ('initial') mass (I + [II – III]) [M1] Correctly calculates mass CO_2 (I + II – III – IV) [M2] awarded if $\delta \pm 15\%$ between supervisor and candidate. [M3] • (Mass of) Q added • (Mass of) flask + acid + Q (added)	(Mass of) Q added	$10.76 - 4.68 = 6.08 \text{ g}$	(Mass of) flask + acid + Q (added)	$139.05 + 6.08 = 143.17 \text{ g}$	Mass of CO_2 formed	Mass of CO_2 formed = $143.17 - 142.24 = 0.93 \text{ g}$		
(Mass of) Q added	$10.76 - 4.68 = 6.08 \text{ g}$									
(Mass of) flask + acid + Q (added)	$139.05 + 6.08 = 143.17 \text{ g}$									
Mass of CO_2 formed	Mass of CO_2 formed = $143.17 - 142.24 = 0.93 \text{ g}$									
(c)	(i)	Correctly calculates amount of $\text{CO}_2 = \text{mass } \text{CO}_2 / 44 \text{ mol}$ [1] Amount of CO_2 formed = $0.93 / 44 = 0.02114 \text{ mol}$		[1]						
	(ii)	Calculate number of moles of Na_2CO_3 used [1] and number of moles of Na_2CO_3 needed. [1] M2 Comparison of moles / masses of Na_2CO_3 used versus needed [1] Mass of Q used = 6.08 g No. of moles of Q added = $5.88 / 106 = 0.05736$ [1] According to the equation, 1 mol of Na_2CO_3 forms 1 mol of CO_2 No of moles of Q needed = 0.02114 [1] no of moles of Q added > no of moles of Q needed [1] Therefore Q is added in excess.		[3]						
	(iii)	Correctly uses (amount H_2SO_4 needed (in 25cm^3) = amount of $\text{CO}_2 = \text{(b)(i) mol}$) [M1] Concentration = $\text{(b)(i)} 1000 / 25 \text{ mol/dm}^3$ AND answer given exact or to 3 sf [M1] According to the equation, 1 mol of H_2SO_4 forms 1 mol of CO_2 No of moles of H_2SO_4 used in 25 cm^3 = 0.02114 [1]		[2]						

		No of moles of H_2SO_4 in 1000 cm^3 $= 0.02114/25 \times 1000$ $= 0.8456 \text{ mol/dm}^3$ [1] $\sim 0.846 \text{ mol/dm}^3$	 KIASU ExamPaper standwide Delivery / Whatsapp Only 88660031 www.KiasuExamPaper.com	
(c)	(i)	Reaction / mixture froths / undergoes (rapid) effervescence AND more likely to overflow / some (reaction mixture) is lost from beaker.	[1]	
	(ii)	Student 1 Hydrogen gas has very low density Error in loss of small mass gives large % error [1] Student 2 Calcium sulfate is insoluble / sparingly soluble Calcium sulfate (formed) coats solid (preventing further reaction) [1]	[2]	
Total: 13				
Question	Skill	Indicative material	Mark	Total
3		Method: I: gravimetric (mass loss) II: measure the time taken to obtain fixed volume of CO_2 III: determine volume of CO_2 collected in fixed time IV: measure the time taken for white ppt to appear in $\text{Ca}(\text{OH})_2$ Use of water bath X Correct set up/ Description (includes all key apparatus) I: need crucible / boiling tube for heating, weighing scale II: need boiling tube for heating, gas syringe, stopwatch III: need boiling tube for heating, gas syringe, stopwatch IV: need boiling tube for heating, delivery tube to $\text{Ca}(\text{OH})_2$, stopwatch Conical flask for heating X Hypothesis/ conclusion/results: I: The longer it takes for no further change in mass loss to be observed, the more reactive the metal. II: the longer the time taken for fixed volume of CO_2 to be obtained, the more reactive the metal. III: the lower the volume of CO_2 collected, the more reactive the metal. IV: the slower the white ppt appears, the more reactive the metal.	ACE:1 MMO: 1 ACE:1	

Question 4a	Skill	Indicative material	Mark	Total
Test 1	MMO	Dirty-green precipitate is formed. insoluble in excess	1	[1]
test 2	MMO	No observable change when acid is added White precipitate is formed when barium nitrate is added.	1	[1]
test 3	MMO	Purple potassium manganate(VII) turns colourless / pink or pale purple solution obtained Red-brown precipitate formed, insoluble in excess	1 1 1	[3]
4b(i)	ion: iron(II) justification: in test 1, dirty green ppt formed when sodium hydroxide added		1	
(ii)	ion: sulfate justification: in test 2, white precipitate is formed when barium nitrate is added.		1	
				
				Total: 7





JUNYUAN SECONDARY SCHOOL
Secondary Four Express
Preliminary Examination 2025

CANDIDATE
NAME

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CLASS

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INDEX
NUMBER

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CHEMISTRY

6092 / 03

Paper 3

27 Aug 2025

1 hour 50 min

Candidates answer on the Question Paper.

Additional Materials: As listed in the Confidential Instructions

READ THESE INSTRUCTIONS FIRST

Write your name, index number and name on all the work you hand in.
Give details of the practical shift and laboratory where appropriate in the boxes provided.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.

Answer **all** the questions in the spaces provided on the Question Paper.
The use of an approved scientific calculator is expected, where appropriate.
You may lose marks if you do not show your working or if you do not use appropriate units.

Qualitative Analysis Notes are printed on page 8.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [] at the end of each question or part question.

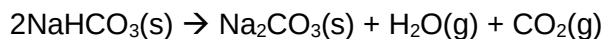
Shift
Laboratory

For Examiner's Use	
1	
2	
3	
Total	40

This document consists of **8** printed pages.

[Turn over

- 1** Sodium hydrogencarbonate, NaHCO_3 , is used as baking soda in cooking and it is known to decompose on heating as shown in the following equation:



An impure sample of sodium hydrogencarbonate is provided and the impurity is a different sodium compound that does not react when heated. Perform the experiment described below to determine the percentage purity of sodium hydrogencarbonate in the sample and identify the impurity.

Read all the instructions carefully before starting the experiments in Question 1.

Solid A is the impure sample of sodium hydrogencarbonate.

- (a) (i)** Use the mass balance to find the mass of an empty test-tube.

Add approximately 1.5 g of A to the test-tube and find the mass of the test-tube and its contents.

Gently heat the test-tube and contents for 3 minutes so that the sodium hydrogencarbonate decomposes.

Leave the test-tube and its contents to cool to room temperature before finding the mass of the test-tube and its contents.

You may begin the experiments in parts **(d)** and **(e)** on page 4 while you are waiting for the test-tube to cool.

Record your results clearly in the space provided.

[4]

- (ii)** Use your results to determine:

the mass of A before heating

the change in mass after heating

[2]

- (b) (i) Use your answers from (a)(ii) and the equation for the decomposition of sodium hydrogencarbonate to calculate the mass of sodium hydrogencarbonate present in the mass of A heated.

[M_r : NaHCO_3 , 84; H_2O , 18; CO_2 , 44]

mass of sodium hydrogencarbonate present =g [2]

- (ii) Calculate the percentage purity of sodium hydrogencarbonate in A.

percentage purity of sodium hydrogencarbonate in A =% [2]

- (c) (i) Suggest why heating the sample once for 3 minutes may not give an accurate value for the percentage purity of sodium hydrogencarbonate in A.

.....
[1]

- (ii) Suggest one way in which the experiment could be improved to obtain a more accurate value of the percentage purity of sodium hydrogencarbonate in A.

.....
[1]

- (d)** B is the solid remaining after decomposing A by heating.

You are provided with a sample of B to use in parts **(d)** and **(e)**.

Carry out the following test on the sample of B provided in a test-tube. Record your observations in the space provided. You should test and name any gas evolved.

Place the test-tube containing the sample of B in a test-tube rack and add dilute nitric acid, a little at a time, until no further reaction occurs.

Keep the final solution for use in **(e)**.

.....

[3]

- (e)** Carry out the following tests on the solution from **(d)**. Record your observations in the space provided.

- (i)** To about 1 cm³ of the solution from **(d)** in a test-tube, add a few drops of aqueous silver nitrate.

.....[1]

- (ii)** To another 1 cm³ of the solution from **(d)** in a test-tube, add an equal volume of aqueous barium nitrate.

.....[1]

- (f)** Identify the impurity in A.

.....[1]

- (g)** **(i)** Why was excess acid added to B in **(d)** before carrying out the tests in **(e)**?

.....
[1]

- (ii)** Why was nitric acid used in **(d)** rather than hydrochloric or sulfuric acid?

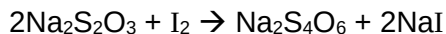
.....
[1]

[Total: 20]

- 2 Iodine is widely used as an antiseptic.

You are going to determine the concentration of iodine in an antiseptic solution by titration with aqueous sodium thiosulfate, $\text{Na}_2\text{S}_2\text{O}_3$, using starch solution as an indicator.

The equation for the reaction is shown below:



Read all the instructions below carefully before starting the experiment.

You are going to carry out a titration experiment.

Q is an antiseptic solution containing iodine.

R is 0.160 mol/dm^3 sodium thiosulfate.

- (a) (i) Put R into the burette.

Pipette 25.0 cm^3 of Q into a flask.

Add R from the burette until the red-brown colour fades to yellow, then add about 4 drops of the starch solution. This will give a dark purple-black colouration.

Continue adding R slowly from the burette until one drop of R causes the purple-black colour to disappear, leaving a colourless solution.

Record your titration results in the space provided, repeating the titration as many times as you consider necessary to achieve consistent results.

Results

[5]

- (ii) From your titration results, obtain an average volume of R to be used in your calculations. Show clearly how you obtain this volume.

average volume of R [1]

- (b) (i) R is 0.160 mol/dm^3 aqueous sodium thiosulfate.

Using your results, calculate the concentration, in mol/dm^3 , of iodine in Q.

concentration of iodine in Q mol/dm^3 [2]

- (ii) Using your answer from (i), calculate the mass of iodine, I_2 , in 1 dm^3 of Q. [A_r : I, 127]

mass of iodine in 1 dm^3 of Q [1]

- (iii) Given that 1 dm^3 of Q has a mass of 1000 g, calculate the percentage by mass of iodine in the solution.

percentage by mass of iodine in Q% [3]

- (c) A student repeated the experiment and accidentally used a 20.0 cm^3 pipette to measure solution Q into the flask in each titration.

The student thought he had used a 25.0 cm^3 pipette.

Describe and explain the effect this would have on the percentage by mass of iodine in the solution calculated by the student.

.....

[2]

[Total: 14]

- 3** The alcohols ethanol (boiling point 78 °C) and propanol (boiling point 97 °C) can both be used during surgery for cleansing. However, the oxidation of these alcohols by air, will limit their ability to clean.

(a) Suggest how you would determine in the laboratory, which of these two alcohols is more quickly oxidised by air. Include all the measurements you would make.

.....
.....
.....
.....
.....
.....[4]

(b) If two bottles of ethanol and propanol are accidentally mixed, suggest a method of separation for the mixture and briefly explain why the method works.

method of separation:
why the method works:
.....[2]

[Total: 6]

QUALITATIVE ANALYSIS NOTES

Test for anions

<i>anion</i>	<i>test</i>	<i>test result</i>
carbonate (CO_3^{2-})	add dilute acid	effervescence, carbon dioxide produced
chloride (Cl^-) [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	white 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.

Test for aqueous cations

<i>cation</i>	<i>effect of aqueous sodium hydroxide</i>	<i>effect of aqueous ammonia</i>
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.
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	green ppt., insoluble in excess
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

Test for gases

<i>gas</i>	<i>test and test result</i>
ammonia (NH_3)	turns damp red litmus paper blue
carbon dioxide (CO_2)	gives white ppt. with limewater (ppt. dissolves with excess CO_2)
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 aqueous acidified potassium manganate(VII) from purple to colourless



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Mark scheme

6092 Chemistry Prelim 2025

Question	Skill	Indicative material	Mark	Total	Remarks
1(a)(i)	PDO	presents 3 sets of mass readings in an appropriate format (clear statements or a table with clear headers): mass of empty test-tube = 15.80 g mass of test-tube and contents = 17.36 g mass of test tube and contents after heating = 16.88 g	1 1	[4]	Generally well done.
	MMO	all mass readings recorded to precision of instrument (0.01 g) all mass readings recorded with correct units	1 1		
1(a)(ii)	MMO	mass of A before heating = (mass of test-tube and contents – mass of empty test tube) = approximately 1.5 g change in mass after heating = (mass of test-tube and contents – mass of test-tube and contents after heating) (with appropriate units)	1 1	[2]	Generally well done. Deduct 1m if no units provided.
1(b)(i)	MMO	mass loss = mass of H₂O vapour + mass of CO₂ = (mol_{water} × Mr of H₂O) + (mol_{carbon dioxide} × Mr of CO₂) = (mol_{water} × 18) + (mol_{carbon dioxide} × 44) Since according to equation: mol_{water} = mol_{carbon dioxide} We represent mol_{water} = mol_{carbon dioxide} = m mass loss = (m × 18) + (m × 44) = m × (18 + 44) 0.48 = m × (18 + 44) m = 0.48 / (18 + 44) = 0.007742 mole ratio of NaHCO₃ : H₂O (or CO₂) = 2:1 no of moles of NaHCO₃ = 2 × 0.007742 = 0.01548	1	[2]	Actual student answer does not need to be so mathematically extensive. The mathematical proof at the beginning of this model answer is for reference only. Allow ECF from part (a)(ii) Poorly done. Many students showed a poor understanding of what they were doing in part (a). The answers in (a)(ii) were meant to be used for this part. But some did not understand what caused the change in mass although it can be derived in the equation provided with state symbols. Hence, some mistook it for the mass of NaHCO₃ while others performed additional

Mark scheme

6092 Chemistry Prelim 2025

Question	Skill	Indicative material	Mark	Total	Remarks
		mass of NaHCO_3 $= \text{mol} \times \text{Mr}$ $= 0.01548 \times 84$ $= 1.3003 \text{ g}$ $= 1.30 \text{ g (3sf)}$	1		subtractions to find another mass loss. Once the mass loss is assigned to the wrong substances, no marks will be awarded for this question due to major conceptual error. Some students could not see that the number of moles calculated from mass loss, is NOT for $\text{H}_2\text{O} + \text{CO}_2$. (Please see mathematical proof in blue.) This caused an error later Minus 1m for use of rounded off values for calculation.
1(b)(ii)	MMO	$\% \text{ by mass of } \text{NaHCO}_3 = (\text{mass of } \text{NaHCO}_3 / \text{mass of A}) \times 100$ $= (1.30003 / 1.56) \times 100$ $= 83.35 \%$ $= 83.4 \% (3\text{sf})$	1 1	[2]	Allow ecf
1(c)(i)	ACE	The sample was heated gently for 3 minutes. Heating gently may not have caused sodium hydrogencarbonate to completely decompose.	1	[1]	Poorly done
1(c)(ii)	ACE	Repeat heating and weighing the same sample until the mass after each heating is constant.	1	[1]	Poorly done
1(d)	MMO	bubbles observed white solid dissolves to give colourless solution, white ppt forms in limewater, gas is carbon dioxide.	any 2 ob [2] 1	[3]	Several weak responses showed test for hydrogen gas when there is clearly no metal involved.
1(e)(i)	MMO	white ppt observed	1	[1]	Generally well done.
1(e)(ii)	MMO	no ppt / no observable (visible) change	1	[1]	Weak responses did not indicate whether a ppt was observed OR, did not indicate

Mark scheme

6092 Chemistry Prelim 2025

Question	Skill	Indicative material	Mark	Total	Remarks
					whether there was a lack of observable change.
1(f)	ACE	sodium chloride	1	[1]	Poorly done. Students did not read the front paragraph where the cation was given.
1(g)(i)	ACE	To ensure that carbonate ions are removed. [When the carbonate ions are present, it will react with silver nitrate and barium nitrate. A white ppt will also be observed, giving a false set of results.]	1	[1]	[comments in square brackets are for reference and understanding. Need not penalize if not written]. Some students wrote that the excess acid was necessary to dissolve all the solid B /fully react B. This answer is not accepted because, even if all the solid B is not dissolved or fully reacted, the tests in (e) can still proceed without results affected.
1(g)(ii)	ACE	Chloride ions from HCl and sulfate ions from H_2SO_4 reacts with silver nitrate and barium sulfate respectively giving white ppt. However, nitrate ions do not react with silver nitrate nor barium nitrate to produce any ppt.	1	[1]	Poorly done. Students are not aware of how solubility affects QA tests. Reject: Partial answers that only spoke about nitric acids forming soluble substances but made no mention of sulfuric and hydrochloric acid.
2(a)(i)	PDO MMO	Results Table: - records initial burette readings, final burette readings and volume added with correct headings and units in titration table. - all burette readings for all accurate titres in titration table are recorded to nearest $\pm 0.05 \text{ cm}^3$. Titration Results: - Accuracy for the average titre (of consistent readings) within 0.20 cm^3 of Supervisor's average value score 2 marks for the average titre (of consistent readings) within 0.30 cm^3 of Supervisor's average value score 1 mark - Concordance	1 1 2 1	[5]	<u>Reject these headers:</u> Final volume / initial volume Final reading of R used / initial volume of R used Generally well done.

Mark scheme

6092 Chemistry Prelim 2025

Question	Skill	Indicative material	Mark	Total	Remarks																				
		at least two titre values are within 0.20 cm³ (using uncorrected titres) Supervisor Results: <table><tr><td>Titration number</td><td>1</td><td>2</td><td>3</td></tr><tr><td>Final</td><td>24.90</td><td>24.90</td><td>24.60</td></tr><tr><td>Initial</td><td>0.40</td><td>0.20</td><td>0.00</td></tr><tr><td>Vol added</td><td>24.50</td><td>24.70</td><td>24.60</td></tr><tr><td>Best titration</td><td>✓</td><td>✓</td><td>✓</td></tr></table>	Titration number	1	2	3	Final	24.90	24.90	24.60	Initial	0.40	0.20	0.00	Vol added	24.50	24.70	24.60	Best titration	✓	✓	✓			
Titration number	1	2	3																						
Final	24.90	24.90	24.60																						
Initial	0.40	0.20	0.00																						
Vol added	24.50	24.70	24.60																						
Best titration	✓	✓	✓																						
2(a)(ii)	MMO	appropriate average volume of R in 2 d.p. from closest titre values (titres should be identified either in the table by a tick, or in a calculation) Average volume of R = $(24.50 + 24.70 + 24.60) / 3$ = 24.60 cm³	1	[1]	Generally well done.																				
2(b)(i)	ACE	Moles of sodium thiosulfate in R = $0.02440 \times 0.160 = 0.003904$ moles of iodine in 25 cm³ of Q = $0.003904 / 2 = 0.001952$ concentration of iodine in Q = $0.001952 / 0.025$ = 0.07808 mol/dm³ = 0.0781 mol/dm³ (3sf) OR $\frac{M \times 25.0}{0.160 \times 24.40} = \frac{1}{2}$ M = 0.07808 mol/dm³ = 0.0781 mol/dm³ (3sf)	1 1	[2]																					
2(b)(ii)	ACE	mass of iodine in 1 dm³ of Q = ans from (2bi) $\times (127 \times 2)$ = 0.07808 $\times 127 \times 2$ = 19.832 g = 19.8 g (3sf)	1	[1]	Weak responses showed students did not understand that (2bi) calculated for the number of moles of iodine in 1dm ³ . So manipulations of multiplying with 25.0cm ³ or																				

Mark scheme

6092 Chemistry Prelim 2025

Question	Skill	Indicative material	Mark	Total	Remarks
					dividing with 25.0cm ³ proceeded to give wrong answers. Several students missed out multiplying Ar of iodine with 2, despite a big hint given in the question which should I ₂ as the formula.
2(b)(iii)	ACE PDO PDO	% by mass of iodine in solution = $\frac{19.832}{1000} \times 100 = 1.9832$ = 1.98% (3sf) percentage by mass of iodine in Q appropriate significant figures in final answers in (b)(i), (ii) and (iii) appropriate units in final answers in (a)(ii), (cm³), (b)(ii), (g)	1 1 1	[3]	No ecf awarded.
2(c)	ACE	Titre values will be lower than expected (due to lesser of volume of Q in flask)/ Student would assume there are lesser number of mols of iodine in 25.0 cm³. Student's calculated percentage by mass of iodine would be lower than actual value.	1 1	[2]	Many students did not read the question which stated that the student thought he had used 25.0cm³ of the solution when he only used 20.0cm³. This means that all the calculations (from bi) thereafter would wrongly use a 25.0 cm³ when it is only a 20.0 cm³. This causes the calculated result to decrease, not increase. Weaker responses assumed that since this is titration, a proportionate amount of thiosulfate (R) would be used for titration. While this is true, all the calculations (from bi) thereafter would be wrong because the student thought he had used 25.0cm³ of iodine solution when he only used 20.0cm³. These volumes are used in the calculations so it will affect the result, it will not remain the same.

Mark scheme

6092 Chemistry Prelim 2025

Question	Skill	Indicative material	Mark	Total	Remarks
3a	P	Place equal volume of each alcohol in a petri dish/beaker separately and place a digital pH probe in contact with the liquid alcohol. Leave both petri dishes in the open air at the same location. Track the recording of pH to observe the time taken for pH to drop below 7. The alcohol with the shortest time taken for pH to drop below 7 is more quickly oxidized by air. OR Accept measurement of time taken for litmus to turn red or pH indicator to change colour. Correct approach – 1m Clear description of procedure – 1m Clear indication of what are the measurements – 1m How to make conclusion – 1m	1 1 1 1		Some students did not read the question and suggested using KMnO_4 for reaction when clearly the intent is to measure rate of oxidation by oxygen in the air.
3b	P	Method of separation = fractional distillation Why the method works = both liquids are miscible; have different boiling points that are quite close	1 1		Reject: They have similar boiling points.

MMO: Manipulation, Measurement, Observation

PDO: Presentation of Data and Observation

ACE: Analysis, Conclusions and Evaluation

P: Planning







KUO CHUAN PRESBYTERIAN SECONDARY SCHOOL

2025 PRELIMINARY EXAMINATION

Secondary 4 Express

NAME

CLASS

REG. NO

CHEMISTRY

6092/03

Paper 3 Practical

14 August 2025

1 hour 50 minutes

Candidates answer on the Question Paper.

Setter: Ms. Eunice Foo

READ THESE INSTRUCTIONS FIRST

Write your name, class and register number on all the work you hand in.

Write in dark blue or black pen.

You may use a soft pencil for any diagrams or graphs.

Do not use staples, paper clips, glue or correction fluid.

Answer **all** questions in the spaces provided on the Question Paper.

The use of an approved scientific calculator is expected, where appropriate.

You may lose marks if you do not show your working or if you do not use appropriate units.

Qualitative Analysis Notes are printed on page 12.

At the end of the examination, fasten all your work securely together.

The number of marks is given in brackets [] at the end of each question or part question.

Shift
Laboratory

For Examiner's Use	
1	/14
2	/11
3	/15
Total	/40

This document consists of **11** printed pages and **1** blank page.

- 1 The reaction between an acid and an alkali is known as neutralisation.

You are provided with a sample of acid, **P**, that is diluted from acid HX.

You are going to determine the percentage purity of the sample of acid, **P**, by titrating it with aqueous sodium hydroxide, using methyl orange as an indicator.

Read all the instructions below carefully before starting the experiment in Question 1.

Instructions

You are going to carry out a titration experiment.

P is a solution containing an impure sample of monobasic acid, HX.

Q is a solution of sodium hydroxide of concentration 0.0800 mol/dm^3 .

- (a) (i) Put **P** into the burette.

Pipette 25.0 cm^3 of **Q** into a conical flask.

Add a few drops of the methyl orange indicator to the solution in the conical flask.

Slowly add **P** from the burette, swirling the flask constantly, until the one drop of **P** causes the methyl orange indicator to change colour permanently, indicating that the end-point is reached.

Record your titration results in the space provided. Repeat the titration as many times as you consider necessary to achieve consistent results.

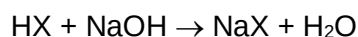
Results

[5]

- (ii) From your titration results, obtain an average volume of **P** to be used in your calculations. Show clearly how you obtained this volume.

average volume of **P** [1]

- (b) The equation for the reaction occurring in the titration is shown.



- (i) **Q** is 0.0800 mol/dm³ aqueous sodium hydroxide.

Use your answer from **(a)(ii)** and the equation for the reaction to calculate the concentration, in mol/dm³, of HX in **P**.

concentration of HX in **P** mol/dm³ [2]

- (ii) Given that the relative molecular mass of HX is 90, use your answer in **(b)(i)** to calculate the concentration, in g/dm³, of HX in **P**.

concentration of HX in **P** g/dm³ [1]

- (iii) **P** was prepared by dissolving 12.0 g of an impure sample of HX in water to make 1 dm³ of solution.

Use your answer to (b)(ii) to calculate the percentage purity of the acid HX which was used to make **P**.

percentage purity of HX in **P** [3]

- (c) The student repeated the titration but did not realise that there was an air bubble below the burette tap and carried out the titration as usual.

Describe and explain the effect of this would have on the calculated concentration of **P** required for the complete neutralisation of **Q**.

.....
.....
.....
..... [2]

[Total: 14]

- 2 Carbonates form an important range of compounds. Many of them occur naturally in rock formation. One example of carbonate is zinc carbonate.

You are provided with solid **S** which is zinc carbonate.

Read all the instructions carefully before starting the experiments in Question 2.

Instructions

- (a) Add 2 levelled spatulas of sample **S** into a dry boiling tube. Heat gently in the boiling tube, then strongly, until no further change occurs. Allow the boiling tube with the residue to cool for approximately 2 minutes. You do **not** need to test any gas evolved.

Record your observations.

.....

 [2]

- (b) You are provided with solution **T**.

Carry out the following tests on **T**. Record your observations in the space provided. You should test and identify any gases evolved.

The volumes given below are approximate and should be estimated rather than measured unless instructed otherwise.

test	observations
Test 1 To 2 cm depth of T in a clean test-tube, add 1 levelled spatula of S .	[1]
Test 2 To 1 cm depth of T in a clean boiling tube, add double the volume of aqueous sodium hydroxide and a piece of aluminium foil. Warm the mixture in the boiling tube.	[1]

Test 3(a) To 1 cm depth of T in a clean boiling tube, add an equal volume of aqueous iron(II) sulfate. Heat the mixture until it just begins to boil.	[1]
Test 3(b) To the mixture in 3(a) , add aqueous ammonia until no further change occurs.	[1]
Test 4 To 1 cm depth of T in a clean boiling tube, add an equal volume of aqueous potassium iodide. Warm the mixture.	[1]

- (c) (i) Deduce the chemical formulae of the cation and anion in **T**, justify your deductions using evidence from your observations.

The cation in **T** is

justification for the cation in **T**:

.....

The anion in **T** is

justification for the anion in **T**:

..... [2]

- (ii) What is the role of **T** in **Test 3(a)**?

Explain your answer.

.....

.....

..... [2]

[Total: 11]

- 3 A student passes electricity through a solution of zinc sulfate using an inert anode and a zinc cathode of known mass. Fig. 3.1 shows the set-up of the experiment.

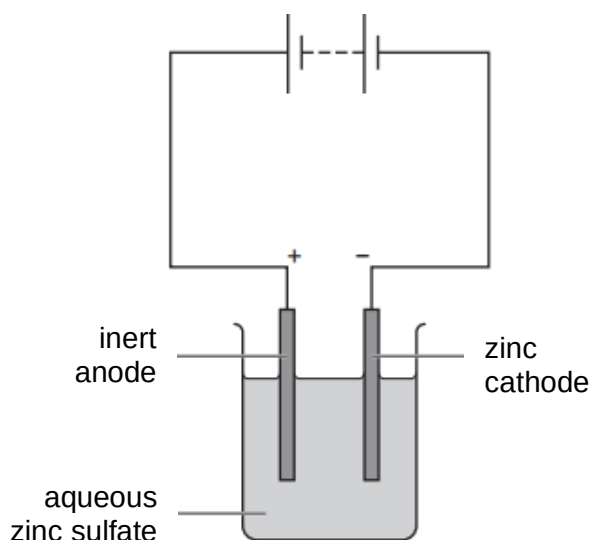


Fig. 3.1

Zinc is deposited at the cathode while effervescence was observed at the anode throughout the experiment.

After 5 minutes, the student removes the cathode to determine the mass of zinc deposited.

- (a) (i) Suggest what the student must do to the cathode after removing it from the solution but before placing it on the electronic balance to measure its mass.

..... [1]

- (ii) Write the ionic equation, with state symbols, for the reaction that takes place at the cathode.

..... [1]

- (iii) Describe a test to confirm the identity of the gas produced at the anode.

.....

..... [2]

- (b) State whether ΔH , the enthalpy change that occurs during the experiment has a positive or negative value.

Explain your answer.

.....

..... [1]

- (c) The student measures the mass of the cathode and then puts it back into the circuit and continues the experiment.

The mass of zinc deposited is measured every five minutes and recorded in Table 3.2.

Table 3.2

time / min	mass of zinc deposited / g
0	0.00
5	0.29
10	0.59
15	0.88
20	1.20
25	1.30
30	1.30
35	1.30

On the grid provided in Fig. 3.3, use the results from Table 3.2 to plot a graph of mass of zinc deposited on the y-axis against time on the x-axis. Label the axes. Draw a straight line through the first five points and draw another straight line through the last three points. Extend both lines so they both intersect.



Fig. 3.3

[3]

(d) Use your graph in Fig. 3.3 to answer the following questions.

(i) Determine the mass of zinc deposited after 18 minutes.

..... g [1]

(ii) Determine the minimum time taken for all the zinc to be deposited.

..... min [1]

- (e) It was discovered that the electronic balance used earlier was faulty.

Outline **another** method, that does not involve the measurement of mass, to determine the number of moles of zinc deposited at the cathode in 30 minutes.

In your method you should include:

- the apparatus you would use
- the measurements you would take
- an explanation of how you would use your results to calculate the number of moles

You can assume all the apparatus and reagents normally found in a school laboratory are available. Use a labelled diagram to illustrate your answer.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [5]

[Total: 15]

-END OF PAPER-

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QUALITATIVE ANALYSIS NOTES

Test for anions

<i>anion</i>	<i>test</i>	<i>test result</i>
carbonates (CO_3^{2-})	add dilute acid	effervescence, carbon dioxide produced
chloride (Cl^-) [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	white 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 chloride.	white ppt.

Test for aqueous cations

<i>cation</i>	<i>effect of aqueous sodium hydroxide</i>	<i>effect of aqueous ammonia</i>
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.
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	green ppt., insoluble in excess
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

Test for gases

<i>gas</i>	<i>test and test result</i>
ammonia (NH_3)	turns damp red litmus paper blue
carbon dioxide (CO_2)	gives white ppt. with limewater (ppt. dissolves with excess CO_2)
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 aqueous acidified potassium manganate(VII) from purple to colourless



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 MARKING RUBRIC

Relative Weighting

Skill Areas	Total Marks	Relative Weighting (%)
Manipulation, measurement and observation (MMO)	6	15.0
Presentation of data and observations (PDO)	12	30.0
Analysis, conclusions and evaluation (ACE)	17	42.5
Planning (P)	5	12.5

From SEAB O Level 6092 Syllabus Document

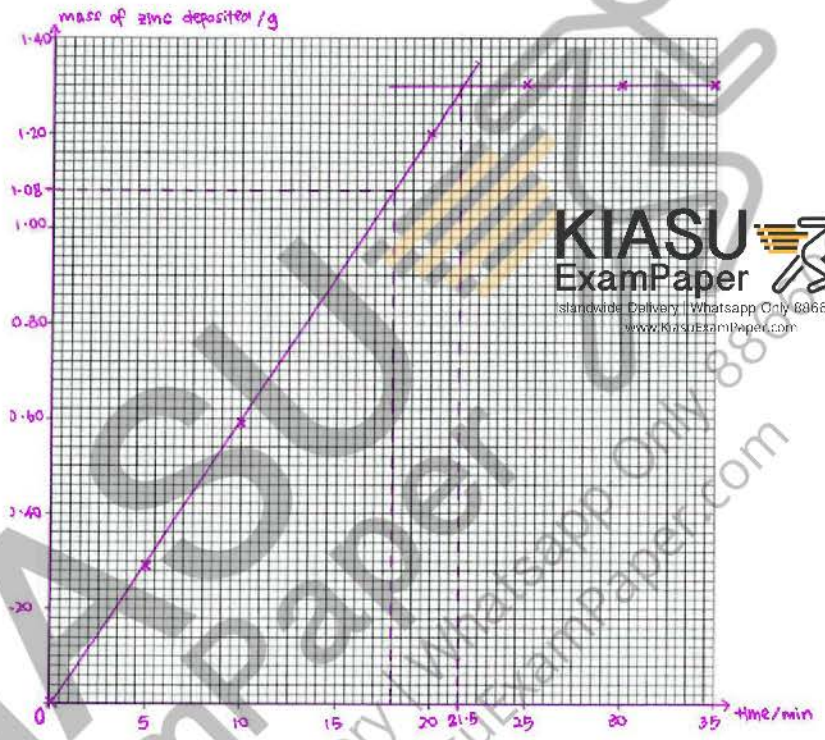
The assessment of Planning (P) will have a weighting of 15%.

The assessment of skill areas MMO, PDO and ACE will have a weighting of 85%.

Question	Skill	Indicative material	Mark	Total
1(a)(i)	PDO	Results table: Records initial burette readings, final burette readings and volume added with correct headings and units in a titration table. mark is not awarded if units appear with the values in the table	1	[5]
		all burette readings for all accurate titres in titration table are recorded to nearest 0.05 cm³	1	
	MMO	Titration Results: accuracy for the average titre (of consistent readings) within 0.20 cm³ of Supervisor's average value score 2 marks for the average titre (of consistent readings) within 0.30 cm³ of Supervisor's average value score 1 mark Supervisors are asked to carry out a standard acid/base titration between solutions P and Q to ensure that the concentrations of the two solutions fall within the given range. It is essential that 25.0 cm³ of Q reacts with between 19.00 cm³ and 21.00 cm³ of P. Supervisor's average titre: 20.05 cm³	2	
		concordance at least two titre values are within 0.20 cm³ (using uncorrected titres)	1	

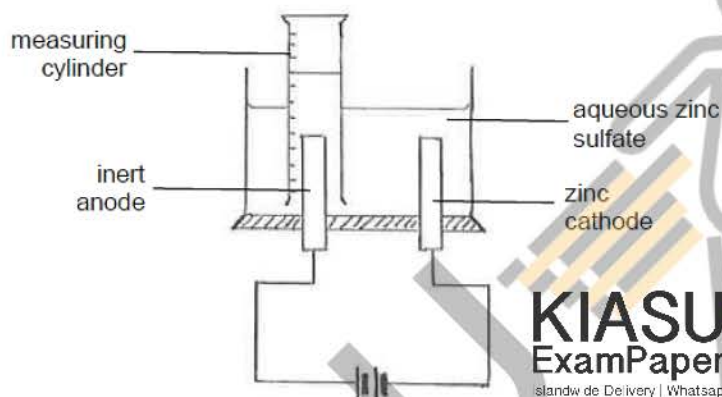
Question	Skill	Indicative material	Mark	Total
1(a)(ii)	MMO	appropriate average volume of P in 2 d.p. from closest titre values (titres should be identified either in the table by a tick, or in a calculation) <i>marks not deducted for volume not in 2 d.p. (mark is only deducted in part (b)(iii))</i>	1	[1]
1(b)(i)	ACE	number of moles of Q = $(0.0800) \times (25.0 / 1000)$ = 0.00200 mol = number of moles of HX in P	1	[2]
	ACE	molar concentration of HX in P = $(0.00200) / (\text{average volume of } \mathbf{P} / 1000)$	1	
1(b)(ii)	ACE	mass concentration of HX in P = answer from (b)(i) $\times$ 90 g/mol	1	[1]
1(b)(iii)	ACE	percentage purity of HX = $(\text{answer from (b)(ii)} / 12.0) \times 100\%$	1	[3]
	PDO	appropriate significant figures and decimal places in final answers of (a)(ii), (b)(i), (ii) and (iii)	1	
	PDO	appropriate units in final answers in (a)(ii), (cm ³) and (b)(iii), %	1	
1(c)	ACE	student's calculated value for concentration of P will be lower than the actual value	1	[2]
		recorded titre value (volume of HX) used will be more than the true value.	1	
Total: 14				

Question	Skill	Indicative material	Mark	Total
2(c)(i)	ACE	Cation in T: <u>H⁺</u> (reject: hydrogen ion)		[2]
	ACE	Justification for cation: From Test (1), <u>the (carbon dioxide) gas produced when S (zinc carbonate) was reacted with T forms a white ppt. in limewater.</u> This suggests that T is an acid. Anion in T: <u>NO₃⁻</u> (reject: nitrate) Justification for anion: From Test 2, <u>the (ammonia) gas produced turned damp red litmus paper blue when sodium hydroxide was added and warmed with aluminium foil.</u>	1 1	
2(c)(ii)	ACE	<u>Oxidising agent</u> <u>Oxidises iron(II) ion to iron(III) ion</u> , (which causes the green solution to turn red-brown, and confirmed when a red-brown ppt. is formed when tested with aq. NaOH in Test 3(b)).	1 1	[2]
			Total: 11	

Question	Skill	Indicative material	Mark	Total
3(a)(i)	ACE	<u>Wash with distilled/deionised water</u> and <u>dry</u> .	1	[1]
3(a)(ii)	ACE	<u>$\text{Zn}^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Zn}(\text{s})$</u>	1	[1]
3(a)(iii)	ACE	<u>Place a glowing splint near the gas.</u> <u>Glowing splint will rekindle / relight / reignite.</u>	1 1	[2]
3(b)	ACE	ΔH is <u>positive</u> (endothermic change) as <u>electrical energy is needed</u> for the reaction.	1	[1]
3(c)	ACE	(refer to larger view at the end of the MS)  • All recorded points plotted correctly. • Both lines drawn accurately and extrapolated to intersect. • Uniform scale chosen to use more than half of each axis + Correctly labelled axes with correct units written.	1 1 1	[3]
3(d)(i)	ACE	<u>1.08</u> (dependent on student's graph)	1	[1]
3(d)(ii)	ACE	<u>21.5</u> (dependent on student's graph)	1	[1]

3(e)

P

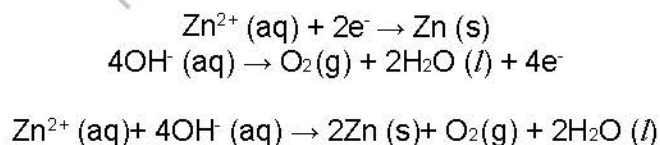


Labelled diagram showing clearly gas collection using appropriate apparatus – [1]

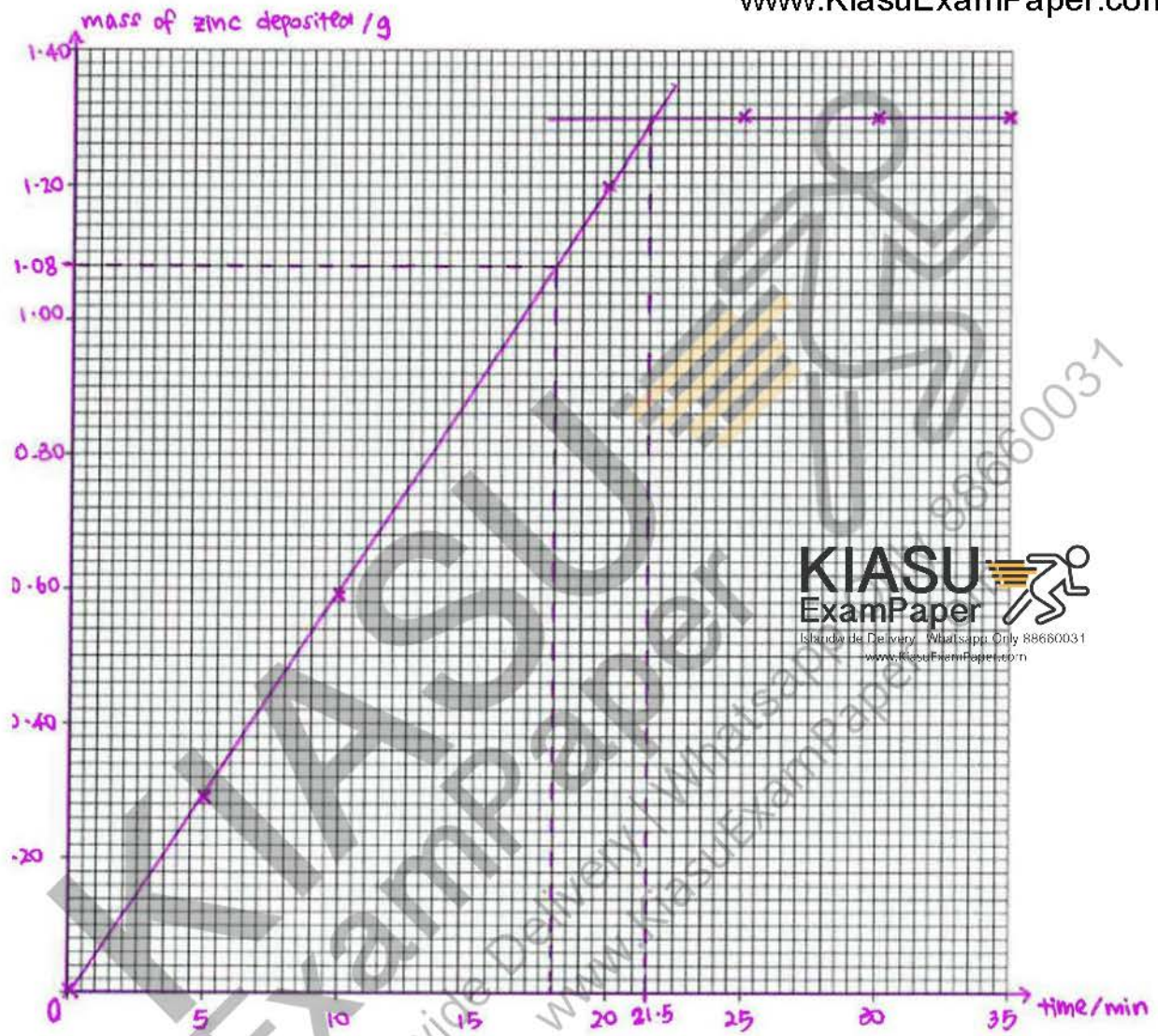
Procedure

1. Repeat the experiment using the same inert anode, zinc cathode and aqueous zinc sulfate as electrolyte. 1
2. Set-up the measuring cylinder as shown in the diagram to measure and record the volume of gas evolved in 30 minutes. 1
3. Calculate the number of moles of oxygen gas evolved by using the formula 1

$$\text{number of moles of oxygen gas} = \text{volume of gas collected (in cm}^3\text{)} \div 24000$$
4. The number of moles of zinc deposited is equal to 2 × number of moles of oxygen gas. 1



Total: 15



-End of MS-





Class/ Index Number /	Centre Number/ 'O' Level Index Number /	Name
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	新加坡海星中学 MARIS STELLA HIGH SCHOOL PRELIMINARY EXAMINATION SECONDARY FOUR
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CHEMISTRY Paper 3 Practical Candidates answer on the Question Paper. No Additional Materials are required.	6092/03 19 August 2025 1 hour 50 minutes
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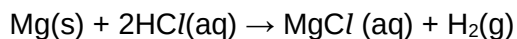
READ THESE INSTRUCTIONS FIRST Write your class, index number, Centre number, O level index number and name in the spaces at the top of this page. Give details of the practical shift and laboratory, where appropriate, in the boxes provided. Write in dark blue or black pen. You may use an HB pencil for any diagrams or graphs. Do not use staples, paper clips, glue or correction fluid or highlighters. Answer all questions in the spaces provided on the Question Paper. The use of an approved scientific calculator is expected, where appropriate. You may lose marks if you do not show your working or if you do not use appropriate units. Qualitative Analysis Notes are printed on page 9. The number of marks is given in brackets [] at the end of each question or part question. The total number of marks for this paper is 40.
--

Shift
Laboratory

Examiner's Use	
1	15
2	25
Total	40

This document consists of **9** printed pages.

- 1 Magnesium reacts with hydrochloric acid as shown in the equation.



You will determine the enthalpy change, ΔH , of the reaction between magnesium and hydrochloric acid. To do this you will measure the change in temperature when a piece of magnesium ribbon reacts with an excess of hydrochloric acid.

Read all the instructions carefully before starting the experiment.

Instructions

A is dilute hydrochloric acid, HCl.

B is magnesium ribbon, Mg.

- (a)
1. Weigh **B** using the beaker provided at the electronic balance and record the mass below.
 2. Support the Styrofoam cup in the 250 cm³ beaker.
 3. Coil **B** such that it will fit into the bottom of the Styrofoam cup and then remove it.
 4. Use the measuring cylinder to transfer 25 cm³ of **A** into the Styrofoam cup.
 5. Place the thermometer in the acid and tilt the cup if necessary, so that the bulb of the thermometer is fully covered. Record the temperature at time = 0.0 minutes in the table of results.
 6. Start timing and do not stop the clock until the whole experiment has been completed at time = 8.0 minutes.
 7. Record the temperature of the acid every one minute for 2 minutes.
 8. At time = 3.0 minutes, carefully drop the coil of **B** into **A** and stir the mixture.
 9. Record the temperature of the mixture at time = 4.0 minutes and complete the table by recording the temperature every one minute. Stir the mixture between thermometer readings.

Results

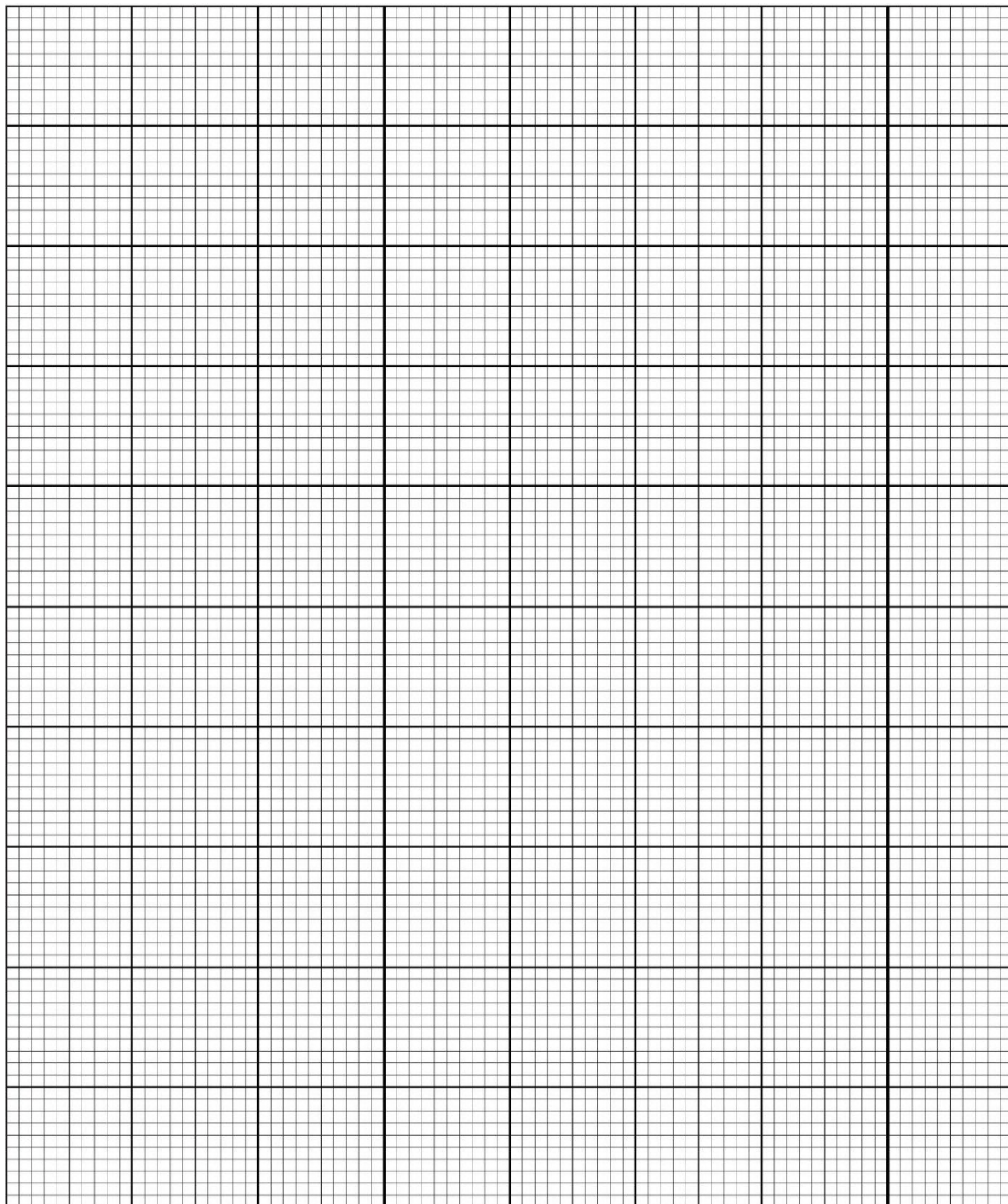
time / min	0.0	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0
temperature / °C									

[4]

- (b) (i) Plot a graph of temperature against time on the grid below.

The scale for the temperature axis should extend 10 °C greater than the maximum temperature you recorded.

You will use the graph to determine the theoretical maximum temperature rise at 3.0 minutes.



[4]

- (ii) Draw two lines of best fit through the points on your graph, the first for the temperature before adding **B** and the second for the cooling of the mixture once the reaction is complete.

Extend the two lines to 3.0 minutes, draw a vertical line at 3.0 minutes to connect these lines and determine the theoretical rise in temperature at this time.

theoretical rise in temperature at 3.0 minutes = [2]

- (c) (i) In reaction (a), **A** used was in excess. Without carrying out any additional tests, state what you could observe during your experiment to confirm this.

.....[1]

- (ii) Given that 4.2 J is needed to raise the temperature of 1.0 cm³ of solution by 1.0 °C, calculate the amount of heat released that occurred for the reaction in (a).

heat released (J) = mass of solution (g) x maximum temperature rise (°C) x 4.2

Assume that 1.0 cm³ of solution has a mass of 1.0 g.

amount of heat released = [1]

- (iii) Using your answer to (ii), calculate the enthalpy change, in kJ/mol, for the reaction between hydrochloric acid and magnesium.

[Ar : Mg, 24]

enthalpy change = [2]

- (iv) Suggest and explain **one** improvement that could be made to the method in (a) to increase the accuracy of the results.

.....[1]

Total [15]

2 Solid C is an alloy of iron and other metals.

In this experiment, you will determine the percentage of iron in **C** by performing a titration using aqueous potassium manganate(VII).

No indicator is needed for this titration as the products of the reaction are almost colourless and one drop of potassium manganate(VII) in excess produces a pale pink colour.

Read all the instructions carefully before starting the experiment in Question 2.

Instructions

D is a solution containing Fe^{2+} , made from dissolving 6.00 g of **C** in dilute sulfuric acid, forming a mixture of metal sulfates and the solution is made up 1.00 dm³.

E is 0.0200 mol/dm³ potassium manganate(VII)

- (a) (i)
- Fill the burette with **E**.
The colour of **E** makes it difficult to see the bottom of the meniscus so you should take all your readings using the top of the meniscus.
 - Use the pipette to transfer 25.0 cm³ of **D** into a conical flask.
 - Add **E** from the burette to the conical flask whilst constantly swirling the flask.

At first the purple colour disappears quickly but as more **E** is added the colour disappears less quickly. At the end-point, one drop of **E** produces a pale pink colour that does not disappear on swirling.
 - Record your titration results in an appropriate format in the space provided. Repeat the titration as many times as you consider necessary to achieve consistent results.

Results

[4]

- (ii) From your titration results, calculate the average volume of **E** required to reach the end-point of the titrations. Show clearly how you obtained this volume.

average volume of **E** = [1]

- (b) (i) Calculate the number of moles of potassium manganate(VII) present in the average volume of **E**.

amount of potassium manganate(VII) = [1]

- (ii) In the reaction five moles of iron(II) sulfate react with one mole of potassium manganate(VII). Using your answer from **(b)(i)**, calculate the number of moles of iron(II) sulfate present in 25.0 cm³ of **D**.

amount of iron(II) sulfate = [2]

- (iii) Using your answer from **(b)(ii)**, calculate the concentration, in mol/dm³, of iron(II) sulfate in **D**.

concentration of iron(II) sulfate = [1]

- (iv) Using your answer from (b)(iii), calculate the mass of iron in 1.00 dm^3 of **D**.
[Ar: Fe, 56]

mass of iron in 1.00 dm^3 of **D** = [1]

- (v) Using your answer from (b)(iv), calculate the percentage of iron in **C**.

percentage of iron in **C** = [2]

- (c) The composition of copper-iron alloy varies and is changed based on the desired properties for a particular application.

Describe a method to determine the percentage by mass of copper in a sample of copper-iron alloy.

You can assume the apparatus and reagents normally found in a school laboratory are available.

You may not use a titration method.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....[4]

- (d) (i) Read all the instructions carefully before starting the experiments in Question (d)(i).

You are provided with solution **F**.

Instructions

Carry out the following tests. You should test and identify any gases evolved. Record your observations in the table.

The volumes given below are approximate and should be estimated rather than measured unless instructed otherwise.

test	instructions	observations
1	(a) To 1 cm depth of aqueous iron(II) sulfate in a test-tube, add an equal volume of F. (b) Add aqueous sodium hydroxide to the mixture from (a).	
2	To 2 cm depth of aqueous acidified potassium manganate(VII) in a test-tube, add an equal volume of F .	
3	(a) To 1 cm depth of F in a test-tube, add 2 pieces of copper turnings. (b) Add aqueous ammonia to the mixture from (a).	

[6]

- (ii) In test **1(a)**, **F** is acting as

In test **2**, **F** is acting as

Use your observations in test **1(a)** to explain how you have reached the conclusion.

.....[3]

[Total: 25]

QUALITATIVE ANALYSIS NOTES

Test for anions

Anion	Test	test result
carbonate (CO_3^{2-})	add dilute acid	effervescence, carbon dioxide produced
chloride (Cl^-) [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	white 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.

Test 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.
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	green ppt., insoluble in excess
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

Test for gases

Gas	test and test result
ammonia (NH_3)	turns damp red litmus paper blue
carbon dioxide (CO_2)	turns white ppt. with limewater (ppt. dissolves with excess CO_2)
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 aqueous acidified potassium manganate (VII) from purple to colourless





Sec 4 Chemistry Paper 3
Preliminary Exam 2025
Mark Scheme

Qn										Mark
1(a)										

Sample Results

Mass of B added to the sulfuric acid = 0.18 g (0.17 g – 0.19 g)

correct statement [1]
reading to 2 dp [1]

time / min	0.0	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0
temperature / °C	30.5	30.5	30.5		59.5	58.5	55.5	54.0	52.0

temperature to 1 decimal place [1]
trend of temperature increasing and decreasing [1]

(b)

(i)

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1
1
1
1

Scale at least half the grid
Two intersecting lines
Labelled axes with units
All points plotted correctly

1
1
1
1

Qn				Mark																
		(ii)	theoretical rise in temperature at 3.0 minutes = $61.5^{\circ}\text{C} - 30.5^{\circ}\text{C}$ $= 31.0^{\circ}\text{C}$ correct calculation of ΔT correct answer for ΔT to 1 dp	1 1																
	(c)	(i)	All the magnesium / solid dissolved / disappeared / used up or no solid / Mg left.	1																
		(ii)	Energy change = $(25 \times 4.2 \times 31.0) \text{ J}$ $= 3\,255 \text{ J}$ $= 3260 \text{ J}$	1																
		(iii)	number of moles of magnesium = $0.18 \text{ g} \div 24 \text{ g/mol}$ $= 0.0075$ Enthalpy change = $\frac{(3\,255) \div 1000}{0.18 \text{ g} \div 24 \text{ g/mol}} \text{ kJ/mol}$ $= -434 \text{ J}$ final answer to 3 sf with negative sign	1 1																
		(iv)	Any one - use lid or use specified extra insulation to reduce heat losses (by convection or conduction); - use a pipette or burette to measure volume of acid to reduce % error / as more accurately calibrated; - use magnesium turnings / powder so reaction can complete sooner to reduce heat loss while magnesium ribbon is still reacting; - use lid or plastic cup with higher walls to reduce acid spray;	1																
2	(a)	(i)	<table border="1"> <tbody> <tr> <td>Final burette reading/cm³</td><td>24.50</td><td>24.20</td><td>24.10</td></tr> <tr> <td>Initial burette reading/ cm³</td><td>0.00</td><td>0.00</td><td>0.00</td></tr> <tr> <td>Volume of solution E used/cm³</td><td>24.50</td><td>24.40</td><td>24.20</td></tr> <tr> <td>Best titration (✓)</td><td></td><td>✓</td><td>✓</td></tr> </tbody> </table> table with correct headings and units burette readings recorded to 2 decimal places 2 consistent titre readings within $\pm 0.20 \text{ cm}^3$ average reading is within 24.10 to 24.50	Final burette reading/cm ³	24.50	24.20	24.10	Initial burette reading/ cm ³	0.00	0.00	0.00	Volume of solution E used/cm ³	24.50	24.40	24.20	Best titration (✓)		✓	✓	1 1 1 1
Final burette reading/cm ³	24.50	24.20	24.10																	
Initial burette reading/ cm ³	0.00	0.00	0.00																	
Volume of solution E used/cm ³	24.50	24.40	24.20																	
Best titration (✓)		✓	✓																	

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(d) (i)

test	instructions	observations
1	(a) To 1 cm depth of aqueous iron(II) sulfate in a test-tube, add an equal volume of F. (b) Add aqueous sodium hydroxide to the mixture from (a) slowly with shaking until no further change is seen.	(a) pale green/colourless solution turns yellow [1] (b) red-brown ppt, insoluble in excess [1] effervescence seen [1], gas relights a glowing splint (oxygen) [1]
2	To 2 cm depth of aqueous acidified potassium manganate(VII) in a test-tube, add an equal volume of F.	purple potassium manganate(VII) turns colourless/decolourised [1] effervescence seen, gas relights glowing splint (oxygen)
3	(a) To 1 cm depth of F in a test-tube, add 2 pieces of copper turnings. (b) Add aqueous ammonia to the mixture from (a).	(a) no visible reaction [1] (b) effervescence seen, gas relights glowing splint (oxygen)

Award marks for effervescence seen [1], gas relights glowing splint [1] (oxygen) [1] once in test 1, 2 or 3.

(c)	(ii)	In test 1 (a), F is acting as <u>oxidising agent</u> .	1
		In test 2, F is acting as <u>reducing agent</u> .	1
		Use your observations in test 1 (a) to explain how you have reached the conclusion. The red-brown precipitate shows that iron(II) ions have been oxidised to iron(III) ions.	1







Name	Class	Register Number
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SECONDARY 4 EXPRESS PRELIMINARY EXAMINATION 2025

CHEMISTRY

6092/03

Paper 3
Tuesday

12 August 2025
1 hour 50 minutes

Candidates answer on the Question Paper.
No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your name, class and register number on all the work you hand in.
Give details of the practical shift and laboratory where appropriate, in the boxes provided.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do **not** use staples, paper clips, glue or correction fluid.

Answer **all** questions in the spaces provided on the Question Paper.

The use of an approved scientific calculator is expected, where appropriate. You may lose marks if you do not show your working or if you do not use appropriate units.

Qualitative Analysis Notes are printed on page 11.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [] at the end of each question or part question.

Shift
Laboratory

For Examiner's Use	
1	
2	
3	
4	
Total	

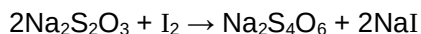
This document consists of **11** printed pages, including the cover page.

- 1** Aqueous hydrogen peroxide is widely used as a germicide and bottles of the solution can be purchased all over the world.

The amount of hydrogen peroxide in an aqueous solution can be determined by reacting it with an excess of iodide ions to produce iodine.



The iodine is then titrated with aqueous sodium thiosulfate, $\text{Na}_2\text{S}_2\text{O}_3$, using starch solution as an indicator.



Read all the instructions below carefully before starting the experiments in Question 1.

Instructions

P contains iodine produced by reacting all the hydrogen peroxide in a bottle of germicide with an excess of iodide ions, and the solution is made up to 250 cm^3 .

Q is 0.221 mol/dm^3 aqueous sodium thiosulfate.

- (a) (i)** Put **Q** into the burette.

Pipette a 25.0 cm^3 portion of **P** into a conical flask.

Add **Q** from the burette until the red-brown colour fades to pale yellow, then add a few drops of the starch indicator. This will give a dark blue solution.

Continue adding **Q** slowly from the burette until one drop of **Q** causes the blue colour to disappear, leaving a colourless solution.

Record your titration results in the space provided, repeating the titration as many times as you consider necessary to achieve consistent results.

Results

[5]

- (ii) From your titration results, obtain an average volume of **Q** to be used in your calculations.

Show clearly how you obtained this volume.

average volume of **Q** = cm³ [1]

- (b) (i) **Q** is 0.221 mol/dm³ aqueous sodium thiosulfate.

Use your answer to **(a)(ii)** to calculate the amount of iodine, in moles, in 25.0 cm³ of **P**.

amount of iodine in 25.0 cm³ of **P** = mol [2]

- (ii) Use your answer to **(b)(i)** to calculate the amount of iodine, in moles, in 250.0 cm³ of **P**.

amount of iodine in 250.0 cm³ of **P** = cm³ [1]

- (iii) Use your answer to **(b)(ii)** and the M_r of hydrogen peroxide to calculate the mass of hydrogen peroxide present in the bottle of germicide.
[Ar: H, 1 ; O, 16]

mass of hydrogen peroxide in the bottle of germicide: g [2]

- (c) A student repeated the experiment but rinsed the conical flask with solution **P** instead of distilled water.

State and explain the effect, if any, this would have on his results.

.....
.....
..... [2]

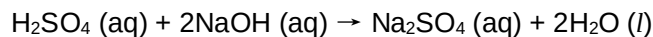
- (d) A student suggests that the experiment could be made more accurate if the volume of starch added was measured using a burette.

Suggest why this change is **unlikely** to have an effect on the accuracy of the experiment.

.....
..... [1]

[Total: 14]

- 2 The reaction between dilute sulfuric acid and aqueous sodium hydroxide is exothermic.



When dilute sulfuric acid is added to a given volume of aqueous sodium hydroxide, the temperature of the mixture increases. The greatest temperature rise is achieved when complete neutralisation occurs.

Read all the instructions below carefully before starting the experiments in Question 2.

Instructions

R is aqueous sodium hydroxide.

S is 1.20 mol/dm³ aqueous sulfuric acid.

(a) Experiment 1

- Using a measuring cylinder, transfer 25.0 cm³ of **R** into a Styrofoam cup. Measure the temperature of **R** and record the value in Table 2.1.
- Transfer 25.0 cm³ of **S** into another measuring cylinder.
- Pour **S** from the measuring cylinder into the Styrofoam cup containing **R**.
- Using the thermometer, stir the final mixture and measure the highest temperature reached. Record the value in Table 2.1.
- Empty the Styrofoam cup and rinse it well with distilled water.

Experiment 2

- Similar to Experiment 1, use the first measuring cylinder to transfer 25.0 cm³ of **R** into the Styrofoam cup. Measure the temperature of **R** and record the value in Table 2.1.
- Transfer 5.0 cm³ of **S** into the second measuring cylinder.
- Add 20.0 cm³ of deionised water to **S** in the measuring cylinder to make the total volume 25.0 cm³.
- Pour the mixture from the measuring cylinder into the Styrofoam cup containing **R**.
- Using the thermometer, stir the final mixture and measure the highest temperature reached. Record the value in Table 2.1.
- Empty the Styrofoam cup and rinse it well with distilled water.

Experiments 3 to 5

- Follow the instructions for **Experiment 2** for the remaining volumes of **S** and the respective volumes of deionised water as shown in Table 2.1.
- Using the thermometer, stir the respective final mixture and measure the highest temperature reached. Record the value in Table 2.1.

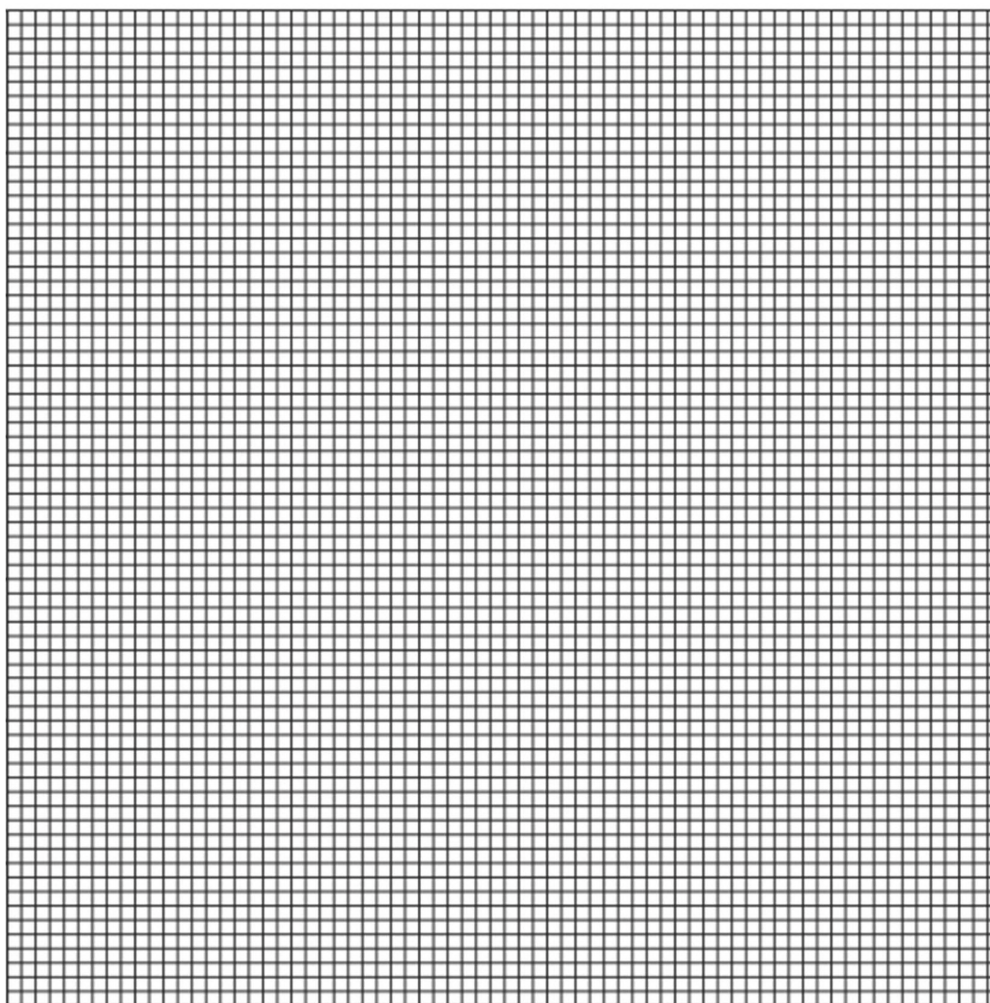
Table 2.1

experiment	volume of R / cm^3	volume of S / cm^3	volume of deionised water / cm^3	initial temperature of R / $^{\circ}\text{C}$	highest temperature of mixture / $^{\circ}\text{C}$	temperature rise / $^{\circ}\text{C}$
1	25.0	25.0	0.0			
2	25.0	5.0	20.0			
3	25.0	10.0	15.0			
4	25.0	15.0	10.0			
5	25.0	20.0	5.0			

[2]

(b) Calculate the temperature rise in each experiment. Record each value in Table 2.1. [1]

(c) (i) Plot a graph of temperature rise against volume of **S** on the grid. Use these points to draw two intersecting straight lines of best fit.



[4]

- (ii) Use your graph to determine the volume of **S** required to completely neutralise 25.0 cm³ of **R**.

..... [1]

- (iii) Using your value in (c)(ii), calculate the concentration, in mol/dm³, of sodium hydroxide in **R**.

concentration of sodium hydroxide in **R**: mol/dm³ [2]

- (d) Explain why deionised water was added to each reaction mixture, from experiments 2 to 5.

.....

 [2]

- (e) Suggest **one** modification to the experiment to improve the accuracy of the temperatures recorded.

.....
 [1]

[Total: 13]

3 Read all the instructions carefully before starting the experiment in Question 3.

You are provided with three solutions, **X**, **Y** and **Z** for use in parts **(a)** to **(c)**.

These solutions are (not necessarily in this order):

- dilute hydrochloric acid
- aqueous silver nitrate
- aqueous sodium carbonate

Instructions

Carry out the following tests on solutions **X**, **Y** and **Z**. Test and identify any gases evolved. Record your observations in the table.

If no observation change is observed for a test, write 'no observable change'.

The volumes given below are approximate and should be estimated rather than measured unless instructed otherwise.

		test	observations
(a)	(i)	Add 1 cm ³ of solution X into a clean test tube. To this test tube, add 1 cm ³ of solution Y and shake the mixture thoroughly until no further change is seen.	
	(ii)	To the same test tube, slowly add 1 cm ³ of solution Z , with shaking, until no further change is seen.	
			[2]
(b)	(i)	Add 1 cm ³ of solution Z into a clean test tube. To this test tube, add 1 cm ³ of solution X and shake the mixture thoroughly until no further change is seen.	
	(ii)	To the same test tube, slowly add 1 cm ³ of solution Y , with shaking, until no further change is seen.	
			[2]

(c)	(i)	Add 1 cm ³ of solution Y into a clean test tube. To this test tube, add 1 cm ³ of solution Z and shake the mixture thoroughly until no further change is seen.	
	(ii)	To the same test tube, slowly add 1 cm ³ of solution X , with shaking, until no further change is seen.	[2]

(d) (i) Using your results, first deduce which of the three solutions is aqueous silver nitrate.

Provide explanations for your deduction.

.....

 [2]

(ii) Using your answer to (d)(i) and the experimental results, deduce which of the remaining two solutions is dilute hydrochloric acid and aqueous sodium carbonate.

dilute hydrochloric acid:

aqueous sodium carbonate: [1]

[Total: 9]

- 4 Eggshells and seashells are some common substances that contain calcium carbonate. However, the amount of calcium carbonate in each of these substances varies.

Outline a method you could use to determine which shell sample contains more calcium carbonate.

You are only provided with separate samples of eggshells and seashells. You can assume all the apparatus and reagents normally found in a school laboratory are available.

You should include in your answer the measurements you could use to determine which shell sample contains more calcium carbonate.

You may wish to use a labelled diagram to illustrate your answer.

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.....

..... [4]

[Total: 4]

QUALITATIVE ANALYSIS NOTES

Test for anions

anion	test	test result
carbonate (CO_3^{2-})	add dilute acid	effervescence, carbon dioxide produced
chloride (Cl^-) [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	white 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.

Test 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.
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	green ppt., insoluble in excess
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

Test for gases

gas	test and test result
ammonia (NH_3)	turns damp red litmus paper blue
carbon dioxide (CO_2)	gives white ppt. with limewater (ppt. dissolves with excess CO_2)
chlorine (Cl_2)	bleaches damp litmus paper
hydrogen (H_2)	'pops' with lighted splint
oxygen (O_2)	relights a glowing splint
sulfur dioxide (SO_2)	turns aqueous acidified potassium manganate (VII) from purple to colourless





PASIR RIS SECONDARY SCHOOL
 2025 Preliminary Examination
 SECONDARY 4 EXPRESS CHEMISTRY
 MARKING SCHEME
 PAPER 3

Qn. No.	Scoring Points	Marks	Max. Mark
1	ai Results table (PDO): records initial burette readings, final burette readings and volume added with correct headings and units in a titration table all burette readings for all accurate titres in titration table are recorded to nearest 0.05 cm ³ Titration results (MMO): <u>Accuracy</u> for the average titre (of consistent readings) within 0.20cm ³ of supervisor's average value score 2 marks for the average titre (of consistent readings) within 0.30cm ³ of supervisor's average value score 1 mark <u>Concordance</u> at least two titre values are within 0.20cm ³ (using uncorrected titres)	1 1 2 1	14
	aii MMO, PDO appropriate average volume of Q in 2 d.p. from closest titre values (titres should be identified either in the table by a tick or in a calculation)	1	
	bi ACE, PDO amount of Na ₂ S ₂ O ₃ in Q used (in moles) $\text{Na}_2\text{S}_2\text{O}_3 : \text{I}_2$ $2 : 1$ amount of I ₂ in P reacted (in moles)	1 1	
	bii ACE, PDO amount of I ₂ in original P = amount of I ₂ in P reacted X 10 (in moles) *accept ECF*	1	
	biii ACE, PDO $\text{H}_2\text{O}_2 : \text{I}_2$ $1 : 1$ amount of I ₂ in original P reacted (in moles) = amount of H ₂ O ₂ (in moles)	1	

	mass of H_2O_2 = amount of H_2O_2 X 34 (in grammes) *accept ECF*	1	
c	ACE, MMO The volume of Q used would be higher than expected/actual as more than 25.0 cm^3 of P will be present in the conical flask. Hence, the calculated mass of H_2O_2 would be higher than expected/actual / the calculated concentration of iodine in P would be higher than expected/actual.	1 1	
d	ACE, MMO Starch is used as an indicator and not one of the reactants. Hence, being more precised in the volume of starch used will not affect the accuracy of the experiment.	1	

Qn. No.		Scoring Points	Marks	Max. Mark
2	a	Results table (PDO): all temperature readings recorded to 0.5 °C Experiment results (MMO): <u>Concordance</u> full set of data + correct trend	1	13
			1	
	b	Results table (PDO): temperature increase correctly calculated (to 1 d.p.)	1	
	ci	PDO Axis labels + units Appropriate scale All points correctly plotted 2 Straight lines of best fit	1 1 1 1	
	cii	MMO In accordance to student's graph. Note: minus 0.5m if no working lines shown	1	
	ciii	ACE, PDO amount of H ₂ SO ₄ in Q used (in moles) = (c)(ii) in dm ³ x 1.2 H ₂ SO ₄ : NaOH 1 : 2 amount of NaOH in P reacted (in moles) concentration of NaOH in P (in mol/dm ³)	1 1	
	d	ACE To ensure that the total volume of the reaction mixture remains constant . This ensures that the concentration of S is proportional to the volume of S . OR As a lower total volume will lead to higher than expected temperature change (related to mcΔT).	1 1	
	e	ACE Use a lid to minimise heat loss. OR Use a burette to measure the volume of R and S instead of measuring cylinder to increase the accuracy of measurement. Note: any other logical modifications will also be accepted	1	

3	ai	PDO A yellowish-brown / pale yellow precipitate is formed.	1	9
	a ii	PDO Effervescence is observed and white precipitate is formed. OR Effervescence is observed and precipitate turns white. (The gas evolved forms white precipitate in limewater. CO ₂ is formed.)	1	
	bi	PDO A white precipitate is formed.	1	
	b ii	PDO Effervescence is observed. (The gas evolved forms white precipitate in limewater. CO ₂ is formed.)	1	
	ci	PDO Effervescence is observed. (The gas evolved forms white precipitate in limewater. CO ₂ is formed.)	1	
	c ii	PDO A white precipitate is formed.	1	
	di	ACE X is silver nitrate. In step (c)(ii), (white) precipitate is only formed when X is added to the mixture of Y and Z. Note: While this is the most straightforward conclusion, any other logical deductions with clear references to steps will also be accepted. Explanation to students: Based on the 3 chemicals used, only the combination of HCl and Na ₂ CO ₃ will not result in the formation of precipitate (but effervescence will be observed). As such, students can take note of which of steps (a)(i), (b)(i) and (c)(i) will result in no precipitate to deduce which chemical is silver nitrate.	1 1	
	d ii	ACE Z is hydrochloric acid. Y is sodium carbonate.	1	

Qn. No.	Scoring Points	Marks	Max. Mark
4	P - Note: marks can be obtained from labelled diagram. Crushing and measuring a fixed mass of each of the shells. Adding an excess of dilute acid of fixed volume and concentration to each sample. Note: minus 0.5m if "excess" is not mentioned. Measure total volume of gas produced over a given time / total decrease in mass of reaction mixture over a given time / total time taken for a fixed volume of gas to be produced / total time taken for a fixed change in temperature of reaction mixture Note: any other logical measurement that is not too onerous will also be accepted. Relevant conclusion based on measurement method and draws link back to objective of experiment (i.e. which shell contains the highest/lowest amount of calcium carbonate).	1 1 1 1	4







Paya Lebar Methodist Girls' School (Secondary)
Preliminary Examination 2025
Secondary 4 Express / G3

CANDIDATE NAME		CLASS		CLASS INDEX NO	
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CENTRE NUMBER	S				
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INDEX NUMBER				
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CHEMISTRY

6092/03

Paper 3 Practical

29 August 2025

1 hour 50 minutes

READ THESE INSTRUCTIONS FIRST

Write your name, class, class index number, centre number and O level index number on the cover page.

Give details of the practical shift and laboratory where appropriate, in the boxes provided.

Write in dark blue or black pen.

You may use a soft pencil for any diagrams or graphs.

Do not use staples, paper clips, glue or correction fluid.

Answer **all** questions in the spaces provided on the Question Paper.

The use of an approved scientific calculator is expected, where appropriate.

You may lose marks if you do not show your working or if you do not use appropriate units.

Qualitative Analysis Notes are printed on page 10.

At the end of the examination, fasten all your work securely together, if applicable.

The number of marks is given in brackets [] at the end of each question or part question.

Shift
Laboratory

For Examiner's Use	
1	/15
2	/21
3	/4
Total	/40

This document consists of 10 printed pages.

[Turn Over

1 Metal displacement reactions are exothermic.

You are going to investigate the temperature changes when two different metals of the same mass are added to aqueous copper(II) sulfate solution separately. Aqueous copper(II) sulfate solution is used in excess.

Read all the instructions below carefully before starting the experiment in Question 1.

Instructions

You are going to do two experiments.

P is 0.80 mol / dm³ copper(II) sulfate.

X and **Y** are two different grey metals in powder form, weighing 0.30 g.

(a) Experiment 1

Using a 50 cm³ measuring cylinder, pour 25.0 cm³ of **P** into a Styrofoam cup and measure the temperature of the solution. Record the temperature at 0 min in the table below.

Transfer metal **X** into the same Styrofoam cup. Start the stopwatch. Stir the mixture constantly, and measure the temperature of the mixture every minute for 8 minutes. Record the temperatures in the table below.

Wash the thermometer and Styrofoam cup with distilled water.

Experiment 2

Repeat Experiment 1, using metal **Y** instead of **X**.

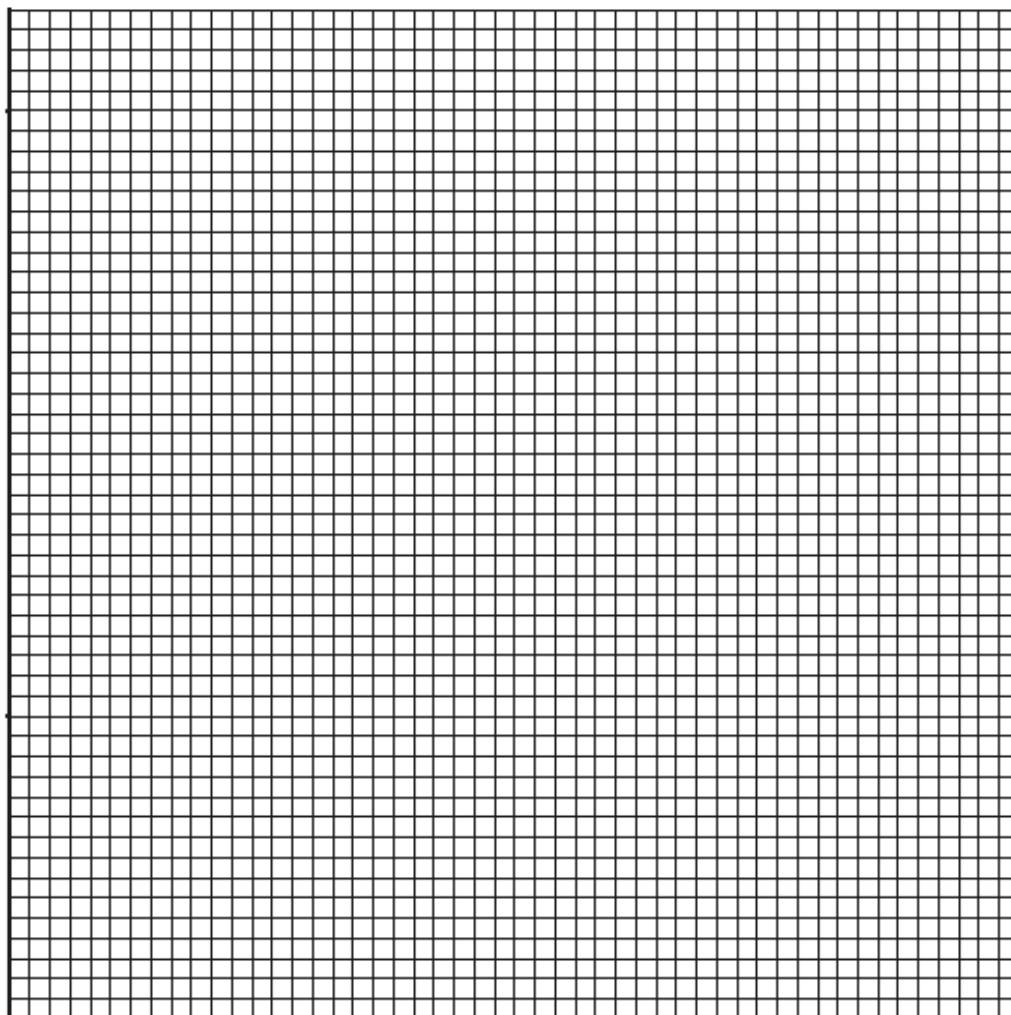
time / min	0	1	2	3	4	5	6	7	8
temperature for metal X / °C									
temperature for metal Y / °C									

[3]

(b) Plot your results for metal **X** on the grid below, with temperature on the *y*-axis and time on the *x*-axis.

Use these points to draw two intersecting straight lines of best fit. Label the graph as **X**.

Plot your results for metal **Y** on the same grid. Use these points to draw two intersecting straight lines of best fit. Label the graph as **Y**.



[4]

(c) From your graphs in **(b)**, calculate the maximum temperature rise in both experiments.

maximum temperature rise for metal **X** = [1]

maximum temperature rise for metal **Y** = [1]

- (d) The amount of heat released in this experiment can be calculated using the expression shown.

heat released (in J) = mass of solution (in g) x maximum temperature rise (in °C) x 4.2

Use this expression to calculate, in J, the amount of heat released for both metals. Leave your answers to 3 significant figures.

Assume that 1.0 cm³ of solution has a mass of 1.0 g.

amount of heat released for metal X = [1]

amount of heat released for metal Y = [1]

- (e) Using your answer in (d), state and explain which metal is more reactive.

.....
.....
..... [1]

- (f) State and explain the effect of using metal strips instead of metal powder on the rate of reaction for metal X.

effect
.....
explanation
.....
.....
..... [3]

[Total: 15]

- 2 Metal ores may contain various metal compounds like carbonates and sulfates of the metal. Metal carbonates decompose on heating, while most metal sulfates do not.

You are provided with a mixture containing hydrated zinc carbonate and a sulfate of an unknown metal **M**. You are to determine the percentage by mass of hydrated zinc carbonate present in the mixture and identify metal **M**.

Heating of the mixture will result in a loss of carbon dioxide and water due to the decomposition of hydrated zinc carbonate.



Read all the instructions carefully before starting the experiment in Question 2.

Instructions

S is a mixture containing hydrated zinc carbonate and a sulfate of an unknown metal **M**.

- (a) Use the electronic balance to find the mass of an empty test-tube.

Add about 1.50 g of **S** to the test-tube and then find the mass of the test-tube and its contents.

Heat the test-tube and contents gently for 2 minutes.

Leave the test-tube and its contents to cool to room temperature before finding the mass of the test-tube and its contents.

Repeat the heating and cooling of the test-tube and its contents again for 2 minutes.

Record your results in an appropriate format in the space provided. Keep the mixture after repeated heating and cooling for part (d).

(i) Results

[4]

[Turn Over

(ii) From your results, determine the change in mass after heating.

..... [1]

(b) (i) Given that the change in mass is due to the loss of carbon dioxide and water, calculate the mass of hydrated zinc carbonate present in the mixture.

[Mr: ZnCO_3 , 125; CO_2 , 44; H_2O , 18]

mass of hydrated zinc carbonate present = [2]

(ii) Calculate the percentage by mass of hydrated zinc carbonate in **S**.

percentage by mass of zinc carbonate in **S** = [1]

(c) (i) Suggest why heating the sample once for 2 minutes may not give an accurate value for the percentage by mass of hydrated zinc carbonate in **S**.

.....
.....[1]

(ii) Suggest one way in which the experiment could be improved to obtain a more accurate value of the percentage by mass of hydrated zinc carbonate in **S**.

.....
.....[1]

- The volumes given below are approximate and should be estimated rather than measured unless instructed otherwise.

[Turn Over

(ii) Deduce the identity of metal **M**.

..... [1]

(iii) State the type of reaction that occurred in **Test 2**.

Use your observations to explain how you have reached this conclusion.

.....

.....

..... [2]

[Total: 21]

3 A student is given a liquid mixture containing an alkene and an alcohol.

Describe how the student could obtain a pure sample of alkene from the mixture, and test to ensure that alkene is collected.

You are provided with:

- aqueous bromine
- distilled water
- ethanol
- solid calcium carbonate
- the apparatus commonly found in the laboratory

In your answer, include:

- the apparatus and material/s needed to separate the alkene from the alcohol
- the method to use
- a description of the test and how the result can be used to identify that it is an alkene

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[Total: 4]

End of paper

QUALITATIVE ANALYSIS NOTES

Test for anions

<i>anion</i>	<i>test</i>	<i>test result</i>
carbonate (CO_3^{2-})	add dilute acid	effervescence, carbon dioxide produced
chloride (Cl^-) [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	white 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.

Test for aqueous cations

<i>cation</i>	<i>effect of aqueous sodium hydroxide</i>	<i>effect of aqueous ammonia</i>
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
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	green ppt., insoluble in excess
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

Test for gases

<i>gas</i>	<i>test and test result</i>
ammonia (NH_3)	turns damp red litmus paper blue
carbon dioxide (CO_2)	gives white ppt. with limewater (ppt. dissolves with excess CO_2)
chlorine (Cl_2)	bleaches damp litmus paper
hydrogen (H_2)	'pops' with lighted splint
oxygen (O_2)	relights a glowing splint
sulfur dioxide (SO_2)	turns aqueous acidified potassium manganate (VII) from purple to colourless

LABORATORY PREPARATION FOR PURE CHEMISTRY PRELIM 2025

Question 1 (per girl)

P - 0.80 mol/dm ³ copper(II) sulfate	75 cm ³
X – zinc	0.3 g
Y – iron	0.3 g
50 cm ³ measuring cylinder	1
Styrofoam cups X and Y in plastic beaker	One labelled X, one labelled Y
Thermometer	1
Stopwatch	1

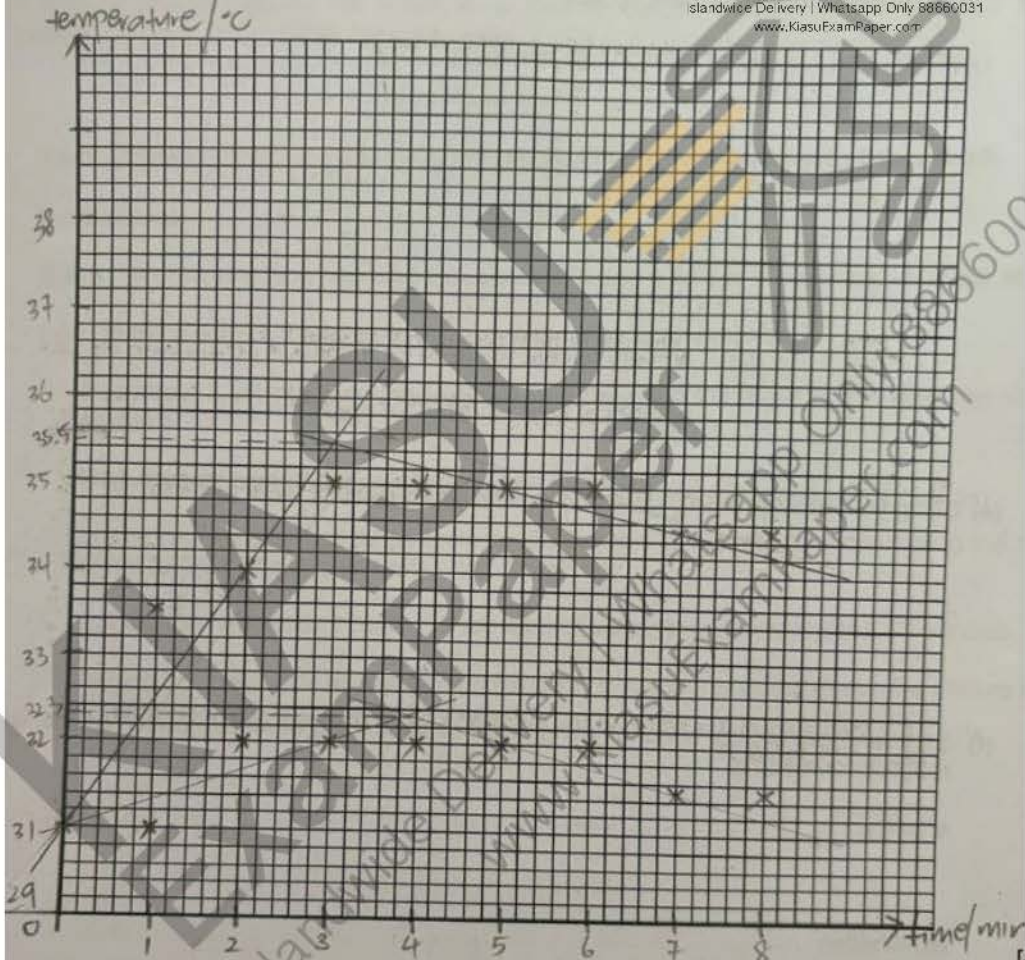
Question 2 (per girl)

S – mixture of ZnCO ₃ and FeSO ₄	2.0 g
Filter paper	1
Filter funnel	1
Boiling tube	1
100 cm ³ beaker	1
Glass rod	1
Dropper	1
Hydrogen peroxide	shared
Acidified potassium manganate (VII)	shared
Aqueous sodium hydroxide	shared
Deionised water	shared
Splint	shared
Test-tube holder	1 each
Bunsen burner	1
Electronic balance with glass beaker	shared



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Answer to Sec 4 Prelim Exams 2025 (actual)

Qn	Answer	Mark																														
1(a)	<table><tr><td>time / min</td><td>0</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td></tr><tr><td>temperature for metal X / °C</td><td>31.0</td><td>33.5</td><td>34.0</td><td>35.0</td><td>35.0</td><td>35.0</td><td>35.0</td><td>34.5</td><td>34.5</td></tr><tr><td>temperature for metal Y / °C</td><td>31.0</td><td>31.0</td><td>32.0</td><td>32.0</td><td>32.0</td><td>32.0</td><td>32.0</td><td>31.5</td><td>31.5</td></tr></table> M1 - Temperature for reaction with metal X showing a rise and then stop rising/drop M2 - Temperature for reaction with metal Y showing a rise and then stop rising/drop M3 - All temperature readings to nearest 0.5 °C 	time / min	0	1	2	3	4	5	6	7	8	temperature for metal X / °C	31.0	33.5	34.0	35.0	35.0	35.0	35.0	34.5	34.5	temperature for metal Y / °C	31.0	31.0	32.0	32.0	32.0	32.0	32.0	31.5	31.5	[3]
time / min	0	1	2	3	4	5	6	7	8																							
temperature for metal X / °C	31.0	33.5	34.0	35.0	35.0	35.0	35.0	34.5	34.5																							
temperature for metal Y / °C	31.0	31.0	32.0	32.0	32.0	32.0	32.0	31.5	31.5																							
1(b)	 M1 – axis with labels [1] M2 – appropriate scale [1] M3 – all points plotted correctly [1] M4 – best fit for both graphs [1]																															
1(c)	Maximum temperature for metal X = $35.5 - 31.0 = 4.5\text{ }^{\circ}\text{C}$ Maximum temperature for metal Y = $32.3 - 31.0 = 1.3^{\circ}\text{C}$	[1] [1]																														
1(d)	Amount of heat released for metal X = $25 \times 4.5 \times 4.2 = 473\text{ J}$ Amount of heat released for metal Y = $25 \times 1.3 \times 4.2 = 137\text{ J}$ OR Amount of heat released for metal X = $25.3 \times 4.5 \times 4.2 = 478\text{ J}$ Amount of heat released for metal Y = $25.3 \times 1.3 \times 4.2 = 138\text{ J}$	[1] [1]																														
1(e)	Metal X is more reactive as the reaction between metal X and copper (II) sulfate solution releases more heat.	[1]																														

1(f)	effect: With larger particle size, the rate of reaction will be slower.		M1 – [1]								
	explanation: With larger particle size in the form of metal strips, there is less surface area exposed for reaction. Hence, the frequency of effective collisions will be lower. This leads to a slower reaction.		M2 – [1] M3 – [1]								
2(a)(i)	<table><tr><td>Mass of empty test-tube /g</td><td>15.48</td></tr><tr><td>Mass of test-tube and contents before heating /g</td><td>16.98</td></tr><tr><td>Mass of test-tube and contents after heating for 2 min /g</td><td>16.56</td></tr><tr><td>Mass of test-tube and contents after heating for 4 min /g</td><td>16.45</td></tr></table>	Mass of empty test-tube /g	15.48	Mass of test-tube and contents before heating /g	16.98	Mass of test-tube and contents after heating for 2 min /g	16.56	Mass of test-tube and contents after heating for 4 min /g	16.45		M1 – headings with units [1] M2 – mass reading to 2 dp [1] M3 – 4 mass readings [1] M4 – mass reading drops after heating for 2 and 4 min [1]
Mass of empty test-tube /g	15.48										
Mass of test-tube and contents before heating /g	16.98										
Mass of test-tube and contents after heating for 2 min /g	16.56										
Mass of test-tube and contents after heating for 4 min /g	16.45										
2(a)(ii)	Change in mass after heating = 16.98 – 16.45 = 0.53 g		[1]								
2(b)(i)	Number of moles of carbon dioxide and water = 0.53 / (44 + 3x18) = 0.00540816 $\text{ZnCO}_3 \cdot 3\text{H}_2\text{O} \rightarrow \text{ZnO} + \text{CO}_2 + 3\text{H}_2\text{O}$ Hence, number of moles of ZnCO_3 = 0.00540816 Mass of hydrated zinc carbonate = 0.00540816 x (125 + 3x18) = 0.968 g		[1] [1]								
2(b)(ii)	Percentage by mass of ZnCO_3 = 0.968 / 1.50 x 100 = 64.5%		[1]								
2(c)(i)	Not all the zinc carbonate may have decomposed / Not all the water of crystallisation has been removed.		[1]								
2(c)(ii)	We should repeat the process of heating and cooling till a constant mass is obtained.		[1]								
2(d)(i)	<table><tr><th>test</th><th>observations</th></tr><tr><td>Test 1 Put about 1 cm depth of solution T in a clean test-tube. Add 1 cm depth of hydrogen peroxide. Shake the test-tube. Keep this solution for Test 4.</td><td>Solution turned from pale green/colourless to pale brown. Effervescence was observed. Gas relit a glowing splint. Gas is oxygen. Test tube felt warm.</td></tr><tr><td>Test 2 Put about 1 cm depth of solution T in a clean test-tube. Add acidified potassium manganate (VII) dropwise, with shaking, till no further change is seen.</td><td>Acidified potassium manganate (VII) turned from purple to colourless. Solution turned from pale green/colourless to brown then to pink/purple.</td></tr><tr><td>Test 3</td><td>Green ppt</td></tr></table>	test	observations	Test 1 Put about 1 cm depth of solution T in a clean test-tube. Add 1 cm depth of hydrogen peroxide. Shake the test-tube. Keep this solution for Test 4 .	Solution turned from pale green/colourless to pale brown . Effervescence was observed. Gas relit a glowing splint . Gas is oxygen. Test tube felt warm .	Test 2 Put about 1 cm depth of solution T in a clean test-tube. Add acidified potassium manganate (VII) dropwise, with shaking, till no further change is seen.	Acidified potassium manganate (VII) turned from purple to colourless . Solution turned from pale green/colourless to brown then to pink/purple .	Test 3	Green ppt		[1] [1] [1] [1]
test	observations										
Test 1 Put about 1 cm depth of solution T in a clean test-tube. Add 1 cm depth of hydrogen peroxide. Shake the test-tube. Keep this solution for Test 4 .	Solution turned from pale green/colourless to pale brown . Effervescence was observed. Gas relit a glowing splint . Gas is oxygen. Test tube felt warm .										
Test 2 Put about 1 cm depth of solution T in a clean test-tube. Add acidified potassium manganate (VII) dropwise, with shaking, till no further change is seen.	Acidified potassium manganate (VII) turned from purple to colourless . Solution turned from pale green/colourless to brown then to pink/purple .										
Test 3	Green ppt										

	Put about 1 cm depth of solution T in a clean test-tube. Add aqueous sodium hydroxide slowly with shaking until no further change is seen.	Ppt insoluble in excess sodium hydroxide	[1]
	Test 4 To the mixture from Test 1 , add aqueous sodium hydroxide slowly with shaking until no further change is seen.	Brown ppt Ppt insoluble in excess sodium hydroxide	[1] [1]
2(d)(ii)	M is iron.		[1]
2(d)(iii)	Test 2 is redox / reduction reaction. Potassium manganate (VII) was reduced as the colour change from purple to colourless showed that the oxidation state of Mn has decreased from +7 in KMnO_4 to +2 in $\text{MnO}_2/\text{Mn}^{2+}$.		M1 – [1] M2 – [1]
3	Add distilled water to the liquid mixture and mix well. The alcohol will dissolve in the distilled water but not the alkene. Pour the mixture into a separating funnel. The alkene will float above the alcohol dissolved in distilled water, since alkenes are immiscible with water. Assume that alkene has lower density. (accept if they say alkene has higher density / forms 2 separate layers because number of carbon atoms is not stated) After the mixture has separated into two layers, turn on the tap to collect the alcohol dissolved in water first. Then collect the alkene in another beaker. Transfer about 1cm^3 of the collected alkene into a test-tube. Add aqueous bromine to the liquid. If the aqueous bromine turns from reddish-brown to colourless / decolourise, the liquid collected is confirmed to be an alkene.		M1 – state solvent [1] / fractional distillation M2 – state separating funnel [1] / condenser and fractionating column M3 – state sequence of collection [1] / separated by boiling point or lower boiling point collect first M4 – test for alkene using aqueous bromine - decolouration [1]

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Name:.....

Register/Index Number:

Class:

PRESBYTERIAN HIGH SCHOOL



CHEMISTRY

6092/03

Paper 3

19 August 2025

Tuesday

1 hour 50 minutes

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2025 SECONDARY FOUR EXPRESS PRELIMINARY EXAMINATION

Instructions to students:

DO NOT OPEN THIS QUESTION PAPER UNTIL YOU ARE TOLD TO DO SO.

Write in dark blue or black pen in the spaces provided on the Question paper.
You may use a pencil for any diagrams, graphs or rough work.

READ THESE INSTRUCTIONS FIRST

Answer **all** questions.

Write your class, register number and name on all the work you hand in.

You may use pencil for any diagrams, graphs, tables or rough working.

Write in dark blue or black pen.

Do not use staples, paper clips, glue or correction fluid.

The use of an approved scientific calculator is expected, where appropriate.

You may lose marks if you do not show your working or if you do not use appropriate units.

Answer **all** questions in the spaces provided on the question paper.

For Examiner's Use	
1	
2	
3	
Total	

Setter: Mr. Clement Yew

Vetter: Ms. Cynthia Lim

This question paper consists of **9** printed pages.

1. **Q** is an aqueous solution which contains a mixture of sodium carbonate, Na_2CO_3 , and sodium hydroxide, NaOH .

Read all the instructions below carefully before starting the experiment in Question 1.

Instructions

You are to determine by titration, the volume of dilute hydrochloric acid, **P**, needed to neutralize a volume of **Q**, using methyl orange as an indicator, and then calculate the concentration of sodium hydroxide present.

Q is a mixture containing 0.0150 mol/dm^3 of Na_2CO_3 and NaOH .

P is 0.100 mol/dm^3 aqueous hydrochloric acid.

- (a) (i) Put **P** into the burette.

Pipette a 25.0 cm^3 portion of **Q** into a conical flask.

Add **P** from the burette using the indicator provided.

Record your titration results in the space provided, repeating the titration as many times as you consider necessary to achieve consistent results.

[5]

Results

1. (a) (ii) From your titration results, obtain an average volume of **P** to be used in your calculations.

Show clearly how you obtained this volume.

average volume of **P** [1]

- (b) **P** is 0.100 mol/dm^3 hydrochloric acid, HCl .

Using your results, calculate the number of moles of hydrochloric acid present.

moles of hydrochloric acid: mol [2]

- (c) The concentration of sodium carbonate, Na_2CO_3 , in the mixture **Q** is 0.0150 mol/dm^3 .

Calculate the number of moles of sodium carbonate present in the volume of **Q**.

moles of sodium carbonate: mol [2]

- (d) Using your answers to (c), deduce the number of moles of hydrochloric acid which react with the sodium carbonate present in your volume of **Q**.

number of moles of hydrochloric acid: mol [2]

1. (e) Using your answers to (b) and (d), calculate the number of moles of hydrochloric acid which react with the sodium hydroxide in your volume of Q.

number of moles of hydrochloric acid:.....mol

- (f) Using your answer to (e), calculate the concentration of sodium hydroxide in Q.

concentration of sodium hydroxide in Q.....mol/dm³

- (g) A student repeated the experiment and accidentally used a 20.0 cm³ pipette to measure solution Q into the flask in each titration and did not realise it.

Describe and explain the effect this would have on his results.

.....
.....

[Total: 18]

2. A mixture of two solid compounds **D** and **E** was analysed.

Solid **D** was a salt which is soluble in water. Solid **E** was an insoluble metal carbonate. The tests on the mixture and some of the observations are in the following table.

Complete the observations in the table.

	tests	observations
(a)	Add one spatula of solid D and solid E each in a boiling tube. The mixture was warmed gently.	[1]
(b)	Distilled water was added to the resulting mixture of solids D and E from part (a) to at least one-third of the boiling tube. The contents of the tube were filtered. Keep the residue for part (c) and the filtrate for part (e).	[3]
(c)	Test on residue: Using a spatula, transfer the residue from the filter paper into a test-tube. To this test tube, add about 3 cm³ of dilute sulfuric acid.	[2]
(d)	(i) Place 1 cm³ of the solution from (c) to a clean dry test tube. To this test tube, add dilute sodium hydroxide dropwise with shaking, until no further change is observed. (ii) Place another 1 cm³ of the solution from (c) to a clean dry test tube. To this test tube, add aqueous ammonia dropwise with shaking, until no further change is observed.	[2]

(e)	Test on filtrate: The filtrate collected from (b) was divided into three approximately equal portions. (i) To the first portion, add drops of aqueous sodium hydroxide, until no further change. (ii) To the second portion, add excess aqueous ammonia, until no further change. (iii) To the third portion, add a few drops of dilute hydrochloric acid and aqueous barium chloride.	[3]
-----	--	------------

(f) What conclusions can you draw about the identity of solid **D**?

Provide evidence to explain your answer.

.....

.....

.....

.....[2]

(g) What conclusions can you draw about the identity of the cation in solid **E**?

Provide **two** pieces of evidence to explain your answer.

.....

.....

.....

.....[3]

[Total:16]

- 3.** Washing soda are crystals of hydrated sodium carbonate, $\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$.

When exposed to the air, some of the water is lost from the crystals and a new substance is formed.

This process occurs faster in hotter climates. Plan an experiment to determine percentage of water by mass present in the new substance.

You are provided with common laboratory apparatus.

[6]

End of Paper

QUALITATIVE ANALYSIS NOTES

Tests for anions

<i>anion</i>	<i>test</i>	<i>test result</i>
carbonate (CO_3^{2-})	add dilute acid	effervescence, carbon dioxide produced
chloride (Cl^-) [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	white precipitate
iodide (I^-) [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	yellow precipitate
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 precipitate

Tests for aqueous cations

<i>cation</i>	<i>effect of aqueous sodium hydroxide</i>	<i>effect of aqueous ammonia</i>
aluminium (Al^{3+})	white precipitate, soluble in excess, giving a colourless solution	white precipitate, insoluble in excess
ammonium (NH_4^+)	ammonia produced on warming	-
calcium (Ca^{2+})	white precipitate, insoluble in excess	no precipitate
copper(II) (Cu^{2+})	light blue precipitate, insoluble in excess	light blue precipitate, soluble in excess, giving a dark blue solution
iron(II) (Fe^{2+})	green precipitate, insoluble in excess	green precipitate, insoluble in excess
iron(III) (Fe^{3+})	red-brown precipitate, insoluble in excess	red-brown precipitate, insoluble in excess
zinc (Zn^{2+})	white precipitate, soluble in excess, giving a colourless solution	white precipitate, soluble in excess, giving a colourless solution

Tests for gases

<i>gas</i>	<i>test and test result</i>
ammonia (NH_3)	turns damp red litmus paper blue
carbon dioxide (CO_2)	gives white precipitate with limewater (precipitate dissolves with excess CO_2)
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 aqueous acidified potassium manganate(VII) from purple to colourless

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).
The Avogadro constant, $L = 6.02 \times 10^{23} \text{ mol}^{-1}$.

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2025 CHEMISTRY PRELIM PAPER 3 PREPARATION LIST

Preparation List

Q1

	Apparatus / Reagents	Quantity (per student)
1	0.0500 mol/dm ³ sodium carbonate [Q]	1
2	0.100 mol/dm ³ aqueous hydrochloric acid [P]	1
3	Methyl orange indicator	1
4	Distilled water	1
5	Conical flask	2
6	Burette	1
7	Pipette	1
8	Pipette filler	1

Q2

	Apparatus / Reagents	Quantity (per student)
1	Boiling tube	1
2	Test tubes	6
3	Tongs	1
4	Lighter	1
5	Filter paper	2
6	Filter funnel	1
7	Spatula	1
8	Measuring cylinder (10 cm ³)	1
9	Litmus paper (red and blue)	2 each
10	Aluminium foil	1
11	Delivery tube	1

12	Test tube rack	1
----	----------------	---

	Apparatus / Reagents	Quantity (per student)
1	Unknown compound D (Zinc Sulfate)	1
2	Unknown compound E (Copper(II) carbonate)	1

	Apparatus / Reagents	Quantity (per bench)
1	Barium chloride	1
2	Silver nitrate	1
3	Common bench reagents - Aq sodium hydroxide - Aq ammonia - Limewater	



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2025 CHEMISTRY PRELIM PAPER 3 MARKING SCHEME

1. You are to determine by titration, the volume of dilute hydrochloric acid, **P**, needed to neutralize a volume of **Q**, using methyl orange as an indicator, and then calculate the concentration of sodium hydroxide present.

Q is mixture containing 0.0150 mol/dm^3 of sodium carbonate.

P is 0.100 mol/dm^3 aqueous hydrochloric acid.

- (a) (i) Put **P** into the burette.

Pipette a 25.0 cm^3 portion of **Q** into a conical flask. Add **P** from the burette using the indicator provided.

Record your titration results in the space provided, repeating the titration as many times as you consider necessary to achieve consistent results.

[5]

Results

Titration number	1	2	3
Final burette reading / cm^3	26.40	26.40	
Initial burette reading / cm^3	0.00	0.00	
Volume of solution P used / cm^3	26.40	26.40	
Best titration results	✓	✓	

Results table:

- Record initial burette readings, final burette readings and volume added with correct headings and units in the titration table. [1]
- All burette readings for all accurate titres in titration table are recorded to nearest 0.05 cm^3 . [1]

Titration results:



- Accuracy
 - Average titre (of consistent readings) within 0.20 cm^3 of supervisor's average value [2]
 - Average titre (of consistent readings) within 0.30 cm^3 of supervisor's average value [1]
- Concordance
 - At least two titre values are within 0.20 cm^3 [1]

Comments on errors made:

1. Some still gave their burette readings in 1 d.p
2. Average reading was rounded to 3 s.f.
3. Initial reading came first before final reading.
4. Initial/final volume was stated instead.

- (a) (ii) From your titration results, obtain an average volume of **P** to be used in your calculations.

Show clearly how you obtained this volume.

Calculation to 2 decimal places

average volume of **P** [1]

- (b) **P** is 0.100 mol/dm³ hydrochloric acid, HCl.

Using your results, calculate the number of moles of hydrochloric acid present.

Assuming titration reading of 26.40 cm³



Moles of hydrochloric acid present in average volume of **P**
 $= (26.40 \times 0.1) / 1000$

= 0.00264 mol

moles of hydrochloric acid: mol [2]

- (c) The concentration of sodium carbonate, Na₂CO₃, in the mixture **Q** is 0.0150 mol/dm³.

Calculate the number of moles of sodium carbonate present in the volume of **Q**.

Assuming titration reading of 21.70 cm³

Moles of sodium carbonate in **Q**
 $= (25.0 \times 0.0150) / 1000$
= 0.000375 mol

moles of sodium carbonate: mol [2]

- (d) Using your answers to (c), deduce the number of moles of hydrochloric acid which react with the sodium carbonate present in your volume of **Q**.

Moles of hydrochloric acid reacting with sodium carbonate
 $= 2 \times 0.000375$
= 0.000750 mol

number of moles of hydrochloric acid: mol [2]

1. (e) Using your answers to (b) and (d), calculate the number of moles of hydrochloric acid which react with the sodium hydroxide in your volume of Q.

Moles of hydrochloric acid reacting with sodium hydroxide
 = 0.00264 (from part b) – 0.000750 (from part d)
 = 0.00189 mol

[2]

number of moles of hydrochloric acid:.....mol

- (f) Using your answer to (e), calculate the concentration of sodium hydroxide in Q.

Concentration of sodium hydroxide in Q
 = (0.00189 x 1000) / 25.0
 = 0.0756 mol/dm³

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[2]

concentration of sodium hydroxide inmol/dm³

- (g) A student repeated the experiment and accidentally used a 20.0 cm³ pipette to measure solution Q into the flask in each titration and did not realise it.
 Describe and explain the effect this would have in his results.

Titre value lower than expected [1]

Students calculated concentration of NaOH would be lower than actual value. [1]

[2]

[Total: 18]

- A mixture of two solid compounds **D** and **E** was analysed.

[11]

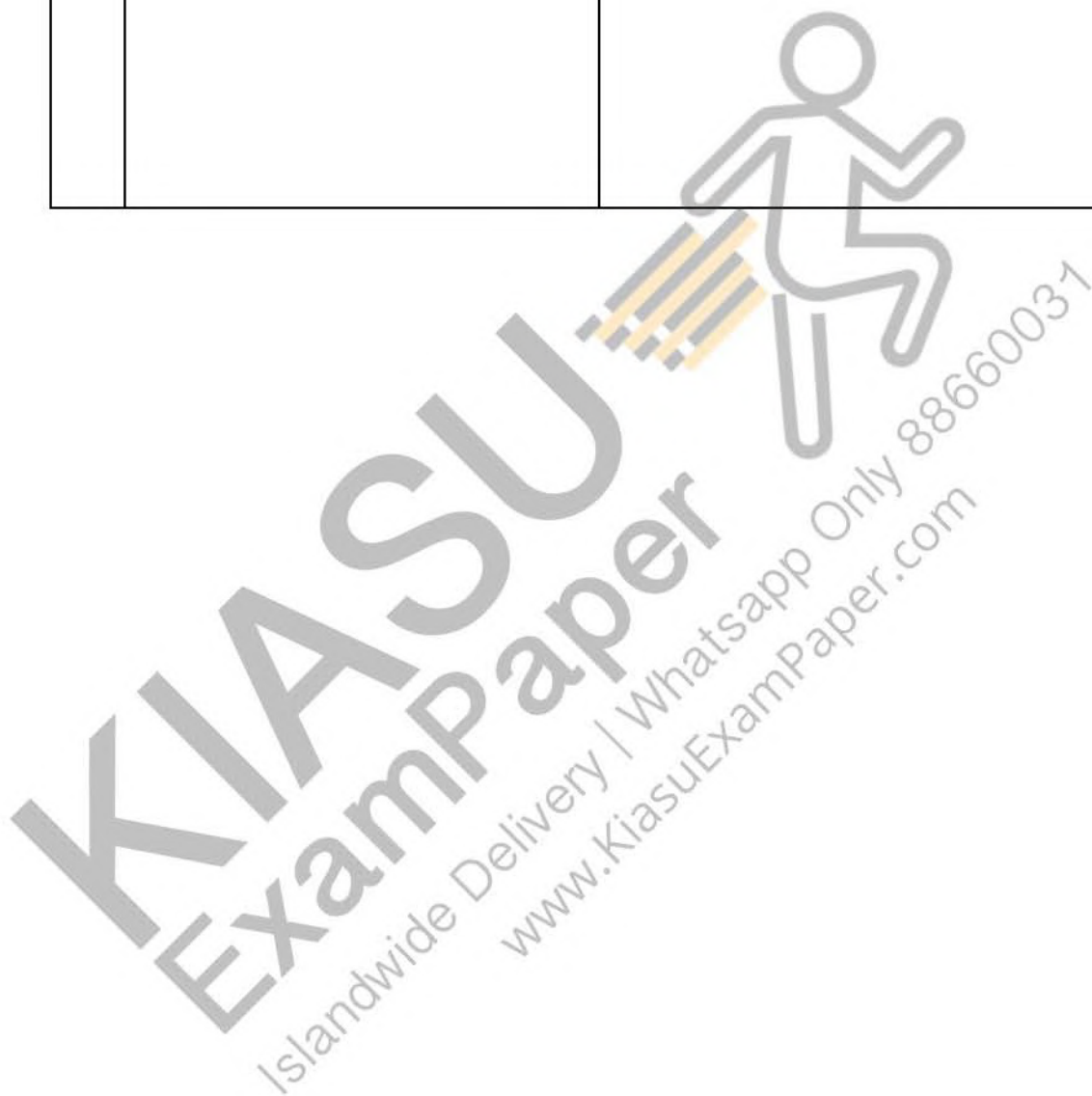
Solid **D** was a salt which is soluble in water. Solid **E** was an insoluble metal carbonate. The tests on the mixture and some of the observations are in the following table.

Complete the observations in the table.



	test s	observations
(a)	Add one flat spatula of solid D and solid E each in a boiling tube. The mixture was warmed gently.	<u>Green solid / Green Mixture</u> formed after gentle heating. [1]
(b)	Distilled water was added to the resulting mixture of solids D and E from part (a) to at least one-third of the boiling tube. The contents of the tube were filtered. Keep the residue for part (c) and the filtrate for part (e).	<u>Green solid formed insoluble</u> in the mixture. [1] <u>Colourless solution</u> collected as the filtrate. [1] <u>Green solid</u> collected as the residue. [1]
(c)	Test on residue: Using spatula, transfer the residue from the filter paper into a test-tube. To this test tube, add about 3 cm ³ of dilute sulfuric acid was added.	<u>Light blue solution</u> [1] formed after adding sulfuric acid. <u>Effervescence seen and white ppt</u> formed in the limewater. [1]
(d)	(i) Place 1 cm ³ of the solution from (c) to a clean dry test tube. To this test tube, add dilute sodium hydroxide dropwise with shaking, until no further change is observed. (ii) Place another 1 cm ³ of the solution from (c) to a clean dry test tube. To this test tube, add aqueous ammonia dropwise with shaking, until no further change is	<u>Light blue ppt formed insoluble in excess aq NaOH.</u> [1] <u>Light blue ppt formed soluble in excess aq NH₃ to give a dark blue solution</u> [1]

observed.



(e)	Test on filtrate: The filtrate from (b) was divided into three approximately equal portions. (i) To the first portion, add drops of aqueous sodium hydroxide, until no further change. (ii) To the second portion, add excess aqueous ammonia, until no further change. (iii) To the third portion, add few drops of dilute hydrochloric acid and aqueous barium chloride.	 KIASU ExamPaper Islandwide Delivery Whatsapp Only 88660031 www.KiasuExamPaper.com <u>White ppt formed soluble in excess aq NaOH to form a colourless solution. [1]</u> <u>White ppt formed soluble in excess aq NH₃ to form a colourless solution. [1]</u> <u>White ppt formed upon adding barium chloride. [1]</u>
-----	---	--

- (f) What conclusions can you draw about the identity of solid D? [2]

Provide evidences to explain your

answer. Solid is zinc sulfate.

In part e(i) and (ii), when aq NaOH and aq NH₃ was added, white ppt formed soluble in excess aq NaOH and aq NH₃ respectively which tells zinc ion is present. [1]

In e(iii), white ppt formed when acidified barium chloride is added, which tells sulfate ion is present. [1]

- (g) What conclusions can you draw about the identity of the cation in solid E? Provide **two** evidences to explain your answer. [3]

Cation present in solid E is copper(II). [1]

In part d, blue ppt is formed insoluble in excess aq NaOH. [1] and blue ppt is formed soluble in excess aq NH₃. [1]

Note: students must state the test / part of the questions in their evidence.

[Total: 16]

Comments on errors made:

1. Many overly heated the given mixture (despite the question mentioned heat gently- bunsen flame should not be a strong one) as a result they obtained the black solid.
2. When describing the residue and filtrate, the physical state should be stated. For example, green solid and colourless solution and not green residue and colourless/white/clear filtrate.
3. In describing the observation of Cu^{2+} with aqueous ammonia, the student must state that light blue ppt is formed initially, before mentioning it dissolves in excess to produce a dark blue solution, instead of dark blue precipitate.
4. In explaining (f), students should explain which observation corresponds to the deduction of what cation or anion is present, and not simply putting down the observations only.
5. In (g), student needs to be careful in stating "cation is copper" and not copper is present. In fact, stating copper(II) or Cu^{2+} is the more straightforward way.
6. The standard tests for the presence of Cu^{2+} are using aqueous NaOH and aqueous NH_3 . As such, students should not use "forming a blue solution when an acid is added to the solid as evidence (since there could be other cations that may give rise to a blue solution-example vanadyl ion, VO^{2+} forms a blue solution in acid).

3. Washing soda are crystals of hydrated sodium carbonate, $\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$.

When exposed to the air, some of the water is lost from the crystals and a new substance is formed.

This process occurs faster in hotter climates. Plan an experiment to determine the percentage of water by mass present in the new substance.

You are provided with common laboratory apparatus.

[6]

Heating to dryness method max [6]:



M1 weigh (any) sample of washing soda to obtain mass of crystals using electronic balance

M2 heat (to remove water of crystallisation)

M3 in named container (must be: evaporating dish)

M4 reweigh & repeat heating

M5 to constant mass

M6 appropriate calculation suggested for the percentage of water mass of water

Comments on errors made:

1. Not stating the use of an electronic balance or simply mentioning weighing scale.
2. Instead of measuring the "mass" of students, they mentioned "weight".
3. Use a crucible/boiling/test-tube/beaker instead of an evaporating dish.
4. Did not mention reweighing and repeat heating to ensure constant mass.
5. Some thought the new substance formed was metal oxide, and carbon dioxide was given off.
6. Instead of taking the loss in mass of the solid over the mass of the solid, students stated over the mass of the "new" substance formed.

[Total: 6]





Name and Index Number: ()	Class:
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SENG KANG SECONDARY SCHOOL 2025 PRELIMINARY EXAMINATION

CHEMISTRY

6092/03

Secondary 4 Express

31 July 2025

Paper 3 Practical

1 hour 50 minutes

Candidates answer on the Question Paper.

Additional Materials: As listed in the Confidential Instructions

READ THESE INSTRUCTIONS FIRST

Write your index number and name on all the work you hand in.

Give the details of the practical shift and laboratory where appropriate, in the boxes provided.

Write in dark blue or black pen.

You may use a soft pencil for any diagrams or graphs.

Do not use staples, paper clips, highlighters, glue or correction fluid.

Answer **all** questions in the spaces provided on the Question Paper.

The use of an approved scientific calculator is expected, where appropriate.

You may lose marks if you do not show your working or if you do not use appropriate units.

Qualitative Analysis Notes are printed on page 12.

At the end of the examination, fasten all your work securely together.

The number of marks is given in brackets [] at the end of each question or part question.

Shift
Laboratory

For Examiner's use	
1	/ 22
2	/ 12
3	/ 6
Total	/ 40
% / Grade	

Parent's / Guardian's Signature:

This document consists of **11** printed pages and **1** blank page.

Do not turn over the page until you are told to do so.

- 1 Hydrogen peroxide is used in disinfectant. It is a strong oxidising agent and antimicrobial agent, making it effective at killing bacteria, viruses and mould.

- (a) The concentrations of solutions of hydrogen peroxide are often represented in terms of 'volume strength'.

In this experiment you will determine the 'volume strength' of a solution of hydrogen peroxide by titration with acidified potassium manganate(VII).

Read all instructions carefully before starting the experiment in Question 1(a).

Instructions

A is 0.03 mol/dm^3 potassium manganate(VII), KMnO_4 .

B is dilute sulfuric acid, H_2SO_4 .

C is aqueous hydrogen peroxide, H_2O_2 .

- (i) • Fill the burette with **A**.

The colour of **A** makes it difficult to see the bottom of the meniscus so you should take all your readings using the top of the meniscus.

- Use the pipette to transfer 25.0 cm^3 of **C** into the conical flask. Ensure the lid is placed back on the container of **C** after use.
- Use the 25 cm^3 measuring cylinder to add 20.0 cm^3 of **B** into the same conical flask.
- Add **A** from the burette to the conical flask whilst constantly swirling the flask.

At first the purple colour disappears quickly but as more **A** is added the colour disappears less quickly. At end-point, one drop of **A** produces a pale pink colour that does not disappear on swirling.

- Record your results in an appropriate format in the space provided. Repeat the titration as many times as you consider to be necessary to achieve consistent results.

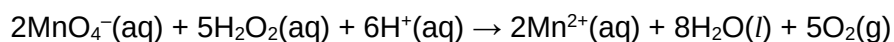
Keep A, B and C for use in Questions 1(b) and 2.

Results

- (ii) From your titration results, calculate the average volume of **A** required to reach the end-point of the titration, Show clearly how you obtain this volume.

average volume of **A** = [1]

- (iii) The equation for the titration reaction is shown.



A is 0.03 mol/dm^3 potassium manganate(VII), KMnO_4 .

Use your answer to **(a)(ii)** to calculate the amount of potassium manganate(VII), in moles, used to reach the end-point of the titration. Use this amount and the equation to calculate the number of moles of hydrogen peroxide, H_2O_2 , present in 25.0 cm^3 of **C**.

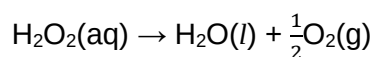
amount of potassium manganate(VII) in the average volume of **A** = mol

amount of hydrogen peroxide, H_2O_2 , in 25.0 cm^3 of **C** = mol [2]

- (iv) Use your answer to **(a)(iii)** to calculate the concentration, in mol/dm^3 , of H_2O_2 in **C**.

concentration of hydrogen peroxide, H_2O_2 in **C** = [2]

- (v) When hydrogen peroxide decomposes in the presence of a catalyst, oxygen is produced.

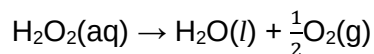


The 'volume strength' of hydrogen peroxide is equal to the volume of oxygen, in dm^3 , produced under room conditions, when 1.00 dm^3 of the solution decomposes.

Use your answer to **(a)(iv)** and the equation to calculate the volume, in dm^3 , of oxygen produced when 1.00 dm^3 of hydrogen peroxide, H_2O_2 , in **C** decomposes. This is the 'volume strength', in vol, of **C**.

'volume strength' of **C** = vol [2]

- (b) In this experiment you will determine the enthalpy change, ΔH , for the catalytic decomposition of hydrogen peroxide into water and oxygen.



Read all instructions carefully before starting the experiments in Question 1(b).

Instructions

C is aqueous hydrogen peroxide, H_2O_2 .

D is manganese(IV) oxide, MnO_2 .

- Place a polystyrene (Styrofoam) cup into a 250 cm³ glass beaker.
- Use the 50 cm³ measuring cylinder to measure 50.0 cm³ of **C** into the polystyrene cup.
- Measure and record the initial temperature of the solution in Table 1.1.
- Add a spatula of **D** to the solution in the polystyrene cup.
- Stir constantly until the maximum temperature is reached and record this temperature in Table 1.1.
- Calculate the change in temperature in your experiment in Table 1.1.

(i) Results

Table 1.1

initial temperature / °C	
maximum temperature / °C	
change in temperature / °C	

[1]

- (ii) The energy released can be calculated using the expression shown.

$$\text{energy released (in J)} = \text{mass of solution (g)} \times \text{temperature rise (in } ^\circ\text{C)} \times 4.2$$

Use this expression to calculate, in J, the energy released.

Assume that 1.0 cm³ of solution has a mass of 1.0 g.

energy released = J [1]

- (iii) Use your answer to (a)(iv) to calculate the number of moles of hydrogen peroxide used in **Experiment 1(b)**.

number of moles of hydrogen peroxide = mol [1]

- (iv) Calculate the enthalpy change ΔH , in kJ/mol, for the decomposition of 1 mole of hydrogen peroxide into water and oxygen.

enthalpy change, ΔH = kJ/mol [1]

- (v) A student suggested that the experiment would be more accurate if a fixed mass of **D**, manganese(IV) oxide, had been weighed out using an electronic balance.

State and explain whether you agree with the student's suggestion.

.....

..... [2]

- (c) A student investigates the rate of decomposition of hydrogen peroxide using three different catalysts:

- manganese(IV) oxide
- copper(II) oxide
- zinc oxide

0.5 g of manganese(IV) powder is added to 20 cm³ of hydrogen peroxide solution in a conical flask. The volume of gas produced is measured every 30 seconds for 180 seconds.

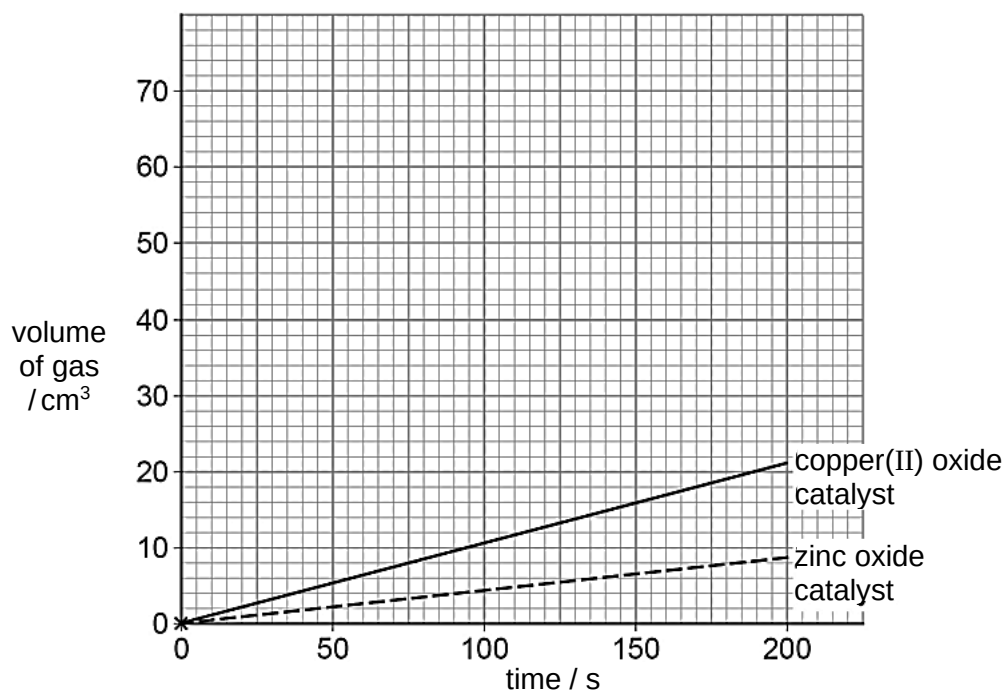
The student repeats the experiment using different catalyst each time.

The student's results for manganese(IV) oxide catalyst are shown.

time / s	0	30	60	90	120	150	180
volume of gas / cm ³	0	22	38	41	54	58	60

- (i) The results for copper(II) oxide catalyst and with zinc oxide catalyst are plotted on the grid (page 7).

Using the given data, plot the results for manganese(IV) oxide catalyst on the same grid. Draw a line of best fit.



[2]

- (ii) Deduce the catalyst which gives the fastest rate of reaction. Use your graph to explain your answer.

catalyst

explanation [1]

- (iii) The rate of reaction is **not** dependent on the volume of hydrogen peroxide solution.

Explain why.

.....

..... [2]

[Total: 22]

- 2 In this experiment, you will determine the identities of substances **E**, **F** and **G**.

Carry out the following tests and record all observations in the spaces provided. You should test and identify any gases evolved.

If no observable change is observed for a test, write 'no observable change'.

The volumes given below are approximate and should be estimated rather than measured unless instructed otherwise.

If heating is required, a boiling tube must be used.

Read all instructions carefully before starting the experiments in Question 2.

Instructions

- (a) **E** is a solution containing **two** cations and **one** anion which is listed in the qualitative analysis notes on page 12.

- (i) To a 1 cm depth of **E** in a boiling tube, add aqueous sodium hydroxide until it is in excess. Then heat the tube, **gently** and carefully.

Keep the mixture obtained in the boiling tube for the test in (a)(ii).

Record all your observations. Identify the cations in **E**.

observations

.....

The cations in **E** are and

[3]

- (ii) To the mixture obtained from (a)(i), carefully add a 1 cm depth of **C**.

Record your observations.

.....

..... [1]

(b) **F** and **G** are solutions, each containing **one** cation and **one** anion.

(i)

test	observations for F	observations for G
Test 1 To a 1 cm depth of solution in a test-tube, add a small spatula of solid sodium carbonate.		
Test 2 To a 1cm depth of solution in a test-tube, add an equal volume of B and a few drops of A , then		
add a few drops of aqueous starch.		
Test 3 To a 1 cm depth of solution in a test-tube, add a few drops of aqueous silver nitrate, then		
add aqueous ammonia.		

[5]

(ii) Identify the anion in **F**.

anion

[1]

(iii) Identify **G**.

G is

[1]

(iv) Carry out **one** further test to confirm the identity of the cation in **G**.

State the name of the reagent you used and record the observation(s) you made.

reagent

observation(s)

.....

[1]

[Total: 12]



You are provided with coffee beans and common laboratory apparatus.

[6]

[6]

[Total: 6]

END OF PAPER

QUALITATIVE ANALYSIS NOTES

Tests for anions

<i>anion</i>	<i>test</i>	<i>test result</i>
carbonate (CO_3^{2-})	add dilute acid	effervescence, carbon dioxide produced
chloride (Cl^-) [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	white 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.

Test for aqueous cations

<i>cation</i>	<i>effect of aqueous sodium hydroxide</i>	<i>effect of aqueous ammonia</i>
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.
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	green ppt., insoluble in excess
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

[Lead(II) ions can be distinguished from aluminium ions by the insolubility of lead(II) chloride.]

Tests for gases

<i>gas</i>	<i>test and test result</i>
ammonia (NH_3)	turns damp red litmus paper blue
carbon dioxide (CO_2)	gives white ppt. with limewater (ppt. dissolves with excess CO_2)
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 aqueous acidified potassium manganate(VII) from purple to colourless

2025 Secondary Four Express Chemistry Prelim Exam Paper 3 Preparation List

Safety

Attention is drawn, in particular, to certain materials used in the examination. The following codes are used where relevant.

C	corrosive	MH	moderate hazard
HH	health hazard	T	acutely toxic
F	flammable	O	oxidising
N	hazardous to the aquatic environment		

The attention of Supervisors is drawn to any local regulations relating to safety and first aid.

'Hazard Data Sheets', relating to materials used in this examination, should be available from your chemical supplier.

Apparatus

- 1 In addition to the fittings ordinarily contained in a chemical laboratory, the apparatus and materials specified below will be necessary.
- 2 For *each candidate* (Note: Labels do **not** need to include concentrations.)

1 × 50cm³ burette
 1 × burette stand
 1 × burette clamp
 1 × 25cm³ pipette
 1 × pipette filler
 2 × 250cm³ conical flask
 1 × filter funnel for filling burette
 1 × 25cm³ measuring cylinder
 1 × waste container, labelled '**WASTE**'
 1 × thermometer
 1 × 250cm³ beaker
 1 × polystyrene (Styrofoam) cup
 1 × 50cm³ measuring cylinder
 2 × white spatulas
 1 × Bunsen burner
 1 × lighter
 3 × teat pipettes / plastic droppers
 1 × boiling tube
 1 × wooden splint
 7 × test-tubes
 1 × delivery tube with rubber bung for connection to a small test-tube
 1 × marker to write on glassware
 access to test-tube rack
 access to test-tube holder
 access to wash bottle of deionised water, labelled as '**Deionised water**'
 access to cloth
 access to paper towels
 access to safety goggles

Chemicals Required

- 1 It is especially important that great care is taken that the confidential information given below does not reach the candidates either directly or indirectly.

2 Particular requirements

hazard	Label	per candidate	identity	preparation
	A	180 cm ³	0.030 mol/dm ³ potassium manganate(VII)	Dissolve 4.74g of KMnO ₄ [N][O][MH] in each dm ³ of solution.
[MH]	B	120 cm ³	1.0 mol/dm ³ sulfuric acid	
	C	180 cm ³	0.075 mol/dm ³ hydrogen peroxide	Note: - The solution can deteriorate so it should be prepared on the day of the examination or prepare one day in advance and kept refrigerated. - The concentration of 6% hydrogen peroxide is approximately 1.76 mol/dm³. Measure 38.30 cm ³ of 6% hydrogen peroxide and add deionised water to make the final volume to be 1 dm ³ .
	D	2 g	powdered manganese(IV) oxide	Provide approximately 2 g of MnO ₂ [MH] in a stoppered vial.
	E	10 cm ³	0.2 mol/dm ³ ammonium iron(II) sulfate	dissolve between 57 – 63 g of (NH ₄) ₂ Fe(SO ₄) ₂ ·6H ₂ O [MH] into 1 dm ³ of deionised water
	F	15 cm ³	0.2 mol/dm ³ potassium iodide	Dissolve 33.2g of KI in each dm ³ of solution.
	G	15 cm ³	0.5 mol/dm ³ hydrochloric acid	Dilute 250 cm ³ of 2.0 mol/dm ³ HCl to 1dm ³ with deionised water.
[MH]	Sodium carbonate	2 g	anhydrous sodium carbonate	Provide approximately 2 g of Na ₂ CO ₃ [MH] in a stoppered container.
	aqueous starch	5 cm ³	starch indicator	
Communal bench reagents (one set/bench)				
[F]	Universal indicator solution		Universal indicator solution	
	magnesium		2 or 3 cm length magnesium ribbons	Packed in a plastic vial
	aqueous sodium		typical concentrations	

	hydroxide		
[C][MH][N]	aqueous ammonia		
[MH]	limewater		
	aqueous silver nitrate		
	red and blue litmus papers		Packed in a plastic vial
	pH paper		Packed in a plastic vial





2025 Secondary 4E Chemistry Prelim Exam Paper 3 Marking Guide

Question	Skill	Indicative material	Mark	Total		
Topics: Titration + Stoichiometry						
1(a)(i)	PDO	<u>(R) Table of Results</u> • records initial burette readings, final burette readings and volume added with correct headings and units in a titration table • all burette readings to nearest 0.05 cm ³	[1]	[1]		
	MMO	<u>Titration Results</u> <u>(A) Accuracy</u> Teacher's average volume = 21.40 – 21.80 cm ³ Teacher's average volume = 21.30, 21.35, 21.85, 21.90 cm ³	[2] [1]	[2]		
		<u>(C) Concordance</u> at least two titre values are within 0.20 cm ³ (using uncorrected titres)	[1]	[1]		
		1(a)(ii)	MMO	Calculate of average volume using candidate's 2 best titration results accurately and tick at least 2 best titration results	[1]	[1]
		1(a)(iii)	MMO	No. of moles of KMnO ₄ = 0.03 × $\frac{\text{ans in (a)(ii)}}{1000}$ --- part 1 [allow ecf] No. of moles of H ₂ O ₂ = ans in part 1 × 2.5 --- part 2 [allow ecf]	[1] [1]	[2]
1(a)(iv)	MMO			Conc. Of H ₂ O ₂ = ans in part 2 × 40 [allow ecf]	[1]	[2]
	PDO	Correct units for 1(a)(ii) with cm ³ , 1(a)(iii) with mol. AND 1(a)(iv) with mol/dm ³	[1]			
1(a)(v)	MMO	Volume of O ₂ = $\frac{\text{ans in (a)(iv)}}{2} \times 24\text{dm}^3$ [allow ecf]	[1]	[2]		
	PDO	Record value in 1(a)(ii) to nearest 0.05 cm ³ AND round off all values from 1(a)(iii)-(v) to 3 significant figures; accept exact values from 1(a)(iii)-(v)	[1]			
Topic: Chemical Energetics						
1(b)(i)	PDO	<u>(R) Table of Results</u> • All temperature readings to .0 or .5 cm ³ AND change in temperature correctly calculated [Note that the temperature rise is minimal.]	[1]	[1]		
1(b)(ii)	MMO	Energy released = 50 × ans in (b)(i) × 4.2 [allow ecf]	[1]	[1]		
1(b)(iii)	MMO	No. of moles of H ₂ O ₂ = ans in (a)(iv) × $\frac{50}{1000}$ [allow ecf]	[1]	[1]		
1(b)(iv)	MMO	$\Delta H = \frac{\text{ans in (b)(ii)}}{\text{ans in (b)(iii)} \times 1000}$ [allow ecf] AND negative sign must be shown	[1]	[1]		
1(b)(v)	ACE	(D/MnO ₂ is a) catalyst, mass of MnO ₂ used does <u>not</u> alter/change/affect the <u>energy released/enthalpy change/change in temperature/temperature rise</u> (for decomposition of H ₂ O ₂)	[1] [1]	[2]		
		Topic: Rate of Reaction				
1(c)(i)	PDO	<u>(G) Graph Plotting</u> • All points plotted correctly [allow at least 4 points plotted correctly; allow a tolerance of $\pm \frac{1}{2}$ a small square] • Line of best fit	[1] [1]	[2]		
		1(c)(ii)	ACE	Catalyst: MnO ₂ / manganese(IV) oxide	[1]	[1]

Question	Skill	Indicative material	Mark	Total
		Explanation: <u>steepest gradient</u> OR produces the <u>most</u> (volume) of gas per second/unit time [reject: highest rate of reaction OR highest frequency of effective collisions]		
1(c)(iii)	ACE	same number of particles per unit volume / in the same volume OR same concentration (of hydrogen peroxide)	[1]	[2]
		same <u>frequency/rate</u> of <u>effective collisions</u> (with catalyst) OR more/higher effective collisions per unit time	[1]	
				Total: 22

Question	Skill	Indicative material		Mark	Total	
Topics: Qualitative Analysis + Redox + Acids						
2(a)(i)	MMO	Green ppt., insoluble in excess		[1]	[3]	
		Ammonia gas turns damp/moist red litmus paper blue		[1]		
	ACE	Cations: Fe^{2+} / iron(II) AND NH_4^+ / ammonium [reject if observations do not match with identity, e.g., no mark should be awarded if blue/white/reddish-brown ppt. is written and concluded that Fe^{2+} is present.]		[1]		
2(a)(ii)	MMO	Green ppt. turns brown / red-brown / orange-brown AND bubbles / effervescence / fizzing		[1]	[1]	
2(b)(i)	MMO		F	G	[1]	[5]
		Test 1	no observable change / no visible reaction / no precipitate / solid (carbonate) dissolves / no effervescence	effervescence which gives white ppt. with limewater, indicating carbon dioxide		
			F	G	[1]	
		Test 2	Colourless solution turns yellow / brown / orange-brown / red-brown / yellow-brown	no observable change / no visible reaction / KMnO_4 / solution stays purple / colourless solution turns purple / purple solution formed		
			(turns) dark blue / deep blue / blue-black / black		[1]	
			F	G	[1]	
		Test 3	(pale) yellow ppt.	white ppt.		
	(ppt) insoluble / does not dissolve / no observable change	(ppt.) dissolves / soluble, giving a colourless solution	[1]			
2(b)(ii)	ACE	Anion: I^- / iodide [reject if observation in Test 3 does not match with identity, e.g., no mark should be awarded if white ppt in Test 3 and concluded that iodide is present in F.]			[1]	
2(b)(iii)	ACE	HCl / Hydrochloric acid [reject sulfuric acid and nitric acid since there's no test for SO_4^{2-} and NO_3^-]			[1]	
2(b)(iv)	P + MMO	Any one of the following: • Place / add a few drops of <u>Universal indicator</u> into G AND turns from green to red. • Add a strip of magnesium into G AND gas/hydrogen			[1]	

Question	Skill	Indicative material	Mark	Total
		'pops' with lighted splint. [reject: pH paper / litmus papers as these are not reagents.] [Note: pH paper is provided which serves as a distractor. Litmus papers are provided to test for ammonia gas in 2(a)(i).]		
				Total: 12

Question	Skill	Indicative material	Mark	Total
Topic: Separation Technique				
3	P	Any six from: 1) crush/grind/powder coffee beans 2) using pestle/mortar 3) add cold water AND stir / mix 4) (filter to collect the coffee powder as residue) 5) heat / hot (water) (to dissolve the residue) 6) filter the mixture [reject: solution] to collect the filtrate 7) leave (filtrate) to cool OR leave to form crystals 8) wash / rinse (crystals / residue / caffeine) (and dry) [Note: Point 3/5 and 6 are compulsory points to be written; max. of 3 marks if these ideas of involving water and filtration are not shown.]		[6]
				[Total: 6]

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CANDIDATE
NAME

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CLASS

4		
---	--	--

INDEX
NUMBER

--	--

CHEMISTRY

Paper 3 Practical Test

6092/03

5 August 2025

1 hour 50 minutes

Candidates answer on the Question Paper.

READ THESE INSTRUCTIONS FIRST

Write your name, class and register number on all the work you hand in.

Write in dark blue or black pen.

You may use a HB pencil for any diagrams or graphs.

Do not use staples, paper clips, glue or correction fluid.

Answer all questions in the spaces provided on the Question Paper.

The use of an approved scientific calculator is expected, where appropriate. You may lose marks if you do not show your working or if you do not use appropriate units.

Qualitative Analysis Notes are printed on page **13**.

The number of marks is given in brackets [] at the end of each question or part question.

Shift
Laboratory

For Examiner's Use	
1	
2	
3	
Total	

This document consists of **13** printed pages and **1** blank page.

- 1 You are going to investigate the reaction between aqueous copper(II) nitrate and aqueous sodium carbonate.

- Step 1: Label the test-tubes 1, 2, 3, 4 and 5 and place them in order in the test-tube rack.
- Step 2: Use the measuring cylinder to pour 5.0 cm^3 of the 1 mol/dm^3 of aqueous copper(II) nitrate into each of the five test-tubes.
- Step 3: Using another measuring cylinder, add 1.0 cm^3 of 1 mol/dm^3 of aqueous sodium carbonate to test-tube 1. Using the glass rod, carefully stir the contents of the test-tube. **Repeat for steps 4 to 7.** Rinse the glass rod with distilled water before stirring it in each test-tube.
- Step 4: Add 2.0 cm^3 of 1 mol/dm^3 of aqueous sodium carbonate to test-tube 2.
- Step 5: Add 3.0 cm^3 of 1 mol/dm^3 of aqueous sodium carbonate to test-tube 3.
- Step 6: Add 4.0 cm^3 of 1 mol/dm^3 of aqueous sodium carbonate to test-tube 4.
- Step 7: Add 5.0 cm^3 of 1 mol/dm^3 of aqueous sodium carbonate to test-tube 5.

Leave the contents of the test-tubes to stand for 15 minutes.

You should start Question 2 while you are waiting for the solid formed in the test-tubes to settle.

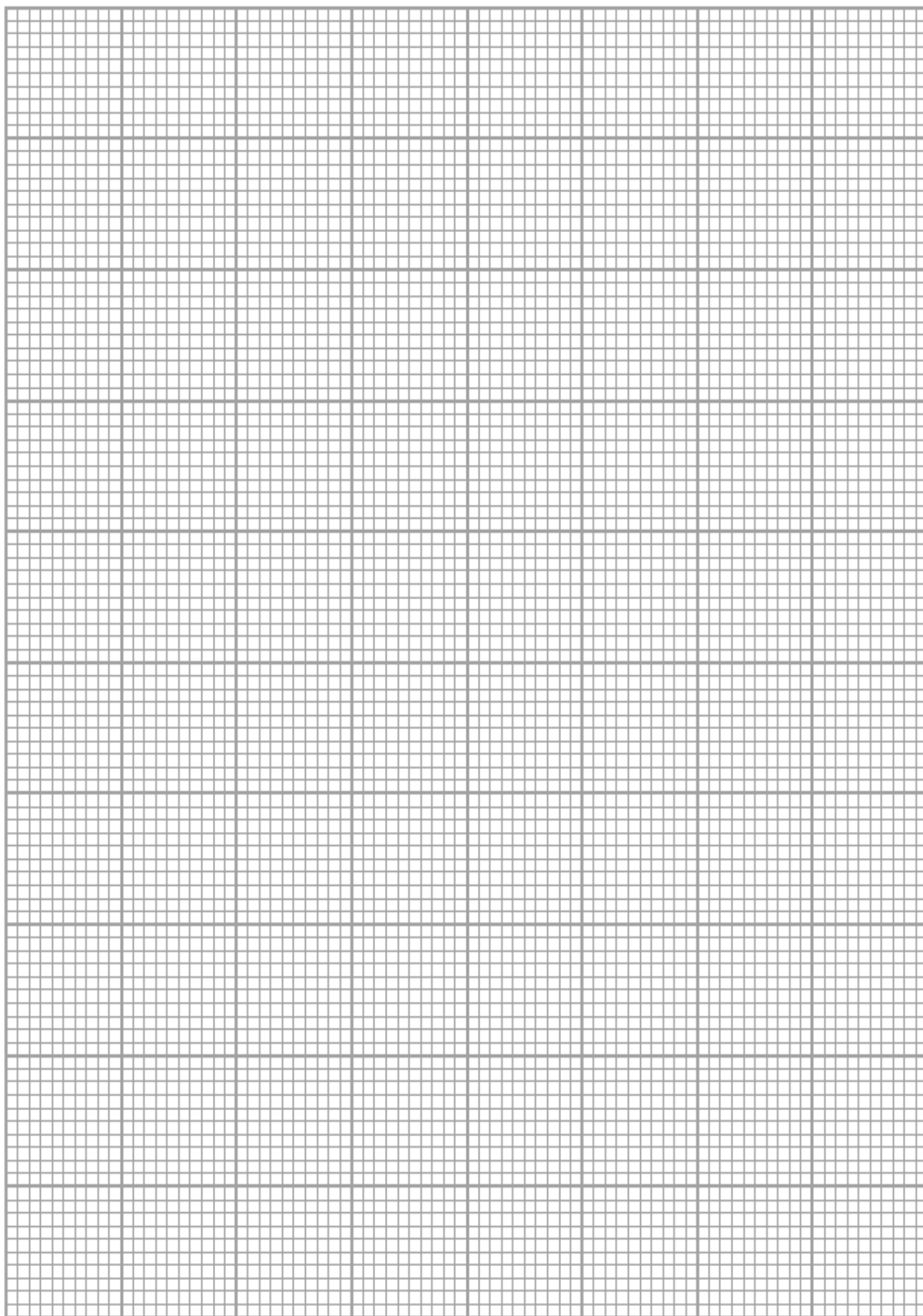
- (a) After 15 minutes, use a ruler to measure the height of the solid formed in each test-tube. In Table 1, record the volume of 1 mol/dm^3 of aqueous sodium carbonate added, and the height (in cm) of the solid formed in each test-tube. Include appropriate headings in Table 1.

Table 1

test-tube number		
1		
2		
3		
4		
5		

[4]

- (b) On the grid provided, plot a graph of height of solid against volume of aqueous sodium carbonate added.



[4]

(c) Describe the trend in the height of the solids formed in test-tubes 1 to 5.

.....
.....[1]

(d) From the graph, deduce the height of the solid formed when 0.0045 moles of aqueous sodium carbonate are added to 0.005 moles of copper(II) nitrate.

.....[1]

(e) Suggest two improvements that can be made in order to improve the accuracy of the results.

.....
.....
.....[2]

[Total: 12]

- 2** Water of crystallisation refers to the water molecules bonded to the lattice structure of ionic compounds.

You are going to investigate the enthalpy change, ΔH_{hyd} , when anhydrous sodium carbonate, Na_2CO_3 , converts to hydrated sodium carbonate, $\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$.

One way to determine the enthalpy change is to measure the changes in temperature when samples of anhydrous sodium carbonate and hydrated sodium carbonate are added separately to excess hydrochloric acid.

Read all the instructions carefully before starting the experiments in Question 2.

Instructions

You are going to carry out two experiments.

X is 2.2 g of anhydrous sodium carbonate, Na_2CO_3 .

Y is 5.5 g of hydrated sodium carbonate, $\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$

Z is 1.50 mol/dm³ hydrochloric acid, HCl .

(a) Experiment 1

Place a Styrofoam cup into a 250 cm³ beaker.

Transfer 25.0 cm³ of **Z** into the cup using the 25 cm³ measuring cylinder. Measure the temperature of **Z** and record the value in the table.

Pour all of **X** into the acid in the cup. Stir, using the thermometer, and measure the highest or lowest temperature reached. Record this temperature in the table.

Experiment 2

Repeat *Experiment 1* using the Styrofoam cup, but use **Y** in place of **X**.

Complete Table 2 and calculate the temperature change for each experiment.

Table 2

experiment	initial temperature of Z /°C	highest or lowest temperature of Z /°C	temperature change /°C
1			
2			

[3]

- (b) (i) The amount of heat transferred in the experiments can be calculated using the expression shown.

Heat transferred (J) = mass of solution (g) x maximum temperature change (°C) x 4.2

Use this expression to calculate, in J, the amount of heat transferred in each experiment.

Assume that 1.0 cm³ of solution has a mass of 1.0 g.

Experiment 1 with X: heat transferred =J

Experiment 2 with Y: heat transferred =J [2]

- (ii) Calculate the enthalpy change, ΔH , in kJ/mol, when all the solid reacts with hydrochloric acid in each experiment.

[M_r : Na_2CO_3 , 106, $\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$, 286]

$$\text{Enthalpy change, } \Delta H = \frac{\text{Heat transferred in kJ}}{\text{Number of moles of solid}}$$

Experiment 1 with X: $\Delta H_1 = \dots\dots\dots$ kJ/mol

Experiment 2 with Y: $\Delta H_2 = \dots\dots\dots$ kJ/mol [2]

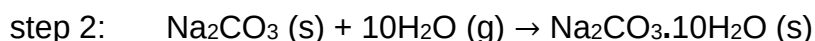
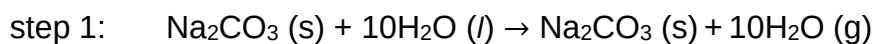
- (iii) The enthalpy change of hydration, ΔH_{hyd} , can be calculated using the expression:

$$\Delta H_{\text{hyd}} = \Delta H_1 - \Delta H_2$$

Use your answers from **(b)(ii)** to calculate the enthalpy change of hydration, ΔH_{hyd} .

$$\Delta H_{\text{hyd}} = \dots\dots\dots \text{ kJ/mol [1]}$$

- (iv) Another way to determine the hydration of anhydrous sodium carbonate can be shown in a two-step chemical equation as shown.



Using your knowledge of Kinetic Particle Theory, explain if **step 1** is an endothermic or exothermic process.

.....
.....
.....[2]

- (v) Explain why it is necessary to stir the mixture in the cup before measuring the highest or lowest temperature reached.

.....
.....[1]

- (vi) State one source of error and suggest one improvement that can made to reduce this error.

error.....
.....
improvement.....
.....[2]

- (vii) A student carrying out the experiment with an anhydrous sodium carbonate, **X**, could not find 1.50 mol/dm^3 hydrochloric acid. The student used the same volume of 0.750 mol/dm^3 sulfuric acid instead.

Predict and explain the effect on the change in temperature obtained by the student. Assume the same mass of **X** was used.

.....

.....

.....[2]

[Total: 15]

3 Read all the instructions carefully before starting the experiments in Question 3.

You are provided with a mixture of two solids, **J** and **K**, which are both salts. **J** is soluble and **K** is insoluble in water.

Carry out the following tests and record your observation. You should test and name any gas evolved. If no change is observed for a test, write 'no observable change'.

Instructions

- (a)** Add 3 spatulas of the mixture to a boiling tube. Add a 6 cm depth of distilled water to the mixture. Stopper the boiling tube with a rubber bung and shake the mixture for a minute.

Filter the mixture and keep the residue for tests later.

Tests on filtrate

Divide the solution into two equal portions in two test-tubes.

test	observations
Test 1 To the first portion of the solution, add about 1 cm depth of aqueous sodium hydroxide and shake the contents. Heat the contents carefully and test any gas evolved with damp litmus paper.	
Test 2 To the second portion of the solution, add a 1cm depth of dilute nitric acid into a test-tube. Add a few drops of aqueous silver nitrate.	

Test on residue

test	observations
Test 3 Use a spatula to transfer some of the residue into a test-tube. Add dilute hydrochloric acid to a depth of approximately 3 cm. To the solution formed, add about 1 cm depth of dilute sulfuric acid.	

[4]

- (b) Deduce the formulae of the cation and anion present in solid **J**.

cation:

anion:

[2]

- (c) Using your knowledge on solubility rules, suggest the identity of solid **K**. Use your observations to explain how you reached the conclusion.

solid **K**

.....

..... [2]

- (d) A farmer would like to fertilise his soil with the fertiliser ammonium sulfate, $(\text{NH}_4)_2\text{SO}_4$. He took a sample of the soil and would like to find out the amount of ammonium sulfate fertiliser already present in the soil.

You are **not** to use precipitation method.

With the help of a chemical equation, outline a method to determine the mass of sulfate ions present in the soil.

.....

.....

.....

.....

.....

.....

.....

.....[5]

[Total: 13]

NOTES FOR QUALITATIVE ANALYSIS

Tests for anions

anion	test	test result
carbonate (CO_3^{2-})	add dilute acid	effervescence, carbon dioxide produced
chloride (Cl^-) [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	white 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.

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.
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	green ppt., insoluble in excess
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)	gives white ppt. with limewater (ppt. dissolves with excess CO_2)
chlorine (Cl_2)	bleaches damp litmus paper
hydrogen (H_2)	'pops' with lighted splint
oxygen (O_2)	relights a glowing splint
sulfur dioxide (SO_2)	turns aqueous acidified potassium manganate(VII) from purple to colourless

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Preparation list

Question 1:	
Apparatus for each candidate: • 1 x test-tube rack • 5 x test-tubes • 1 x test-tube holder • 1 x glass rod • 2 x droppers • 1 x wash bottle with distilled water • 2 x 10 cm³ measuring cylinder • 1 x black marker • 1 x filter funnel • 1 x 15 cm ruler	Chemicals for each candidate: • 100 cm³ of 1 mol/dm³ aqueous sodium carbonate • 100 cm³ of 1 mol/dm³ aqueous copper(II) nitrate

Question 2	
Apparatus for each candidate: • 1 x 250 cm³ beaker • 1x thermometer (-10°C to +110°C) • 1 x Styrofoam cup • 1 x 25 cm³ measuring cylinder	Chemicals for each candidate: • anhydrous sodium carbonate (labelled X) Provide 2.2 ± 0.1 g of Na₂CO₃ in a stoppered container • hydrated sodium carbonate (labelled Y) Provide 5.5 ± 0.1 g of Na₂CO₃ · 10H₂O in a stoppered container • 1.5 mol/dm³ hydrochloric acid (labelled Z) 70 cm³ per student

Question 3:**Apparatus for each candidate:**

- 1 x test-tube rack
- 3 x test-tubes
- 1 x lighter
- 1 x test-tube holder
- 3 x spatula
- 1 x glass rod
- 1 x dropper
- 1 x wooden splint
- litmus papers (1 bottle each)
- 1 x wash bottle with distilled water
- 1 x 10 cm³ measuring cylinder
- 2 x boiling tubes
- 1 x stopper for boiling tube
- 2 x filter papers
- 1 x filter funnel
- 1 x delivery tube

Chemicals for each candidate:

- Aqueous sodium hydroxide
- Dilute hydrochloric acid
- Dilute sulfuric acid
- Dilute nitric acid
- Aqueous silver nitrate
- Aqueous barium nitrate
- Aqueous ammonia
- Limewater
- 1 vial of mixture of ammonium chloride and barium carbonate about 3.0 g.







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CANDIDATE
NAME

ANSWERS

CLASS

4

INDEX
NUMBER

CHEMISTRY

Paper 3 Practical Test

6092/03

**5 August 2025
1 hour 50 minutes**

Candidates answer on the Question Paper.

READ THESE INSTRUCTIONS FIRST

Write your name, class and register number on all the work you hand in.
Write in dark blue or black pen.
You may use a HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.

Answer all questions in the spaces provided on the Question Paper.

The use of an approved scientific calculator is expected, where appropriate. You may lose marks if you do not show your working or if you do not use appropriate units.

Qualitative Analysis Notes are printed on page **13**.

The number of marks is given in brackets [] at the end of each question or part question.

Shift	
Laboratory	

For Examiner's Use	
1	
2	
3	
Total	

This document consists of **13** printed pages and **1** blank page.

- 1 You are going to investigate the reaction between aqueous copper(II) nitrate and aqueous sodium carbonate.

- Step 1: Label the test-tubes 1, 2, 3, 4 and 5 and place them in order in the test-tube rack.
- Step 2: Use the measuring cylinder to pour 5.0 cm^3 of the 1 mol/dm^3 of aqueous copper(II) nitrate into each of the five test-tubes.
- Step 3: Using another measuring cylinder, add 1.0 cm^3 of 1 mol/dm^3 of aqueous sodium carbonate to test-tube 1. Using the glass rod, carefully stir the contents of the test-tube. **Repeat for steps 4 to 7.** Rinse the glass rod with distilled water before stirring it in each test-tube.
- Step 4: Add 2.0 cm^3 of 1 mol/dm^3 of aqueous sodium carbonate to test-tube 2.
- Step 5: Add 3.0 cm^3 of 1 mol/dm^3 of aqueous sodium carbonate to test-tube 3.
- Step 6: Add 4.0 cm^3 of 1 mol/dm^3 of aqueous sodium carbonate to test-tube 4.
- Step 7: Add 5.0 cm^3 of 1 mol/dm^3 of aqueous sodium carbonate to test-tube 5.

Leave the contents of the test-tubes to stand for 15 minutes.

You should start Question 2 while you are waiting for the solid formed in the test-tubes to settle.

- (a) After 15 minutes, use a ruler to measure the height of the solid formed in each test-tube. In Table 1, record the volume of 1 mol/dm^3 of aqueous sodium carbonate added, and the height (in cm) of the solid formed in each test-tube. Include appropriate headings in Table 1.

Table 1

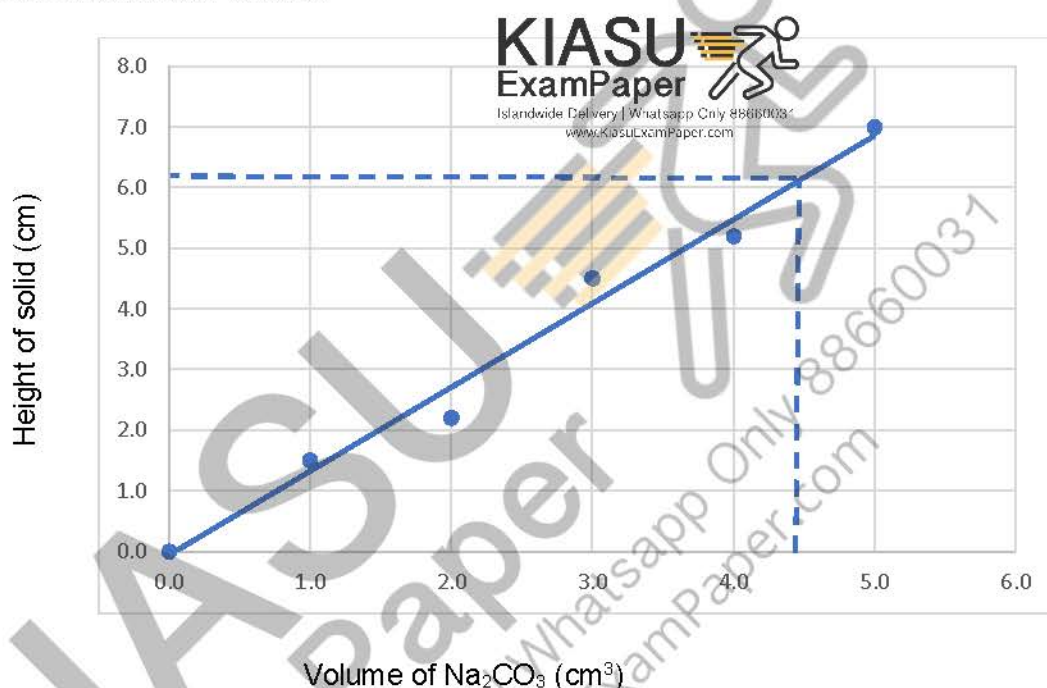


test-tube number	Volume of Na_2CO_3 (aq) / cm^3	Height of solid / cm
1	1.0	1.5
2	2.0	2.2
3	3.0	4.5
4	4.0	5.2
5	5.0	7.0

[4]

Volume of Na_2CO_3 (aq) in cm^3 measured to 1 d.p.	[1]
Height of solid in cm measured to 1 d.p. (allow mm measurement to nearest whole number)	[1]
Appropriate heading and correct units	[1]
Full set of data shows - correct volumes of Na_2CO_3 (aq), according to question - height increasing with test-tube number	[1]

- (b) On the grid provided, plot a graph of height of solid against volume of aqueous sodium carbonate added.



Axis labels and correct units (based on table of values)	[1]
Appropriate axis and scale must include (0,0) origin (vertical: height of solid / cm; horizontal: volume of aqueous Na_2CO_3 added / cm^3).	[1]
All points plotted correctly from table of values	[1]
Best fit line that uses all/most points and starts from origin Line can be straight or curved, whichever is more suitable (ECF if already penalised for axis not including origin)	[1]

[4]

- (c) Describe the trend in the height of the solids formed in test-tubes 1 to 5.

The height of the precipitate generally increases as the volume of aqueous sodium carbonate added increases [1].

.....[1]

- (d) From the graph, deduce the height of the solid formed when 0.0045 moles of aqueous sodium carbonate is added to 0.005 moles of copper(II) nitrate.

Value from graph with unit (indicated with dotted line) when 4.5 cm^3 of aqueous sodium carbonate is added to 5 cm^3 of copper(II) nitrate.

.....[1]

- (e) Suggest two improvements that can be made in order to improve the accuracy of the results.

Use a burette to add the copper(II) nitrate to the test tubes.

Repeat experiment twice and calculate average height of precipitate for each test tube.

Allow the precipitate a longer time to settle to the bottom of the test-tube.

[Any two]

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.....[2]

[Total: 12]

- 2 Water of crystallisation refers to the water molecules bonded to the lattice structure of ionic compounds.

You are going to investigate the enthalpy change, ΔH_{hyd} , when anhydrous sodium carbonate, Na_2CO_3 , converts to hydrated sodium carbonate, $\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$.

One way to determine the enthalpy change is to measure the changes in temperature when samples of anhydrous sodium carbonate and hydrated sodium carbonate are added separately to excess hydrochloric acid.

Read all the instructions carefully before starting the experiments in Question 2.

Instructions



You are going to carry out two experiments.

X is 2.2 g of anhydrous sodium carbonate, Na_2CO_3 .

Y is 5.5 g of hydrated sodium carbonate, $\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$

Z is 1.50 mol/dm³ hydrochloric acid, HCl .

(a) Experiment 1

Place a Styrofoam cup into a 250 cm³ beaker.

Transfer 25.0 cm³ of **Z** into the cup using the 25 cm³ measuring cylinder. Measure the temperature of **Z** and record the value in the table.

Pour all of **X** into the acid in the cup. Stir, using the thermometer, and measure the highest or lowest temperature reached. Record this temperature in the table.

Experiment 2

Repeat *Experiment 1* using the Styrofoam cup, but use **Y** in place of **X**.

Complete Table 2 and calculate the temperature change for each experiment.

Table 2

experiment	initial temperature of Z /°C	highest or lowest temperature of Z /°C	temperature change /°C
1	30.0	38.5	8.5
2	30.0	21.0	-9.0

All four thermometer readings recorded to .0 °C or .5 °C.

ΔT calculated correctly using $T_{\text{final}} - T_{\text{initial}}$ with negative sign for Experiment 2. Experiment 1 temperature increase AND experiment 2 temperature decrease

Full set of data

2 correct answers= 1mk



[3]

- (b) (i) The amount of heat transferred in the experiments can be calculated using the expression shown.

Heat transferred (J) = mass of solution (g) x maximum temperature change (°C) x 4.2

Use this expression to calculate, in J, the amount of heat transferred in each experiment.

Assume that 1.0 cm³ of solution has a mass of 1.0 g.

Heat transferred in Experiment 1 = $25 \times 4.2 \times 8.5 = \underline{892.5} \text{ J}$ [1]

Heat transferred in Experiment 2 = $25 \times 4.2 \times 9.0 = \underline{945} \text{ J}$ [1]

Allow ECF from incorrect ΔT

Answers to be in 2-3 sf

Experiment 1 with X: heat transferred =J

Experiment 2 with Y: heat transferred =J [2]

- (ii) Calculate the enthalpy change, ΔH , in kJ/mol, when all the solid reacts with hydrochloric acid in each experiment.

[M_r : Na_2CO_3 , 106, $\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$, 286]

$\text{Enthalpy change, } \Delta H = \frac{\text{Heat transferred in kJ}}{\text{Number of moles of solid}}$

$$\begin{aligned}\Delta H_1 &= \frac{892.5 \times 106}{2.2 \times 1000} \\ &= -43.0 \text{ kJ/mol}\end{aligned}$$

[1]

$$\begin{aligned}\Delta H_2 &= \frac{945 \times 286}{5.5 \times 1000} \\ &= +49.1 \text{ kJ/mol}\end{aligned}$$

[1]

H_1 is negative (exothermic) and ΔH_2 is positive (endothermic).

Answers to be in 3 sf

Experiment 1 with X: $\Delta H_1 = \dots\dots\dots$ kJ/mol

Experiment 2 with Y: $\Delta H_2 = \dots\dots\dots$ kJ/mol [2]

- (iii) The enthalpy change of hydration, ΔH_{hyd} , can be calculated using the expression:

$$\Delta H_{\text{hyd}} = \Delta H_1 - \Delta H_2$$

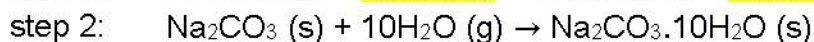
Use your answers from (b)(ii) to calculate the enthalpy change of hydration, ΔH_{hyd} .

$$\begin{aligned}\Delta H_{\text{hyd}} &= \Delta H_1 - \Delta H_2 \quad [1] \\ &= -43.0 - 49.1 \\ &= -92.1 \text{ kJ/mol}\end{aligned}$$

Allow ECF

$\Delta H_{\text{hyd}} = \dots\dots\dots$ kJ/mol [1]

- (iv) Another way to determine the hydration of anhydrous sodium carbonate can be shown in a two-step chemical equation as shown.



Using your knowledge of Kinetic Particle Theory, explain if **step 1** is an endothermic or exothermic process.

Since energy is taken in to weaken the forces of attraction [1]
between the water molecules, the reaction is endothermic [1].

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- (v) Explain why it is necessary to stir the mixture in the cup before measuring the highest or lowest temperature reached.

Ensure even distribution of heat in the mixture

.....[1]

- (vi) State one source of error and suggest one improvement that can be made to reduce this error.

Error: Volume of liquids measured is not accurate. [1]

Improvement: Use a burette which is of higher accuracy. [1]

OR

Error: Heat loss from solution to surroundings [1]

Improvement: Use a lid to minimise heat loss to the surroundings.

[1]

- (vii) A student carrying out the experiment with an anhydrous sodium carbonate, **X**, could not find 1.50 mol/dm^3 hydrochloric acid. The student used the same volume of 0.750 mol/dm^3 sulfuric acid instead.

Predict the effect on the change in temperature obtained by the student. Assume the same mass of **X** was used.

There will be no change or no effect on the temperature change [1]

Since sulfuric acid is a dibasic acid, it will have the same mole/concentration of H^+ ions as the 1.50 mol/dm^3 of HCl . [1]

.....[2]

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[Total: 15]

3 Read all the instructions carefully before starting the experiments in Question 3.

You are provided with a mixture of two solids, **J** and **K**, which are both salts. **J** is soluble and **K** is insoluble in water.

Carry out the following tests and record your observation. You should test and name any gas evolved. If no change is observed for a test, write 'no observable change'.

Instructions

- (a) Add 3 spatulas of the mixture to a boiling tube. Add a 6 cm depth of distilled water to the mixture. Stopper the boiling tube with a rubber bung and shake the mixture for a minute.

Filter the mixture and keep the residue for tests later.



Tests on filtrate

Divide the solution into two equal portions in two test-tubes.

test	observations
Test 1 To the first portion of the solution, add about 1 cm depth of aqueous sodium hydroxide and shake the contents. Heat the contents carefully and test any gas evolved with damp litmus paper.	No observable change. Pungent gas evolved turns <u>moist red litmus blue</u> . Gas is <u>ammonia / NH₃</u> . [both answers=1 mk]
Test 2 To the second portion of the solution, add a 1cm depth of dilute nitric acid into a test-tube. Add a few drops of aqueous silver nitrate.	White ppt formed. [1]

Test on residue

test	observations
Test 3 Use a spatula to transfer some of the residue into a test-tube. Add dilute hydrochloric acid to a depth of approximately 3 cm. To the solution formed, add about 1 cm depth of dilute sulfuric acid	 Effervescence. Gas forms white ppt in limewater. Gas is CO_2 [1] White ppt formed [1]

[4]

- (b) Deduce the formulae of the cation and anion present in solid J.

cation: NH_4^+ anion: Cl^-

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[2]

- (c) Using your knowledge on solubility rules, suggest the identity of solid K. Use your observations to explain how you reached the conclusion.

solid K **barium / calcium / lead carbonate** [1]

When hydrochloric acid is added to the residue, effervescence is formed indicating the anion is a carbonate. White ppt formed when sulfuric acid is added indicating the cation can be either Ba^{2+} , Ca^{2+} or Pb^{2+} . [1]

[2]

- (d) A farmer would like to fertilise his soil with the fertiliser ammonium sulfate, $(\text{NH}_4)_2\text{SO}_4$.
He took a sample of the soil from his farmland and would like to find out the amount of ammonium sulfate fertiliser already present in the soil.

You are **not** to use precipitation method to answer.

With the help of a chemical equation, outline a method to determine the mass of sulfate ions present in the soil.

- **Dissolve** a known mass (e.g 5.0 g) of the soil sample in **water**.
- **Filter** the mixture and **collect ammonium sulfate** solution as **the filtrate**.
- Add **excess NaOH** to the filtrate and warm. **Use a gas syringe** to collect the **volume of ammonia gas** produced.



- Find the **number of moles of ammonia gas and ammonium/sodium sulfate**:

$$\text{Moles of ammonia gas} = \frac{\text{Volume of ammonia gas}}{24000}$$

$$\text{Number of moles of sodium sulfate} = \frac{\text{Number of moles of ammonia gas}}{2}$$

- Number of moles of sodium sulfate = Number of moles of sulfate (SO_4^{2-})
- Calculate mass of sulfate (SO_4^{2-}): **Number of moles X molar mass**

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[5]

[A] Approach (correct concept) Ammonium salt reacts with alkali to form salt, NH_3 gas and water Reject: Precipitation method	[1]
[P] Procedure • Dissolve a known mass of soil in water and filter • Add excess NaOH and measure NH_3 gas using a gas syringe	[1] [1]
[DP] Data Processing • Chemical equation (correct reactants and products with proper balancing) • Show correctly how the number of moles of ammonia and the mass of sulfate are formed	[1] [1]

[Total: 13]

Common mistakes:

- Did not dissolve soil in water and filter, add NaOH (aq) immediately instead
- React ammonium sulfate with acid (HCl) to form ammonia/hydrogen gas instead of alkali
- Use precipitation method instead (did not read the question carefully)
- Heat the ammonium sulfate solution to get sulfate ions and calculate the mass
- Incorrect or unbalanced chemical equation for the reaction between ammonium sulfate and alkali.



NOTES FOR QUALITATIVE ANALYSIS**Tests for anions**

anion	test	test result
carbonate (CO_3^{2-})	add dilute acid	effervescence, carbon dioxide produced
chloride (Cl^-) [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	white 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.

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.
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	green ppt., insoluble in excess
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)	gives white ppt. with limewater (ppt. dissolves with excess CO_2)
chlorine (Cl_2)	bleaches damp litmus paper
hydrogen (H_2)	'pops' with lighted splint
oxygen (O_2)	relights a glowing splint
sulfur dioxide (SO_2)	turns aqueous acidified potassium manganate(VII) from purple to colourless

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Name	Index Number	Class
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WOODGROVE SECONDARY SCHOOL

A COMMUNITY OF FUTURE-READY LEARNERS AND THOUGHTFUL LEADERS

O-LEVEL PRELIMINARY EXAMINATIONS 2025

LEVEL & STREAM : SECONDARY FOUR EXPRESS

SUBJECT (CODE) : CHEMISTRY (6092)

PAPER NO : 3

DATE (DAY) : 7 AUGUST 2025 (THURSDAY)

DURATION : 1 hour 50 minutes

READ THESE INSTRUCTIONS FIRST

Write your name, index number and class on all the work you hand in.
 Give details of the practical shift and laboratory, where appropriate, in the boxes provided.
 Write in dark blue or black pen.
 You may use a soft pencil for any diagrams, graphs, tables or rough working.
 Do not use staples, paper clips, highlighters, glue or correction fluid.

Answer all questions in the spaces provided on the Question Paper.

The use of an approved scientific calculator is expected, where appropriate.
 You may lose marks if you do not show your working or if you do not use appropriate units.
 Qualitative Analysis Notes are printed on page 10.

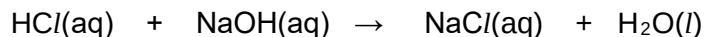
At the end of the examination, fasten all your work securely together.
 The number of marks is given in brackets [] at the end of each question or part question.

Shift		For Examiner's Use			
Laboratory		1		/18	
		2		/5	
Student's Signature		Parent's Signature		3	/17
Date		Date		Total	/ 40

This document consists of 10 printed pages including this cover page.
 Setter: Mdm Shuryati

- 1 The neutralisation reaction between sodium hydroxide and dilute hydrochloric acid is exothermic. The enthalpy change (ΔH) for the reaction can be found by mixing different volumes of the two reactants and measuring the change in temperature.

The chemical equation for the reaction between dilute hydrochloric acid and aqueous sodium hydroxide is given below.



You are going to investigate the temperature change of the reaction between sodium hydroxide and dilute hydrochloric acid and calculate the enthalpy change (ΔH) of the reaction.

Read all instructions below carefully before starting the experiments in Question 1.

Instructions

You are going to carry out five experiments.

P is dilute hydrochloric acid, HCl , of an unknown concentration.

Q is 1.5 mol / dm^3 aqueous sodium hydroxide, NaOH .

(a) Experiment 1

Using a measuring cylinder, measure 10 cm^3 of **P** into a Styrofoam cup. Support the cup in a 250 cm^3 beaker. Measure the initial temperature of **P** and record it in the table below.

Using another measuring cylinder, measure 50 cm^3 of **Q** and pour it into the Styrofoam cup containing **P**. Stir the mixture gently with the thermometer.

Measure the highest temperature reached and calculate the change in temperature.

Wash the thermometer and Styrofoam cup with water.

Experiments 2 to 6

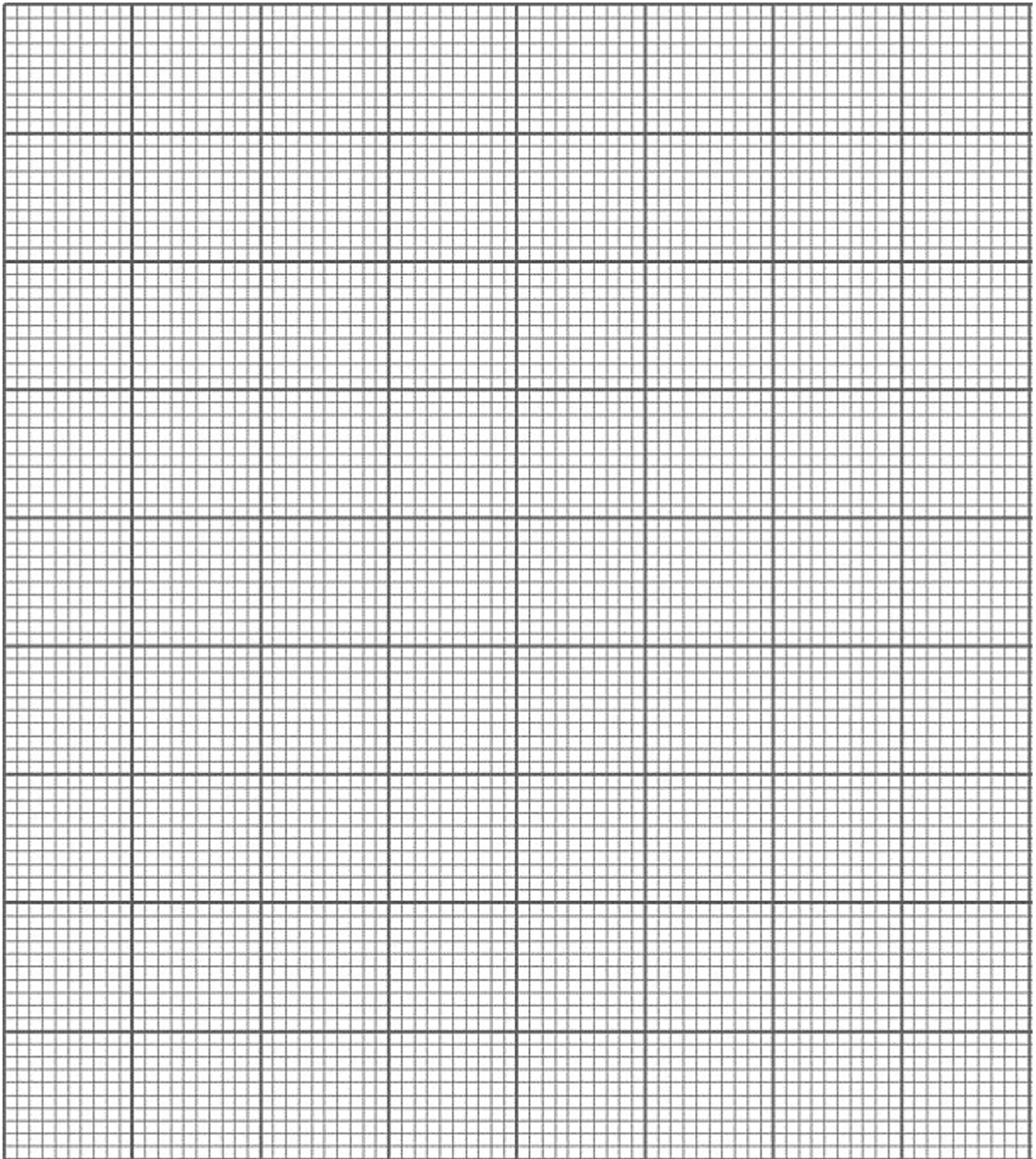
Repeat experiment 1, using the different volumes of **P** and **Q**, keeping the total volume of the mixture to 60 cm^3 .

experiment	volume of P / cm^3	volume of Q / cm^3	initial temperature of P / $^{\circ}\text{C}$	highest temperature reached / $^{\circ}\text{C}$	change in temperature / $^{\circ}\text{C}$
1	10	50			
2	20	40			
3	30	30			
4	40	20			
5	50	10			

[4]

- (b) Use the results in (a) to plot a graph of change in temperature against the volume of **P** used on the grid below.

Using these points, draw two best fit lines. The two lines should cross each other.



[4]

- (c) From the graph, determine the largest change in temperature (ΔT) and the volume of **P** that caused it.

Using dotted lines, show clearly on your graph how you obtained the answers.

$$\Delta T = \text{_____}^{\circ}\text{C} \quad [1]$$

$$\text{volume of P used} = \text{_____ cm}^3 \quad [1]$$

- (d) (i) State the corresponding volume of sodium hydroxide that reacted with the volume of **P** in (c).

$$\text{volume of sodium hydroxide that reacted} = \text{_____ cm}^3 \quad [1]$$

- (ii) Hence, calculate the number of moles of hydrochloric acid present in the volume of **P** found in (d).

$$\text{number of moles of hydrochloric acid present} = \text{_____ mol} \quad [1]$$

- (iii) Using your answers in (c) and (d)(ii), calculate the enthalpy change for the reaction using the formula:

$$\text{Enthalpy change} = -\left(\frac{50 \times 4.2 \times \Delta T}{\text{number of moles of HCl}}\right) \text{ J / mol}$$

enthalpy change = _____ J / mol [1]

- (e) Why is it important to keep the total volume constant?

[2]

- (f) Other than neutralisation, name another example of an exothermic reaction.

[1]

- (g) The enthalpy change calculated in (d)(iii) is larger than the value given in a data book. The main source of error is likely to be heat loss.

- (i) Suggest a reason, other than heat loss, why the calculated result is different from the data book value.

[1]

- (ii) Suggest one improvement you could make to the experiment to reduce the error stated in (g)(i).

[1]

Total: [18]

- 2 You will determine the percentage by mass of NaHCO_3 in **J** again, this time by thermal decomposition. Sodium hydrogencarbonate decomposes on heating.



Read all the instructions carefully before starting the experiment in Question 2.

Instructions

J is impure sodium hydrogencarbonate.

- (a)** Use the balance to find the mass of an empty test-tube.

Add about 1.5 g of **J** to the test-tube and then find the mass of the test-tube and its contents.

Gently heat the test-tube and its contents for 3 minutes so that the sodium hydrogencarbonate decomposes.

Leave the test-tube and its contents to cool to room temperature before finding the mass of the test-tube and its contents.

You may continue with question **3** on page 6 while you are waiting for the test-tube to cool.

Calculate the starting mass of **J** and the change in mass after heating.

Record your results in an appropriate format in the space provided.

[2]

- (b)** Use the change in mass after heating and the equation for the decomposition of sodium hydrogencarbonate to calculate the mass of sodium hydrogencarbonate present in the mass of **J** heated.

[M_r: NaHCO₃, 84.0; H₂O, 18.0; CO₂, 44.0]

mass of NaHCO₃ present = _____g [2]

- (c)** Calculate the percentage by mass of sodium hydrogencarbonate in **J**.

Percentage by mass of NaHCO_3 in **J** = _____% [1]
Total: [5]

- 3 (a)** You are provided with solutions **R** and **T**.

Carry out the following tests on **R** and **T**. You should test any gases that evolve. Record all your observations in the table. The volumes given below are approximate and should be estimated rather than measured unless instructed otherwise.

(i)	test number	test	observation
	1	Gently warm 2 cm depth of R in a test-tube.	
	2(i)	To 1 cm depth of aqueous sodium chloride in a test-tube, add 2 – 3 drops of aqueous silver nitrate.	
	2(ii)	To the mixture from test 2(i) , add R , with shaking, until no further change occurs.	
	3	To 1 cm depth of aqueous copper(II) sulfate in a test-tube, add R , with shaking, until no further change occurs.	
	4	To 1 cm depth of aqueous zinc sulfate in a test-tube, add R , with	

	shaking, until no further change occurs.	
5	To 1 cm depth of T in a test-tube, add R until no further change occurs. Keep this mixture for use in Test 6 .	
6	To 1 cm depth of aqueous hydrogen peroxide in a boiling tube, add the mixture from Test 5 .	
7	To 2 cm depth of T in a test-tube, add an equal volume of sodium hydroxide and a strip of aluminium foil. Warm the mixture.	

[10]

(ii) Name substance **R**.

[1]

(iii) Give the chemical formula of substance **T**.formula of substance **T** [1]

- (b) Labels on cooking oil often include information on whether it is saturated or unsaturated oils. There are C=C double bonds present in unsaturated oils, but single C-C bonds for saturated oils. The greater the number of C=C double bonds, the greater the degree of unsaturation of the oil.

carbonate (CO_3^{2-})	add dilute acid	effervescence, carbon dioxide produced
chloride (Cl^-) [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	white 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.

Test for aqueous cations

<i>cation</i>	<i>effect of aqueous sodium hydroxide</i>	<i>effect of aqueous ammonia</i>
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.
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	green ppt., insoluble in excess
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

Test for gases

<i>gas</i>	<i>test and test result</i>
ammonia (NH_3)	turns damp red litmus paper blue
carbon dioxide (CO_2)	forms a white ppt. in limewater (ppt. dissolves with excess CO_2)
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 aqueous acidified potassium manganate(VII) from purple to colourless

6092 Chemistry

Preliminary Examinations 2025

Paper 3

Number of candidates:

4A : 26 students

4B: 39 students

Preparation list:

Label	Amount	Identity
P	250 cm ³	1.5 mol / dm ³ hydrochloric acid
Q	250 cm ³	1.5 mol / dm ³ sodium hydroxide
	1 bottle	deionised water
J	2 g in vial	Ratio 4 parts solid sodium hydrogencarbonate and 1 part solid sodium chloride (mix 120 g sodium hydrogencarbonate : 30 g sodium chloride)
Copper(II) sulfate	5 cm ³ in vial	1 mol / dm ³ Copper(II) sulfate
R	30 cm ³ (bottle)	1 mol/dm ³ aqueous ammonia 30 cm ³ bottle
T	10 cm ³ vial	1 mol/dm ³ aqueous iron(III) nitrate
zinc sulfate solution	10 cm ³ vial	1 mol/ dm ³ zinc sulfate solution
sodium chloride	5 cm ³ vial	1 mol/ dm ³ aq sodium chloride
Hydrogen peroxide	5 cm ³ vial	Hydrogen peroxide (sealed)

Apparatus required

1 x Safety goggles

1x Styrofoam cup

2 x 250 ml beaker

1 x thermometer

8 x electronic balance (4 in front and 4 behind) , place 250 cm³ of beaker beside the balance

6 × test-tubes

1 × test-tube rack

1 × test-tube holder

1 × glass rod (for stirring)

2 × boiling tubes

1 × Bunsen burner

2 × teat / dropping pipettes

2 × blue / red litmus paper

1 × filter funnel

1 × spatula

1 × wash bottle containing distilled water

paper towels

2 x 50 cm³ measuring cylinder

1 x delivery tube connected to rubber bung and rubber tubing (big)

1 x delivery tube connected to rubber bung(small)

3 x plastic droppers

Reagents list:

1 x Wooden splint

3 x Red and blue litmus papers

2 x Aluminium foil

Bench reagents

1. Dilute nitric acid
2. Dilute sulfuric acid
3. Dilute hydrochloric acid
4. Aqueous sodium hydroxide
5. Aqueous ammonia
6. Limewater
7. Silver nitrate (aq)





PRELIM 2025 WOOGREOVE SECONDARY SCHOOL

Marking scheme

6092/ PAPER 3

Q	Answer						Mark
1 (a)	experiment	volume of P / cm^3	volume of Q / cm^3	initial temperature of P / $^{\circ}\text{C}$	highest temperature reached / $^{\circ}\text{C}$	change in temperature / $^{\circ}\text{C}$	
	1	10.0	50.0	31.0	32.5	+1.5	
	2	20.0	40.0	31.0	34.5	+3.5	
	3	30.0	30.0	31.0	36.5	+5.5	
	4	40.0	20.0	31.0	34.5	+3.5	
	5	50.0	10.0	31.0	32.5	+1.5	
	6	60.0	0.0	31.0	31.0	0.0	
	All temperature readings recorded to 0.5°C [1] All change in temperature readings correctly calculated with '+' sign [1] Correct temperature trend for change in temperature (increasing then decreasing) [1] Highest recorded change in temperature readings within $\pm 1^{\circ}\text{C}$ of supervisor's results [1]						[4]
b)	Correct axes label with units [1] (change in temperature / $^{\circ}\text{C}$, volume of P / cm^3) Appropriate scale [1] All points plotted correctly [1] Two lines of best fit that intersect [1] i.e.						

	Change in Temperature / °C Volume of P / cm³ intersection pt must be above the highest recorded value	[4]
c)	$\Delta T = 5.45\text{ }^{\circ}\text{C}$ (nearest 0.05 °C) volume of P used = 29.5 cm ³	[1] [1]
d) i)	60 – (c) = 30.5 cm ³	[1]
ii)	Moles of HCl = moles of NaOH $= (30.5 / 1000) \times 1.5$ $= 0.0458\text{ mol}$ (3 sf)	[1]
iii)	Enthalpy change = $-[(50 \times 4.2 \times \text{answer in (d)}) / \text{answer in (e)ii}]$ $= -[(50 \times 4.2 \times 5.45) / 0.045750]$ $= -25016.39\text{ J / mol}$ $\approx -25000\text{ J / mol}$ (3 sf)	[1]
e)	MP1 Constant total volume eliminates volume as a variable, so any differences in temperature change are only due to the different ratios of acid to alkali, not due to different amounts of solution. MP2 The same total volume means the same total mass of solution in each experiment. Since heat capacity depends on mass, keeping the volume constant ensures that the same amount of heat energy will produce the same temperature change.	[1] [1]
f)	Displacement reactions / metal – acid reactions / respiration / combustion / condensation / freezing	[1]
g) i)	A measuring cylinder was used to measure the volumes, and is <u>not</u> a <u>precise</u> measuring instrument.	[1]
ii)	Use a <u>burette</u> to measure the volume of both solutions accurately.	[1]

	or any other appropriate method: - use of plastic droppers, and count the number of drops of aq bromine used	
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Qn	Answer	Mark																				
2(a)	MP 1: Full set of data, 3 readings and 2 calculations: - Mass of test-tube, - mass of test-tube and sample J before and after heating, - starting mass of sample J and change in mass. MP2: Mass of J and change in mass from 0.10g to 0.40g. (within 10% to 40% of their starting mass)	[1] [1]																				
2(b)(i)	No of moles of $\text{NaHCO}_3 = \text{change in mass} / (18+44) \times 2$ Mass of $\text{NaHCO}_3 = \underline{\hspace{2cm}} \times 84.0$	[1] [1]																				
2(b)(ii)	percentage by mass of NaHCO_3 = (b)(i) / measured mass in (a) $\times 100\%$ Allow ecf	[1]																				
KIASU ExamPaper Islandwide Delivery Whatsapp Only 88660031 www.KiasuExamPaper.com																						
3(a) (i)	<table border="1"> <thead> <tr> <th>test number</th><th>test</th><th>observation</th><th>Marks</th></tr> </thead> <tbody> <tr> <td>1</td><td>Gently warm 2 cm depth of R in a test-tube.</td><td>Colourless, pungent gas produced that turns moist red litmus blue. The gas is ammonia.</td><td>[1]</td></tr> <tr> <td>2(i)</td><td>To 1 cm depth of aqueous sodium chloride in a test-tube, add 2 – 3 drops of aqueous silver nitrate.</td><td>White ppt. formed</td><td>[1]</td></tr> <tr> <td>2(ii)</td><td>To the mixture from test 2(i), add R, with shaking, until no further change occurs.</td><td>White ppt. dissolves on addition of R</td><td>[1]</td></tr> <tr> <td>3</td><td>To 1 cm depth of aqueous copper(II) sulfate in a test-tube, add R, with shaking,</td><td> Blue ppt. formed. Ppt. dissolved/soluble in excess R to form a <u>dark</u> blue solution. </td><td> [1] [1] </td></tr> </tbody> </table>	test number	test	observation	Marks	1	Gently warm 2 cm depth of R in a test-tube.	Colourless, pungent gas produced that turns moist red litmus blue. The gas is ammonia.	[1]	2(i)	To 1 cm depth of aqueous sodium chloride in a test-tube, add 2 – 3 drops of aqueous silver nitrate.	White ppt. formed	[1]	2(ii)	To the mixture from test 2(i), add R, with shaking, until no further change occurs.	White ppt. dissolves on addition of R	[1]	3	To 1 cm depth of aqueous copper(II) sulfate in a test-tube, add R, with shaking,	Blue ppt. formed. Ppt. dissolved/soluble in excess R to form a <u>dark</u> blue solution.	[1] [1]	
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		until no further change occurs.		
	4	To 1 cm depth of aqueous zinc sulfate in a test-tube, add R , with shaking, until no further change occurs.	White ppt. formed. Ppt. dissolved/soluble in excess R to form a colourless solution	[1] [1]
	5	To 1 cm depth of T in a test-tube, add R until no further change occurs. Keep this mixture for use in Test 6.	Reddish brown ppt. formed, insoluble in excess R . 	[1]
	6	To 1 cm depth of aqueous hydrogen peroxide in a boiling tube, add the mixture from Test 5.	Effervescence, A gas that rekindles a glowing splint. The gas is oxygen.	[1]
	7	To 2 cm depth of T in a test-tube, add an equal volume of sodium hydroxide and a strip of aluminium foil. Warm the mixture.	Reddish brown ppt. formed. (no mark) A pungent gas produced that turns moist red litmus blue. The gas is ammonia	[1]
3	(a)(ii)	Aqueous ammonia Reject: ammonia/ ammonium hydroxide		[1]
	(a)(ii)	$\text{Fe}(\text{NO}_3)_3$		[1]
3	(b)	Variables: Variables to be changed: Types of cooking oils Variables to be kept constant: concentration of aqueous bromine, volume of cooking oil used in titration		[1]
		Assumptions Aqueous bromine only reacts with carbon-carbon double bonds in the cooking oils and no other side reactions.		[1]
		Description of procedure: 1. Pipette 25.0 cm^3 of coconut oil and place it into a conical flask. Set up the apparatus as shown above, 2. Titrate the coconut oil against aqueous bromine until one drop of aqueous bromine does not decolourise. Record the volume of aqueous bromine used in the titration. 3. Repeat step 1 – 2 using palm oil and sunflower oil.		[1] [1]
		How measurements collected is used to draw a conclusion		

		The larger the volume of aqueous bromine used during the titration, the more unsaturated the cooking oil.	[1]
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XINMIN SECONDARY SCHOOL
新民中学
SEKOLAH MENENGAH XINMIN

Preliminary Examination 2025

CANDIDATE NAME

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CLASS

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INDEX NUMBER

--	--

CHEMISTRY

6092/03

Secondary 4 Express

12 August 2025

Setter: Ms Tiffany Lim

Vetter: Ms Una Hsu

1 hour 50 minutes

Candidates answer on the Question Paper.

Additional Materials: As listed in the Confidential Instructions

READ THESE INSTRUCTIONS FIRST

Write your name, class and index number on the work you hand in.

Write in dark blue or black pen.

You may use an HB pencil for any diagrams or graphs.

Do not use staples, paper clips, glue, correction fluid or highlighters.

The use of an approved scientific calculator is expected, where appropriate.

You may lose marks if you do not show your working or if you do not use appropriate units.

Answer all questions in the spaces provided on the Question Paper.

Qualitative Analysis Notes are printed on page 12.

At the end of the examination, fasten all your work securely together.

The number of marks is given in brackets [] at the end of each question or part question.

Shift
Laboratory

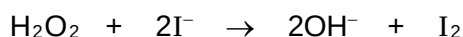
For Examiner's Use	
1	14
2	11
3	15
Total	40
Parent's Signature	

Answer **all** questions.

Write your answers in the spaces provided.

- 1** **P** is an aqueous solution of hydrogen peroxide acting as an oxidising agent.
Q is an aqueous solution of potassium iodide, mixed with another substance.

When **P** and **Q** react together, they produce iodine according to the reaction below.



The addition of starch solution to the mixture allows the iodine to be detected as the solution turns blue-black. In **Q**, there is another substance present which rapidly converts iodine back into iodide ions and so the blue-black colour only appears when all of this substance is used up.

You will carry out 5 experiments. In each of the experiments 1 – 5, the same amount of iodine is produced before the mixture turns blue-black.

Experiment 1

- (a) (i) Put **Q** into a burette and use it to measure out 10 cm³ of **Q** into a conical flask. To **Q** in the flask, add 2 cm³ of starch solution using a 10 cm³ measuring cylinder. Place the flask and its contents on a white tile.
- (ii) Measure 25 cm³ of **P** as accurately as possible, using a 25 cm³ measuring cylinder. Pour this volume of **P** rapidly into the mixture of **Q** and starch solution in the flask. Start the stopwatch immediately and swirl the contents of the flask, then leave the mixture to stand. When the mixture first turns blue-black, stop the stopwatch. Record the time taken to the nearest second in Table 1.1.
- (iii) Empty the conical flask and rinse it thoroughly with water.

Experiment 2 – 5

- (iv) Repeat the procedure described in steps (i) – (iii) of Experiment 1 but varying the volume of **P** used.

Hence, in experiment 2, measure 20 cm³ of **P** as accurately as possible, using a measuring cylinder and then add deionised water to **P** until the total volume of solution in the measuring cylinder is 25 cm³.

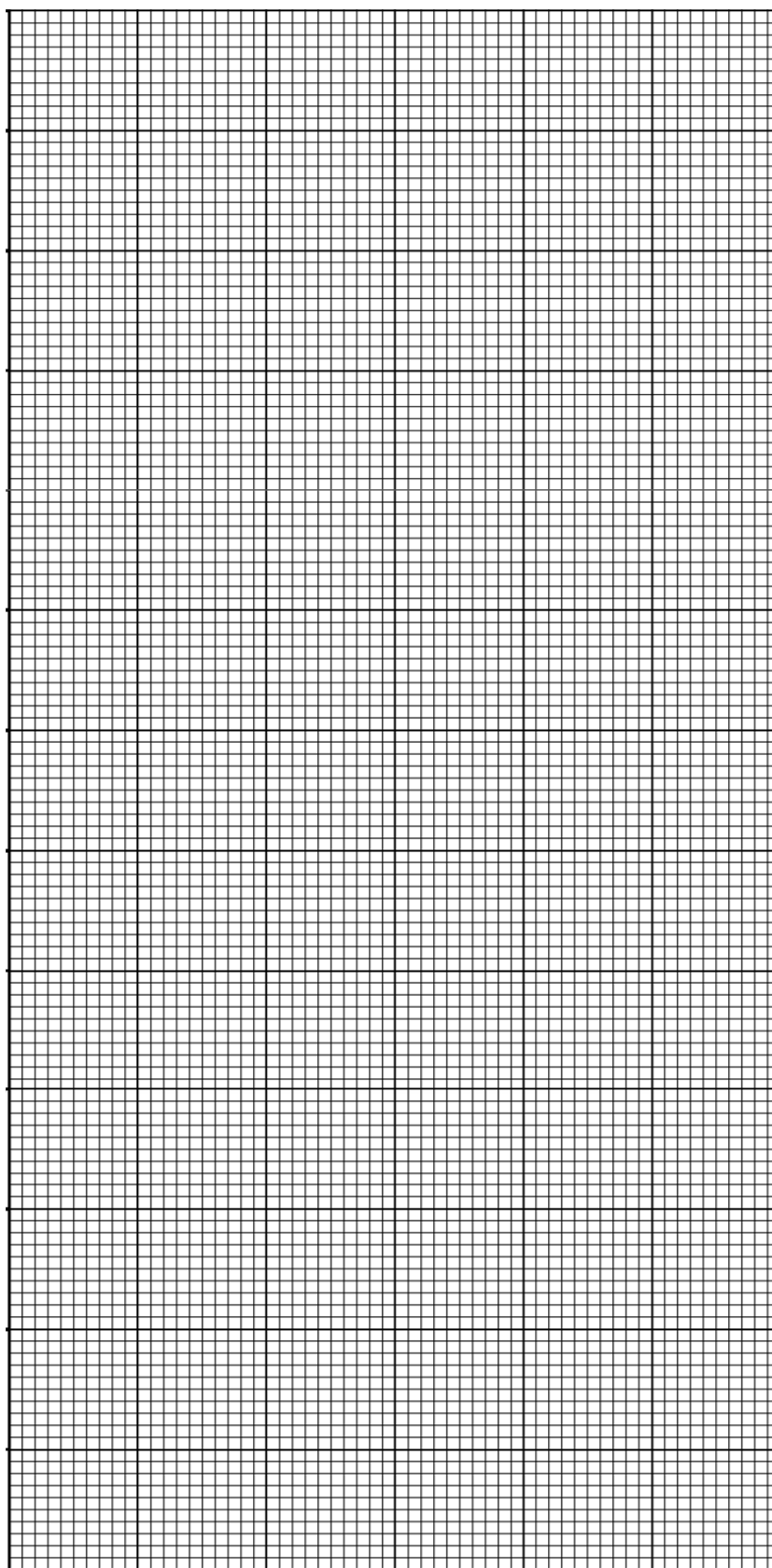
Then, for experiments 3 – 5, choose different volumes of **P** and water and repeat the steps. Record the volumes you have chosen for **P** and water in Table 1.1.

Table 1.1

experiment number	volume of Q / cm ³	volume of P / cm ³	volume of water / cm ³	time taken for blue-black colour to appear / s
1	10	25	0	
2	10	20	5	
3	10			
4	10			
5	10			

[3]

- (b) Plot a graph of time taken for the blue-black colour to appear against volume of **P** in the grid below. Using these points, draw a line of best fit.



[4]

- (c) Using collision theory, explain the trend shown by the graph in (b).

.....

.....

.....

..... [2]

- (d) Suggest **one** change that could be made to the equipment used for the experiments to improve the accuracy of the results.

.....

..... [1]

- (e) It has been suggested that metal ions such as Pb^{4+} , Fe^{3+} and Mn^{4+} can act as catalysts for reactions involving hydrogen peroxide. However, these three metals ions have different effectiveness as catalysts.

Given the same solutions, **P** and **Q**, describe how you would investigate the effectiveness of Pb^{4+} , Fe^{3+} and Mn^{4+} catalysts by experiment.

You can assume that all the apparatus and reagents normally found in the school laboratory are available. You should include the measurements you would take and explain how you would use your results to confirm the suggestion.

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.....

..... [4]

[Total: 14]

- 2 (a) In this experiment, you will determine the identities of acids **R** and **S**.

R and **S** each contain one anion which is listed in the qualitative analysis notes on page 12. The two anions are **not** the same.

Select reagents to determine the identity of the anions in each of the acids, **R** and **S**. You should only use the bench reagents provided.

Carry out 3 tests on **R** and the same 3 tests on **S**. One of the tests has been provided for you in Table 2.1. You should test and name any gas evolved.

If no observable change is observed for a test, write 'no observable change'.

If heating is required, a boiling tube must be used.

Table 2.1

test	observations for R	observations for S
Add about 1cm depth of R in a clean boiling tube. Add 2 cm depth of aqueous sodium hydroxide, shake the contents and then add a piece of aluminium foil. Heat the contents carefully. Repeat the test using S .		

[4]

(b) Use your observations in Table 2.1 to deduce the formulae of the acids in **R** and **S**.

R is

S is

[1]

(c) Neutralisation reactions are exothermic.

In this experiment, you will determine the enthalpy change of a neutralisation reaction between a sample of 1.00 mol/dm³ aqueous potassium hydroxide and acid **S**.

(i) **Instructions**

- Using a 25 cm³ measuring cylinder, measure out 25 cm³ of acid **S**.
- Transfer acid **S** into a clean 250 cm³ beaker.
- Measure and record the temperature of acid **S**.
- Use the 50 cm³ measuring cylinder to measure out 25 cm³ of aqueous potassium hydroxide.
- Add the aqueous potassium hydroxide into the beaker and gently stir the mixture using the thermometer.
- Measure and record the highest temperature of the mixture.
- Record your results in Table 2.2. Calculate the change in temperature for your experiment.

Table 2.2

temperature of acid S / °C	
highest temperature of the mixture / °C	
change in temperature / °C	

[2]

(ii) Enthalpy change of a neutralisation reaction can be calculated by the formula below.

$$\text{Enthalpy change} \left(\frac{\text{kJ}}{\text{mol}} \right) = - \frac{V \times 4.2 \times T}{1000 n}$$

where V = total volume of solution used in cm³

T = change in temperature in °C

n = no. of moles of aqueous potassium hydroxide

Using the formula above, calculate the enthalpy change for the neutralisation reaction between aqueous potassium hydroxide and acid **S**.

[2]

- (iii) The theoretical value of the enthalpy change of neutralisation between aqueous potassium hydroxide and acid **S** is -57.0 kJ.

Explain why there could be a difference between the theoretical value and your calculated value in **(c)(ii)**.

.....
.....
..... [2]

[Total: 11]

- 3 Ethanedioic acid is used in some stain removal products. In the solid crystals of ethanedioic acid, $\text{C}_2\text{H}_2\text{O}_4$, each molecule is combined with x molecules of water.

The formula of the crystals is $\text{C}_2\text{H}_2\text{O}_4 \cdot x\text{H}_2\text{O}$ where x is a whole number. You are to determine the value of x given the information below.

A is aqueous ethanedioic acid. 1.00 dm^3 of **A** contains 8.90 g of $\text{C}_2\text{H}_2\text{O}_4 \cdot x\text{H}_2\text{O}$.

B is 0.150 mol/dm^3 of sodium hydroxide, NaOH .

25.0 cm^3 of solution **A** was titrated against solution **B** using thymolphthalein indicator and the results are shown in Fig. 2.3.

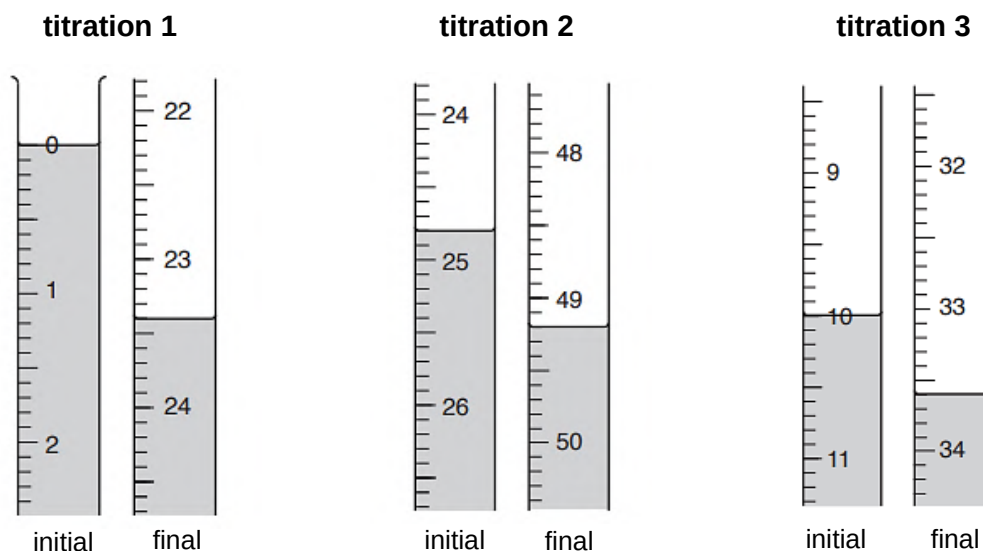


Fig. 2.3

- (a) (i) Use the diagrams in Fig. 2.3 to complete the results table and select the best titration results by indicating a check (✓).

Results

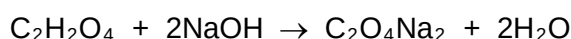
- (ii) Calculate the average volume of **B** required for the titration.

average volume of **B** = cm³ [1]

- (b) (i) **B** is 0.150 mol/dm³ of sodium hydroxide.
Using the titration results, calculate the amount of sodium hydroxide, in moles, used to reach the end-point of the titration. Leave your answers to 3 significant figures.

amount of NaOH in the average volume of **B** = mol [1]

- (ii) The equation for the titration reaction is shown.



Using your answer from **(b)(i)** and the equation for the reaction to calculate the number of moles of ethanedioic acid, C₂H₂O₄, present in 25.0 cm³ of **A**. Leave your answers to 3 significant figures.

amount of ethanedioic acid, C₂H₂O₄, in 25.0 cm³ of **A** = mol [1]

- (iii) Calculate the amount, in moles, of ethanedioic acid, C₂H₂O₄, in 1.00dm³ of **A**. Leave your answers to 3 significant figures.

amount of ethanedioic acid, C₂H₂O₄, in 1.00dm³ of **A** = mol [1]

- (iv) Calculate the mass of ethanedioic acid, $\text{C}_2\text{H}_2\text{O}_4$, in 1.00 dm^3 of solution **A**. Leave your answers to 3 significant figures.

$[A_r: \text{C}, 12; \text{H}, 1; \text{O}, 16]$

mass of ethanedioic acid in 1.00 dm^3 of **A** = g [1]

- (v) The mass of the ethanedioic acid crystals, $\text{C}_2\text{H}_2\text{O}_4 \cdot x\text{H}_2\text{O}$, that is dissolved in 1.00 dm^3 is 8.90 g.

Use your answer to **(b)(iv)** to calculate the amount, in moles, of water present in 8.90 g of crystals $\text{C}_2\text{H}_2\text{O}_4 \cdot x\text{H}_2\text{O}$. Leave your answers to 3 significant figures.

$[A_r: \text{H}, 1; \text{O}, 16]$

amount of water = mol [3]

- (vi) Use your answer to **(b)(iii)** and **(b)(v)** to calculate the value of x in the ethanedioic acid crystals, $\text{C}_2\text{H}_2\text{O}_4 \cdot x\text{H}_2\text{O}$.

value of x = [1]

- (c) (i) A student completes this experiment. During each titration, the student carelessly dispenses some solution **B** on the walls of the conical flask and attempts to wash them down into the conical flask using some deionised water.

State the explain the effect, if any, that this would have on the volume of **B** required to reach the end-point of the titration.

.....

 [1]

- (ii) Another student performs one of the titrations but realised midway that he had forgotten to add the indicator.

Describe and explain what the student can do to determine if the titration reaction has reached its end-point.

.....

 [2]

[Total: 15]

End of paper

QUALITATIVE ANALYSIS NOTES

Test for anions

<i>anion</i>	<i>test</i>	<i>test result</i>
carbonate (CO_3^{2-})	add dilute acid	effervescence, carbon dioxide produced
chloride (Cl^-) [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	white 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.

Test for cations

<i>cation</i>	<i>effect of aqueous sodium hydroxide</i>	<i>effect of aqueous ammonia</i>
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.
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	green ppt., insoluble in excess
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

Test for gases

<i>gas</i>	<i>test and test result</i>
ammonia (NH_3)	turns damp red litmus paper blue
carbon dioxide (CO_2)	gives white ppt. with limewater (ppt. dissolves with excess CO_2)
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 aqueous acidified potassium manganate(VII) from purple to colourless

Confidential Instructions
Chemistry Preliminary Examination 2025

Question 1

Chemical List

label	per candidate	identity	notes
P	150 cm ³	0.1 mol/dm ³ acidified hydrogen peroxide	59 cm ³ H ₂ O ₂ (6%) + 441 cm ³ H ₂ O + 500 cm ³ H ₂ SO ₄ (1M)
Q	150 cm ³	an aqueous solution of 0.075 mol/dm ³ potassium iodide with 0.025 mol/dm ³ sodium thiosulfate	Dissolve 12.5 g potassium iodide, KI and 6.2 g sodium thiosulfate pentahydrate, Na ₂ S ₂ O ₃ ·5H ₂ O in distilled water and dilute to 1 dm ³ .
starch solution	15 cm ³	2% starch solution	Mix 2 g of soluble starch with a little cold water until a firm paste is obtained. Add 100 cm ³ of boiling water and stir. Boil until a clear solution is obtained (about 5 min). This solution should be freshly prepared.

Note: To ensure results fall within the required limits, carry out the following experiment.

To 20 cm³ of Q, add six drops of starch solution and then 30 cm³ of P. The time taken for the mixture to turn blue-black should be within 10-20 s. To adjust the time taken, increase or decrease the concentration of P.

Apparatus

The following apparatus must be provided to each candidate:

Apparatus	Quantity
deionised water	at least 300 cm ³
10 cm ³ measuring cylinder	1
25 cm ³ measuring cylinder	1
250 cm ³ conical flask	1
burette	1
white tile	1
stopwatch	1
waste container	1
dropper	2

Question 2:**Apparatus and Chemicals**

The following apparatus must be provided to each candidate:

Label	Quantity/ Volume	Material identity	Remarks
	1	250 cm ³ beaker	
	1	50 cm ³ measuring cylinder	
	1	thermometer, –10 °C to +110 °C at 1°C graduations	
	1	delivery tube for test tube	
	4	test-tubes	
	2	boiling tube	
	5	red litmus papers	
	5	blue litmus papers	
	2	wooden splints	
	4	droppers	
	2	aluminium foil	
R 	15 cm ³	0.5M dilute nitric acid	F in 2024
S 	70 cm ³	0.5M dilute sulfuric acid	new
aqueous silver nitrate	at least 50 cm ³	bench reagent	
aqueous barium nitrate	at least 50 cm ³	bench reagent	
dilute nitric acid	at least 50 cm ³	bench reagent	
aqueous sodium hydroxide	at least 50 cm ³	bench reagent	
aqueous potassium hydroxide	55 cm ³	1M aqueous sodium hydroxide	





Marking Scheme
Chemistry Preliminary Examination 2025

Mark scheme will use these abbreviations

/	alternatives
+	statements on both sides of the + are needed for that mark
R	reject
A	accept (for answers correctly cued by the question)
Ig	ignore as irrelevant
ref	with reference to
ecf	error carried forward
AW	alternative wording (where responses vary more than usual)
AVP	alternative valid point
ORA	or reverse argument
OWTTE	or words to that effect
<u>underline</u>	actual word given must be used by candidate (grammatical variants excepted)
()	the word / phrase in brackets is not required but sets the context



Paper 3

Qn	Marking Scheme	Marks	Marker's Report																														
1a	1. 1m – correct volumes of P and water for experiments 3 to 5 2. 1m – record time to nearest second 3. 1m – increasing trend for time taken <table><thead><tr><th>experiment</th><th>volume of Q / cm³</th><th>volume of P / cm³</th><th>volume of water / cm³</th><th>time taken for blue-black colour to appear / s</th></tr></thead><tbody><tr><td>1</td><td>10</td><td>25</td><td>0</td><td>10-16</td></tr><tr><td>2</td><td>10</td><td>20</td><td>5</td><td>17-24</td></tr><tr><td>3</td><td>10</td><td>15</td><td>10</td><td>25-35</td></tr><tr><td>4</td><td>10</td><td>10</td><td>15</td><td>40-65</td></tr><tr><td>5</td><td>10</td><td>5</td><td>20</td><td>about 200</td></tr></tbody></table>	experiment	volume of Q / cm ³	volume of P / cm ³	volume of water / cm ³	time taken for blue-black colour to appear / s	1	10	25	0	10-16	2	10	20	5	17-24	3	10	15	10	25-35	4	10	10	15	40-65	5	10	5	20	about 200	max 3	R: Time is not nearest second.
experiment	volume of Q / cm ³	volume of P / cm ³	volume of water / cm ³	time taken for blue-black colour to appear / s																													
1	10	25	0	10-16																													
2	10	20	5	17-24																													
3	10	15	10	25-35																													
4	10	10	15	40-65																													
5	10	5	20	about 200																													

1b	1. appropriate scale (1) 2. labelled axes (with units) (1) 3. curved line of best fit (1) 4. 5 data points (1) penalize 1 if axes are reversed penalize if students write vol. amt. temp.	4	Minus MP4 as long as one point is off.
1c	1. As the volume of P decreases, there are <u>fewer number of reacting particles of P per unit volume</u> 2. <u>Less frequency of effective collisions</u> between P and Q, hence time taken increases. ORA	2	 Islandwide Delivery Whatsapp Only 88660031 www.KiasuExamPaper.com
1d	Use a burette instead of measuring cylinder to measure out solution P / starch solution / water / all solutions.	1	A: using pipette only if the volume is specified and need to state multiple pipettes. R: data logger
1e	(Aim: To determine which catalyst is effective in speeding up the rate of reaction between P and Q.) MP1: steps (a) (i) and (ii). Students must ensure that catalyst is added before they start the stopwatch. MP2: fixed or known mass/volume of catalyst MP3: repeat with remaining catalysts MP4: analysis & conclusion of the results Example: a) Measure out 10 cm ³ of Q using a measuring cylinder and transfer it into a beaker. b) To the beaker, add 2 cm ³ of starch solution using a 10 cm ³ measuring cylinder. (Place the flask and its contents on a white tile.) c) Add 1.0 g of Pb ⁴⁺ catalyst into the beaker. d) Measure 25 cm ³ of P as accurately as possible, using a 25 cm ³ measuring cylinder. e) Pour P into Q and immediately start the stopwatch and swirl the flask. f) When the mixture first turns blue-black, stop the stopwatch and record the time taken. g) Repeat steps a) to f) using 1.0 g of Fe ³⁺ and Mn ⁴⁺ catalysts. h) Analysis of results: The catalyst that recorded the shortest time taken is the most effective catalyst. Alternative response: MP1: 1. Carry out step (a) (i) of experiment 1.	1 1 1 1	

2. Using an electronic balance, weigh and transfer <u>1g</u> of Pb^{4+} catalyst into the conical flask (Accept if students measure out a known volume of solution with correct apparatus as the state of the catalyst is not known). MP2: 3. Carry out step (a) (ii) in experiment 1 and start the stopwatch. 4. When the mixture turns blue-black, stop the stopwatch and record the time taken. MP3: 5. Repeat steps 1 – 4 using <u>same mass or volume</u> of the Fe^{3+} and Mn^{4+} catalysts. MP4: 6. The catalyst that recorded the shortest time/smallest value is the most effective catalyst. A: the catalyst that allows KI to change colour the fastest is the most effective catalyst.	 KIASU ExamPaper Islandwide Delivery Whatsapp Only 88660031 www.KiasuExamPaper.com
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Qn	Marking Scheme			Marks	Marker's Report
2a)	test	observations for R	observations for S	4 Every 2 correct boxes – 1 m	 Islandwide Delivery Whatsapp Only 88660031 www.KiasuExamPaper.com
	Add about 1cm depth of R into a test tube. Add dilute nitric acid, then aqueous silver nitrate. Repeat with S. OWTTE	No observable change	No observable change		
	Add about 1cm depth of R into a test tube. Add dilute nitric acid, then aqueous barium nitrate Repeat with S. OWTTE	No observable change	White ppt.		
	Add about 1cm depth of R in a clean boiling tube. Add 2 cm depth of aqueous sodium hydroxide, shake the contents and then add a piece of aluminium foil. Heat the contents carefully. Repeat the test using S.	(Pungent gas,) turns moist red litmus paper blue. Gas is ammonia	No observable change Accept: Moist red litmus paper remained red		
	Accept: no visible change/observation/reaction. Reject: all others e.g. no change seen. Penalize once only, ecf the rest.				
2b	R: HNO_3 S: H_2SO_4			1	
2ci	Temperature readings to 1d.p and no units Correct calculation of temperature change with '+' sign.			1 1	Teachers' reading = +6 °C

2cii	Correct calculation of enthalpy change using the formula. Final answer to 3.s.f AND correct units	1 1	Teachers' value = - 50.4kJ/mol Second MP not awarded if value is inaccurate or missing the negative sign
2ciii	As the reaction is done in a beaker, there could be <u>heat loss</u> to the surroundings, which causes the <u>temperature measured to be lower</u> than expected. This would result in a <u>less negative calculated</u> enthalpy change. A: lower enthalpy change A: energy loss AVP: In order to determine the maximum temperature rise, varying volumes of KOH should be added to varying volumes of acid S. Then a graph should be plotted and the highest temperature rise determined by finding the point of intersection between the 2 lines of best fit.	1 1 1 1	402: Generally, students were able to identify that there will be heat/energy loss to surroundings but could not state the effect on calculated enthalpy change

Qn	Marking Scheme	Marks	Marker's Report																				
3ai	<table border="1"> <thead> <tr> <th></th><th>1</th><th>2</th><th>3</th></tr> </thead> <tbody> <tr> <td>final reading /cm³</td><td>23.40</td><td>49.20</td><td>33.60</td></tr> <tr> <td>initial reading / cm³</td><td>0.00</td><td>24.80</td><td>10.00</td></tr> <tr> <td>volume used / cm³</td><td>23.40</td><td>24.40</td><td>23.60</td></tr> <tr> <td>best titration result</td><td>✓</td><td></td><td>✓</td></tr> </tbody> </table>		1	2	3	final reading /cm ³	23.40	49.20	33.60	initial reading / cm ³	0.00	24.80	10.00	volume used / cm ³	23.40	24.40	23.60	best titration result	✓		✓	3	1 – correct table headings 1 – correct readings from burette to 2dp 1 – correct selection of best titration results R: vol.
	1	2	3																				
final reading /cm ³	23.40	49.20	33.60																				
initial reading / cm ³	0.00	24.80	10.00																				
volume used / cm ³	23.40	24.40	23.60																				
best titration result	✓		✓																				
3aii	23.50cm ³ average volume correctly calculated AND to 2 d.p	1																					
3bi	No of mol of B = [average volume of B / 1000] x 0.15 [0.00353]	1	For all calculation, - Answers must match working - credit is award if answer is correct without working - answers written on the will be the final answer M1: ECF from (a)(i) M2: ECF from previous step																				
3bii	No of mol of A (in 25 cm ³) = ans / 2 [0.00177 or 0.00176]	1																					
3biii	No of mol of A (in 1 dm ³) = [answer in (b)(ii)] x 40 [0.0704/0.0705/0.0706/0.0708]	1																					
3biv	Mass of A = [answer in (b)(iii)] x 90 [6.34/6.35/6.37]	1																					





NAME:		()	CLASS:	
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YISHUN TOWN SECONDARY SCHOOL

G3

PRELIMINARY EXAMINATION 2025

SECONDARY 4

G3 CHEMISTRY

(6092/3)

DATE : 19 August 2025

DAY : Tuesday

DURATION: 1 h 50 min

MARKS: 40 marks

READ THESE INSTRUCTIONS FIRST

Write your name, class and register number in the spaces provided at the top of this page.

Write in dark blue or black pen.

You may use an HB pencil for any diagrams or graphs.

Answer all the questions in the spaces provided.

INFORMATION FOR CANDIDATES

The use of an approved scientific calculator is expected, where appropriate. You may lose marks if you do not show your workings or if you do not use appropriate units.

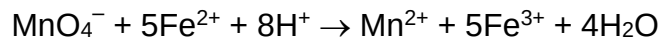
Qualitative Analysis Notes are printed on the last page.

The number of marks is given in brackets [] at the end of each question or part question.

Question 1	/ 20
Question 2	/ 13
Question 3	/ 7
TOTAL	/ 40

This question paper consists of **10** printed pages.

- 1 You are to determine the percentage purity of a sample of hydrated iron (II) sulfate, $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$, by titrating with aqueous potassium manganate (VII), KMnO_4 .



Read all the instructions carefully before starting the experiment.

Instructions

A is 0.020 mol/dm^3 of potassium manganate (VII)

B is 35.0 g of impure hydrated iron (II) sulfate dissolved in 1.0 dm^3 dilute sulfuric acid

- (a) (i) Place **A** into the burette.

Pipette a 25.0 cm^3 portion of **B** into a conical flask. Ensure that the lid is placed back on the bottle of **B** after use.

Add **A** from the burette to the conical flask whilst constantly swirling the flask.

The end-point of the titration is when one drop of **A** changes the colour of the solution to pale pink which does not change on swirling.

Record your results in an appropriate format in the space provided. Repeat the titration as many times as you consider to be necessary to achieve consistent results.

Results

[5]

- (ii) From your titration results, obtain an average volume of **A** to be used in your calculations. Show clearly how you obtained this volume.

average volume of **A** = [1]

(b) (i) Calculate the amount, in moles, of iron (II) ions in 1 dm³ of solution.

amount of iron (II) ions = [2]

(ii) Calculate the mass of hydrated iron (II) sulfate in 1 dm³ of solution.
[M_r of $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$ = 278]

mass of hydrated iron (II) sulfate = [1]

(iii) Calculate the percentage purity of hydrated iron (II) sulfate in the sample.

percentage purity = [2]

(c) The lid for the bottle containing **B** is placed back after use to minimise exposure to air.

State and explain how your results may be affected after solution **B** is exposed to air.

.....
.....
.....
.....
..... [3]

- (d)** The percentage purity of hydrated iron (II) sulfate can also be determined by precipitation of an insoluble sulfate compound.

Solid hydrated iron (II) sulfate has a high solubility in water. You are provided with 1.0 mol/dm^3 of aqueous barium chloride and other common apparatus that can be found in a school laboratory.

Describe an experiment to determine the percentage purity of a given 2.0 g solid sample of impure hydrated iron (II) sulfate.

In your description, you need to include:

- any measurements.
- any assumption.
- detailed calculations.

The molar mass of $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$ and BaCl_2 are 278 g/mol and 208 g/mol respectively.

..... [6]

[Total: 20]

- 2 You are to investigate the temperature change when magnesium reacts with dilute sulfuric acid of different concentrations.

Read all the instructions carefully before starting the experiment.

Instructions

C is 1.00 mol/dm³ dilute sulfuric acid.

You are provided with five pieces of magnesium metal of the same length.

You are to do five experiments.

(a) Experiment I

1. Use a 25 cm³ measuring cylinder to pour 20.0 cm³ dilute sulfuric acid into a 100 cm³ beaker.
2. Use a thermometer to measure the initial temperature of the dilute acid in the beaker. Record the initial temperature in the table on the next page. Be careful that the thermometer does not cause the beaker to topple over.
3. Add a piece of magnesium metal into the beaker and start the stopwatch simultaneously.
4. Gently stir the contents in the beaker using the thermometer to ensure that the whole piece of magnesium is in contact with the acid at all times.
5. After 30 seconds, measure the temperature of the contents in the beaker. Record this temperature in the table.
6. Calculate the temperature difference.

$$\text{temperature difference} = \text{temperature after 30 s} - \text{initial temperature}$$

7. Discard the contents of the beaker. Rinse the beaker with distilled water.

Experiment V

1. Place 16.0 cm³ of distilled water into the measuring cylinder. Top up with 4.0 cm³ of dilute sulfuric acid such that the total volume is 20.0 cm³.
2. Pour the mixture into the beaker.
3. Repeat Step 2 to 7 in **Experiment I**.

Note:

Place any unreacted magnesium pieces into the beaker or container labelled “waste”. Do not discard unreacted magnesium pieces into the sink to prevent clogging up the sink.

Experiment II, III and IV

Repeat **Experiment V** by varying the volume of distilled water and dilute sulfuric acid, keeping the total volume constant at 20.0 cm³. Record all volumes in the table on the next page.

Results

<i>Experiment</i>	<i>volume of dilute sulfuric acid / cm³</i>	<i>volume of distilled water / cm³</i>	<i>initial temperature / °C</i>	<i>temperature after 30 s / °C</i>	<i>temperature difference / °C</i>
I	20.0	0.0			
II					
III					
IV					
V	4.0	16.0			

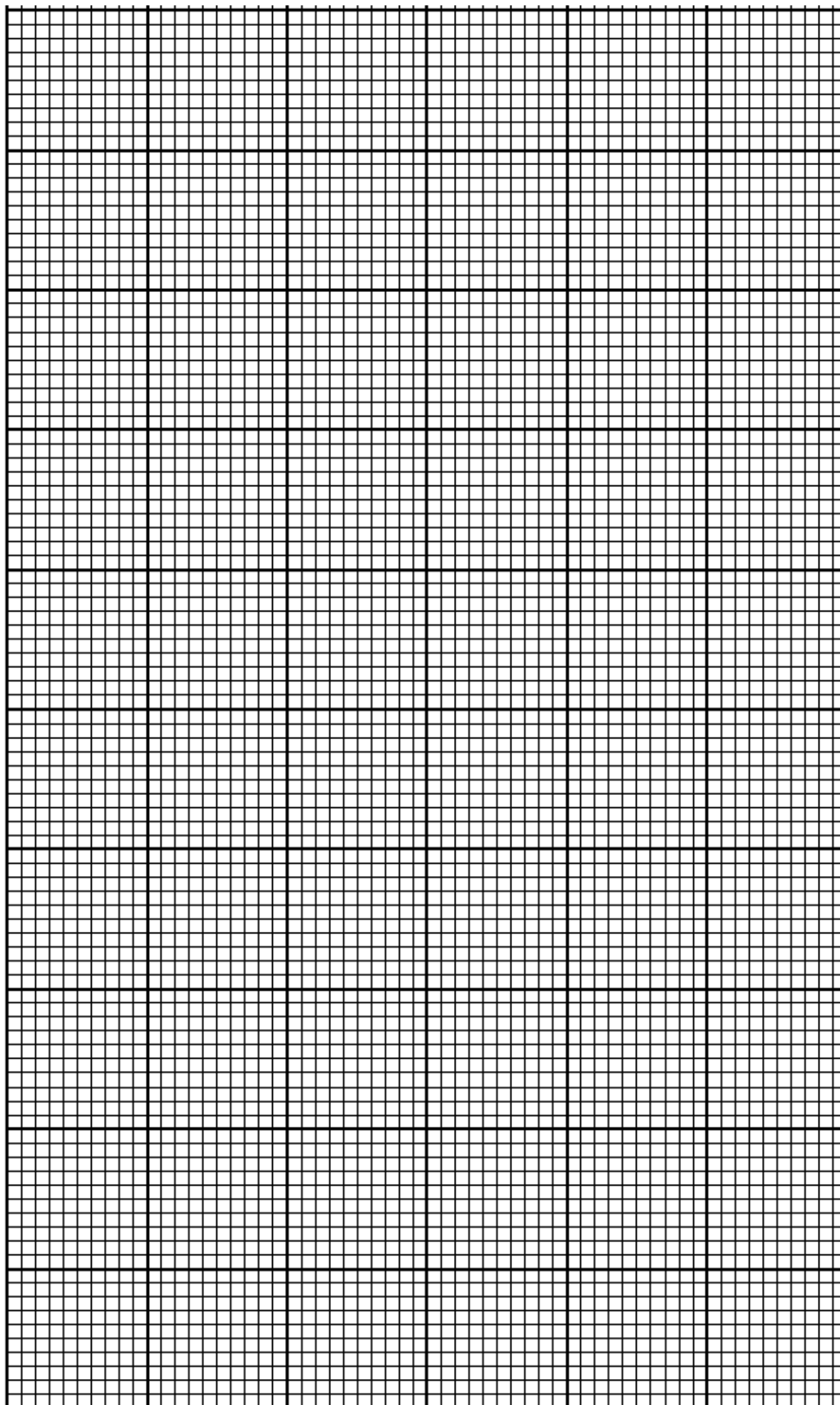
[4]

(b) Explain whether the reaction is exothermic or endothermic.

.....

..... [1]

(c) (i) Plot a suitable graph on the grid. Draw a line of best fit.



(ii) Using your graph, describe and explain the trend shown by your graph.

.....

.....

.....

..... [2]

(d) (i) Using your graph, find out the temperature change when 13.0 cm³ of dilute sulfuric acid is used.

..... [1]

(ii) Calculate the concentration of sulfuric acid when 13.0 cm³ of dilute sulfuric acid is used.

concentration of sulfuric acid = mol/dm³ [1]

[Total: 13]

3 Mixture **D** contains two cations and one anion.

(a) Carry out the following tests to identify the ions in mixture **D**. Test and identify any gas produced. Record your observations in the table. The volumes given below are approximate and should be estimated rather than measured.

tests	instructions	observations
1	Add about 1 cm depth of mixture D in a test tube. Add about 2 cm depth of aqueous sodium hydroxide.	
	Warm the mixture. Keep the final solution for Test 2 below.	
2	To the resulting solution from Test 1 , add aqueous sodium hydroxide until it is about two-third of a test tube full (an excess).	
	Add a piece of aluminium foil. Heat the contents carefully. <u>SAFETY PRECAUTION:</u> DURING HEATING, ENSURE THAT THE CONTENTS IN THE TEST TUBE DO NOT SPATTER OUT. REMOVE THE TEST TUBE AWAY FROM THE FLAME WHEN THE CONTENTS ARE CLOSE TO BOILING.	
3	Add about 1 cm depth of mixture D in a test tube. Add aqueous ammonia with shaking until no further change is seen.	

[4]

(b) Write the formula of the three ions present in solution **D**.

..... [1]

(c) In **Test 2**, give **two** reasons why excess aqueous sodium hydroxide is added.

.....

 [2]

[Total: 7]

QUALITATIVE ANALYSIS NOTES

Tests for anions

Anion	Test	Test result
Carbonate (CO_3^{2-})	Add dilute acid	Effervescence, carbon dioxide produced
Chloride (Cl^-) [in solution]	Acidify with dilute nitric acid, then add aqueous silver nitrate	White 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.

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.
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	Green ppt. insoluble in excess
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)	Gives white ppt. with limewater (ppt. dissolves with excess CO_2)
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 aqueous acidified potassium manganate (VII) from purple to colourless





Marking Scheme

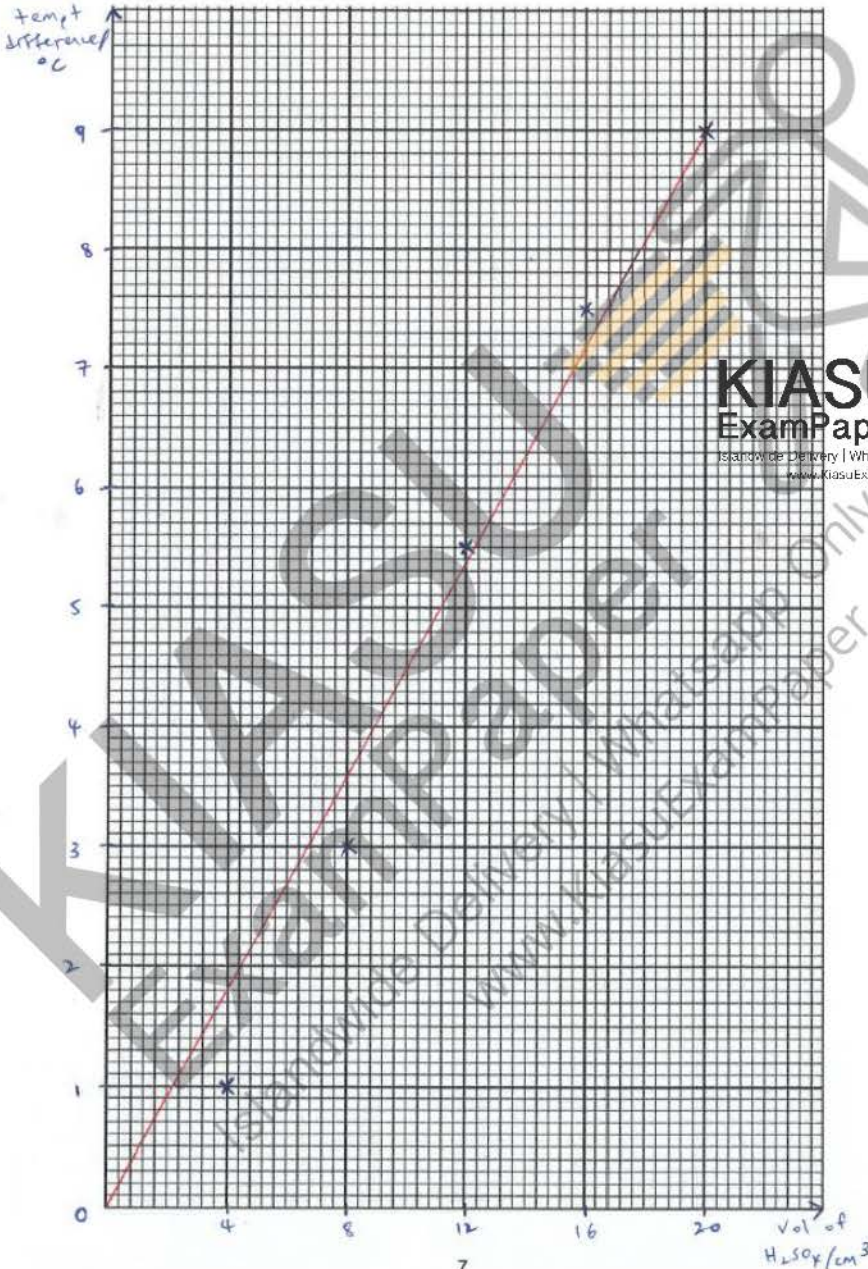
	Answers	Remarks
1(a)(i)	<u>Titration Results Table:</u> - Correct headings / labels for initial burette readings, final burette readings and volume with correct units in a table - All burette readings for accurate titres in table are recorded to the nearest 0.05 cm³ (larger values for "initial" and smaller for "final") and volume calculated correctly Titration Results: Accuracy - Average titre (of consistent volumes) within ± 0.20 cm³ of supervisor's results (range: 25.50 cm³ to 25.90 cm³) - Average titre (of consistent volumes) within ± 0.30 cm³ of supervisor's results (range: 25.40 cm³ to 26.00 cm³) - Concordance At least 2 titre values are within 0.20 cm³ (using uncorrected titres)	1 1 2 or 1 1
(a)(ii)	- average titre calculated to 2 dp <u>with units and workings</u> using consistent burette volume - this mark is lost if non-consistent burette volume is used for calculation of average	1
(b)(i)	(Assume average volume = 25.70 cm³) Number of moles of KMnO₄ = $25.70 / 1000 \times 0.020$ = 0.000514 mol Number of moles of Fe²⁺ in 25.0 cm³ = 0.000514×5 = 0.00257 mol Number of moles of Fe²⁺ in 1 dm³ = $0.00257 \times 1000 / 25.0$ = 0.1028 mol = 0.103 mol (3 sf)	1 for 25 cm³ 1 for 1 dm³
(b)(ii)	Mass of (pure) FeSO₄·7H₂O in 1 dm³ = 0.1028×278 = 28.578 g = 28.6 g (3 sf)	1
(b)(iii)	Percentage purity = $28.578 / 35 \times 100$ = 81.7 %	1 1 for all correct units and 3 sf in part (b)
(c)	(Some) Fe²⁺ / FeSO₄ would be oxidised to Fe³⁺ / Fe₂(SO₄)₃. (Number of moles of Fe²⁺ in conical flask decreased.) Volume of KMnO₄ required (for titration) decreased, calculated mass of (hydrated) iron (II) sulfate decreased and percentage purity of (hydrated) iron (II) sulfate decreased.	1 1 1

(d)	<u>Measurements to collect</u> 1. Dissolved 2.0 g of impure sample in excess / 20 cm³ (or above) of (distilled) water. 2. Add excess / 20 cm³ (or above) of aqueous (1.0 mol/dm³) barium chloride to the mixture / solution (and stir to precipitate the solid barium sulfate). 3. Filter the mixture. 4. (Wash and) dry the solid / residue collected (between pieces of filter paper / in an autoclave / etc). 5. Weigh the mass of solid / residue collected, m. <u>Assumption (any 1)</u> • There are no other sulfate containing compound in the impure sample. • No solid / residue is lost during filtering / drying. (or: All solid is transfer into the filter funnel / paper during filtration.) <u>Calculate percentage purity</u> mol ratio FeSO₄·7H₂O : BaCl₂ : BaSO₄ = 1 : 1 : 1 Number of moles of FeSO₄·7H₂O = $\frac{m}{208}$ Pure mass of FeSO₄·7H₂O = $\frac{m}{208} \times 278$ Percentage purity = $(278m / 208) \div 2 \times 100\%$ $= \frac{278m \times 100}{2 \times 208} \%$
-----	---

1 (for Step 1 & 2, solubility of FeSO₄·7H₂O is about 30 g/100 cm³ at 25°C) ("Stir" is not a marking point) 1 (for filter and dry) 1 (for weighing) 1 (accept other possible suggestion. Reject: insufficient BaCl₂ added) 1 (for no. of mole of FeSO₄·7H₂O) 1 (for mass and percentage purity, no need to simplify)

2(a)	• Each interval difference between experiments ranges from 3.0 cm³ to 5.0 cm³, AND total volume for each experiment is 20.0 cm³ • All volumes and temperatures are recorded to 1 dp • Temperature difference calculated correctly, temperature difference is in decreasing trend from I to V, with no repeating value • Temperature difference for Expt I is between 8.0 °C and 10.0 °C (inclusive) AND temperature difference for Expt V is between 0.5 °C to 1.5 °C (inclusive) <u>Sample results</u> <table border="1"> <thead> <tr> <th>Expt</th><th>vol H₂SO₄ / cm³</th><th>vol H₂O / cm³</th><th>T initial / °C</th><th>T after 30 s / °C</th><th>T diff / °C</th></tr> </thead> <tbody> <tr> <td>I</td><td>20.0</td><td>0.0</td><td>30.0</td><td>39.0</td><td>9.0</td></tr> <tr> <td>II</td><td>16.0</td><td>4.0</td><td>30.5</td><td>38.0</td><td>7.5</td></tr> <tr> <td>III</td><td>12.0</td><td>8.0</td><td>30.5</td><td>36.0</td><td>5.5</td></tr> <tr> <td>IV</td><td>8.0</td><td>12.0</td><td>30.5</td><td>33.5</td><td>3.0</td></tr> <tr> <td>V</td><td>4.0</td><td>16.0</td><td>30.5</td><td>31.5</td><td>1.0</td></tr> </tbody> </table>	Expt	vol H ₂ SO ₄ / cm ³	vol H ₂ O / cm ³	T initial / °C	T after 30 s / °C	T diff / °C	I	20.0	0.0	30.0	39.0	9.0	II	16.0	4.0	30.5	38.0	7.5	III	12.0	8.0	30.5	36.0	5.5	IV	8.0	12.0	30.5	33.5	3.0	V	4.0	16.0	30.5	31.5	1.0
Expt	vol H ₂ SO ₄ / cm ³	vol H ₂ O / cm ³	T initial / °C	T after 30 s / °C	T diff / °C																																
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V	4.0	16.0	30.5	31.5	1.0																																

1 (accept difference of 3.5 cm³ and 4.5 cm³) 1 1 1
--

(b)	exothermic, because temperature increases (or temperature difference is positive)	1 (reject: because heat is evolved)
(c)(i)	- Correctly labelled axes with units (temperature difference on y-axis and volume of x-axis) - Non-odd scale chosen such that plotted points covering at least half of grid, scale MUST start from origin - All points plotted correctly to $\frac{1}{2}$ of small box - Best fit line passing through origin (can be either straight or not depending on student's data) 	1 1 1 1 (if student's scale did not start from origin, then just mark for best fit line)
(c)(ii)	As volume of dilute sulfuric acid increases, temperature difference also increases. Concentration of dilute sulfuric acid increases and rate of reaction increases (hence more heat is evolved within 30 s / a fixed time interval).	1 1

(d)(i)	show construction lines as workings on graph - read temperature to $\frac{1}{2}$ of small box with units 5.8 °C	1 (accept 1 dp or 2 dp depending on scale and graph)
(d)(ii)	No. of moles of sulfuric acid = $(13.0/1000) \times 1.00$ = 0.0130 mol Concentration of sulfuric acid = $0.0130 / (20.0/1000)$ = 0.650 mol/dm³	1 (answers to 3 sf)
3(a)	<u>Test 1</u> - White precipitate formed. (cannot mention whether soluble in excess or not since questions require only about 2 cm³ to be added) - Gas that turns <u>damn</u> red litmus paper blue evolved. - Gas is ammonia / NH₃. <u>Test 2</u> - White ppt is soluble in excess (aqueous NaOH) to give colourless solution. (Effervescence observed on surface of aluminium foil.) - Gas that turns <u>damn</u> red litmus paper blue evolved. - Gas is ammonia / NH₃. <u>Test 3</u> - White ppt, insoluble in excess (aqueous ammonia)	(no credit, but "white ppt" can be marked under Test 2) 1 (for 2nd & 3rd points after dotted line) 1 1 (do not double penalise "damn" or "ammonia") 1
(b)	NH ₄ ⁺ , NO ₃ ⁻ , Al ³⁺	1
(c)	- to completely remove ammonium ions from the solution / so that no ammonium ions would give a positive test when testing for nitrate ion / etc - to test for (identity of) cation / to test for solubility of precipitate (solid)	1 1







ZHONGHUA SECONDARY SCHOOL
PRELIMINARY EXAMINATION 2025
SECONDARY 4 EXPRESS

Candidate's Name

Class

Register Number

	4E	
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CHEMISTRY

6092 /03

Paper 3 Practical

19 August 2025
1 hour 50 minutes

READ THESE INSTRUCTIONS FIRST

Write your name, index number and class in the spaces at the top of this page.

Write in dark blue or black pen.

You may use a HB pencil for any diagrams or graphs.

Do not use staples, paper clips, highlighters, glue or correction fluid.

Answer **all** questions.

All of your answers should be written in this Question paper:
scrap paper must **not** be used.

Shift
Laboratory

You are expected to record all your observations as soon as they are made.

You may lose marks if you do not show your working or if you do not use appropriate units.

Qualitative Analysis Notes are printed on page 9.

A copy of the Periodic Table is given on page 10.

The use of an approved scientific calculator is expected, where appropriate.

For Examiner's Use	
1	/ 20
2	/ 14
3	/ 6
Total	/40

At the end of the examination, fasten all your work securely together. The number of marks is given in brackets [] at the end of each question or part question.

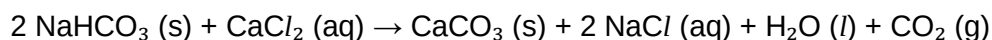
Set by: Mr Tan Li Chun

Vetted by: Ms Ong Lay Hong

This document consists of **10** printed pages.

- 1 Sodium hydrogen carbonate (NaHCO_3) is commonly known as baking soda. Sodium hydrogen carbonate, in the presence of water, reacts respectively with calcium chloride, citric acid, and ethanoic acid.

The reaction between sodium hydrogen carbonate and aqueous calcium chloride is represented by the following equation:



The reaction between sodium hydrogen carbonate and citric acid is **more endothermic** than the reaction between sodium hydrogen carbonate and ethanoic acid.

You are investigating the reaction of sodium hydrogen carbonate with calcium chloride solution and with two acidic solutions, **X** and **Y**. One of these acids is citric acid, and the other is ethanoic acid.

In this investigation, you are to,

1. calculate the percentage yield of calcium carbonate produced in the reaction between sodium hydrogen carbonate and aqueous calcium chloride;
2. identify the two acid solutions, **X** and **Y**, based on the temperature changes that occur in their reactions with sodium hydrogen carbonate.

Apparatus and chemicals

50 cm ³ Measuring cylinder, 3	Distilled water
Styrofoam cups, 3	Tissue papers
250 cm ³ Beaker	Filter paper, 3
250 cm ³ Conical flask	Glass rod
Thermometer	Spatula, 2
Filter funnel	Dropper, 3

Reagents

Part 1 1.0 mol/dm³ aqueous calcium chloride (50 cm³)
 NaHCO_3 (s), **2.00 g** (1 vial)

Part 2 **X**, 1.0 mol/dm³ (50 cm³)
Y, 1.0 mol/dm³ (50 cm³)
 NaHCO_3 (s), **6.00 g** (2 vials)

Read through the following instructions before starting the task.

Record all observations and readings in a suitable format.

- (a) **Part 1: To prepare calcium carbonate from sodium hydrogen carbonate and aqueous calcium chloride**

1. Using a measuring cylinder, measure **15 cm³** of aqueous calcium chloride into a Styrofoam cup.
2. Empty vial with **2.00 g** of sodium hydrogen carbonate into the solution in the Styrofoam cup. Stir the mixture with a glass rod.
3. When the reaction has stopped, filter the resulting mixture, which contains a solid product, into a boiling tube.

Note: Wash and dry the empty vial from Step 2 and proceed to Part 2 while waiting for the filtration to complete.

4. Wash the solid product with a little distilled water.
5. Dry the solid product between two pieces of filter paper.
6. Measure and record the mass of the empty vial (from Step 2).
7. Transfer the dry solid product into the empty vial. Measure and record the mass of the vial with the solid product.
8. Calculate and record the mass of the dry solid product.

Results

[4]

- (b) Identify one source of error and explain how it affects the results in **part 1**.

[2]

- (c) Using your results in **part 1**,

- (i) Identify, by calculations, **the limiting reagent**.

(Reagents are 15 cm³ of 1.0 mol/dm³ aqueous calcium chloride, 2 g of NaHCO₃)

limiting reagent: [3]

- (ii) Calculate the theoretical mass of calcium carbonate.

theoretical massg [2]

- (iii) Calculate the percentage yield of calcium carbonate.
Give your answers to three significant figures.

percentage yield% [3]

(d) Part 2: To identify the two acid solutions, X and Y

9. Using a measuring cylinder, measure **30 cm³** of the acid solution, **X**, into a Styrofoam cup.
10. Measure and record the initial temperature of the acid solution, **X**.
11. Empty one vial of sodium hydrogen carbonate (**6.00 g**) into the acid solution, **X**. Stir the mixture with the thermometer quickly to prevent overflow and record the lowest temperature reached.
12. Repeat steps 9 to 11 using the acid solution, **Y**, instead of **X**.
13. Calculate and record the maximum temperature change for each acid solution, **X** and **Y**.
14. Hence, identify the two acid solutions, **X** and **Y**.

Results

Solution **X** is Solution **Y** is [4]

- (e)** Suggest one way to improve the accuracy of the experiments in **Part 2**.
Give a reason for your answer.

..... [2]

 [Total: 20]

2 You are provided with the following unknown substances

- solid salt **P**, 1.5 g (1 boiling tube)
- solid salt **P**, 0.4 g (1 test-tube)
- aqueous solution of salt **Q**, 15 cm³ (1 vial)

You are also provided with hydrogen peroxide, H₂O₂(aq)

Carry out the following tests on **P** and **Q** to determine their identities, recording all your observations in the table. You should test any gas evolved.

If no observable change is observed for a test, write 'no observable change'.

If heating is required, a boiling tube must be used.

test	observations
Test 1 Remove the stopper from the boiling tube of salt P . Heat the solid P , gently at first and then strongly, until no further change is observed. Test for any gas evolved.	[3]
Test 2 Add about 4 cm depth of nitric acid into the test-tube containing solid P . Test for any gas evolved. Shake the test-tube if required to completely dissolve solid P to form solution P . Transfer 2 cm depth of the solution into a clean test-tube. To this test-tube, add aqueous ammonia slowly shaking until no further change is seen.	[3]
Test 3 Add 2 cm depth of solution Q into a test-tube. Add aqueous sodium hydroxide slowly with shaking until no further change is seen.	[1]
Test 4 Add 2 cm depth of solution Q into a test-tube. Add equal volume of hydrogen peroxide to the test-tube.	[2]

Test 5

Add 2 cm depth of solution **Q** into a test tube.
Add equal volume of dilute nitric acid and then
add a few drops of aqueous silver nitrate.

[1]

(b) Deduce the formula of **P**.

[1]

(c) Use the results of your tests to deduce the name of **Q**.

[1]

(d) Deduce the role of hydrogen peroxide in **Test 4**. Explain your answer.

[2]

[Total: 14]

- 3 (a)** A catalyst increases the rate of a chemical reaction and remains chemically unchanged at the end.

Hydrogen peroxide (H_2O_2) slowly decomposes to form oxygen gas. This process occurs very slowly without a catalyst.

Describe a method to compare the effectiveness of copper(II) oxide and maganese(IV) oxide as catalysts for this reaction and whether the catalysts are used up during the reaction.

The description should include:

- apparatus and method
- any measurements or observations
- how to analyse the results

You can assume that all apparatus and reagents normally found in a school laboratory are available.

You may wish to include one or more labelled diagrams as part of your answer.

[5]

- (b)** Suggest a method to store hydrogen peroxide to prevent it from decomposing quickly.

[1]

[Total: 6]

QUALITATIVE ANALYSIS NOTES

Tests for anions

<i>anion</i>	<i>Test</i>	<i>test result</i>
carbonate (CO_3^{2-})	add dilute acid	effervescence, carbon dioxide produced
chloride (Cl^-) [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	white 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.

Test for aqueous cations

<i>cation</i>	<i>effect of aqueous sodium hydroxide</i>	<i>effect of aqueous ammonia</i>
aluminium (Al^{3+})	white ppt., soluble in excess, giving a colourless solution	white ppt., insoluble in excess
ammonium (NH_4^+)	ammonia produced on heating	-
calcium (Ca^{2+})	white ppt., insoluble in excess	no ppt. or very slight white ppt.
copper (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	green ppt., insoluble in excess
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

<i>gas</i>	<i>test and test result</i>
ammonia (NH_3)	turns damp red litmus paper blue
carbon dioxide (CO_2)	gives white ppt. with limewater (ppt. dissolves with excess CO_2).
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 aqueous acidified potassium manganate(VII) from purple to colourless

The Periodic Table of Elements

Group																			
1	2	1 H hydrogen 1												13	14	15	16	17	18
		Key																	
		proton (atomic) number atomic symbol name relative atomic mass																	
3 Li lithium 7	4 Be beryllium 9																		
11 Na sodium 23	12 Mg magnesium 24																		
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84		
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium -	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131		
55 Cs caesium 133	56 Ba barium 137	57-71 lanthanoids		72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium -	85 At astatine -	86 Rn radon -	
87 Fr francium -	88 Ra radium -	89-103 actinoids		104 Rf rutherfordium -	105 Db dubnium -	106 Sg seaborgium -	107 Bh bohrium -	108 Hs hassium -	109 Mt meitnerium -	110 Ds darmstadtium -	111 Rg roentgenium -	112 Cn copernicium -	114 Fl flerovium -	116 Lv livermorium -					

Preparation List

Question 1

Apparatus and chemicals

50 cm³ Measuring cylinder, 3
 Styrofoam cups, 3
 250 cm³ Beaker
~~250 cm³ Conical flask~~
 Thermometer
 Filter funnel
 Boiling tube, 1

Distilled water
 Tissue papers
 Filter paper, 3
 Glass rod
 Spatula, 2
 Dropper, 3

Reagents

Part 1 1.0 mol/dm³ aqueous calcium chloride (50 cm³)
 NaHCO₃ (s), **2.00 g** (1 vial)

Part 2 **X**, 1.0 mol/dm³ (50 cm³)
Y, 1.0 mol/dm³ (50 cm³)
 NaHCO₃ (s), **6.00 g** (2 vials)

Question 2 - QA

Apparatus and chemicals

Apparatus

Test tubes, x 5
 Delivery tube
 - for test tube x 1
 - for boiling tube x 1

Bench reagents

Limewater, x 1
 Sodium hydroxide, x 1
 Potassium hydroxide, x 1
 Aqueous ammonia, x1
 Barium nitrate
 Silver nitrate
 Litmus paper (blue and red)
 Wooden splint
 Lighter

Hydrochloric acid, x 1
 Nitric acid, x 1
 Sulfuric acid, x 1

Reagents

Solid P - zinc carbonate

- 1 x boiling tube, 1.5 g
- 1 x test tube, 0.4g

Solution of salt Q – iron(II) chloride

- 1 x vial, 15 cm³

Hydrogen peroxide solution





Answers for 2025 Prelim Practical

Chemicals: P: zinc Carbonate Q: iron(II) chloride

Qn	Ans	Marks						
1(a)	Refer to class students results. <table border="1"> <tr> <td>mass of vial + calcium carbonate/g</td><td>6.15</td></tr> <tr> <td>mass of empty vial/g</td><td>4.90</td></tr> <tr> <td>mass of calcium carbonate/g</td><td>6.15 – 4.90 = 1.25</td></tr> </table> Marking points - Header with units -1m - Precision (2 d.p) -1m - Complete set of readings. -1m - Correct calculation of dry mass (2 d.p) -1m	mass of vial + calcium carbonate/g	6.15	mass of empty vial/g	4.90	mass of calcium carbonate/g	6.15 – 4.90 = 1.25	4
mass of vial + calcium carbonate/g	6.15							
mass of empty vial/g	4.90							
mass of calcium carbonate/g	6.15 – 4.90 = 1.25							
(b)	<table border="0"> <tr> <td style="vertical-align: top;"> <u>key sources of error</u> - calcium carbonate may not be completely dry - loss of some calcium carbonate during filtration / during transfer into vial Source of error 1m Correct effect 1m </td><td style="vertical-align: top;"> <u>Effect on results</u> - mass of calcium carbonate obtained will be greater than expected - mass of calcium carbonate obtained will be lower than expected </td></tr> </table>	<u>key sources of error</u> - calcium carbonate may not be completely dry - loss of some calcium carbonate during filtration / during transfer into vial Source of error 1m Correct effect 1m	<u>Effect on results</u> - mass of calcium carbonate obtained will be greater than expected - mass of calcium carbonate obtained will be lower than expected	2				
<u>key sources of error</u> - calcium carbonate may not be completely dry - loss of some calcium carbonate during filtration / during transfer into vial Source of error 1m Correct effect 1m	<u>Effect on results</u> - mass of calcium carbonate obtained will be greater than expected - mass of calcium carbonate obtained will be lower than expected							
(c)(i)	$2 \text{ NaHCO}_3 (\text{s}) + \text{CaCl}_2 (\text{aq}) \rightarrow \text{CaCO}_3 (\text{s}) + 2 \text{ NaCl} (\text{aq}) + \text{H}_2\text{O} (\text{l}) + \text{CO}_2 (\text{g})$ <u>NaHCO₃</u> Mass = 2g M = 1.0 mol/dm³ V = 15/1000 dm³ = 0.015 dm³ Mr NaHCO₃ = 23+1+12+(16X3) = 84 <table border="1"> <tr> <td>NaHCO₃</td><td>CaCl₂</td></tr> <tr> <td>No of mol of NaHCO₃ = 2/84 = 0.0238 mol</td><td>No of moles of CaCl₂ = M X V = 1.0 X 0.015 = 0.015 mol</td></tr> </table> According to equation 1 mol of CaCl₂ : 2 mol of NaHCO₃ 0.015 mol of CaCl₂ : 2X 0.015 mol of NaHCO₃ = <u>0.03 mol of NaHCO₃</u> Limiting reactant is NaHCO₃	NaHCO ₃	CaCl ₂	No of mol of NaHCO ₃ = 2/84 = 0.0238 mol	No of moles of CaCl ₂ = M X V = 1.0 X 0.015 = 0.015 mol	1 1 1		
NaHCO ₃	CaCl ₂							
No of mol of NaHCO ₃ = 2/84 = 0.0238 mol	No of moles of CaCl ₂ = M X V = 1.0 X 0.015 = 0.015 mol							
(ii)	2 mol of NaHCO₃ reacts to form 1 mole of CaCO₃ 0.0238 mol of NaHCO₃ reacts to form 0.0238/2 mol of CaCO₃							

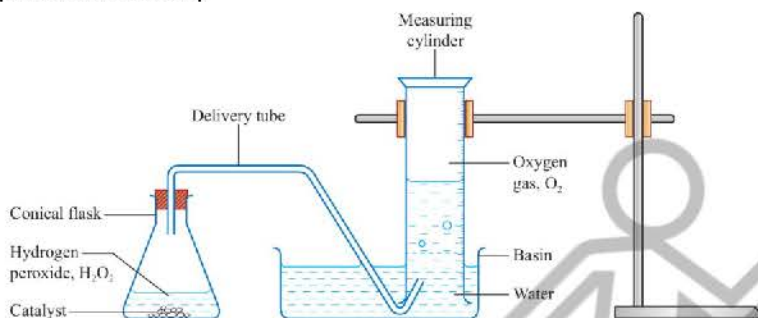
	Mass of CaCO_3 (theoretical mass) = $0.0238/2 \times \text{Mr CaCO}_3$ = 0.0119×100 = 1.19 g	1 1												
(iii)	Percentage yield = Student's Actual yield (table) / theoretical yield $\times 100\%$ = $1.25 \text{ g} / 1.19 \text{ g} \times 100$ = 104.63 % = 105% (3sf – follow instructions)	1 1 1												
(d)	<table border="1"> <thead> <tr> <th>solution</th><th>initial temperature / °C</th><th>lowest temperature reached / °C</th><th>change of temperature/°C</th></tr> </thead> <tbody> <tr> <td>X</td><td>30.0</td><td>22.5</td><td>7.5</td></tr> <tr> <td>Y</td><td>30.0</td><td>14.0</td><td>16.0</td></tr> </tbody> </table> X: <u>ethanoic acid</u> Y: <u>citric acid</u> Headers with units -1m Precision (0.5 °C) -1m Correct calculation of change of temperature -1m Identities of X and Y -1m (Y should show a larger change in temperature as the reaction is more endothermic)	solution	initial temperature / °C	lowest temperature reached / °C	change of temperature/°C	X	30.0	22.5	7.5	Y	30.0	14.0	16.0	4
solution	initial temperature / °C	lowest temperature reached / °C	change of temperature/°C											
X	30.0	22.5	7.5											
Y	30.0	14.0	16.0											
(e)	Use a lid To prevent convection/ heat transfer / gain or lost from the surrounding	1 1												
2	Test 1 Gas													

	- White ppt formed when gas bubbled through limewater (carbon dioxide is formed)	1
	Residue	
	- yellow when hot - white when cold	1 1
	Test 2	
	Effervescence / CO ₂ produced	1
	White ppt formed when gas bubbled through limewater (carbon dioxide)	1
	White ppt formed, soluble in excess aqueous ammonia (zinc ions)	1
	Test 3	
	Green ppt formed, insoluble in excess sodium hydroxide	1
	Test 4	
	green ppt turns reddish-brown	1
	gas evolved relights glowing splint.	1
	Test 5	
	white ppt formed (chloride ions)	1
(b)	ZnCO ₃	1
(c)	Iron(II) chloride	1
(d)	Oxidising agent	1
	Green iron (II) ions are oxidised to reddish-brown brown iron(III) ions	1

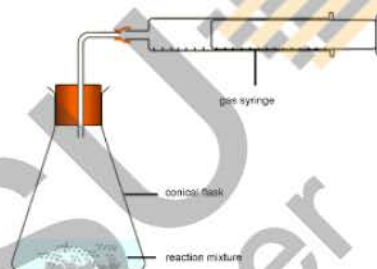
3a	Approach Decomposition of hydrogen peroxide produces oxygen. The effectiveness of the catalyst, thus the rate of reaction, can be determined by either 1. measuring the time take for a fixed volume of oxygen to be collected via water displacement, 2. measuring mass of gas loss Variables - change the type of catalyst Constants - same volume and concentration of hydrogen peroxide - same mass of catalysts. Marking points (5 out of 7 points) 1. Measure the time taken to collect a fixed volume of gas (approach) using copper(II) oxide/ manganese(IV) oxide. 2. Variable to be fixed: same concentration and volume of H_2O_2. 3. Variable to be fixed: same mass of catalysts. 4. Apparatus: Either: Collection of gas Gas syringe and stopwatch/ water displacement apparatus (measuring cylinder/ burette) and stopwatch or Alternative method: Mass of gas lost electronic balance and stopwatch 5. Repeat with the use of another catalyst, Copper (II) oxide /manganese(IV) oxide 6. Wash, dry and weigh the catalyst. Mass of catalyst remains unchanged. 7. Data processing Collection of gas: The shorter the time taken, the more effective the catalyst. =====	5
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Method 1 - measuring the time take for a fixed volume of oxygen to be collected via water displacement,

Water displacement setup



Alternative method - to collect volume of gas using a gas syringe is acceptable



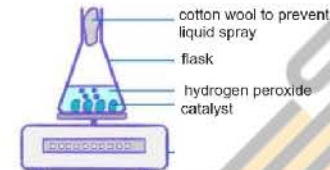
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Record:

1. Using 1.00 g of copper(II) oxide as the catalyst and 100.0 cm³ of 1.0 mol/dm³ H₂O₂, **record the time taken for 50 cm³ of oxygen gas to be collected in the measuring cylinder/ gas syringe**
2. Once experiment had completed, **filter** the reaction mixture. The residue is copper(II) oxide.
3. **Wash** the copper(II) oxide with deionized water and **dry** between filter paper. **Weigh** the dry copper(II) oxide on electronic balance to find the mass. Repeat the experiment with 1.00 g of lead(IV) oxide as the catalyst instead.

Conclusion:

- The time taken for a 50 cm³ of oxygen gas will be **shorter for the catalyst that is more effective**
- The mass of catalysts should **remain the same** at 1.00 g.

	Method 2 - measuring mass of gas loss  Experimental setup for measuring loss in mass 1. Using 1.00 g of copper(II) oxide as the catalyst and 100.0 cm³ of 1.0 mol/dm³ H₂O₂, record the time taken for the reaction to complete where no further change in mass is observed. 2. Once experiment had completed, filter the reaction mixture. The residue is copper(II) oxide. 3. Wash the copper(II) oxide with deionized water and dry between filter paper. Weigh the dry copper(II) oxide on electronic balance to find the mass. Repeat the experiment with 1.00 g of lead(IV) oxide as the catalyst instead. Conclusion: - The time taken for the reaction to complete will be shorter for the catalyst that is more effective. - The mass of catalysts should remain the same at 1.00 g.	
b	Either Keep in a cool place / in the refrigerator Or Keep in a dark container	1



