KUO CHUAN PRESBYTERIAN SECONDARY SCHOOL

2024 Preliminary Examination
Secondary 4 Express

NAME

CLASS | **REG. NO**

CHEMISTRY

6092/03

Paper 3 Practical

14 August 2024
1 hour 50 minutes

Candidates answer on the Question Paper.

Setter : Mr. Sam Yew Yishen

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 14.

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	17
2	10
3	13
Total	40

1 Malic acid is a carboxylic acid found in apple juice.

The equation for the reaction between malic acid, $H_2C_4H_4O_5$, and aqueous potassium hydroxide, KOH, is shown.

$$2KOH + H_2C_4H_4O_5 \rightarrow K_2C_4H_4O_5 + 2H_2O$$

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

Instructions

The concentration of aqueous malic acid is determined by titration with aqueous potassium hydroxide, KOH.
Thymolphthalein indicator, is used to determine the end-point of the titration.

P is apple juice containing malic acid.
Q is 0.0500 mol/dm^3 aqueous potassium hydroxide, KOH(aq).
I is thymolphthalein indicator.

(a) (i) Fill the burette with **P**.

Use the pipette to transfer 25.0 cm^3 of **Q** into a conical flask.

Add a few drops of thymolphthalein indicator, **I**, to the solution in the conical flask.
Ensure the lid is placed back on the vial of **I** after use.

Add **P** from the burette, swirling the flask constantly.
At the end-point, one drop of **P** would cause the solution to remain colourless for at least 30 seconds.
The end-point is when the solution remains colourless for 30 seconds.

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** = ...cm^3 [1]

(b) (i) **Q** is 0.0500 mol/dm^3 KOH(aq).

Calculate the number of moles of aqueous KOH in 25.0 cm^3 of **Q**.

number of moles of aqueous KOH = ...mol [1]

(ii) Use your answer from **(b)(i)** to calculate the number of moles of malic acid, $H_2C_4H_4O_5$, in the average volume of **P** used.

number of moles of malic acid = ...mol [1]

(iii) Use your answer from **(b)(ii)** to calculate the concentration (mol/dm^3) of malic acid in **P**.

concentration of malic acid in **P** = ...mol/dm^3 [1]

(c) Suggest why the accurate titration of apple juice with aqueous KOH usually produces an average value higher than your answer from **(b)(iii)**.

....

.... [1]

(d) You are provided copper(II) salt **R**.

(i) Carry out the following tests on **R.** You are not required to carry out any gas tests.

Record your observations in Table 1.1.

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

Table 1.1

test	observations
Test 1 Soak the end of a wooden split with deionised water. Dip the wet end of the splint into a sample of salt **R**. Make sure that the end of the splint is well covered with salt **R**. Adjust the Bunsen burner to give a blue flame. Place the wet end of the splint in the flame.	
Test 2 Place about 2 cm depth of dilute nitric acid into the test-tube containing salt **R**.	
Add one spatula-load of solid sodium chloride. Insert a rubber bung and shake the test-tube thoroughly to dissolve the solid.	
Test 3 Add deionised water until the test-tube is half full. Mix the contents of the test-tube thoroughly.	[4]

(ii) Complete Table 1.2 by describing a positive test to identify the anion of the solution obtained in **Test 3.**

Carry out the experimental steps and record its observation in Table 1.2.

Table 1.2

description of positive test	observation
	[2]

(iii) Explain why dilute nitric acid was added to salt **R** in **Test 2**.

....

.... [1]

[Total: 17]

2 A student investigated the effects of concentration on the rate of reaction by measuring the time taken to collect 40 cm^3 of hydrogen gas when magnesium reacts with dilute sulfuric acid.
Five experiments were done using the apparatus shown in Fig. 2.1.

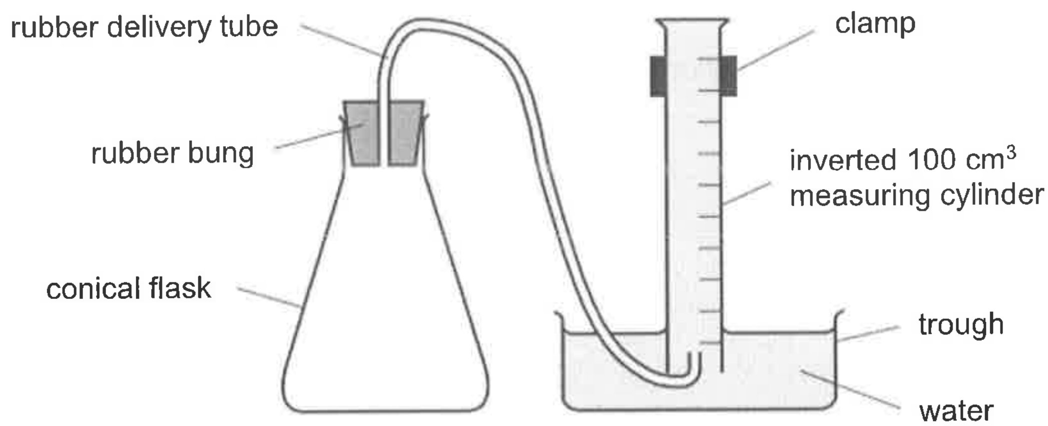


Fig. 2.1

Experiment 1

- Using a measuring cylinder, 16.0 cm^3 of 1.0 mol/dm^3 of dilute sulfuric acid was poured into the conical flask.
- Using a second measuring cylinder, 24.0 cm^3 of deionised water was added to the acid in the conical flask.
- The apparatus was set up as shown in Fig. 2.1, while ensuring that the inverted measuring cylinder was fully-filled with water.
- The rubber bung was removed from the conical flask.
- A coiled magnesium ribbon of 5 cm was added into the conical flask and the rubber bung was immediately replaced and the timer was started.
- The time taken for 40 cm^3 of gas to be collected was measured.

Experiments 2 to 5

- The conical flask was rinsed out with deionised water. Dilute sulfuric acid and deionised water for each experiment were added according to the volumes shown in Table 2.2.

Table 2.2

experiment	volume of dilute sulfuric acid / cm^3	volume of deionised water / cm^3	time taken to collect 40 cm^3 of gas / s
1	16.0	24.0	72
2	20.0	20.0	45
3		16.0	33
4	32.0	8.0	23
5	40.0		16

(a) **(i)** Complete Table 2.2 with the two missing volumes. [1]

(ii) The rate of reaction can be calculated using the equation given.

$$\text{rate of reaction} = \frac{\text{volume of gas collected}}{\text{time taken to collect the gas}}$$

Use this equation to calculate the rate of reaction in experiment 1.
Give your answer in 2 decimal places.

rate of reaction = ... [1]

(b) Describe how the rate of the reaction changes across the experiments.
Use Table 2.2 to explain your answer.

....

....

....

.... [2]

(c) Fig. 2.3 shows a modified conical flask that can be used in this investigation.

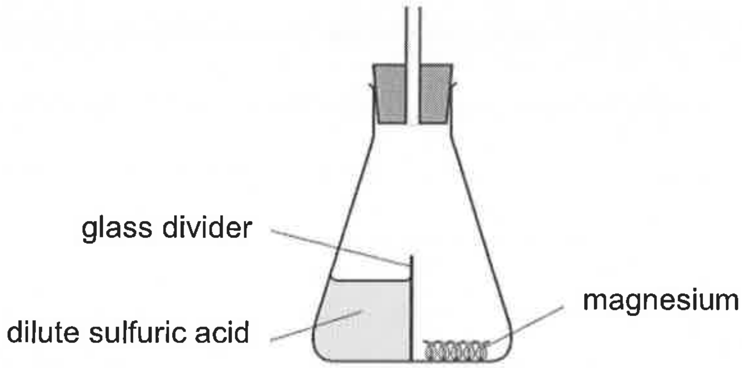


Fig. 2.3

Suggest the advantage of using this modified conical flask instead of the original conical flask used in the investigation.

....

.... [1]

(d) The student decides to investigate the effect of concentration of dilute sulfuric acid on the rate of its reaction with magnesium using another method, apart from the collection of gas.

Outline a method to determine the effect of concentration on the rate of reaction.

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 determine the effect of concentration on the rate of reaction

You may assume the apparatus normally found in a school laboratory is available.

You may use a labelled diagram to illustrate your answer.

....

....

....

....

....

....

....

....

....

.... [5]

[Total: 10]

3 You are going to determine the enthalpy change for a metal displacement reaction using a known volume and concentration of copper(II) sulfate solution and an excess of powdered zinc.

Read all the instructions carefully before starting the experiment.

Solution **T** is 0.800 mol/dm^3 copper(II) sulfate, $CuSO_4$.

(a) Instructions

1. Use the balance to measure and record the total mass of the container and zinc powder.
2. Place a polystyrene (styrofoam) cup into a 250 cm^3 glass beaker.
3. Use a measuring cylinder to measure 25 cm^3 of solution **T** into the polystyrene cup.
4. Measure and record the temperature of solution **T** in Table 3.1.
5. Start the stopwatch and do not stop until the whole experiment has been completed.
6. Measure and record the temperature of solution every minute.
7. At time = 1.5 minutes, transfer all the zinc powder in the container into the cup.
8. Stir the mixture gently with the thermometer and record the temperature of the mixture every minute for a total of 8 minutes.
9. Reweigh the total mass of the container and any residue of zinc and record the mass.
10. Record all mass results in an appropriate format below.

Results

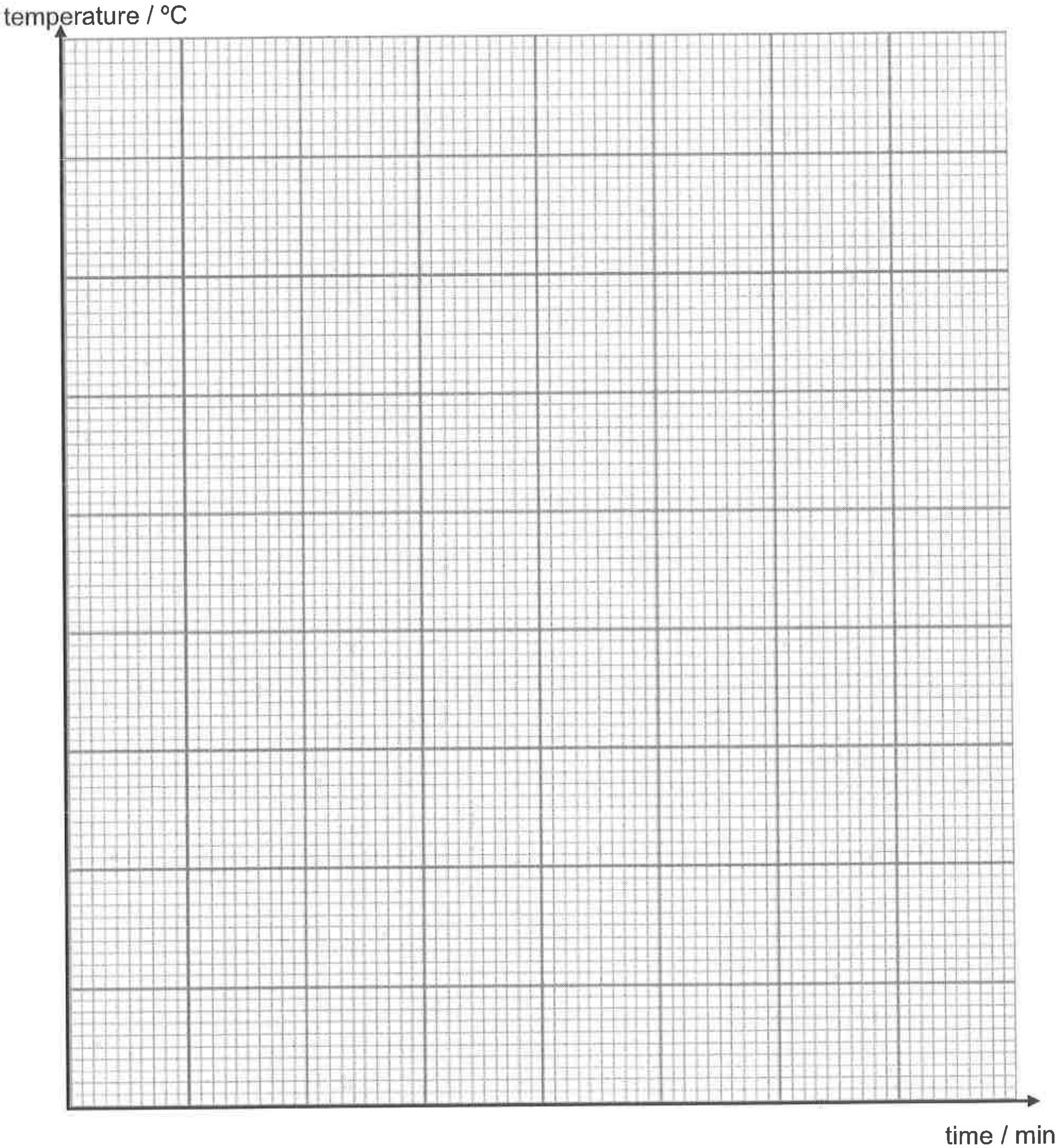
Table 3.1

time / min	temperature / °C
0	
1	
2	
3	
4	
5	
6	
7	
8	

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

The scale for the temperature axis should extend 5 °C higher than the temperature that you have recorded.

Draw **three** connecting lines of best fit through the points on your graph.



[3]

(c) **(i)** Calculate the mass of copper(II) sulfate added to the cup in **(a)**.
[A_r: Cu: 64; S: 32; O: 16]

mass of $CuSO_4$ = ... [1]

(ii) Use your answer in **(c)(i)** to calculate the heat energy, in joules, given out when zinc powder is added to solution **T**.

[Heat energy = mass × 4.2 × total change in temperature]

heat energy given out = ... J [1]

(iii) Using your answer in **(c)(ii)**, calculate the enthalpy change of reaction, in kJ/mol, when 1 mole of copper(II) sulfate reacts with excess zinc powder.

enthalpy change = ... kJ/mol [1]

(d) **(i)** Heat loss is a major source of error in the results of this experiment.

Suggest how the following changes would affect the amount of heat loss, if any.

change	**effect of heat loss**	**explanation**
1. The concentration of aqueous copper(II) sulfate used is 1.6 mol/dm^3.		
2. A length of zinc ribbon is used in the same mass as the zinc powder.		

[2]

(ii) State and explain one change that could be made to the apparatus, that would improve the accuracy of the results, apart from minimising heat loss.

....

.... [1]

[Total: 13]

- End of Paper -

QUALITATIVE ANALYSIS NOTES

Test for anions

anion	*test*	*test result*
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

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 a lighted splint
oxygen (O_2)	relights a glowing splint
sulfur dioxide (SO_2)	turns aqueous acidified potassium manganate (VII) from purple to colourless

BLANK PAGE

ST. JOSEPH'S INSTITUTION
PRELIMINARY EXAMINATION 2024
(YEAR 4)

CANDIDATE NAME	

CLASS		INDEX NUMBER	

CHEMISTRY **6092/03**

Paper 3 **27 August 2024**

Candidates answer on the Question Paper.
No Additional Materials are required.
1 hour 50 minutes

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, glue or correction fluid or highlighters.

Answer **all** questions 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 10.**

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	/ 15
3	/ 10
Total	/ 40

This document consists of **10** printed pages.

1 You are going to use titration to determine the relative atomic mass of metal **M**, which forms the metal oxide **M**O.

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

Instructions

S is an aqueous solution made by reacting 3.78 g of the metal oxide, **M**O, with 1.00 dm^3 of 0.200 mol/dm^3 hydrochloric acid. The hydrochloric acid was in excess.

T is 0.0640 mol/dm^3 aqueous sodium hydroxide.

(a) **(i)** Put **S** into the burette.

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

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

Add **S** from the burette, swirling the flask constantly.

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

[5]

(ii) Use your titration results to obtain the average volume of **S** used.
Show clearly how you obtained this volume.

average volume of **S** = ... [1]

(b) **(i)** **T** is 0.0640 mol/dm^3 aqueous sodium hydroxide.

Use your answer from **(a)(ii)** to calculate the concentration, in mol/dm^3, of hydrochloric acid in **S**.

concentration of hydrochloric acid in **S** = ... [2]

(ii) Use your answer from **(b)(i)** to calculate the number of moles of hydrochloric acid in the 1.00 dm^3 solution that was reacted with 3.78 g of the metal oxide, **M**O.

number of moles of hydrochloric acid that reacted = ... [1]

(iii) Use your answer from **(b)(ii)** to deduce the number of moles of the metal oxide, **M**O, that reacted with 1.00 dm^3 of 0.200 mol/dm^3 hydrochloric acid.

number of moles of metal oxide **M**O that reacted = ... [1]

(iv) Use your answer from **(b)(iii)** to calculate the relative atomic mass of metal **M**.

[A_r: O, 16]

relative atomic mass of metal **M** = ... [2]

(c) A student accidentally washed the conical flask with some **S** before he pipetted 25.0 cm^3 of **T** into the conical flask.

Describe and explain the effect this has on the calculated value for the relative atomic mass of **M**.

....

....

....

....

....

....

....[3]

[Total: 15]

2 You are going to determine the concentration of an acid by investigating the temperature change when volumes of aqueous alkali and acid are mixed together.

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

Instructions

You are going to carry out seven experiments.

P is sulfuric acid of an unknown concentration.

Q is 1.00 mol/dm^3 aqueous sodium hydroxide.

(a) *Experiment 1*

Place a Styrofoam cup into a 250 cm^3 glass beaker.

Use a measuring cylinder to measure 10 cm^3 of **P**. Pour this volume of **P** into the Styrofoam cup. Measure the temperature of **P** and record the value in the table.

Use another measuring cylinder to measure 40 cm^3 of **Q**. Pour this volume of **Q** into the Styrofoam cup containing **P**. Stir, using the thermometer, and measure the highest temperature reached. Record this temperature in the table.

Empty the Styrofoam cup and rinse it with water.

Experiments 2 to 7

Repeat Experiment 1 but use the different volumes of **P** and **Q** for each experiment given in the table.

Complete the table by calculating the temperature change for each experiment.

experiment	volume of **P** / cm^3	volume of **Q** / cm^3	initial temperature of **P** / °C	highest temperature of mixture / °C	temperature change / °C
1	10	40			
2	15	35			
3	20	30			
4	25	25			
5	30	20			
6	35	15			
7	40	10			

[3]

(b) Plot a graph of temperature change against volume of **P** on the grid below.

Use these points to draw two intersecting straight lines of best fit.

[4]

(c) **(i)** From your graph, read the volume of **P** where the two lines intersect.

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

(ii) Calculate the concentration of sulfuric acid in **P**.

concentration of sulfuric acid in **P** = ... [2]

(d) Comment on the reaction that has occurred at the point with the highest temperature rise.

....

....

....[2]

(e) **(i)** State the key source of error in the experiment and explain how it affects the results of the experiment.

....

....[1]

(ii) Suggest one improvement to reduce the error in **(e)(i)**.

....

....[1]

(f) Suggest one other change that could be made to this experiment to improve the accuracy of the results.

....

....[1]

[Total: 15]

3 (a) **Read all the instructions carefully before starting the experiments in Question 3(a).**

(i) You are provided with a solution of compound **M**.

Carry out the following tests on **M**. 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.

test	*instructions*	*observations*
1	Put about 1 cm depth of **M** into a test-tube. Add aqueous sodium hydroxide slowly with shaking until no further change is seen. **Keep this mixture for Test 2.**	
2	To the mixture from **Test 1**, add a 1 cm depth of hydrogen peroxide.	
3	Put about 1 cm depth of **M** into a test-tube. Add a few drops of aqueous silver nitrate, followed by 1 cm depth of dilute nitric acid.	
4	Put about 1 cm depth of **M** into a test-tube. Add a few drops of aqueous barium nitrate, followed by 1 cm depth of dilute nitric acid.	

[4]

(ii) Name compound **M**.

....[1]

(b) Old concrete contains calcium carbonate. Calcium carbonate reacts with dilute hydrochloric acid.

Given a lump of concrete and dilute hydrochloric acid of known concentration, outline a method by which the percentage by mass of calcium carbonate in the concrete can be determined.

You may assume that all the apparatus and reagents normally found in a school laboratory are available.

In your method, you should note any assumptions that you make, include the measurements you would take and explain how you would use your results to determine the percentage by mass of calcium carbonate in the lump of concrete.

[A_r: C, 12; O, 16; Ca, 40]

....

....

....

....

....

....

....

....

....

....

....

....

....

....[5]

[Total: 10]

END OF PAPER

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	pale 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

Name:	Class:	Class Register Number:

中正中学

CHUNG CHENG HIGH SCHOOL (MAIN)

PRELIMINARY EXAMINATION 2024
SECONDARY 4

CHEMISTRY
6092/03

Paper 3 Practical

August 2024

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 register number clearly in the spaces provided 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.

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
Laboratory

For Examiner's Use	
1	
2	
3	
Total	/ 40

This document consists of **10** printed pages and **2** blank pages.

1 Magnesium oxide is often used to treat heartburn. To determine the percentage purity of a sample of magnesium oxide, a method known as back titration is used.

Procedure

1) Dissolve a sample of magnesium oxide in a known volume and concentration of hydrochloric acid, which is used in excess.

$$MgO + 2HCl \rightarrow MgCl_2 + H_2O$$

2) Determine the amount of unreacted acid by titrating the solution with aqueous sodium hydroxide.

$$NaOH + HCl \rightarrow NaCl + H_2O$$

3) From the amount of unreacted acid, determine the amount of hydrochloric acid that has reacted with magnesium oxide.

4) Determine the amount of magnesium oxide that has reacted and hence its mass.

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

P is aqueous 0.200 mol/dm^3 sodium hydroxide.

Q is a solution made by dissolving 1.20 g of magnesium oxide in 100 cm^3 of 1.00 mol/dm^3 dilute hydrochloric acid and the solution made up to 250 cm^3 with distilled water.

R is methyl orange indicator.

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

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

Add a few drops of **R** to the flask.

Add **P** from the burette to the flask until the solution changes colour.

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

[5]

(ii) Calculate the average volume of **P** used.

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

(b) **(i)** Calculate the amount, in moles, of hydrochloric acid that has reacted with **P**.

amount of hydrochloric acid = ... mol [1]

(ii) Calculate the amount, in moles, of hydrochloric acid in **Q**.

amount of hydrochloric acid = ... mol [1]

(c) **(i)** Calculate the amount, in moles, of magnesium oxide that has reacted with hydrochloric acid.

amount of magnesium oxide = ... mol [2]

(ii) Calculate the mass of magnesium oxide in the sample.

[A_r: O = 16, Mg = 24]

mass of magnesium oxide = ... g [1]

(iii) Calculate the percentage purity of the magnesium oxide sample.

percentage purity = ... % [1]

[Turn over

(d) State an assumption made when determining the percentage purity of magnesium oxide by titration.

....

....[1]

(e) A student used a wet burette without rinsing it with aqueous sodium hydroxide first. Explain how this would affect the titration results.

....

....

....[2]

[Total: 15]

2 You are provided with a solution **X**, that contains two ionic compounds.

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

Instructions

Carry out the following experiments and test and identify any gases evolved. Carefully record your observations.

The volumes given below, unless referring to drops of solution, are approximate and should be estimated rather than measured.

	Tests	observations
(a)	Place 3 cm depth of solution **X** in a clean test tube. Add an equal volume of dilute hydrochloric acid.	[3]
(b)	Place 2 cm depth of solution **X** in a clean test tube. Add aqueous sodium hydroxide until no further change is seen. Warm the mixture gently.	[3]
(c)	Place 2 cm depth of solution **X** in a clean test tube. Add a few drops of aqueous silver nitrate followed by excess dilute nitric acid.	[2]
(d)	Place 2 depth of solution **X** in a clean test tube. Add a few drops of aqueous barium nitrate followed by excess dilute nitric acid.	[2]

(e) Consider the results of your experiment.

Identify the ions present in solution **X**. Give evidence to support each of your choices.

....

....

....

....

....

....

....

....[4]

[Total: 14]

3 Aqueous hydrogen peroxide decomposes at room temperature in the presence of a catalyst to form water and oxygen.

$$2H_2O_2\ (aq) \rightarrow 2H_2O\ (l) + O_2\ (g)$$

A student investigates the rate of decomposition of hydrogen peroxide. The results are shown in the table.

time / s	total volume of oxygen / cm^3
0	0
20	19
40	30
60	38
80	44
100	48
120	50
140	50

(a) Name the two pieces of apparatus used to make the recorded measurements in the table above.

....[2]

(b) Plot a graph of total volume of oxygen against time using the results in the table. Draw a line of best fit through the points.

[3]

(c) What is the total mass of oxygen produced?

.... [1]

(d) From the **graph**, calculate the average rate of oxygen produced

in the first 50 seconds, ...

in the second 50 seconds .... [2]

[Turn over

(e) **(i)** Instead of measuring the volume of oxygen gas produced, describe a different method to investigate the rate of decomposition of hydrogen peroxide.

....

....

....

....[2]

(ii) Suggest one source of error, other than reaction time, that affects the accuracy of the experiment described in **(e)(i)**.

....

....[1]

[Total: 11]

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 lighted splint
oxygen (O_2)	relights a glowing splint
sulfur dioxide (SO_2)	turns aqueous acidified potassium manganate(VII) from purple to colourless

KUO CHUAN PRESBYTERIAN SECONDARY SCHOOL
SECONDARY FOUR EXPRESS
2024 EOC CHEMISTRY PRACTICAL TEST PRELIM EXAMS
MARKING RUBRIC

Relative Weighting

Skill Areas	Total Marks	Relative Weighting (%)
Manipulation, measurement and observation (MMO)	5	37.5
Presentation of data and observations (PDO)	13	15.0
Analysis, conclusions and evaluation (ACE)	16	37.5
Planning (P)	6	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%.

Titration number	1	2	3
Final burette reading / cm^3	27.10	20.90	23.20
Initial burette reading / cm^3	11.10	7.20	9.30
volume of P used /cm^3	16.00	13.70	13.90
Best titration results (√)		√	√

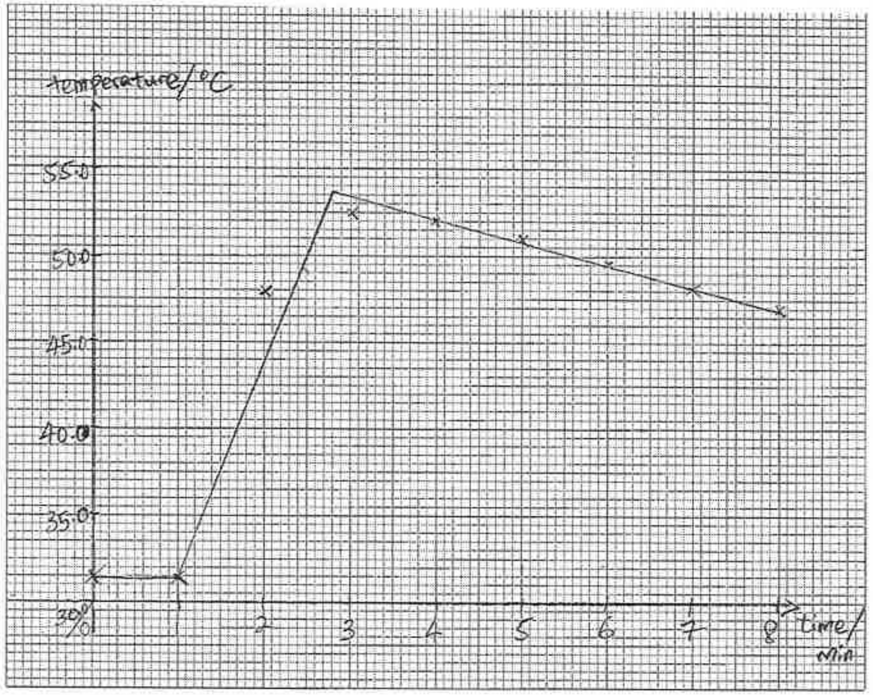
Qn	Skill	Indicative Material	Mark	Total
1(a)(i)				[5]
	PDO	Correct header with units	1	
	PDO	Readings to the nearest 0.05 cm^3	1	
	PDO	Compare average value with teacher's value: *±0.20 cm^3, ± 0.30 cm^3*	2	
	PDO	Concordance: *±0.20 cm^3*	1	
1(a)(ii)	ACE	average volume of P = (13.70 + 13.90) / 2 = 13.80 cm^3 *(with 2 dp and correct units)*	1	[1]
1(b)(i)	ACE	No. of moles of KOH (aq) = 0.0500 x 25.00 / 1000 = 0.00125 mol	1	[1]
1(b)(ii)	ACE	No. of moles of malic acid in average volume of P = ½ x 0.00125 = 0.000625 mol	1	[1]
1(b)(iii)	ACE	Concentration (mol/dm^3) of malic acid in P = 0.000625 / 0.01380 = 0.453 mol/dm^3 (e.c.f. applies)	1	[1]
1(c)	ACE	Presence of other **acids** in the juice, so greater volumes of KOH needed to neutralise it.	1	[1]
1(d)(i)	MMO	Test 1: A <u>green/blue-green flame</u> is observed.	1	[4]
		Test 2: The <u>green solid</u> <u>dissolves</u> in nitric acid to form a <u>blue solution</u>.	1	
		The <u>blue solution</u> turns <u>green</u>.	1	
		Test 3: Upon adding water, the <u>green solution</u> turns back to <u>blue</u>.	1	
1(d)(ii)	P	Test 4: Add nitric acid, and add aqueous silver nitrate.	1	[2]
	MMO	observation: A white ppt. will be formed.	1	
1(d)(iii)	ACE	To remove any possible carbonate ions that might be present in the sample of salt R.	1	[1]
2(a)(i)	PDO	24.0; 0.0 [Note: both values correct and in correct d.p. for 1 mark]	1	[1]
2(a)(ii)	PDO	Correct calculation of (40/72 = 0.56) AND correct units cm^3/s	1	[1]
2(b)	ACE	Increasing volume of dilute sulfuric acid and decreasing volume of deionised water → increase concentration of dilute sulfuric acid	1	[2]
		Resulting in decrease in time taken and thus higher rate of reaction (accept: faster reaction; relate time to *rate of reaction*) OR *show calculation of rate of reaction for the experiments*.	1	
2(c)	ACE	The reaction can be started by tipping the flask, thus do not have to replace / remove the bung, so that no gas escapes / all the hydrogen gas produced can be accurately collected and measured (while the bung is removed / replaced).	1	[1]
2(d)	P	<u>Apparatus (A)</u> • Electronic balance • Conical flask/beaker (Reject: evaporating dish) • stopwatch	1	[5]
		<u>Method (M)</u> • Add 0.5 g magnesium and 25.0 cm^3 of 1.0 mol/dm^3 sulfuric acid together for 5 min. • Add 0.5 g magnesium and 25.0 cm^3 of 0.5 mol/dm^3 sulfuric acid together for 5 min. [Note: Both Apparatus & Method for 1 mark; Variation of concentration for 1 mark]	1	

Qn	Skill	Indicative Material	Mark	Total
		Measurements (M) • Record the mass of contents of the conical flask/beaker/boiling tube **before** reaction • Record the mass of the contents of the conical flask/beaker/boiling tube **after** 5 min Data processing (C) • mass loss = final mass – initial mass • rate of reaction = $\frac{\text{mass loss}}{\text{time taken to collect the gas}}$ • higher rate of reaction, higher concentration	1 1 1	
3(a)	PDO MMO	Records mass readings to 2 d.p. with units; • Correct heading and units o Mass of container + zinc /g o Mass of container + zinc residue/g [Note: Reject mass of empty container/ mass of container without zinc] • Mass of zinc added between 2.6 g and 3.2 g [Note: Do not award if mass of zinc powder > 3.2g or < 2.6g] • All temperature readings recorded to 0.5 °C. • Trend: constant (±0.5) before 1.5 minute • Rises from 2 minute then decreases [Note: Reject if the last few points are relatively constant] Examiner's data:	1 1 1 1	[4]

time / min	temperature / °C
0	31.5
1	31.5
2	48.0
3	52.5
4	52.0
5	51.0
6	49.5
7	48.0
8	47.0

Qn	Skill	Indicative Material	Mark	Total
3(b)	PDO	• All recorded points plotted correctly (including the middle segment when the temperature increases) • Appropriate lines of best fit drawn (Points not on the line must be balanced on either side of the best fit line and any points ringed or labelled as anomalous ignored.) • Uniform scale chosen to use more than half of each axis including 5°C above the highest recorded temperature [Note: Reject awkward scale e.g., 4, 8,12..] *[Note: See last page for graph]*	1 1 1	[3]

Qn	Skill	Indicative Material	Mark	Total
3(c) (i)	ACE	0.800 x (25 / 1000) = 0.0200 mol 0.0200 x 160 = 3.20 g	1	[1]
3(c) (ii)	ACE	Amount of heat released = 3.20 x 4.2 x 22 = 295.68 ≈ 296 J Correct calculation (allow ecf from (c)(i))	1	[1]
3(c) (iii)	ACE	Enthalpy change $= -\frac{295.68}{0.02 \times 1000}$ = - 14.784 kJ/mol ≈ - 14.8 kJ/mol [Note: Negative sign must be shown. Allow ecf]	1	[1]
3(d) (i)	ACE	Change #1 (heat loss) increases/doubled; increased energy output/temperature rise/more exothermic change occurs/increased energy generated by **more moles** of $CuSO_4$ reacting; [Note: Reject $CuSO_4$ is more concentrated.] Change #2 no change [Note: Reject no effect]; no change in mass, means there is no change in number of moles. *[Note: Every 2; = 1m]*	1 1	[2]
3(d) (ii)	ACE	• Use a pipette or burette for solution T as it has a higher precision (Avoid 'accuracy' – same as question) • Use lid or plastic cup with higher walls to reduce acid spray; • Use of digital thermometer /data logger **with** temperature probe/sensor for greater precision [Note: Reject use lid or use specified extra insulation to reduce heat losses (by convection or conduction)]	1	[1]



temperature/°C
55.0
50.0
45.0
40.0
35.0
30.0
0
2
3
4
5
6
7
8
time/min

St. Joseph's Institution
2024 Year 4 OP Preliminary Exam Answer Scheme

Paper 3 Question 1

Qn	Suggested answers	Mark
1ai	**Skills: MMO & PDO** **Results table:** 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:** **Accuracy:** • For the average titre (of consistent readings) within 0.20 cm^3 of Supervisor's average value scores 2 marks. • For the average titre (of consistent readings) within 0.30 cm^3 of Supervisor's average value scores 1 mark. **Full marks: 24.50 to 24.90 cm^3** **1 mark: 24.40 and 25.00 cm^3** **Concordance:** At least two titre values are within 0.20 cm^3 (using uncorrected titres)	 1 1 2 1
1aii	Average volume of **S** = [24.70 + 24.70] / 2 = 24.70 cm^3 (to 2 d.p.)	1
1bi	No. of moles of **T** = (25.0 / 1000) x 0.0640 = 0.00160 mol $NaOH + HCl \rightarrow NaCl + H_2O$ No. of moles of hydrochloric acid in **S** = 0.00160 mol Concentration of hydrochloric acid in **S** = 0.00160 / (24.70 / 1000) = 0.064777 mol/dm^3 = 0.0648 mol/dm^3 (to 3 s.f.)	1 1
1bii	No. of moles of hydrochloric acid that reacted with the metal oxide = 0.200 - 0.064777 = 0.135223 mol = 0.135 mol (to 3 s.f.)	1
1biii	$MO + 2HCl \rightarrow MCl_2 + H_2O$ No. of moles of metal oxide that reacted = 0.135223 / 2 = 0.067611 mol = 0.0676 mol (to 3 s.f.)	 1
1biv	Relative molecular mass of **MO** = 3.74 / 0.067611 = 55.908 Relative atomic mass of **M** = 55.908 – 16 = 39.9 (to 3 s.f.)	1 1
1c	The relative atomic mass of **M** will be **higher than expected.** [must state but no mark] **Some S reacted with T** in the conical flask so the **volume of S used for titration will be lower** than expected. The **concentration of hydrochloric acid in S will be higher** than expected, hence the **number of moles of hydrochloric acid and metal oxide that reacted will be lower.** The **relative molecular mass of the metal oxide will be higher** and hence the relative atomic mass of **M** will be **higher than expected.**	 1 1 1
	TOTAL	**15**

Paper 3 Question 2

Qn	Suggested answers	Mark
2a	temperature readings recorded to 0.5 °C correct calculation of temperature change with positive sign (+) indicated in temperature change temperature change shows an increasing trend from 10.0 cm^3 to 25.0 cm^3 of **P** and a decreasing trend from 25.0 cm^3 to 40.0 cm^3 of **P**	1 1 1
2b	appropriate scale chosen, both axes are labelled correctly all points plotted correctly two best fit lines that intersect best fit line on the left must pass through origin, point of intersection must be higher / same as the highest point plotted	1 1 1 1
2ci	correct volume reading from the graph with units (cm^3), working shown clearly on graph (dotted lines with values on x-axis and y-axis indicated clearly)	1
2cii	$H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + H_2O$ Volume of sodium hydroxide (**Q**) = 50.0 - 24.5 = 25.5 cm^3 No. of moles of sodium hydroxide (**Q**) = (25.5/1000) x 1.00 = 0.0255 mol No. of moles of sulfuric acid (**P**) = 0.0255 / 2 = 0.01275 mol Concentration of sulfuric acid (**P**) = 0.01275 / (24.5/1000) = 0.520 mol/dm^3 (to 3 s.f.)	 1 1

Qn	Suggested answers	Mark
2d	At the point with the highest temperature rise, **complete neutralisation** has occurred, and the **maximum amount of heat is released.**	1 1
2ei	**Heat loss to the surroundings.** This results in the **highest temperature measured / temperature rise / temperature change** to be **lower than expected.**	1
2eii	Use a lid to cover the Styrofoam cup during the experiment.	1
2f	**Any one of the below:** • Use a burette to measure the volumes of **P** and **Q** • Use a data-logger with temperature probe to measure temperature • Dry the Styrofoam cup after rinsing with water so that the concentration of the solutions will not be diluted.	1
	TOTAL	**15**

Paper 3 Question 3

3(a)(i)

test	*instructions*	*observations*
1	Put about 1 cm depth of **M** into a test-tube. Add aqueous sodium hydroxide slowly with shaking until no further change is seen. **Keep this mixture for Test 2.**	**Reddish-brown ppt formed.** **Reddish-brown ppt is insoluble in excess aqueous sodium hydroxide.**
2	To the mixture from **Test 1**, add a 1 cm depth of hydrogen peroxide.	**Effervescence of colourless gas.** **Gas relights glowing splint.** **Gas is oxygen.**
3	Put about 1 cm depth of **M** into a test-tube. Add a few drops of aqueous silver nitrate, followed by 1 cm depth of dilute nitric acid.	**White ppt formed.** **White ppt is insoluble in dilute nitric acid / No visible reaction.**
4	Put about 1 cm depth of **M** into a test-tube. Add a few drops of aqueous barium nitrate, followed by 1 cm depth of dilute nitric acid.	**No visible reaction / Solution remains yellow / No ppt formed.**

[every 2 observations – 1 mark] [4]

Qn	Suggested answers	Mark
3aii	iron(III) chloride	1

Qn	Suggested answers	Mark

3b	<u>**Method 1 (Mass of residue left unreacted):**</u>
	• **Measure the initial mass,** m_1 g of the concrete lump using an electronic balance.
	• **Crush** lump using the **mortar and pestle** and place the powdered concrete into a conical flask / beaker.
	• Add **excess hydrochloric acid.**
	• After the **reaction is complete** / no more effervescence, **filter the mixture** to obtain the **residue.**
	• **Wash** the residue with deionised water and **dry** with sheets of filter paper.
	• Measure the **final mass,** m_2 g of residue using an electronic balance.
	• To find percentage by mass of $CaCO_3$:
	  o $[(m_1 - m_2) / m_1] \times 100\%$
	
	Assumptions (any one):
	• The concrete does not contain any other impurities that will react with hydrochloric acid to produce other gases.
	• Only calcium carbonate in the concrete reacts with hydrochloric acid.
	• Only carbon dioxide gas is produced when the concrete reacts with hydrochloric acid.
	
	<u>**Method 2 (Volume of gas collected):**</u>
	• **Measure** the (initial) **mass,** *m* g of the concrete lump using an electronic balance.
	• **Crush** lump using the **mortar and pestle** and place the powdered concrete into a conical flask.
	• Add **excess hydrochloric acid.**
	• Stopper the conical flask with a delivery tube connected to a calibrated gas syringe.
	• After the **reaction is complete** / no more effervescence, measure the volume of carbon dioxide gas collected.
	• To find percentage by mass of $CaCO_3$:
	  o No. of moles of CO_2 = volume of CO_2 (in dm^3) / 24 dm^3 = y mol
	  o No. of moles of $CaCO_3$ = y mol
	  o Mass of $CaCO_3$ = y x M_r of $CaCO_3$ (100) = z g
	  o % by mass of $CaCO_3$ = (z / *m*) x 100%
	
	<u>**Method 3 (Mass loss):**</u>
	• Place a conical flask containing **excess hydrochloric acid** on an electronic balance.
	• Place a **cotton wool** at the mouth of the conical flask
	• Measure the mass of the setup, m_1 g.
	• **Measure the mass of the concrete lump** using an electronic balance, m_2 g.
	• **Crush** lump using the **mortar and pestle** and place powdered concrete into a conical flask.
	• The total **initial mass** is $(m_1 + m_2)$ g.
	• After the **reaction is complete** / no more effervescence, measure the final mass of the setup using an electronic balance, m_3 g.
	• To find percentage by mass of $CaCO_3$:
	  o No. of moles of CO_2 = $(m_1 + m_2 - m_3)$ / M_r of CO_2 (44) = y mol
	  o No. of moles of $CaCO_3$ = y mol
	  o Mass of $CaCO_3$ = y x M_r of $CaCO_3$ (100) = z g
	  o % by mass of $CaCO_3$ = (z / m_2) x 100%
		5

	TOTAL	**10**

2024 Sec 4 Prelim Chemistry P3 Mark Scheme

Question	Skill	Indicative material	Mark	Total
1(a)(i)	PDO	*Results table:*		**[5]**
		records initial burette readings, final burette reading and volume of ***Q*** added with correct headings and units in titration table.	1	
		all burette readings for accurate titre in titration table recorded to nearest 0.05 cm^3	1	
	MMO	*Titration Results: 22.50 cm^3*		
		accuracy for the average titre (of consistent readings) within 0.20 cm^3 of teacher's average value scores 2 marks for the average titre (of consistent readings) within 0.30 cm^3 of teacher's average value scores 1 mark	2	
		concordance at least two titre values are within 0.20 cm^3 (using uncorrected titres)	1	
1(a)(ii)	MMO	appropriate average volume of **P** in 2 d.p. from closest titre values (titre should be identified either in the table by a tick or in calculation)	1	**[1]**
1(b)(i)	ACE	No. of moles of **P** = 22.50/1000 x 0.2 = 0.00450 mol 1 mole of **P** reacts with 1 mole of HC*l* No. of moles of HC*l* = 0.00450 mol	1	**[1]**
(ii)	ACE	No. of moles of HC*l* = 0.00456/0.025 x 0.25 (*Allow e.c.f.*) = 0.0450 mol	1	**[1]**
1(c)(i)	ACE	No. of moles of HC*l* that has reacted with MgO = (0.1 x 1 mol/dm^3) – 0.0450 = 0.055 mol (*Allow e.c.f.*) 1 mole of MgO reacts with 2 moles of HC*l* No. of moles of MgO = 0.055/2 = 0.0275 mol	1 1	**[2]**
(ii)	ACE PDO	Mass of MgO = 0.0275 x (24+16) (*Allow e.c.f.*) = 1.10 g (with unit)	1	**[1]**
1(c)(iii)	ACE	Percentage purity = 1.10/1.2 (*Allow e.c.f.*) = 91.7%	1	**[1]**
(d)	P	Impurities in magnesium oxide does not react with acid.	1	**[1]**
(e)	ACE	Water dilutes aqueous sodium hydroxide, lower concentration of sodium hydroxide. Higher volume of aqueous sodium hydroxide required to neutralize acid.	1 1	**[2]**

Total: 15

Question	Skill	Indicative material	Mark	Total
2(a)	MMO	Effervescence. Gas evolved produces white precipitate in limewater. Gas is CO_2	1 1 1	**[3]**
2(b)	MMO	No observable change. Gas evolved on warming, turns damp red litmus blue. Gas is NH_3	1 1 1	**[3]**
2(c)	MMO	White precipitate formed and then dissolves / no ppt /no observable change effervescence on addition of nitric acid	1 1	**[2]**
2(d)	MMO	White precipitate formed Precipitate insoluble in HNO_3	1 1	**[2]**
2(e)	ACE	NH_4^+/ammonium – When X is warmed with NaOH(aq) in (b), ammonia gas is produced CO_3^{2-}/carbonate – When HCl (aq) added to X in (a), CO_2 produced SO_4^{2-}/sulfate – white precipitate formed with $Ba(NO_3)_2$ in (d), insoluble in HNO_3 Na^+/K^+/sodium/potassium - the carbonate is soluble 1m each Alternative: identify NH_4^+, CO_3^{2-}, SO_4^{2-} 1m 1m each for each supporting evidence		**[4]**

Total: 14

Question	Skill	Indicative material	Mark	Total
3(a)	P	Stopwatch Gas syringe/burette	1 1	[2]
3(b)	PDO	Appropriate scale with correctly labelled axis Correctly plot all the point. Draw a best fit line	1 1 1	[3]
3(c)	ACE	Mass of oxygen = 0.05/24 x 32 = 0.0667 g	 1	[1]
3(d)	ACE	First 50s: $34\pm1/50 = 0.68\pm0.2\ cm^3/s$ Second 50s: $(48-34\pm1)/50 = 0.28\pm0.2\ cm^3/s$ No unit –1m working required (qn says calculate)	1 1	[2]
3(e)	P	Measure the mass/mass loss/change in mass of hydrogen peroxide (1m) at regular time intervals (1m)	2	[2]
3(f)	P	The change in mass is too small to be measured accurately. / Some oxygen has dissolved in solution / increased temperature as reaction is exothermic, faster rate of reaction.	1	[1]
				Total: 11
				Question paper total: [40]