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.

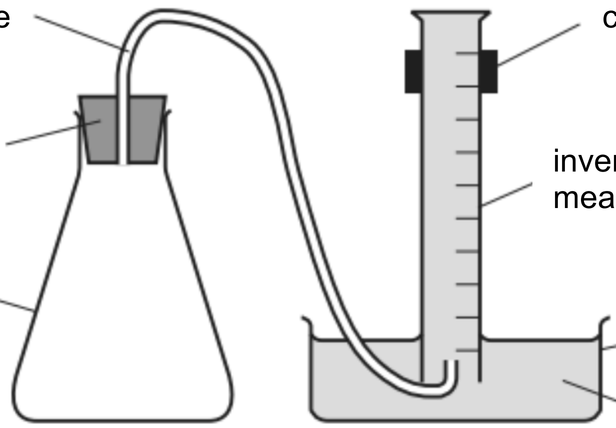

Fig. 2.1

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.

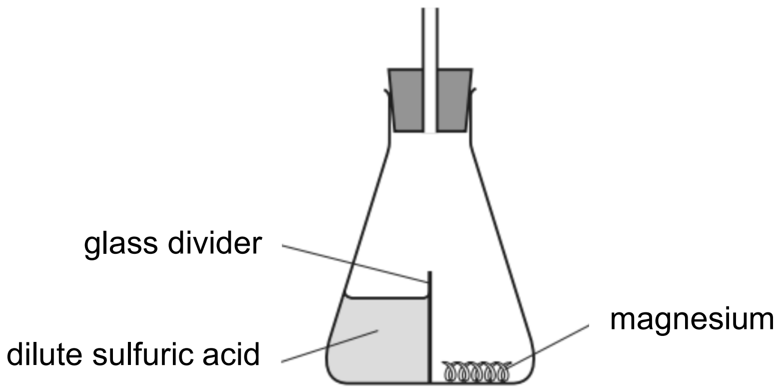

Fig. 2.3

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.

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....

.... [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

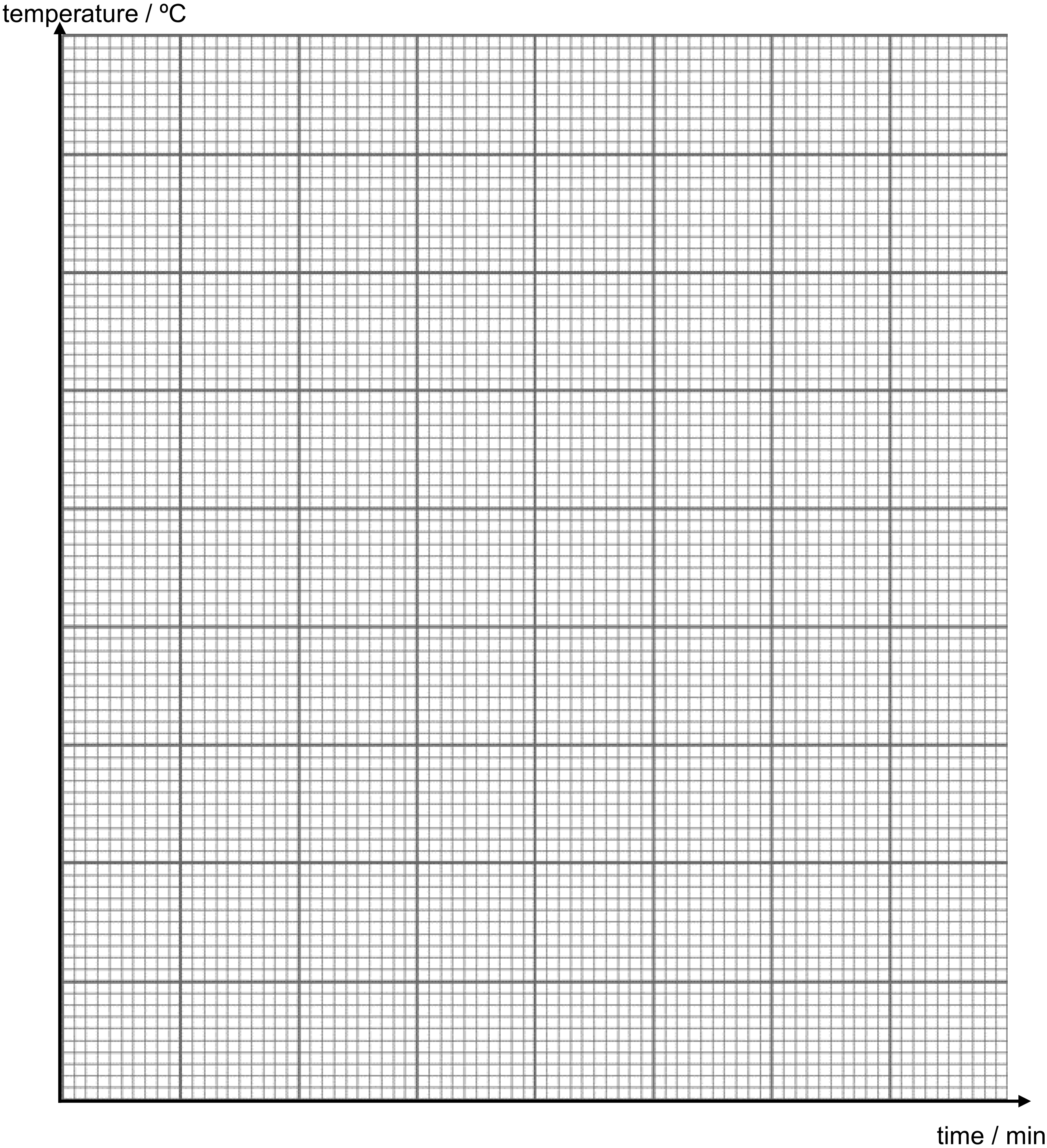
Table 3.1

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 -

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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