Paya Lebar Methodist Girls' School (Secondary)
Preliminary Examination 2024
Secondary 4 Express / G3

CANDIDATE NAME		CLASS		CLASS INDEX NO	

CENTRE NUMBER	S					INDEX NUMBER				

CHEMISTRY 6092/03

Paper 3 Practical **23 August 2024**

1 hour 50 minutes

READ THESE INSTRUCTIONS FIRST

Write your name, class, class index number, centre number and O level index number on all 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 11.

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	**/18**
2	**/12**
3	**/10**
Total	**/40**

This document consists of 11 printed pages.

[Turn Over

1 Some cleaning products contain a solution of sulfamic acid.

You are going to determine the concentration of sulfamic acid in a sample of a cleaning product by titration with sodium hydroxide.

The sulfamic acid can be represented by the formula, HA. The equation for the reaction occurring in the titration is shown.

$$HA + NaOH \rightarrow NaA + H_2O$$

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

Instructions

P is 0.200 mol / dm^3 sodium hydroxide.
Q contains aqueous sulfamic acid. The solution was made by diluting a sample of 100 cm^3 of the cleaning product to 1.00 dm^3 by adding deionised water.
T 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 the thymolphthalein indicator, **T**, to the solution in the conical flask.

Ensure the lid is placed back on the container of **T** after use.

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

At the end-point, one drop of **P** produces a blue 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 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) **P** is 0.200 mol / dm^3 sodium hydroxide.

Use your answer from **(a)(ii)** and the equation for the reaction to calculate the number of moles of sulfamic acid in 25.0 cm^3 of **Q**.

number of moles of sulfamic acid in 25.0 cm^3 of **Q** ……mol [1]

(ii) Use your answers from **(b)(i)** to calculate the concentration, in mol / dm^3, of sulfamic acid in the sample of the cleaning product.

concentration of sulfamic acid in cleaning product ……mol / dm^3 [2]

[Turn Over

(c) The label on the bottle of cleaning product gives the concentration of sulfamic acid in g / dm^3.

To convert your answer from **(b)(ii)** to g / dm^3, it is necessary to know the relative molecular mass, M_r, of sulfamic acid.

The M_r can be determined by reacting some **solid** sulfamic acid with aqueous sodium carbonate and measuring the volume of carbon dioxide produced.

The equation for the reaction is shown.

$$2HA + Na_2CO_3 \rightarrow CO_2 + H_2O + 2NaA$$

(i) Use this information to outline a method to determine the *M*r of sulfamic acid.

Your method should use gas collection by displacement of water.

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 M_r of sulfamic acid.

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

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

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……… [5]

(ii) Carbon dioxide is soluble in water.

Suggest how this may cause your calculated value for the M_r of sulfamic acid to be different from its theoretical value.

Explain your answer.

……

……

……

……… [3]

(iii) Suggest and explain **one** change you could make to your experiment to improve the accuracy of your calculated value for M_r.

change ……

explanation ……

…… [1]

[Total: 18]

[Turn Over

2 Metal carbonate decomposes on heating. The following equation shows the decomposition of carbonate of metal M, where M has a charge of +2.

$$MCO_3 \rightarrow MO + CO_2$$

You are supplied with two samples of metal carbonates where the metals have charge of +2. The more reactive a metal is, the greater the thermal stability of the metal carbonate, the harder it is to decompose the metal carbonate. You are to determine the order of reactivity between the two metals.

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

Instructions

X is carbonate of metal **R**.
Y is carbonate of metal **S**.

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

Add about 1.00 g of **X** to the test-tube and then find the mass of the test-tube and its contents. Record the colour of the metal carbonate.

Heat the test-tube and contents strongly for 1 minute. Record any colour change.

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 content up to 3 mins.

Repeat the experiment with 1.00 g of **Y**.

Record your results in an appropriate format in the space provided.

Results

Metal carbonate	**X:** carbonate of metal **R**	**Y:** carbonate of metal **S**
Colour of carbonate before heating		
Colour change during heating/cooling		
Mass of test-tube and contents before heating /g		
Mass of test-tube and contents after heating for 1 min /g		
Mass of test-tube and contents after heating for 2 min /g		
Mass of test-tube and contents after heating for 3 min /g		
Total mass loss after heating /g		

[5]

(ii) From your results, determine the order of reactivity between metal **R** and metal **S**. Explain your answer.

more reactive metal …… less reactive metal …….

explanation ……..……..……..

……..

……..

[2]

(b) Carbonates **X** and **Y** react with nitric acid to produce solutions.

(i) With the common laboratory chemicals, suggest how you can identify metal **R** and **S** using the solutions produced.

..……

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..…….……[2]

(ii) Carry out the tests based on your answers in **(b)(i)** to identify the metals **R** and **S**.

1. Add a small spatula of carbonate **X** into a test tube.
2. Add nitric acid slowly to the test tube until all the carbonate has been reacted. You are not required to test for the gas produced.
3. Carry out the tests stated in **(b)(i)** on the solution produced in step 2.
4. Record your observations in the table below.
5. Repeat steps 1 to 4 for carbonate **Y**.

	Solution with metal ions of **R** (prepared using carbonate **X**)	Solution with metal ions of **S** (prepared using carbonate **Y**)
Tests in **(b)(i)**		

metal **R**: …….. metal **S**: …….

[3]

[Total: 12]

[Turn Over

3 Metal **R** is more reactive than iron, and displaces iron from aqueous iron(II) sulfate. The reaction is exothermic.

The student investigates the amount of heat released during this reaction by using the following method.

1. Using a measuring cylinder, pour 10 cm^3 of 0.500 mol/dm^3 aqueous iron(II) sulfate into a boiling tube.
2. Measure the initial temperature of aqueous iron(II) sulfate in the boiling tube and record the value in the table.
3. Measure and transfer 2.0 g of powdered **R** to aqueous iron(II) sulfate in the boiling tube. Stir the mixture gently with the thermometer.
4. Measure and record the highest temperature reached.
5. Repeat the experiment, using different volumes of aqueous iron(II) sulfate and distilled water.

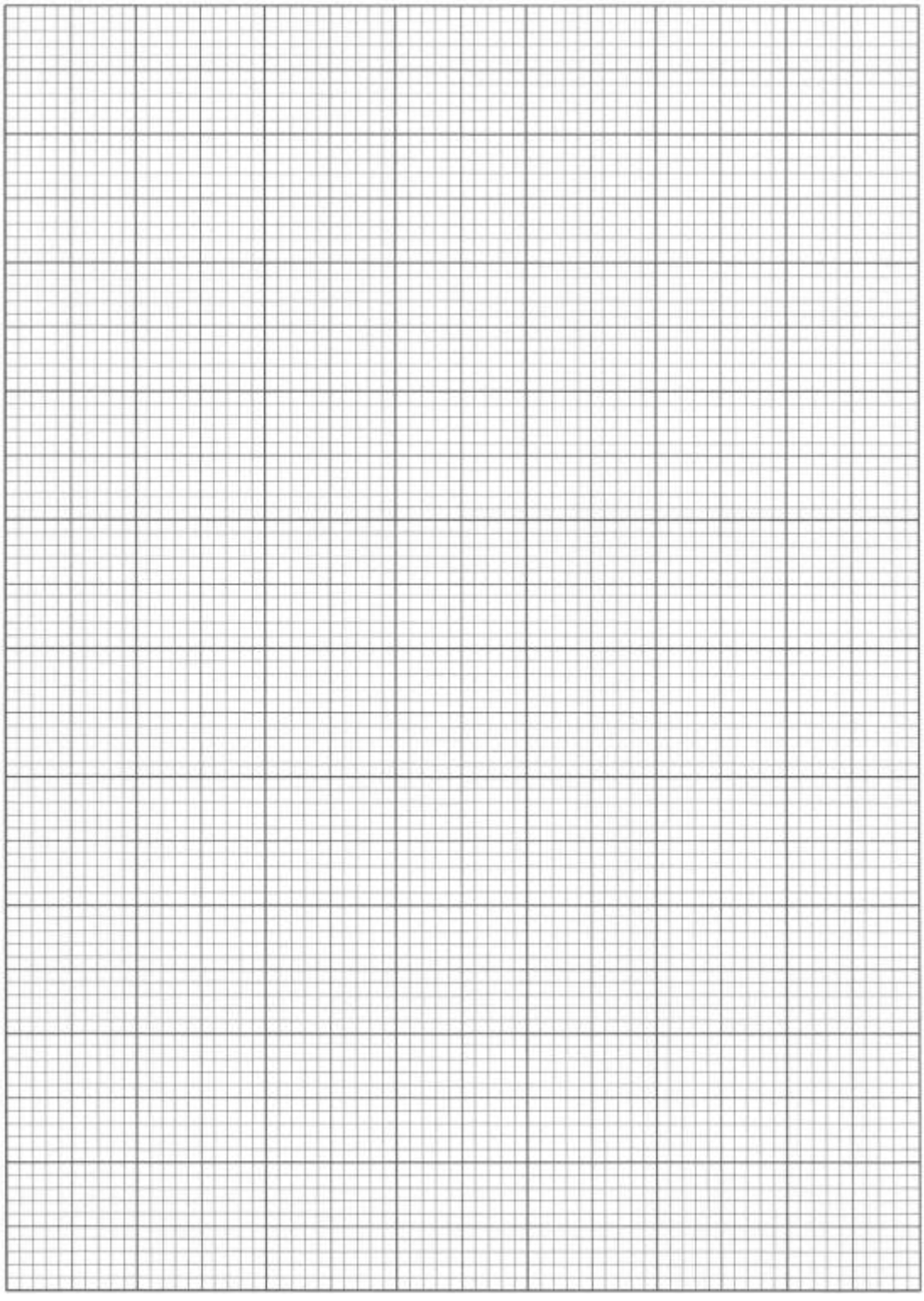
The results the student obtained are shown.

experiment	volume of aqueous iron(II) sulfate /cm^3	volume of distilled water /cm^3	initial temperature /^{O}C	highest temperature /^{O}C	change in temperature /^{O}C
1	10.0	0.0	30.0	46.5	
2	8.0	2.0	29.5	44.5	
3	6.0	4.0	29.0	41.0	
4	4.0	6.0	29.5	37.0	
5	2.0	8.0	29.5	33.0	

(a) Complete the table above. [1]

(b) Use the results you have obtained to plot a suitable graph on the grid on the next page.

Draw a straight line of best fit.



[4]

(c) (i) Describe and explain the trend shown by your graph in **(b)**.

……

……

……[2]

[Turn Over

(ii) Determine the expected change in temperature if the experiment was repeated with 0.0035 mol of iron(II) sulfate in the 10 cm^3 of solution.

Show clearly **on the graph** how you obtained your answer.

…….[2]

(iii) Predict the change in temperature if 2.0 g of metal **R** was added to 10 cm^3 of 1.00 mol/dm^3 iron(II) sulfate.

…….[1]

[Total: 10]

End of paper

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

LABORATORY PREPARATION FOR PURE CHEMISTRY PRELIM 2024

Question 1 (per girl)

P - 0.200 mol/dm^3 sodium hydroxide	150 cm^3
Q - 0.150 mol/dm^3 hydrochloric acid **[Reading is 18.50 cm^3]** 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 cm^3 of **Q** reacts with between 17.00 cm^3 and 20.00 cm^3 of **P**.	150 cm^3
Burette	1
Pipette	1
Funnel	1
Conical flask	2
Pipette filler	1
Distilled water	1 bottle
Thymolphthalein indicator	1 bottle
Dropper	1

Question 2 (per girl)

Zinc carbonate (in bag)	2.0 g
Calcium carbonate (in bag)	2.0 g
Dilute nitric acid	1 bottle (to share between 2 girls)
Aqueous sodium hydroxide	1 bottle (to share between 2 girls)
Aqueous ammonia	1 bottle (to share between 2 girls)
Distilled water	250 cm^3
Test-tubes	6 each
Spatula	2 each
Test-tube holder	1 each
Bunsen burner	1
Electronic balance	shared
Plastic beaker	shared