ST JOSEPH'S INSTITUTION
PRELIMINARY EXAMINATION 2022
(YEAR 4)

CANDIDATE NAME								
CLASS						INDEX NUMBER		

CHEMISTRY **6092/03**

Paper 3 **30 August 2022**

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

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 fluid ink pen.
You may use a soft pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, glue or correction fluid.

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 12.**

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

Shift
Laboratory

For Examiner's Use	
1	**/ 16**
2	**/ 10**
3	**/ 14**
Total	**/ 40**

1 You are going to investigate what happens when aqueous sodium hydroxide reacts with aqueous solutions of two different acids, **A** and **B**.

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

Instructions
You are going to carry out two experiments.

(a) Experiment 1

Use a measuring cylinder to pour 25 cm^3 of aqueous sodium hydroxide into the Styrofoam cup provided. Put the cup into a 250 cm^3 beaker for support.

Measure the initial temperature ($\mathbf{T_i}$) of the solution and record it in the table below.

Fill the burette to the 0.00 cm^3 mark with acid **A**. Add 5.00 cm^3 of acid **A** to the aqueous sodium hydroxide in the cup and stir the mixture. Measure and record the maximum temperature of the mixture in the table below.

Immediately add a further 5.00 cm^3 of acid **A** to the cup and stir the mixture. Measure and record the maximum temperature of the mixture in the table below. Continue to add 5.00 cm^3 portions of acid **A** to the cup, until a total volume of 40.00 cm^3 of acid has been added. Stir after each addition and measure and record the temperatures in the table.

Calculate the temperature rise for each addition by subtracting the initial temperature from the maximum temperature.

At the end of this experiment, pour the mixture away and rinse the Styrofoam cup.

volume of acid A added / cm^3	**temperature of mixture in Styrofoam cup / °C**	**temperature rise / °C**
0.00	**T_i =**	
5.00		
10.00		
15.00		
20.00		
25.00		
30.00		
35.00		
40.00		

[2]

(b) Experiment 2

Empty the burette and rinse it with water, followed by rinsing the burette with acid **B**.

Fill the burette to the 0.00 cm^3 mark with acid **B**.

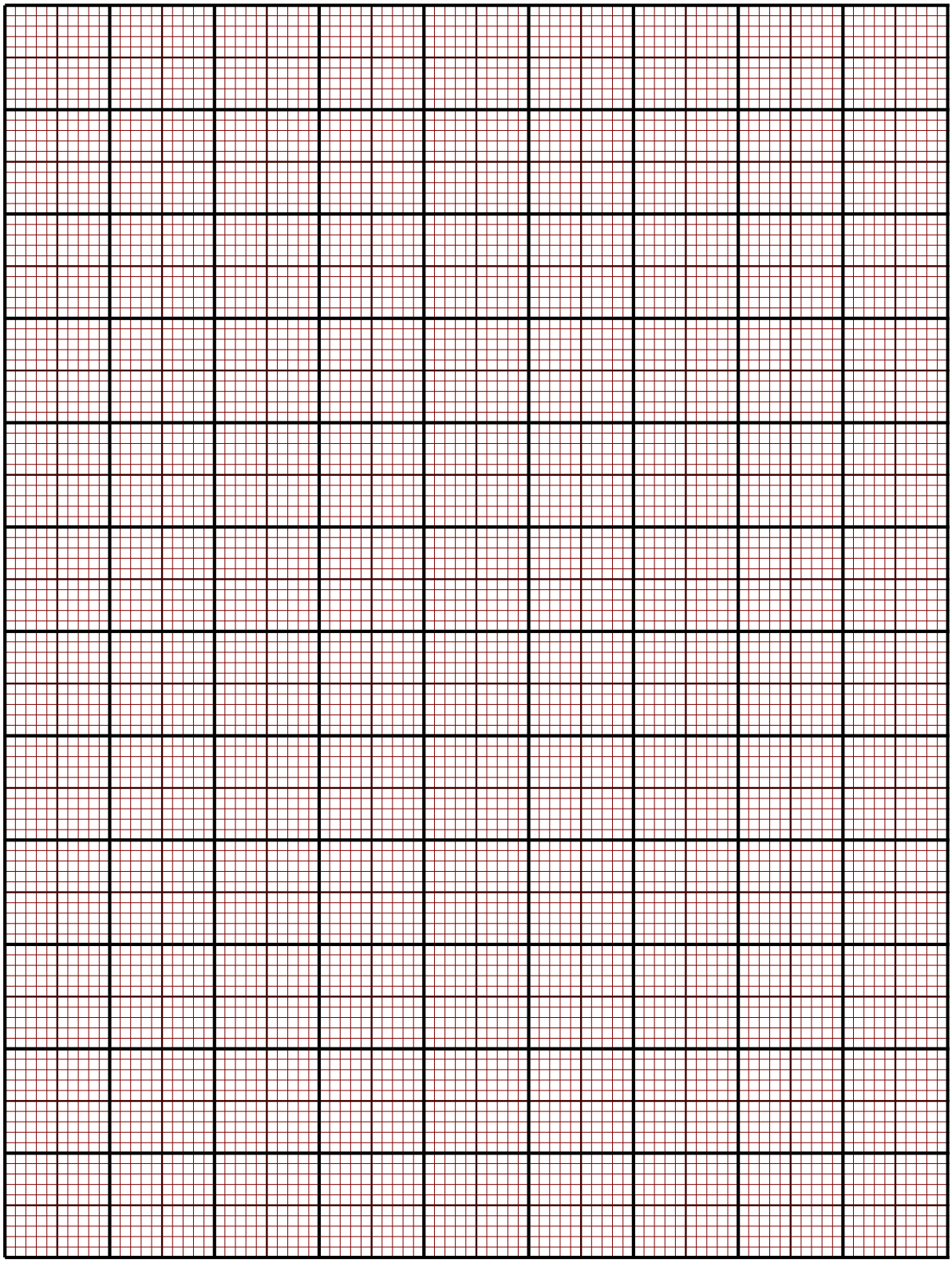
Repeat the procedure in Experiment 1 using acid **B** instead of acid **A**.

Record your results in the table below.

volume of acid B added / cm^3	**temperature of mixture in Styrofoam cup / °C**	**temperature rise / °C**
0.00	**T_i =**	
5.00		
10.00		
15.00		
20.00		
25.00		
30.00		
35.00		
40.00		

[2]

(c) Plot graphs of temperature rise against the volume of acid added for both Experiments 1 and 2 on the grid. For each graph, draw two straight best-fit lines that intersect each other. Clearly label your graphs.



[4]

(d) **(i)** Using the relevant graph, determine the volume of acid **A** required to neutralise 25 cm^3 of aqueous sodium hydroxide.

Show clearly on the graph how you obtained your answer.

……[1]

(ii) Hence, calculate the concentration of aqueous sodium hydroxide given that acid **A** is a monobasic acid with concentration 1.00 mol/dm^3.

[2]

(e) What type of chemical reaction, other than neutralisation, occurs when acid **A** reacts with sodium hydroxide?

……[1]

(f) In Experiment 2, why is the burette rinsed with acid **B** after rinsing with water?

……

……[1]

(g) The solutions of acids **A** and **B** are of the same concentration.

In which experiment is the maximum temperature change greater? Suggest a reason for your answer.

……

……[1]

(h) Describe the key source of error in the experiments and suggest an improvement to reduce this source of error.

……

……

……[2]

[Total: 16]

2 You are provided with solid **W**.

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

Instructions

Carry out the following experiments and record all your observations in the table. You should test and name any gas evolved.

Test no.	Test	Observations
1	Place one spatula of solid **W** into a test tube. Add about 2 cm^3 of dilute hydrochloric acid to solid **W**.	
2	Place one spatula of solid **W** into a test tube. Add about 5 cm^3 of aqueous copper(II) sulfate and heat the mixture gently. Leave the test tube to stand.	
3	Place one spatula of solid **W** into a test tube. Add one spatula of ammonium chloride to solid **W** and shake the test tube. Heat the mixture gently.	

[8]

What conclusions can you make about solid **W**?

……

……[2]

[Total: 10]

3 When potassium chlorate(V) is heated, it decomposes and oxygen is evolved.

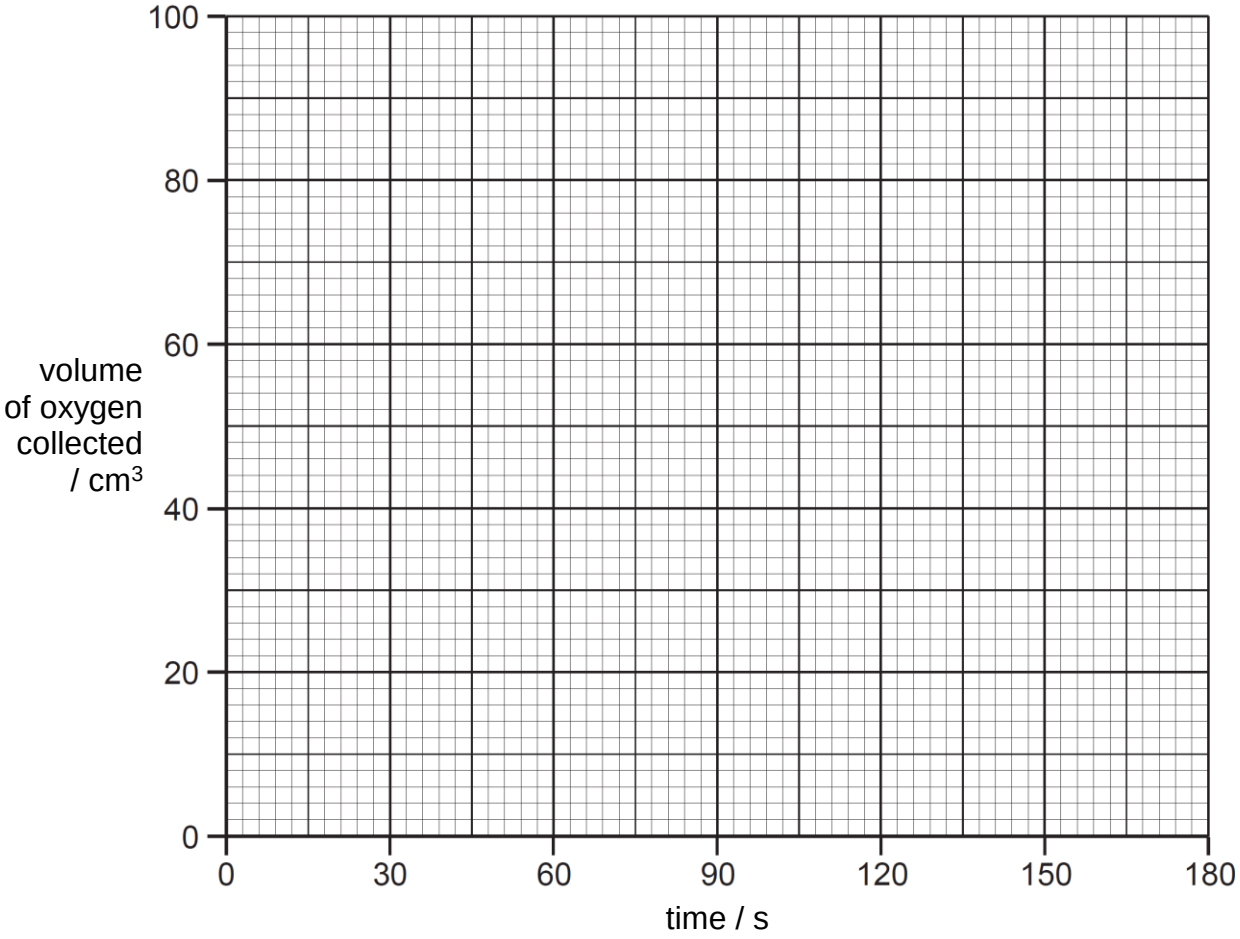
Experiment 1
A student heats a sample of potassium chlorate(V) for three minutes. The volume of oxygen produced is measured using a gas syringe.

Experiment 2
The experiment is repeated using the same mass of potassium chlorate(V) to which a small amount of copper(II) oxide is added. All other conditions are the same.

The results for Experiments 1 and 2 are shown in the table below.

time / s	**volume of oxygen collected in Experiment 1 / cm^3**	**volume of oxygen collected in Experiment 2 / cm^3**
30	22	32
60	40	52
90	54	64
120	64	70
150	70	72
180	72	72

(a) Plot the results for both Experiments 1 and 2 on the grid below and draw a smooth curve through each set of points. Label the curves '**Experiment 1**' and '**Experiment 2**'.



[2]

(b) Use your graphs to answer the following questions.

(i) What is the volume of oxygen produced in Experiment 1 after 45 seconds?

volume of oxygen = …….. [1]

(ii) How much more oxygen is produced after 75 seconds in Experiment 2 than in Experiment 1? Show your working clearly.

volume of oxygen = …….. [1]

(c) Suggest the function of copper(II) oxide in Experiment 2.

……

……[1]

(d) Why are the final two readings recorded in the table for Experiment 2 the same?

……

……[1]

(e) The equation for the reaction is

$$2KClO_3 \rightarrow 2KCl + 3O_2$$

By referring to the results in the table, calculate the mass of potassium chlorate(V) used in the experiment.

[A_r: O,16; C*l*, 35.5; K, 39]

mass of potassium chlorate(V) = …….. [3]

(f) You are provided with a solid mixture containing copper(II) oxide and copper(II) carbonate. Outline what you should do to determine the percentage of copper(II) carbonate in the mixture.

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

In your method, you should note any assumptions you make, include the measurements you would take and explain how you would use your results to determine the percentage of copper(II) carbonate in the mixture.

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……[5]

[Total: 14]

- 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	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.

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
lead(II) (Pb^{2+})	white ppt., soluble in excess, giving a colourless solution	white 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.]

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