Candidate Name	Form Class	Index Number

ANG MO KIO SECONDARY SCHOOL
PRELIMINARY EXAMINATION 2024
SECONDARY FOUR EXPRESS

CHEMISTRY
Paper 3

6092/03
16 August 2024
1 hour 50 minutes

Setter: Mrs Joselyn Luei

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

READ THESE INSTRUCTIONS FIRST

Write your Name, Class and Index Number in the spaces at the top of this paper.
Write in dark blue or black pen.
You may use a 2B pencil for any diagrams or graphs.
Do not use staples, paper clips, highlighters, glue or correction fluid/tape.

Answer **all** the questions in the spaces provided on the Question Paper.
Notes for qualitative analysis are printed on pages 13 and 14.
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.

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.

For Examiner's use	
1	
2	
3	
4	
TOTAL	

This document consists of **14** printed pages.

1 Mangalloy is made by alloying steel with manganese. The percentage by mass of manganese in mangalloy can be determined by converting all the manganese in the alloy into aqueous manganate(VII) ions and then using the solution to titrate a solution containing iron(II) ions.

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

G is an aqueous solution of manganate(VII) ions, MnO_4^-. The solution was prepared by converting all the manganese in a 2.12 g sample of mangalloy into manganate(VII) ions and making the final volume up to 250 cm^3 by adding water.

H is a solution which initially contained 0.0800 mol/dm^3 iron(II) ions dissolved in an unknown acid.

(a) Put **G** into the burette.

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

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

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

Record your titration results in the space provided on page 3, repeating the titration as many times as you consider necessary to achieve consistent results.
Show clearly how you obtain an average volume of **G** to be used in your calculations.

Results:

[5]

(b) From your titration results, obtain an average volume of solution **G** used. Show clearly how you obtained this volume.

[1]

Average volume of **G** required is ……..

(c) **H** is 0.0800 mol/dm^3 iron(II) ions solution.
Calculate the number of moles of iron(II) ions present in the volume of **H** used.

number of moles of iron(II) ions …… [1]

(d) Using your answer from **(c)**, calculate the number of moles of manganate(VII) ions present in 1 dm^3 of **G** required.
[Five moles of iron(II) ions react with one mole of manganate(VII) ions.]

number of moles of manganate(VII) ions in 1 dm^3 of **G** …….. [2]

(e) Using your answer from **(d)**, calculate the number of moles of manganate(VII) ions in 250 cm^3 of **G**.

number of moles of manganate(VII) ions in 250 cm^3 of **G** …… [1]

(f) Using your answer from **(e)**, calculate the mass of manganese in the 2.12 g sample of mangalloy.
[A_r: Mn, 55]

mass of manganese in 2.12 g of mangalloy …… [1]

(g) Using your answer from **(f)**, calculate the percentage by mass of manganese in mangalloy.

percentage by mass of manganese in mangalloy: ……% [1]

(h) A student repeated the experiment and accidentally used a 20.0 cm^3 pipette to measure solution **H** into the flask for each titration.

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

Describe the effect it would have on the percentage by mass of manganese in the mangalloy calculated by the student.

…….....

…….....

……..... [1]

[Total: 13]

2 Reactions between acids and alkali are exothermic.

You are going to determine the concentration of sodium hydroxide by measuring the highest temperature change when hydrochloric acid is added to aqueous sodium hydroxide.

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

Instructions

P is 1.00 mol/dm^3 of hydrochloric acid.

Q is aqueous sodium hydroxide of unknown concentration.

(a) Put **Q** into a burette.

Place Styrofoam cup into a beaker.

Using a measuring cylinder, measure 25.0 cm^3 of **P** into a Styrofoam cup.

Measure the temperature of the solution and record in the table below.

Add 5.00 cm^3 of **Q** to solution **P**, stirring with the thermometer. Measure the highest temperature of the mixture and record your results in the table below.

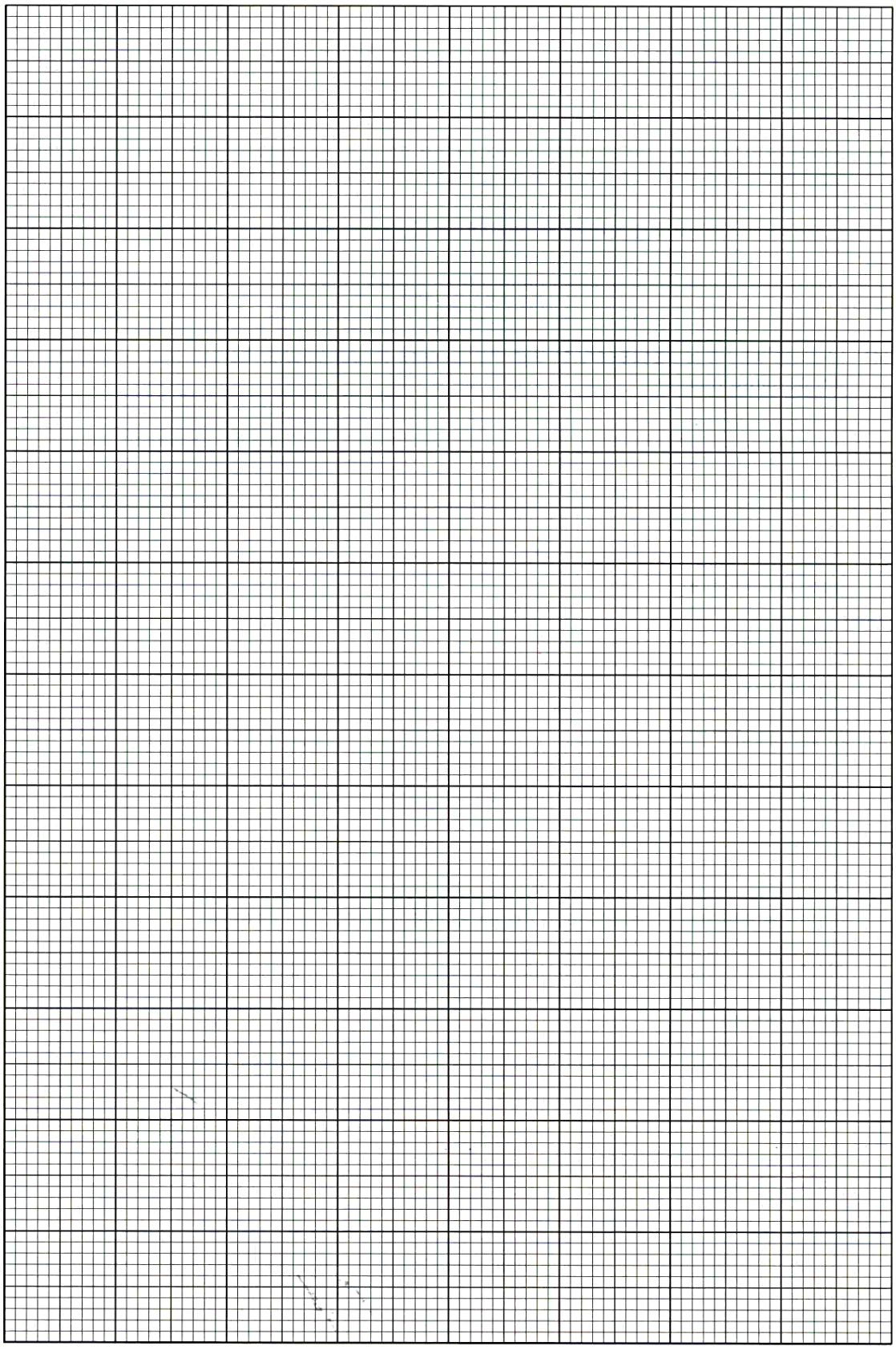
Continue to add 5.00 cm^3 of **Q** to the Styrofoam cup, stirring with the thermometer until a total volume of 40.00 cm^3 of **Q** has been added. Measure and record the highest temperature reached after each addition of 5.00 cm^3 of **Q** in **Table 1**.

Table 1

total volume of **Q** added /cm^3	highest temperature reached/°C
0.00	
5.00	
10.00	
15.00	
20.00	
25.00	
30.00	
35.00	
40.00	

[2]

(b) Use the results you have obtained to plot a graph of highest temperature reached against total volume of **Q** added. Draw two straight lines of best fit. The lines should cross each other.



[3]

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

…….....

……..... [2]

(d) Show clearly **on the graph** how you obtained the volume of **Q** needed to for complete neutralisation of 25.0 cm^3 of **P**.

volume of **Q** required for complete neutralisation = ……..... cm^3 [1]

(e) Identify **one** key source of experimental error and explain how it affects the results.

…….....

……..... [2]

[Total: 10]

3 You are provided with a sample of solid mixture, **R**. **R** contains two cations and one anion.
Read all the instructions below carefully before starting the experiment in Question 3.

Instructions

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

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

	tests	observations
(a)	Transfer approximately one third of solid **R** into a dry **hard glass** test-tube. Heat the sample **strongly** until no further changes are seen. **Leave this test-tube to stand in the test-tube rack for a few minutes.**	[4]
(b)	Transfer 1 spatula of solid **R** into the test-tube. Add dilute hydrochloric acid to the test-tube until all the solids have dissolved. Add distilled water until the test-tube is half full. This is **solution R**. **You must retain solution R for use in parts (c), (d) and (e)**.	

		[2]
(c)	Put 2 cm^3 of solution **R** from **(b)** to a clean test-tube. Add sodium hydroxide solution until no further change. Warm the solution.	[2]
(d)	Put 2 cm^3 of solution **R** from **(b)** to a clean test-tube. Add aqueous ammonia until no further change.	[1]
(e)	Put 2 cm^3 of solution **R** from **(b)** to a clean test-tube. Add equal volume of dilute nitric acid followed a few drops of barium nitrate solution.	[1]

(f) Identify all **three** ions present in solid mixture **R**.

……..... [1]

[Total: 11]

4 Washing soda is a useful component of household cleaning products that are used to clean laundry, bathrooms and the kitchen.

Washing soda crystals are crystals of hydrated sodium carbonate, $Na_2CO_3.10H_2O$.
When exposed to the air, some of the water is lost from the crystals. This process occurs faster in hotter climates.

Outline the method to determine the percentage by mass of water present in a sample of the washing soda crystals.

You are provided with common laboratory apparatus.

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……

……. [6]

[Total: 6]

End of Paper 3

NOTES FOR USE IN 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
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.]

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