O

CONVENT OF THE HOLY INFANT JESUS SECONDARY
Preliminary Examination in preparation for
the General Certificate of Education Ordinary Level 2024

CANDIDATE NAME			
CLASS		REGISTER NUMBER	

CHEMISTRY 6092/03

Paper 3 Practical **15 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 class, register number and name in the spaces on top of this page.
Write in dark blue or black pen on both sides of the paper.
You may use an HB pencil for any diagrams or graphs.
Do not use 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 should show the essential steps in any calculations and record experimental results.
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	

BLANK PAGE

1 Hydrated potassium carbonate forms crystals of formula $K_2CO_3 \cdot \mathbf{x}H_2O$.

You are going to determine the value of **x** in the formula $K_2CO_3 \cdot \mathbf{x}H_2O$ by titration with dilute hydrochloric acid.

$$K_2CO_3 \cdot \mathbf{x}H_2O + 2HCl \rightarrow 2KCl + (\mathbf{x}+1)H_2O + CO_2$$

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

Instructions

P is a solution containing 8.00 g of $K_2CO_3 \cdot \mathbf{x}H_2O$ in 1.00 dm^3 of solution.
Q is 0.100 mol/dm^3 hydrochloric acid.

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

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

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

Add **Q** from the burette, swirling the flask constantly, until the end-point is reached.

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 **Q** used.

Show clearly how you obtained this volume.

average volume of **Q** ..... cm^3 [1]

[Turn over

(b) **Q** is 0.100 mol/dm^3 hydrochloric acid.

Using your results from **(a)**, calculate the amount, in mol, of potassium carbonate in 25.0 cm^3 of **P**.

amount of potassium carbonate in 25.0 cm^3 of **P** ..... mol [2]

(c) Using your answer from **(b)**, calculate the amount, in mol, of potassium carbonate in 1.00 dm^3 of **P**.

amount of potassium carbonate in 1.00 dm^3 of **P** ..... mol [1]

(d) **(i)** Using your answer from **(c)**, calculate the concentration, in g/dm^3, of potassium carbonate in **P**.
[M_r: K_2CO_3, 138]

concentration of potassium carbonate ..... g/dm^3 [1]

(ii) Hence, calculate the mass of water in 8.00 g of hydrated potassium carbonate.

mass of water ..... g [1]

(iii) Hence, calculate the amount, in mol, of water in 8.00 g of hydrated potassium carbonate.
[M_r: H_2O, 18]

amount of water = ……. mol [1]

(iv) Calculate the value of **x** in the formula $K_2CO_3 \cdot \mathbf{x}H_2O$.

x = ……. [1]

(e) Describe another method by which the value of **x** in the formula $K_2CO_3 \cdot \mathbf{x}H_2O$ can be determined.

Your method should include the apparatus you would use, and the measurements you would take in order to carry out the calculations required. You may use the space below to present your answers.

You can assume the apparatus and reagents normally found in a school laboratory are available.
[M_r: K_2CO_3, 138; M_r: H_2O, 18]

……...

……...

……..

……...

……...

……..

……...

……. [5]

[Total: 18]

[Turn over

2 E924 is a compound commonly used as a flour improver to strengthen dough in baking. E924 contains the elements potassium, bromine and oxygen.

You are provided with a solid sample of E924, labelled **X**.

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

Instructions

(a) Adjust the Bunsen burner to give a non-luminous flame. Moisten the end of a wooden splint with deionised water, and dip the moist end of the splint into the sample of solid **X**. Place this end of the splint in the Bunsen burner flame.

Record your observation.

……..

……. [1]

(b) Heat sample **X** in the test-tube gently for about 2 minutes.

Record all your observations, including testing the gas produced with a glowing splint.

……...

……...

……..

……. [2]

(c) The residue from **(b)** is dissolved in deionised water. This resulting solution is solution **Y**.

Carry out the following tests on solution **Y**. Record your observations in the table.

test	observations
Test 1 Place about 2 cm depth of solution **Y** into a clean test-tube. Add, with shaking, an equal volume of potassium iodide solution. Then add a few drops of starch solution and shake the test-tube.	
Test 2 Place about 2 cm depth of solution **Y** into a clean test-tube. Add an equal portion of dilute nitric acid. Then add a few drops of aqueous silver nitrate.	
Test 3 Place about 1 cm depth of solution **Y** into a clean test-tube. Add aqueous sodium hydroxide slowly with shaking until no further change is seen.	

[4]

(d) State whether solution **Y** is an oxidising or reducing agent, explain your reasoning.

nature of solution **Y** ……

reasoning ……..

……..

……. [2]

[Total: 9]

[Turn over

3 You will determine the enthalpy change for a metal displacement reaction using a known volume and concentration of aqueous copper(II) sulfate and excess zinc powder.

The equation for this reaction is shown.

$$Zn(s) + CuSO_4(aq) \rightarrow ZnSO_4(aq) + Cu(s)$$

Read all the instructions below carefully before starting the experiment.

Instructions

S is approximately 3 g of zinc powder.
T is 0.800 mol/dm^3 copper(II) sulfate.

(a) Place a Styrofoam cup into a beaker.

Use a measuring cylinder to measure 25 cm^3 of **T** into the Styrofoam cup. Measure the initial temperature of **T** at time = 0 minute and record the value in the table.

Start the stopwatch, and do not stop the stopwatch until the whole experiment has been completed. Record the temperature of **T** at time = 0.5 minutes and time = 1 minute, and record the values in the table.

At time = 1.5 minutes, carefully add the zinc powder to the Styrofoam cup. Using the thermometer, continually stir the mixture.

Record the temperature every half a minute in the table until time = 5 minutes. Stir the mixture between thermometer readings.

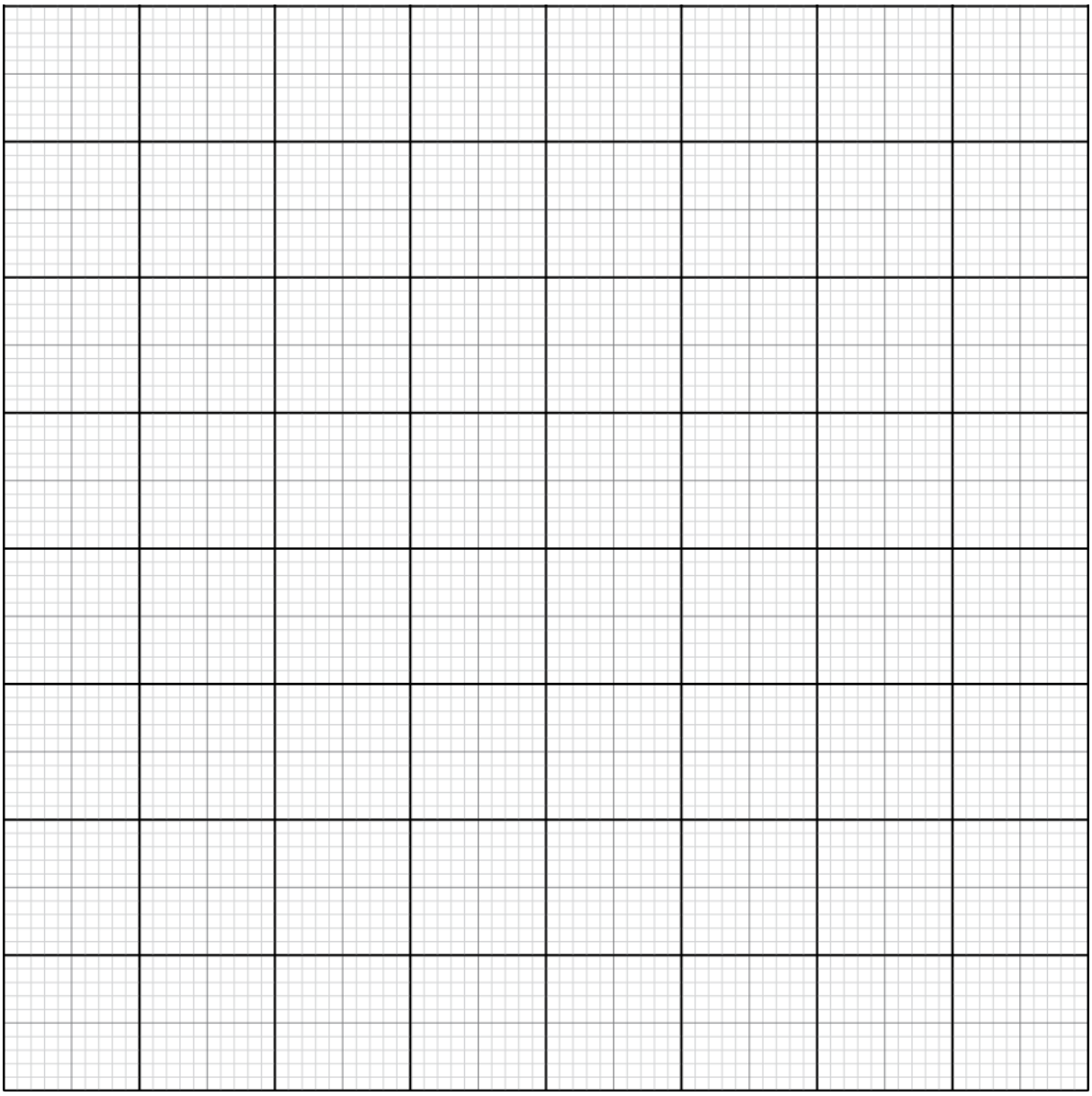
time / min	temperature / °C
0	
0.5	
1	
1.5	–
2	–
2.5	
3	
3.5	
4	
4.5	
5	
5.5	

[3]

(b) Plot a graph of temperature against time on the grid below. The scale for the temperature axis should extend 5 °C greater than the highest temperature that you have recorded.

Use these points to draw two straight lines of best fit:

- the first line for the temperature before adding the zinc powder, and
- the second line for the **cooling** of the mixture.



[4]

(c) Extend the two lines to time = 1.5 minutes and draw a vertical line connecting them.

Hence, determine the temperature **rise** at time = 1.5 minutes.

temperature rise at 1.5 minutes = …….. °C [2]

[Turn over

(d) **(i)** The amount of heat released in this experiment can be calculated using the expression.

heat released (in J) = mass of solution (in g) × maximum temperature rise (in °C) × 4.2

Use this expression and your answer from **(c)**, to calculate, in J, the amount of heat released.

Assume that 1.0 cm^3 of solution has a mass of 1.0 g. You do not need to consider the mass of zinc added.

heat energy released …… J [1]

(ii) Calculate the amount, in mol, of copper(II) sulfate used in this experiment.

amount of copper(II) sulfate …….. mol [1]

(iii) Hence, calculate the enthalpy change of reaction when 1 mol of copper(II) sulfate reacts with zinc powder.

enthalpy change …… kJ/mol [1]

(e) Suggest **one** change that could be made to the equipment used in the experiment to improve the accuracy of the results.

……..

……..

……. [1]

[Total: 13]

End of Paper

BLANK PAGE

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.

Tests 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 in 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