	Class	Register Number
Name		

6092/03
CHEMISTRY

24/Prelim/6092/3

PAPER 3

WEDNESDAY **14 August 2024** **1 hour 50 minutes**

Shift
Laboratory

VICTORIA SCHOOL

PRELIMINARY EXAMINATION
SECONDARY FOUR

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 pen.
You may use a HB 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.

For examiners' use	
Question 1	/ 19
Question 2	/ 17
Question 3	/ 4
Total	/ 40

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**.

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.

1 The reaction of aqueous solutions of strong acids and alkalis is exothermic.

You are going to investigate the temperature rise when volumes of aqueous alkali and acid are mixed together.

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

Instructions

You are going to carry out seven experiments.

P is dilute sulfuric acid.

Q is 1.23 mol/dm^3 aqueous sodium hydroxide.

(a) Experiment 1

Place a Styrofoam cup into a 250 cm^3 glass beaker.

Put **P** into a burette and measure 40.00 cm^3 of **P** into the Styrofoam cup. Measure the temperature of **P** and record the value in the table.

Use a measuring cylinder to measure 10 cm^3 of **Q**. Pour this volume of **Q** into the Styrofoam cup containing **P**. Stir, using the thermometer, and measure the highest temperature reached.

Record this temperature in the table.

Empty the Styrofoam cup and rinse it with water.

Experiments 2 to 7

Repeat Experiment 1 but use the different volumes of **P** and **Q** for each experiment given in the table.

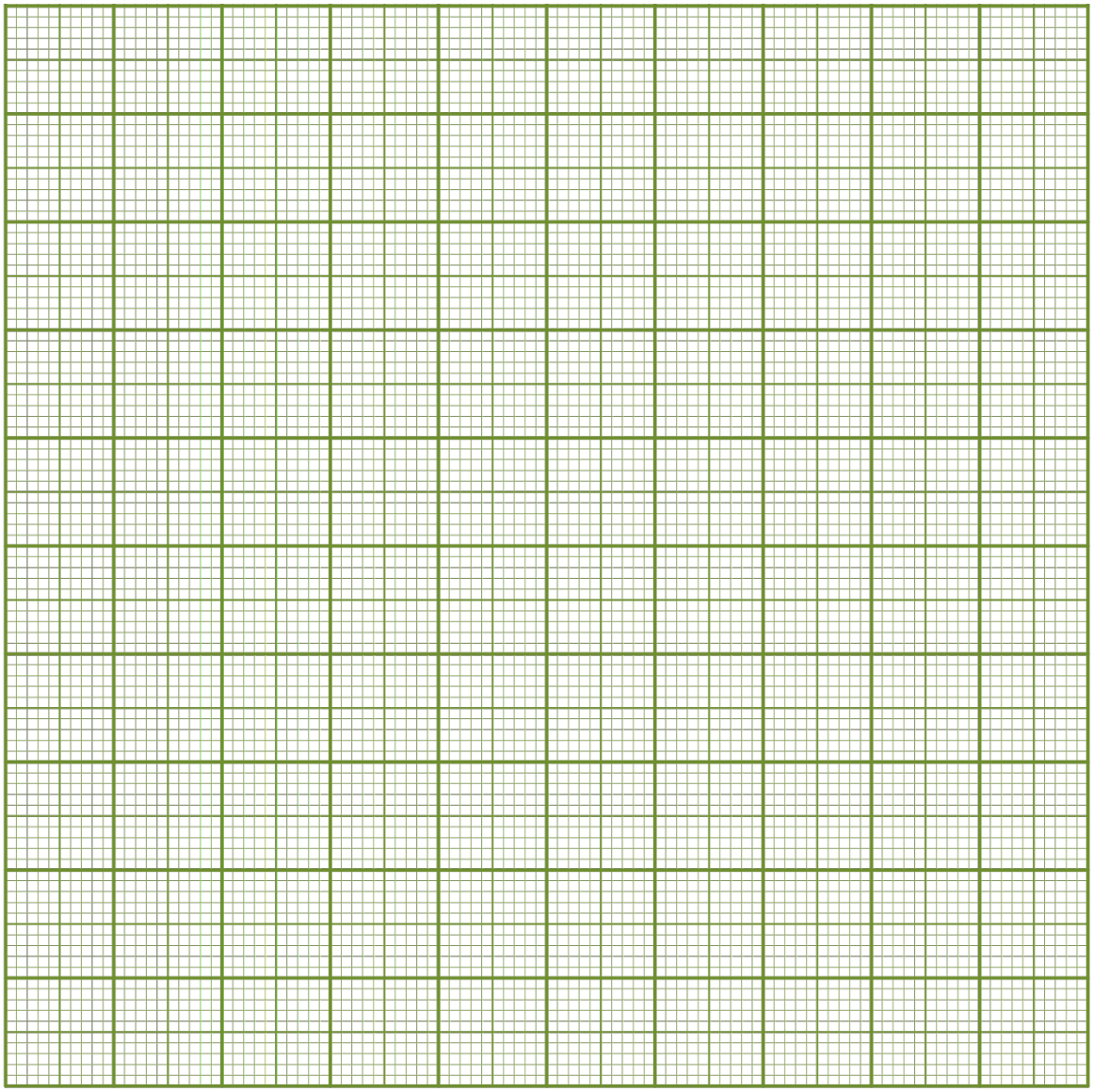
Complete the table by calculating the temperature rise for each experiment.

experiment	volume of **P** /cm^3	volume of **Q** /cm^3	initial temperature of **P** /°C	highest temperature of mixture /°C	temperature rise /°C
1	40.00	10			
2	35.00	15			
3	30.00	20			
4	25.00	25			
5	20.00	30			
6	15.00	35			
7	10.00	40			

[4]

(b) Plot a graph of temperature rise against volume of **Q** on the grid below.

Use these points to draw two intersecting straight lines of best fit.



[4]

(c) From your graph, read the volume of **Q** and the temperature rise where the two lines intersect.

Show clearly on the graph how you obtained your answer.

volume of **Q** = ……..…… cm^3

temperature rise = …….. °C [2]

(d) **(i)** Write the chemical equation for the reaction between sodium hydroxide and sulfuric acid.

……[1]

(ii) Calculate the number of moles of **P** required to neutralise the volume of **Q** in **(c).**

Number of moles of **P** = ……...……mol [1]

(iii) Calculate the volume of **P** required to neutralise the volume of **Q** in **(c).**

Volume of **P** = ……..…… [1]

(iv) Calculate the concentration of the sulfuric acid in **P**.

Concentration of sulfuric acid in **P** = ……...…… [2]

(e) The energy change of the reaction in this experiment can be calculated by the expression shown.

energy change (in J) = mass of solution (in g) x maximum temperature rise (in °C) x 4.2

Use this expression to calculate, in J, the energy change of the reaction.

Leave your answer to 1 decimal place.

Assume the density of the solution = 1.05 g/cm^3

Energy change = ……..…… [2]

(f) The experiment was repeated using the same concentration of another acid, **R**.

In this second experiment, the highest temperature obtained from the graph was approximately half that of the reaction with dilute sulfuric acid.

Twice as much acid was also required to neutralise the aqueous sodium hydroxide.

Two students made the following statements after studying the results.

Student A: Acid **R** is a strong monobasic acid.

Student B: Acid **R** is a weak dibasic acid.

Comment on the two students' statements.

……..

……..

……..

……[2]

[Total: 19]

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

(a) **A** is a 2.00 g sample of metal carbonate that is contaminated with an unknown salt, **B**.

There is no need to weigh the sample of **A**.

1. Use a 50 cm^3 measuring cylinder to add 50.0 cm^3 of dilute nitric acid to the conical flask.

2. Weigh of the conical flask and acid and record the mass.

3. Carefully add all of sample **A** to the conical flask. Start the stopwatch at the same time.

4. Swirl the conical flask continuously for 2 minutes.

5. Reweigh the conical flask and its contents and record the mass.

6. Record all your results in an appropriate format.

Results:

[2]

(b) You are provided with solutions **X** and **Y**, which are samples of **A** that have been reacted with excess dilute nitric acid and dilute hydrochloric acid respectively.

Carry out the following tests and identify any gases evolved. Record your observations in the table. If no change is observed for a test, write 'no observable changes'.

The volumes given below are approximate and should be estimated rather than measured.

test no.	instructions	observations
1	To 1 cm depth of **X** in a test tube, add aqueous ammonia slowly with shaking until no further change occurs.	
2	To 2 cm depth of **X** in a boiling tube, add aqueous sodium hydroxide until no further change is observed. Warm the mixture gently.	
3	To 1 cm depth of **X** in a test tube, add aqueous silver nitrate.	
4	To 2 cm depth of **Y** in a boiling tube, add aqueous sodium hydroxide until no further change is observed. Add a piece of aluminum foil and warm the mixture gently.	

5	To 1 cm depth of **Y** in a test tube, add aqueous barium nitrate.	
6	To a 1 cm depth of **Y**, add aqueous potassium iodide until no further change is observed. Leave the mixture to stand.	

[6]

(c) Conclusions

(i) Tick (√) the most likely identity of the cation the metal carbonate in **A**.

cation	tick (√)
copper(II)	
iron(II)	
iron(III)	

[1]

(ii) Deduce the identity of the cation and anion present in unknown salt **B** and describe the observation which allowed you to make that deduction.

cation in salt **B** ……..……..

observation……

……[1]

anion in salt **B** ……..……..

observation……

……[1]

(d) **(i)** Calculate the mass loss in the experiment from **(a)**.

mass loss = ……..……g [1]

(ii) The impurity does not react with dilute nitric acid.

By using your answers to **2(c)(i)** and **2(d)(i)**, calculate the percentage purity of the sample of metal carbonate.

[A_r: C, 12; Ca, 40; Cu, 64; Fe, 56; O, 16]

percentage purity of the sample of metal carbonate = ……..…… [2]

(e) State one other assumption that needs to be made in your calculations.

……..

…….[1]

(f) Suggest one change that could be made to the experiment above to improve the accuracy of the results.

……..

…….[1]

(g) Explain why is it important that solutions **X** and **Y** are prepared using excess acid.

……..

…….[1]

[Total: 17]

3 When acidified aqueous sodium iodate ($NaIO_3$) is mixed with aqueous potassium iodide, the solutions react slowly to form iodine. A few drops of starch solution can be used as an indicator for this reaction, because once a certain amount of iodine is formed, the mixture will undergo a sudden colour change to blue-black.

Describe a method a student can use to find the effect of the concentration of aqueous potassium iodide on the rate of the reaction between acidified sodium iodate and aqueous potassium iodide.

You may include a diagram of the apparatus required. You may assume that the apparatus normally found in a school laboratory are available.

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……[4]

[Total: 4]

End of Paper

NOTES FOR QUALITATIVE ANALYSIS

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 a lighted splint
oxygen (O_2)	relights a glowing splint
sulfur dioxide (SO_2)	turns aqueous acidified potassium manganate(VII) from purple to colourless