Class:	Register No:	Name:

CRESCENT GIRLS' SCHOOL
SECONDARY FOUR
PRELIMINARY EXAMINATION

MARK SCHEME

6092/03
CHEMISTRY

PAPER 3 Practical

14 AUGUST 2024

1 hour 50 minutes

READ THESE INSTRUCTIONS FIRST

Write your name, register number and class in the spaces provided at the top of this 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 2B 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 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.

Shift
Laboratory

For Examiner's Use	
Q1	**/17**
Q2	**/15**
Q3	**/8**
Total	**/40**

This document consists of 11 printed papers.

1 You are to determine the enthalpy change of neutralisation of sodium hydroxide by an acid and the concentration of hydrogen ions in the acid.

These can be found by measuring the temperature change when solutions of the acid and alkali are mixed.

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

Instructions

You are going to carry out seven experiments.

P is 1.50 mol/dm^3 sodium hydroxide, NaOH.
Q is an aqueous solution of a strong acid.

(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 10.0 cm^3 of **Q**. Pour this volume of **Q** into the Styrofoam cup containing **P**. Stir gently, using the thermometer, and measure the highest temperature reached.
Record this temperature in the table.

Empty the Styrofoam cup and rinse it with deionised water.

Experiments 2 to 7

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

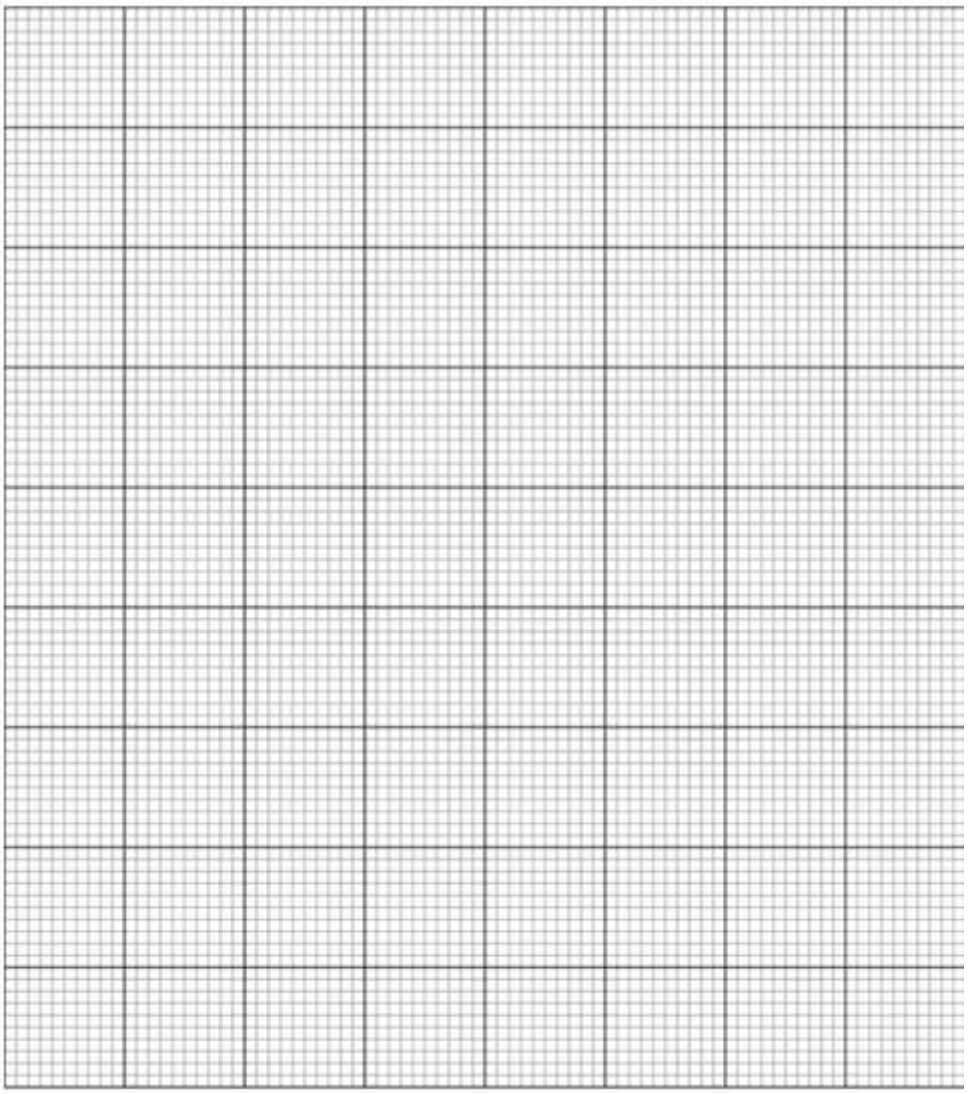
Complete the table by calculating the temperature rise for each experiment.

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	10.0	31.0	35.5	4.5
2	35.00	15.0	32.0	37.0	5.0
3	30.00	20.0	31.5	39.0	7.5
4	25.00	25.0	31.5	41.0	8.5
5	20.00	30.0	31.5	39.5	8.0
6	15.00	35.0	31.5	38.0	6.5
7	10.00	40.0	31.0	36.0	5.0

ALL temperature recorded up to 1 dp [1]
Correct temperature rise calculated [1]
Trend in temperature rise. Increases and then decreases. [1] **[3]**

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

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



[4]

Scale – suitable scale is used. E.g x axis is interval of 5 cm^3 , y axis in interval of 1 cm^3 [1]
Line of best fit [1]
Axis – correct heading and units [1]
Points – correct plotting of points. Measure up to half the smallest division. [1]

(c) Use the temperature rise obtained when the two lines meet to calculate the maximum amount of heat energy produced during the reaction.

[Assume that 4.3 J are required to raise the temperature of 1 cm^3 of any solution by 1°C]

Let (y) be the temperature rise.

Amount of heat = 4.3 x 50 x (y)
Correct value of (y) AND amount of heat energy released [1]

amount of heat produced = _____J

(d) From your graph, read the volume of **P** where the two lines intersect. Show clearly on the graph how you obtain your answer.

volume of **P** = _____ cm^3 **[1]**

(e) Calculate the number of moles of **P** in **(d)**.
No. of moles of P = volume of P (cm^3) in (d) x 1.50

number of moles of **P** = _____ mol **[1]**

(f) The ionic equation for the reaction between **P** and **Q** is as given.

$$OH^-(aq) + H^+(aq) \rightarrow H_2O(l)$$

(i) Calculate the volume of **Q** that reacts with volume of **P** in **(d)**.

Volume of Q = 50 – (answer in (d)) = x cm^3

volume of **Q** = _____cm^3

(ii) Hence, calculate the concentration of hydrogen ions, H^+, in **Q** in mol/ dm^3.

Concentration of hydrogen ions = (answer in (e)) ÷ $\frac{x}{1000}$

concentration of hydrogen ions = _____ **[2]**

Answer in 3 sf [1]
Correct unit [1]

(g) If **Q** is sulfuric acid, state the concentration of the acid in mol/ dm^3.

Explain your reasoning.

concentration = **answer in f(ii) ÷ 2 [1]**

reasoning

Sulfuric acid is a dibasic acid. **1 mole of the acid dissociates fully in water to form 2 moles of hydrogen ions AND concentration of sulfuric acid is half concentration of hydrogen ions [1]**

[2]

(h) A student mentioned that the experiment was not accurate because the temperature changes measured were small.

Suggest and state how one modification to the experimental method can give larger changes in temperature.

Insulate the Styrofoam cup/wrap the Styrofoam cup with cloth [1]	**Reduces heat loss to the surrounding AND highest temperature rise can be recorded. [1]**
OR	
Use of magnetic stirrer [1]	**To ensure the solution is well mixed so that maximum amount of energy can be released OR Well-mixed solution to allow even distribution of heat so highest temperature rise can be recorded more accurately [1]**

[2]

[Total: 15]

2 You are given a hydrated salt, **M**.$6H_2O$.

On heating, hydrated **M**.$6H_2O$ loses its water of crystallisation.

$$\mathbf{M}.6H_2O\ (s) \rightarrow \mathbf{M}(s) + 6H_2O(g)$$

Read all the instructions carefully before starting the experiments.

Carry out the following tests on solid **M**.$6H_2O$, recording all of your observations in the spaces provided.

(a) Instructions

1. Use an electronic balance to measure and record mass of an empty boiling tube.
2. Add about 1.00 g of **M**.$6H_2O$ into the boiling tube.
3. Measure and record the total mass of the boiling tube and **M**.$6H_2O$.
4. Gently heat the contents for 1 minute.
5. Record your observation in **(a)(i)**.
6. Leave the boiling tube to cool to room temperature.

You may start working on Question 2c while waiting for the boiling tube to cool.

7. Reweigh the boiling tube and its contents and record the total mass.
8. Record all your results in an appropriate format in **(a)(ii)**.

(i) Observation

Colourless liquid forms on the upper part of the test tube. AND
Orange solid melts to form reddish brown liquid.

[1]

(ii) Results

Mass of an empty boiling tube (g)	M1 30.14
Mass of an empty boiling tube and **M**.$6H_2O$ before heating/ (initial mass) (g)	M2 31.14
Mass of an empty boiling tube and **M**.$6H_2O$ after heating/cooling (g)	M3 30.53

Correct heading and units [1]
Mass recorded up to 2 dp [1]

[2]

(b) **(i)** State the mass loss and hence calculate the percentage loss in mass of **M**.$6H_2O$ on heating using the equation below.

percentage loss in mass on heating = $\frac{loss\ in\ mass\ on\ heating}{original\ mass\ of\ sample}$

M3-M2 [1]

mass loss = _____ g

percentage loss = **answer in 3 sf [1]** % **[2]**

(ii) In your calculations, you assume that **M**.$6H_2O$ is pure.

State how the percentage loss in mass on heating will change if an impurity of copper(II) carbonate is present in **M**.$6H_2O$ salt. Assume same mass of sample is used as in **(a)(i)**.

Explain your reasoning.

Percentage loss will be greater [1]

Copper(II) carbonate decomposes to form carbon dioxide which will escape the boiling tube, [1] hence decrease in mass will be greater.

[2]

(c) Place the remaining amount of **M**.$6H_2O$ in a boiling tube and add deionised water to dissolve the solid to produce aqueous solution of **M**.

Carry out the following tests on the aqueous solution of **M** in a test tube. Record your observations in the space provided. You should test and name any gas evolved.

(i) To about 1 cm depth of the solution of **M**, add a few drops of aqueous sodium hydroxide until in excess.

Reddish brown precipitate that is insoluble in excess aqueous sodium hydroxide[1]

[1]

(ii) To about 1 cm depth of the solution of **M**, add a few drops of aqueous silver nitrate.

White precipitate forms

(iii) To about 1 cm depth of the solution of **M**, add a few drops of aqueous barium nitrate.

No visible observation/ No visible change/no change is observed

Reject: nothing happen/no change

[1]

(iv) To about 1 cm depth of the solution of **M**, add a few drops of aqueous potassium iodide.
The yellow solution turns brown/reddish brown

[1]

(d) **(i)** Identify the salt, **M**.
Iron(III) chloride/$FeCl_3$

[1]

(ii) State one chemical property of **M**. Explaining your reasoning by stating evidence.

chemical property

It is an **oxidising agent. [1]**

reasoning

When M is mixed with KI, **brown solution** is formed.[1]
M **oxidises KI/ iodide to iodine**. [1]

Other possible answers: [1] only
Brown solution of iodine formed/ M oxidises KI

[3]

[Total: 14]

3 A student investigates the effect of concentration on rate of reaction of aqueous solutions **G** and **H**.

G is a mixture of potassium iodide and another substance.
H is an aqueous solution of ammonium peroxodisulfate, $(NH_4)_2S_2O_8$.

G and **H** reacts to produce iodine, I_2.

The student investigates the rate of reaction by using the following method at room temperature condition.

1. Put **G** into a burette and measure 10.00 cm^3 of **G** into a conical flask. To **G** in the conical flask, add 2 cm^3 of starch solution.
2. Transfer 25.0 cm^3 of **H** into the mixture of **G** and starch in the conical flask.
3. Start the stopwatch immediately and swirl the contents of the flask. Then leave the mixture to stand. When the mixture turns blue-black, stop the stopwatch. Record time taken to the nearest second in the table.
4. Empty the conical flask and rinse it with distilled water,
5. Repeat the procedure 1 to 4, using different volumes of **H** and water.

(a) The results which the student obtains are shown.

experiment	volume of **G**/cm^3	volume of **H**/cm^3	volume of water/cm^3	time taken for blue-black colour to appear/s
1	10.00	25.0	0	4
2	10.00	20.0	5	6
3	10.00	15.0	10	10
4	10.00	10.0	15	15
5	10.00	5.0	20	22

(i) How does the concentration of ammonium peroxodisulfate in experiment 2 compare with its concentration in experiment 4?

The concentration of ammonium peroxodisulfate in experiment 2 is twice that in experiment 4

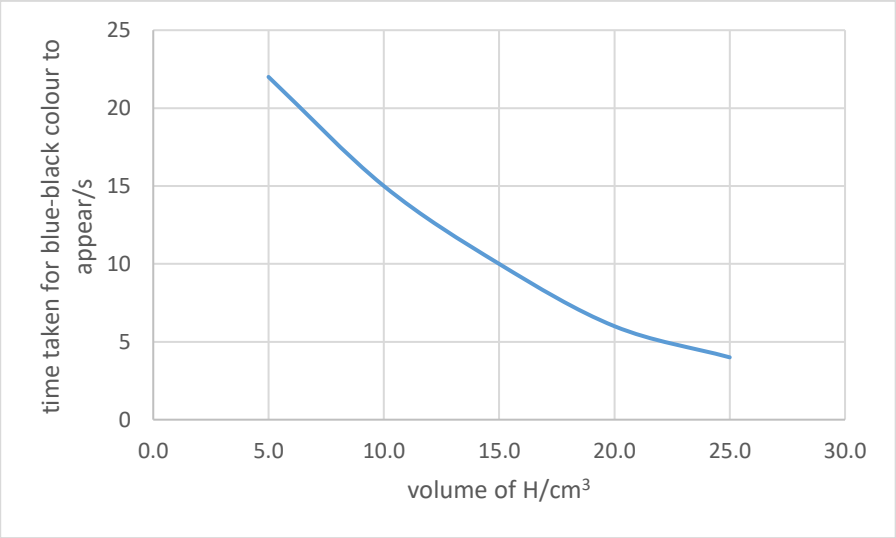
[1]

(ii) Explain why water is added to each reaction mixture for Experiments 2 to 5.
To keep the total volume of solution constant in all the experiments [1].

This results in the volume of ammonium peroxodisulfate used to be directly proportional to its concentration [1].

[2]

(c) The results are then plotted on a graph as shown.



(i) Describe the relationship between concentration of **H** and rate of reaction.

Explain your answer using the graph.

As the concentration of H increases, rate of reaction increases.[1]
As the volume of H increases, a graph with negative gradient is obtained [1]
Reject: As the volume of H increases, time taken decreases.

[2]

(d) A statement states that the rate of reaction doubles for every 10°C rise in temperature.

Given the same solutions of **G** and **H**, describe how you would investigate this statement by experiment.

You can assume that all the apparatus and reagents normally found in a school laboratory are available. You should include the measurements you would take and explain how you would use your results to confirm this statement.

Method and apparatus

1. Put **G** into a burette and measure 10.00 cm^3 of **G** into a conical flask. To **G** in the conical flask, add 2 cm^3 of starch solution.

2. Measure the temperature of **H** and then transfer 25.0 cm^3 of **H** into the mixture of **G** and starch in the conical flask. Let temperature of **H** be 30°C.
3. Start the stopwatch immediately and swirl the contents of the flask. Then leave the mixture to stand. When the mixture turns blue-black, stop the stopwatch. Record time taken to the nearest second in the table.
4. Empty the conical flask and rinse it with distilled water.
5. Heat solution **H** to 40°C.
6. Repeat the procedure 1 to 4, but this time use the solution **H** with temperature of 40°C and 50°C

Conclusion

If the time taken to form the blue-black solution by the 40°C is about half the time taken by the 30°C, but about twice the time taken by 50°C, the rate of reaction has doubled for every 10°C rise in temperature.

OR

temperature of solution/ °C	time taken for blue-black colour to appear/s
30	T_1
40	T_2
50	T_3

If T_1 is twice than T_2 and T_2 is twice than T_3, the rate of reaction has doubled for every 10°C rise in temperature.

Method	- Mention either solution H or G having **at least three** different temperatures e.g. 30°C, 40°C, 50°C (difference of 10°C) [1]
Apparatus	- Students can use the same apparatus as given in the previous procedure. - Else, state suitable apparatus to measure and hold the solution e.g. pipette AND stopwatch [1]
Conclusion	Compare time taken and state the difference. [1]

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
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 acidified potassium manganate(VII) from purple to colourless