ST JOSEPH'S INSTITUTION
PRELIMINARY EXAMINATION 2021
(YEAR 4)

CANDIDATE NAME							
CLASS						INDEX NUMBER	

CHEMISTRY **6092/03**

Paper 3 **25 August 2021**

Additional Materials : Nil **1 hour 50 minutes**

READ THESE INSTRUCTIONS FIRST

Write your name, class and index number on the cover page of this Question Paper.
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.

Candidates are reminded that all quantitative answers should include appropriate units.
Candidates are advised to show all their working in a clear and orderly manner.
The number of marks is given in brackets [ ] at the end of each question or part question.
The use of an approved scientific calculator is expected, where appropriate.

Shift
Laboratory

For Examiner's Use	
Total	**/ 40**

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

Instructions

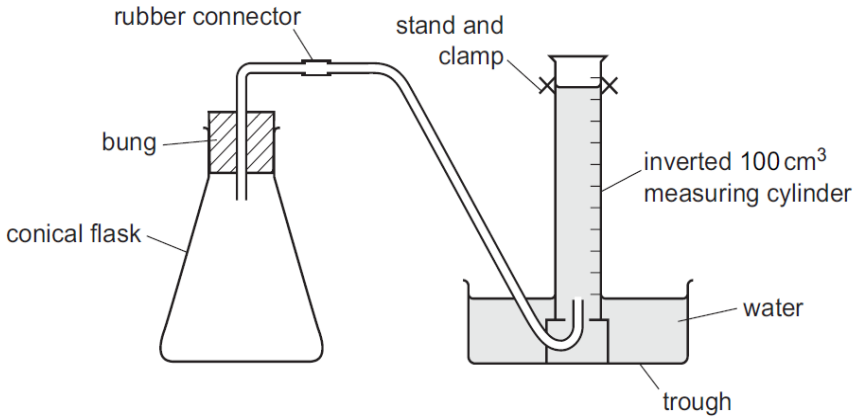
You are going to carry out two experiments on two strong acids **X** and **Y** of the same concentration.

(a) Experiment 1

Set up the apparatus as shown in the diagram below.

Fill the plastic trough to about three-quarters full of water. Place the bee hive stand into the trough and insert the free end of the delivery tube through the bee hive stand. The other end of the delivery tube is connected to a rubber bung.

Fill the 100 cm^3 measuring cylinder fully with water and cover the mouth of the cylinder with your palm. Invert the cylinder into the trough of water and remove your hand, ensuring that there is minimal air in the measuring cylinder. Place the cylinder onto the bee hive stand, with the tip of the delivery tube in the mouth of the cylinder. Clamp the cylinder to a retort stand.



Using a 50 cm^3 measuring cylinder, measure 50 cm^3 of acid **X**. Pour it into the conical flask.

Cut one of the strips of magnesium into four pieces. Ensure that the free end of the delivery tube is properly inserted into the measuring cylinder filled with water and place all four pieces of magnesium into the conical flask. Stopper the conical flask and start the stopwatch immediately, noting the volume of gas in the measuring cylinder at the same time. Swirl the contents of the flask and leave it to stand.

In the table, record the volume of gas collected in the measuring cylinder every 30 seconds for three minutes.

time / s	0	30	60	90	120	150	180

[3]

(b) Experiment 2

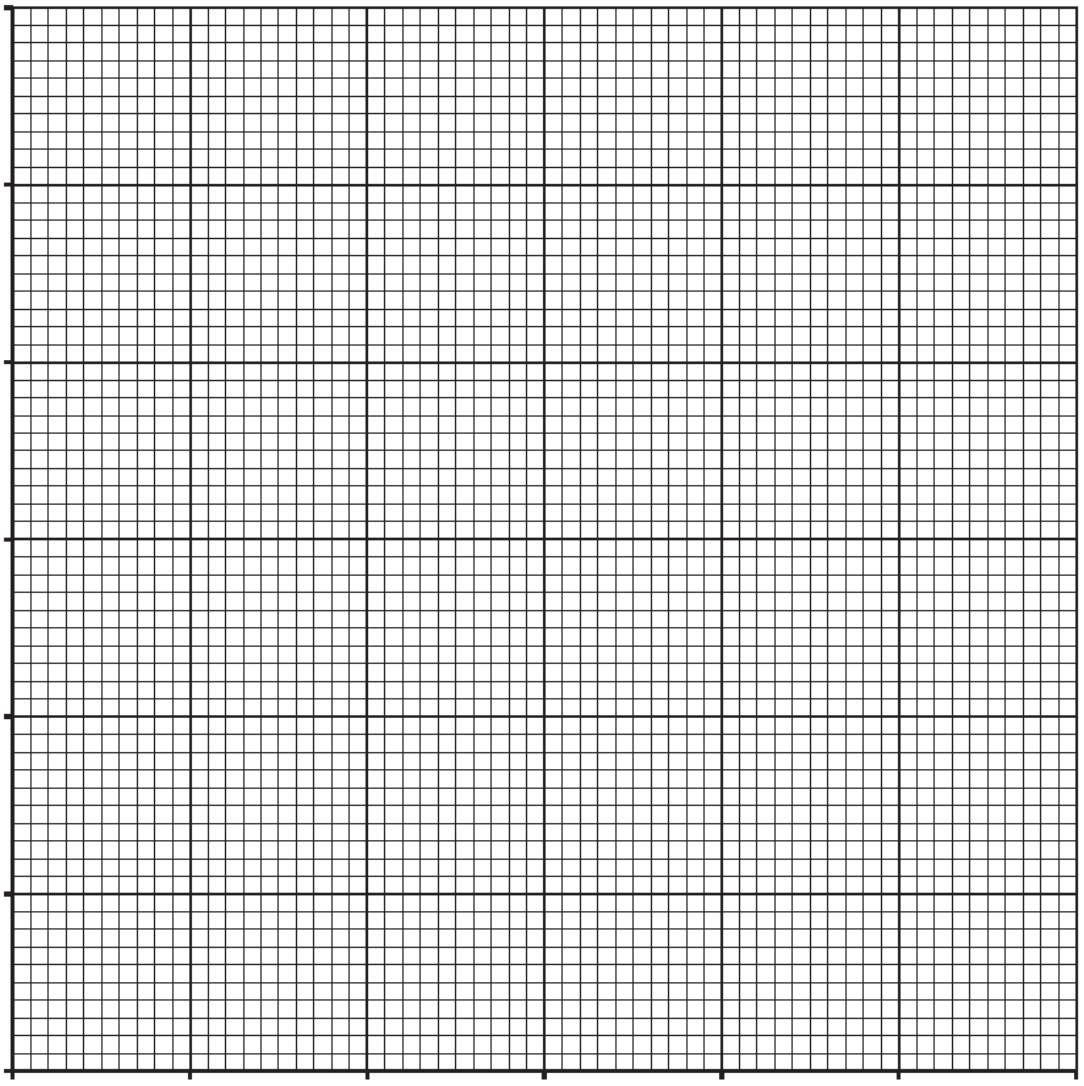
Repeat the whole of Experiment 1 using 50 cm^3 of acid **Y**.

In the table, record the volume of gas collected in the measuring cylinder every 30 seconds for three minutes.

time / s	0	30	60	90	120	150	180

[2]

(c) Plot the graph of volume of gas against time for both experiments on the grid below. Label the graphs for Experiment 1 and Experiment 2 clearly.



[4]

(d) **(i)** Which experiment has a faster rate of reaction?

Explain your reasoning using your graph in **(c)**.

……..…

……..……[1]

(ii) Suggest a reason for your answer in **(d)(i)**.

……..[1]

(iii) The rate of this reaction can be calculated using:

$$\text{rate} = \frac{\text{volume of gas}}{\text{time taken}}$$

Calculate the rate of reaction for the first 30 seconds for the experiment in **(d)(i)**.

rate ……..[2]

(e) A student suggested that the magnesium should be rubbed with sandpaper before starting the experiment.

Explain why.

……..……..……

……..……..[1]

(f) Suggest how the accuracy of the experiment can be improved.

……

……..……..[1]

(g) If the experiment is conducted using zinc carbonate instead of magnesium strips, the volume of gas measured by the apparatus will not be accurate.

Explain why.

Hence, suggest an improvement that can be made to the experiment.

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……[2]

[Total: 17]

2 You are provided with solids **P** and **Q**. Solid **P** is water-soluble, while **Q** is insoluble in water.

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

Instructions

Carry out the following tests on **P** and **Q**, recording all your observations at each stage. You should test and name any gas evolved.

Add 15 cm^3 of distilled water to the solid **P** in the boiling tube. Stopper and shake the boiling tube for about one minute. Use the resulting solution for the following tests.

tests on the solution of P

(a) **(i)** To about 1 cm^3 of the solution, add a few drops of aqueous sodium hydroxide.

observation ……..

……[1]

(ii) Add excess aqueous sodium hydroxide to the mixture from **(a)(i)**.

observation ……..

……...

……[2]

(b) To about 1 cm^3 of the solution, add aqueous ammonia until in excess.

observation ……..

……[2]

(c) To about 1 cm^3 of the solution, add a portion of aqueous barium nitrate, followed by dilute nitric acid.

observation ……..

……[2]

(d) Identify solid **P**.

……[1]

tests on solid Q

Using a spatula, transfer approximately equal portions of solid **Q** into two test tubes.

(e) Heat the solid in the first test tube gently and then strongly.

observation ……..

……[1]

(f) Add about 2 cm^3 of dilute hydrochloric acid to the second test tube. Test any gases evolved. Keep the resulting solution for test **(g)**.

observation ……..

……

……[3]

(g) After two minutes, add an equal volume of distilled water and shake the test tube. Leave the test tube to stand, then use the resulting solution for the following tests.

(i) To about 1 cm^3 of the solution, add a few drops of aqueous sodium hydroxide until in excess.

observation ……..

……[2]

(ii) To about 1 cm^3 of the solution, add a few drops of aqueous ammonia until in excess.

observation ……..

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……[3]

(h) Identify solid **Q**.

……[1]

[Total: 18]

3 You are provided with a rusty iron nail. The mass of the nail is between 0.10 to 0.20 g.

Outline a method you would use to determine the mass of rust in the iron nail.

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 mass of rust in the iron nail.

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……[5]

[Total: 5]

- 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