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MINISTRY OF EDUCATION, SINGAPORE
in collaboration with
CAMBRIDGE ASSESSMENT INTERNATIONAL EDUCATION
General Certificate of Education Ordinary Level

CANDIDATE NAME: SUPERVISOR'S RESULTS

CENTRE NUMBER: S 2 8 3 1

INDEX NUMBER:

* 5 8 3 8 9 9 5 1 2 6 *

CHEMISTRY

SHIFT : 1/2/3/4

LOCATION: CHEM LAB 1/2

6092/03

Paper 3 Practical

October/November 2020

1 hour 50 minutes

Candidates answer on the Question Paper TEMPERATURE OF LAB : 32.0°C

Additional Materials: As listed in the Confidential Instructions

READ THESE INSTRUCTIONS FIRST

Write your Centre number, index number and name 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 an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE ON ANY BARCODES.

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 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.

Shift
Laboratory
Chemistry Lab 1&2

For Examiner's Use	
1	
2	
3	
Total	

This document consists of **10** printed pages and **2** blank pages.

1 Some cleaning products contain a solution of sulfamic acid.

You are going to determine the concentration of sulfamic acid in a sample of a cleaning product by titration with sodium hydroxide.

The sulfamic acid can be represented by the formula, HA. The equation for the reaction occurring in the titration is shown.

$$HA + NaOH \longrightarrow NaA + H_2O$$

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

Instructions

P is 0.200 mol / dm^3 sodium hydroxide.
Q contains aqueous sulfamic acid. The solution was made by diluting a sample of 100 cm^3 of the cleaning product to 1.00 dm^3 by adding deionised water.
T is thymolphthalein indicator.

(a) (i) Fill the burette with **P**.

Use the pipette to transfer 25.0 cm^3 of **Q** into a conical flask.

Add a few drops of the thymolphthalein indicator, **T**, to the solution in the conical flask.

Ensure the lid is placed back on the container of **T** after use.

Add **P** from the burette, swirling the flask constantly.

At the end-point, one drop of **P** produces a blue colour that does not disappear on swirling.

Record your titration results in the space provided. Repeat the titration as many times as you consider necessary to achieve consistent results.

Results

Titration number	1	2
Final reading / cm^3	19.40	19.40
Initial reading / cm^3	0.00	0.00
Volume of P used / cm^3	19.40	19.40
Best titration results	✓	✓

[5]

(ii) From your titration results, obtain an average volume of **P** to be used in your calculations. Show clearly how you obtained this volume.

average volume of P $= \frac{19.40 + 19.40}{2}$

$= 19.40\ cm^3$

average volume of **P** 19.40 cm^3 cm^3 [1]

(b) (i) **P** is 0.200 mol/dm^3 sodium hydroxide.

Use your answer from **(a)(ii)** and the equation for the reaction to calculate the number of moles of sulfamic acid in 25.0 cm^3 of **Q**.

moles of NaOH $= 0.200 \times \frac{19.40}{1000}$

$= 0.00388$ mol

moles of HA $= 0.00388$ mol

number of moles of sulfamic acid in 25.0 cm^3 of **Q** 0.00388 mol [1]

(ii) Use your answer from **(b)(i)** to calculate the concentration, in mol/dm^3, of sulfamic acid in the sample of the cleaning product.

moles of HA in sample $= \frac{0.00388}{25} \times 1000$

$= 0.155$ mol.

Concentration of HA in sample $= \frac{0.155}{\frac{100}{1000}}$

$= 1.55$ mol/dm^3

concentration of sulfamic acid in cleaning product 1.55 mol/dm^3 [3]

(c) The label on the bottle of cleaning product gives the concentration of sulfamic acid in g/dm^3.

To convert your answer from **(b)(ii)** into g/dm^3, it is necessary to know the relative molecular mass, M_r, of sulfamic acid.

The M_r can be determined by reacting some **solid** sulfamic acid with aqueous sodium carbonate and measuring the volume of carbon dioxide produced.

The equation for the reaction is shown.

$$2HA + Na_2CO_3 \rightarrow CO_2 + H_2O + 2NaA$$

(i) Use this information to outline a method to determine the M_r of sulfamic acid.

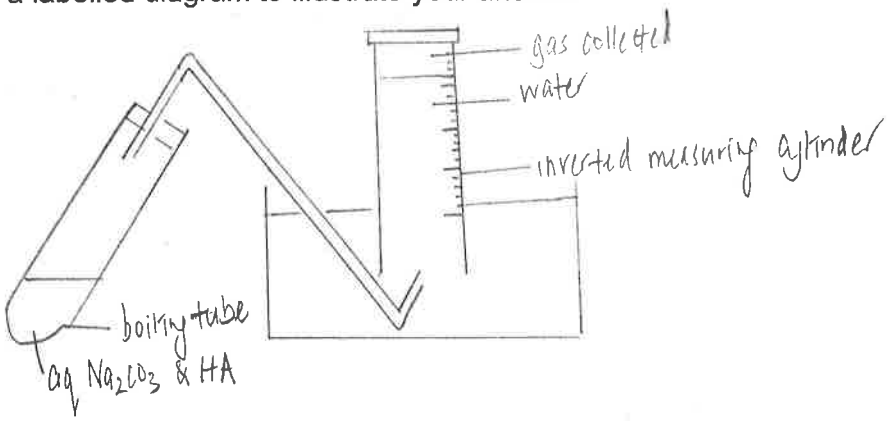
Your method should use gas collection by the displacement of water.

In your method you should include:

- the apparatus you would use
- the measurements you would take
- an explanation of how you would use your results to determine the M_r of sulfamic acid.

You can assume the apparatus and reagents normally found in a school laboratory are available.

You may wish to use a labelled diagram to illustrate your answer.



Weigh 1 g of solid sulfamic acid using an electronic balance and add the solid to a boiling tube.

Add excess ~~sol~~ aqueous sodium carbonate. Measure and record the volume of gas collected in the inverted measuring cylinder containing water as shown in the diagram. A

Let x dm^3 be the volume of carbon dioxide collected.

moles of $CO_2 = \frac{x}{24}$

moles of HA $= \frac{x}{24} \times 2$

$= \frac{x}{12}$

$\therefore$ M_r of HA $= \frac{1}{\frac{x}{12}} = \frac{12}{x}$

.....

.....

.....

.....

.....

.....

..... [5]

(ii) Carbon dioxide is soluble in water.

Suggest how this may cause your calculated value for the M_r of sulfamic acid to be different from its theoretical value.

Explain your answer.

When CO_2 is soluble in water, a smaller volume of CO_2 will be collected. Hence, the moles of CO_2 calculated will be smaller and moles of HA will also be smaller. As moles of HA is smaller, calculated value of Mr will be larger as Mr of HA = $\frac{\text{mass of HA}}{\text{moles of HA}}$ [3]

(iii) Suggest and explain **one** change you could make to your experiment to improve the accuracy of your calculated value for M_r.

change Collect the gas using a gas syringe.

explanation This will prevent CO_2 from dissolving in water, and give a more accurate reading for volume of CO_2 collected.

[1]

[Total: 19]

2 'Burgundy mixture' and 'Bordeaux mixture' are used as fungicides on some plants. They are both mixtures of **two** metal compounds.

R is a sample of Burgundy mixture.
S is a sample of Bordeaux mixture.

You will carry out tests on **R** and **S** to identify ions in both mixtures.

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

Instructions

(a) Carry out the following tests on **R** and **S**. You should test and identify any gases evolved. Record your observations in the table.

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

test	observations for **R**	observations for **S**
Test 1 To the sample in the boiling tube, carefully add dilute nitric acid to a depth of approximately 6 cm. Use a glass rod to stir the mixture. Keep the final solution for use in Tests 2–4.	Effervescence observed. White-blue solid dissolves in nitric acid to form a blue solution. White ppt. formed when gas bubbled through limewater. Gas evolved is carbon dioxide.	Green solid dissolves to form a blue solution.
Test 2 Put 1 cm depth of the solution from Test 1 in a clean test-tube. Add aqueous ammonia slowly with shaking until no further change is seen.	Blue ppt. formed, which is soluble in excess aqueous ammonia to form a deep blue solution.	Blue ppt. formed, which is soluble in excess aqueous ammonia to form a deep blue solution.
Test 3 Put another 1 cm depth of the solution from Test 1 in a clean test-tube. Add aqueous sodium hydroxide slowly with shaking until no further change is seen.	Blue ppt. formed, which is insoluble in excess sodium hydroxide.	Blue ppt. formed, which is insoluble in excess sodium hydroxide.

test	observations for **R**	observations for **S**
Test 4 Put 2 cm depth of the solution from Test 1 in a clean test-tube. Add an equal volume of aqueous barium nitrate. Keep the final solution for use in Test 5.	White ppt. is formed in a blue solution.	White ppt. is formed in a blue solution.
Test 5 Filter the contents of the test-tube from Test 4 into a clean test-tube. Add an equal volume of aqueous silver nitrate to the filtrate.	No ppt. formed.	White ppt. is formed in a blue solution.

[8]

(b) One of the compounds in **R** is the same as one of the compounds in **S**. Suggest the name of this compound and explain your reasoning.

compound present in both **R** and **S** ..... copper(II) sulfate. .....

reasoning ..... In tests 2 and 3, a blue ppt. was formed when aqueous sodium hydroxide and aqueous ammonia was added to R and S, hence there are Cu^{2+} ion. In test 4, a white ppt. is formed when aqueous barium nitrate was added to R and S, hence there are SO_4^{2-} ions. [2]

(c) Both compounds in **R** are soluble. Use this information and the results of your tests to suggest the other compound in **R**. Explain your reasoning.

other compound in **R** ..... Na_2CO_3 .....

reasoning ..... In test 1, effervescence was observed when dilute HNO_3 was added and gas evolved was CO_2. Hence, CO_3^{2-} ions are present. Since the carbonate is soluble and all carbonates are insoluble, except for Group I metal carbonates, the cation is likely to be Na^+. [2]

(d) Use the results of your tests to identify the other anion in **S**.

..... Cl^- ions. ..... [1]

[Total: 13]

3 A student investigates the effect of temperature on the rate of the reaction of zinc with dilute hydrochloric acid.

The student places a piece of zinc in a conical flask containing dilute hydrochloric acid. The student records the total mass of the flask and its contents at timed intervals.

The student repeats the experiment at different temperatures.

The student's results are shown.

Experiment 1 at 20 °C			Experiment 2 at 30 °C			Experiment 3 at 40 °C		
time /min	total mass/g	loss in mass/mg	time /min	total mass/g	loss in mass/mg	time /min	total mass/g	loss in mass/mg
0	81.130	0	0	81.132	0	0	81.129	0
2	81.116	14	2	81.114	18	2	81.100	29
5	81.099	31	5	81.094	38	5	81.075	54
10	81.082	48	10	81.076	56	10	81.065	64
15	81.071	59	15	81.069	63	15	81.063	66
20	81.066	64	20	81.067	65	20	81.063	66

(a) Explain why there is a loss in mass as the reaction proceeds.

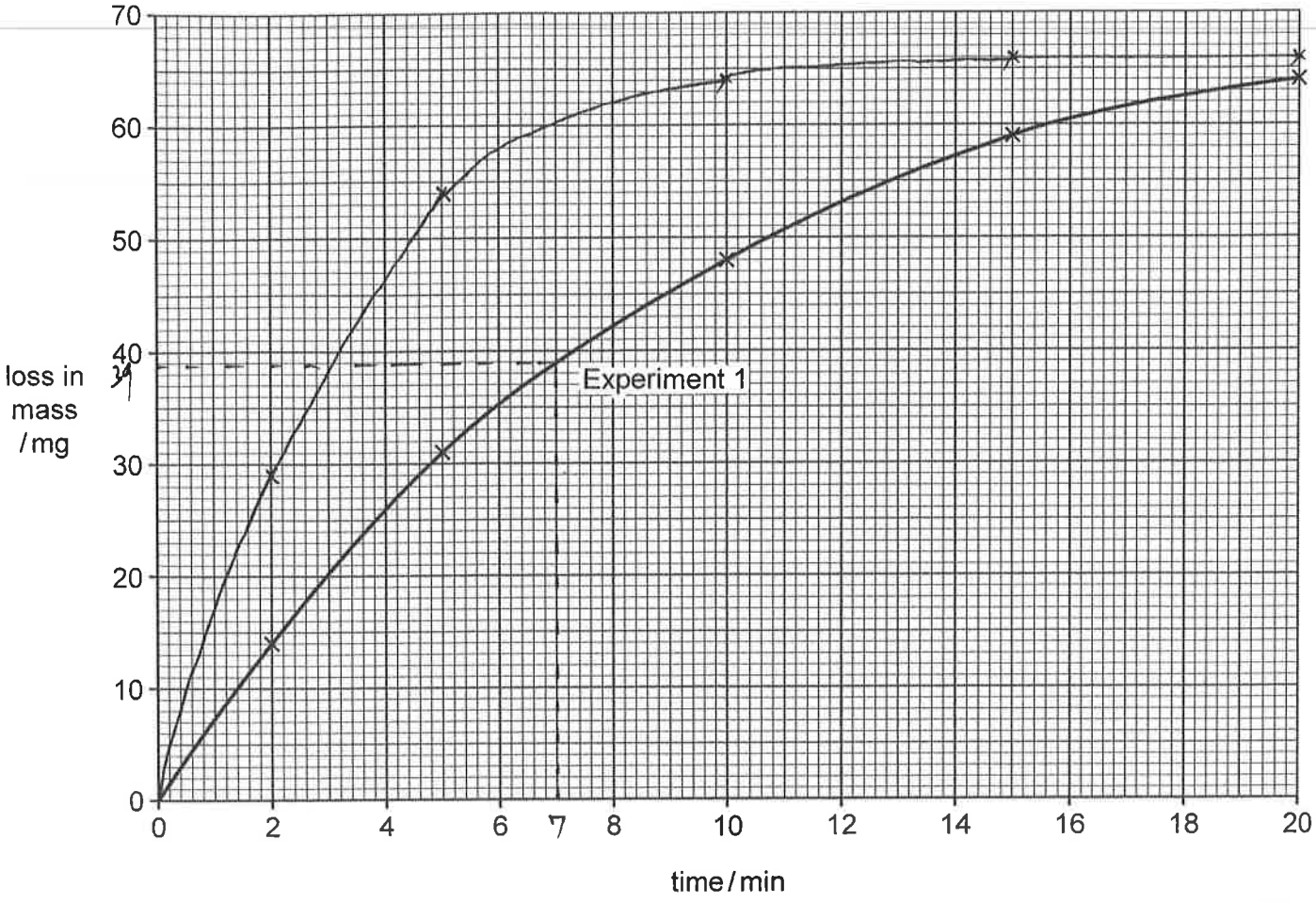
Mass will be lost via H_2 gas.

..... [1]

(b) Complete the table to show the loss in mass, in mg, for Experiment 2. [1]

(c) (i) The results for Experiment 1 are plotted on the grid below.

Plot the results for Experiment 3 on the grid. Draw a line of best fit.



[2]

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

$$\text{average rate of reaction} = \frac{\text{loss in mass}}{\text{time taken}}$$

For Experiment 1, calculate the average rate over the first 7 minutes of the reaction.

Give the units for your answer.

average rate of reaction = $\frac{39}{7}$ = 5.57 mg/min

average rate of reaction ..... 5.57 mg/min. ..... [3]

(d) The student concluded that the reaction in Experiment 3 had finished.

Suggest how the student reached this conclusion.

The loss in mass remains constant from 15 min to 20 min.

..... [1]

[Total: 8]