Practical #1 (2025)

ZHONGHUA SECONDARY SCHOOL

PRELIMINARY EXAMINATION 2025

SECONDARY 4 EXPRESS

Candidate's Name	Class	Register Number
	4E	

CHEMISTRY

6092 /03

Paper 3 Practical

19 August 2025
1 hour 50 minutes

① Percentage purity
② energy change
③ QA (H_2O_2)
④ Planning – compare effectiveness of catalyst through decomposition of H_2O_2.

READ THESE INSTRUCTIONS FIRST

Write your name, index number and class in the spaces at the top of this page.
Write in dark blue or black pen.
You may use a HB pencil for any diagrams or graphs.
Do not use staples, paper clips, highlighters, glue or correction fluid.

Answer **all** questions.
All of your answers should be written in this Question paper:
scrap paper must **not** be used.

Shift
Laboratory

You are expected to record all your observations as soon as they are made.
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 9.
A copy of the Periodic Table is given on page 10.
The use of an approved scientific calculator is expected, where appropriate.

For Examiner's Use	
1	/ 20
2	/ 14
3	/ 6
Total	/40

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.

Set by: Mr Tan Li Chun
Vetted by: Ms Ong Lay Hong

1 Sodium hydrogen carbonate ($NaHCO_3$) is commonly known as baking soda. Sodium hydrogen carbonate, in the presence of water, reacts respectively with calcium chloride, citric acid, and ethanoic acid.

The reaction between sodium hydrogen carbonate and aqueous calcium chloride is represented by the following equation:

$$2\ NaHCO_3\ (s) + CaCl_2\ (aq) \rightarrow CaCO_3\ (s) + 2\ NaCl\ (aq) + H_2O\ (l) + CO_2\ (g)$$

The reaction between sodium hydrogen carbonate and citric acid is **more endothermic** than the reaction between sodium hydrogen carbonate and ethanoic acid.

You are investigating the reaction of sodium hydrogen carbonate with calcium chloride solution and with two acidic solutions, **X** and **Y**. One of these acids is citric acid, and the other is ethanoic acid.

In this investigation, you are to,

1. calculate the percentage yield of calcium carbonate produced in the reaction between sodium hydrogen carbonate and aqueous calcium chloride;

2. identify the two acid solutions, **X** and **Y**, based on the temperature changes that occur in their reactions with sodium hydrogen carbonate.

Apparatus and chemicals

50 cm^3 Measuring cylinder, 3	Distilled water
Styrofoam cups, 3	Tissue papers
250 cm^3 Beaker	Filter paper, 3
250 cm^3 Conical flask	Glass rod
Thermometer	Spatula, 2
Filter funnel	Dropper, 3

Reagents

Part 1 1.0 mol/dm^3 aqueous calcium chloride (50 cm^3)
$NaHCO_3$ (s), **2.00 g** (**1** vial)

Part 2 **X**, 1.0 mol/dm^3 (50 cm^3)
Y, 1.0 mol/dm^3 (50 cm^3)
$NaHCO_3$ (s), **6.00** g (**2** vials)

mass of vial and calcium carbonate = 6.15g

Read through the following instructions before starting the task.
Record all observations and readings in a suitable format.

(a) ***Part 1*****: To prepare calcium carbonate from sodium hydrogen carbonate and aqueous calcium chloride**

1. Using a measuring cylinder, measure **15 cm^3** of aqueous calcium chloride into a Styrofoam cup.

2. Empty vial with **2.00 g** of sodium hydrogen carbonate into the solution in the Styrofoam cup. Stir the mixture with a glass rod.

3. When the reaction has stopped, filter the resulting mixture, which contains a solid product, into a boiling tube.

Note: Wash and dry the empty vial from Step 2 and proceed to Part 2 while waiting for the filtration to complete.

4. Wash the solid product with a little distilled water.

5. Dry the solid product between two pieces of filter paper.

6. Measure and record the mass of the empty vial (from Step 2). 4.90 g

7. Transfer the dry solid product into the empty vial. Measure and record the mass of the vial with the solid product.

8. Calculate and record the mass of the dry solid product.

Results

[4]

(b) Identify one source of error and explain how it affects the results in **part 1**.

.....

.....

[2]

(c) Using your results in **part 1**,

(i) Identify, by calculations, **the limiting reagent**.
(Reagents are 15 cm^3 of 1.0 mol/dm^3 aqueous calcium chloride, 2 g of $NaHCO_3$)

limiting reagent: ..... [3]

(ii) Calculate the theoretical mass of calcium carbonate.

theoretical mass .....g [2]

(iii) Calculate the percentage yield of calcium carbonate.
Give your answers to three significant figures.

percentage yield .....% [3]

(d) *Part 2:* **To identify the two acid solutions, X and Y**

9. Using a measuring cylinder, measure **30 cm^3** of the acid solution, **X**, into a Styrofoam cup.

10. Measure and record the initial temperature of the acid solution, **X**. 30.0°C

11. Empty one vial of sodium hydrogen carbonate **(6.00 g)** into the acid solution, **X**. Stir the mixture with the thermometer quickly to prevent overflow and record the lowest temperature reached. 22.5°C

12. Repeat steps 9 to 11 using the acid solution, Y, instead of **X**. solution Y: 30.0°C lowest temp = 14.0°C

13. Calculate and record the maximum temperature change for each acid solution, **X** and **Y**.

14. Hence, identify the two acid solutions, **X** and **Y**.

Results

Solution **X** is ..... Solution **Y** is ..... [4]

(e) Suggest one way to improve the accuracy of the experiments in **Part 2**.
Give a reason for your answer.

..... [2]

[Total: 20]

2 You are provided with the following unknown substances

- solid salt **P**, 1.5 g (1 boiling tube)
- solid salt **P**, 0.4 g (1 test-tube)
- aqueous solution of salt **Q**, 15 cm^3 (1 vial)

You are also provided with hydrogen peroxide, $H_2O_2(aq)$

Carry out the following tests on **P** and **Q** to determine their identities, recording all your observations in the table. You should test any gas evolved.

If no observable change is observed for a test, write 'no observable change'.

If heating is required, a boiling tube must be used.

test	observations
Test 1 Remove the stopper from the **boiling tube** of salt **P**. Heat the solid **P**, gently at first and then strongly, until no further change is observed. Test for any gas evolved.	white solid turns yellow (1) on cooling, yellow solid turns white (1) gas evolved forms white ppt when bubbled into limewater, CO_2 present. (1) [3]
Test 2 Add about 4 cm depth of nitric acid into the **test-tube** containing solid **P**. Test for any gas evolved. Shake the test-tube if required to completely dissolve solid **P** to form solution **P**. Transfer 2 cm depth of the solution into a clean test-tube. To this test-tube, add aqueous ammonia slowly shaking until no further change is seen.	effervescence (1) · _____ · CO_2 present (1) white ppt formed, soluble in excess to form a colourless solution. (1) [3]
Test 3 Add 2 cm depth of solution **Q** into a test-tube. Add aqueous sodium hydroxide slowly with shaking until no further change is seen.	green ppt formed, insoluble in excess. (1) [1]
Test 4 Add 2 cm depth of solution **Q** into a test-tube. Add equal volume of hydrogen peroxide to the test-tube.	green ppt turned reddish brown. (1) effervescence · gas relights a glowing splint (1) · _____ present. [2]

Test 5 Add 2 cm depth of solution **Q** into a test tube. Add equal volume of dilute nitric acid and then add a few drops of aqueous silver nitrate.	white ppt formed. (1) [1]

(b) Deduce the formula of **P**.

.....[1]

(c) Use the results of your tests to deduce the name of **Q**.

.....[1]

(d) Deduce the role of hydrogen peroxide in **Test 4**. Explain your answer.

.....

.....

.....[2]

[Total: 14]

3 **(a)** A catalyst increases the rate of a chemical reaction and remains chemically unchanged at the end.

Hydrogen peroxide (H_2O_2) slowly decomposes to form oxygen gas. This process occurs very slowly without a catalyst.

Describe a method to compare the effectiveness of copper(II) oxide and maganese(IV) oxide as catalysts for this reaction and whether the catalysts are used up during the reaction.

The description should include:

- apparatus and method
- any measurements or observations
- how to analyse the results

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

You may wish to include one or more labelled diagrams as part of your answer.

[5]

(b) Suggest a method to store hydrogen peroxide to prevent it from decomposing quickly.

[1]

[Total: 6]

Practical #2 (2025)

XINMIN SECONDARY SCHOOL
新民中学
SEKOLAH MENENGAH XINMIN

Preliminary Examination 2025

CANDIDATE NAME

CLASS | | | | INDEX NUMBER | | |

CHEMISTRY

6092/03

Secondary 4 Express

12 August 2025

Setter: Ms Tiffany Lim
Vetter: Ms Una Hsu

1 hour 50 minutes

Candidates answer on the Question Paper.
Additional Materials: As listed in the Confidential Instructions

READ THESE INSTRUCTIONS FIRST

Write your name, class and index number on the work you hand in.
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, correction fluid or highlighters.

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.

Answer all questions in the spaces provided on the Question Paper.
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

① Rate of reaction + planning : effectiveness of catalyst.

② QA - identify acids + energy change

③ titration calculation

For Examiner's Use	
1	/14
2	/11
3	/15
Total	/40
Parent's Signature	

Answer **all** questions.
Write your answers in the spaces provided.

1 **P** is an aqueous solution of hydrogen peroxide acting as an oxidising agent.
Q is an aqueous solution of potassium iodide, mixed with another substance.

When **P** and **Q** react together, they produce iodine according to the reaction below.

$$H_2O_2 + 2I^- \rightarrow 2OH^- + I_2$$

The addition of starch solution to the mixture allows the iodine to be detected as the solution turns blue-black. In **Q**, there is another substance present which rapidly converts iodine back into iodide ions and so the blue-black colour only appears when all of this substance is used up.

You will carry out 5 experiments. In each of the experiments 1 – 5, the same amount of iodine is produced before the mixture turns blue-black.

Experiment 1

(a) (i) Put **Q** into a burette and use it to measure out 10 cm^3 of **Q** into a conical flask. To **Q** in the flask, add 2 cm^3 of starch solution using a 10 cm^3 measuring cylinder. Place the flask and its contents on a white tile.

(ii) Measure 25 cm^3 of **P** as accurately as possible, using a 25 cm^3 measuring cylinder. Pour this volume of **P** rapidly into the mixture of **Q** and starch solution in the flask. Start the stopwatch immediately and swirl the contents of the flask, then leave the mixture to stand. When the mixture first turns blue-black, stop the stopwatch. Record the time taken to the nearest second in Table 1.1.

(iii) Empty the conical flask and rinse it thoroughly with water.

Experiment 2 – 5

(iv) Repeat the procedure described in steps **(i) – (iii)** of Experiment 1 but varying the volume of **P** used.

Hence, in experiment 2, measure 20 cm^3 of **P** as accurately as possible, using a measuring cylinder and then add deionised water to **P** until the total volume of solution in the measuring cylinder is 25 cm^3.

Then, for experiments 3 – 5, choose different volumes of **P** and water and repeat the steps. Record the volumes you have chosen for **P** and water in Table 1.1.

Table 1.1

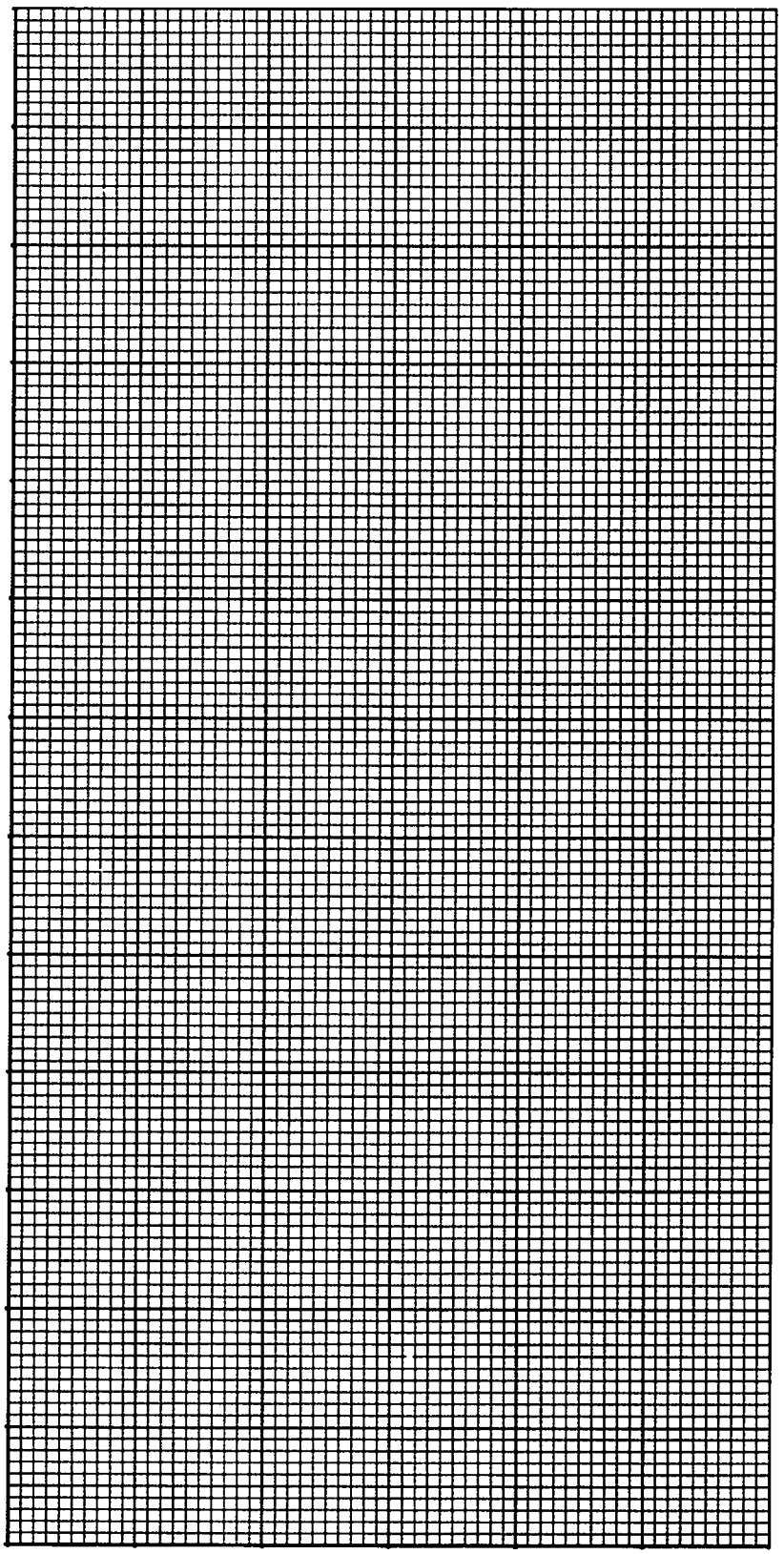
① which set of data is correct.

experiment number	volume of **Q** / cm^3	volume of **P** / cm^3	volume of water / cm^3	time taken for blue-black colour to appear / s		
1	10	25	0	14	14.1	0.14
2	10	20	5	20	20.4	0.20
3	10	15	10	27	27.3	0.27
4	10	10		45	45.6	0.45
5	10	5		200	201.3	2.00

[3]

② what should be ↑ the volume of water

(b) Plot a graph of time taken for the blue-black colour to appear against volume of **P** in the grid below. Using these points, draw a line of best fit.



[4]

(c) Using collision theory, explain the trend shown by the graph in **(b)**.

.....

.....

.....

..... [2]

(d) Suggest **one** change that could be made to the equipment used for the experiments to improve the accuracy of the results.

.....

..... [1]

(e) It has been suggested that metal ions such as Pb^{4+}, Fe^{3+} and Mn^{4+} can act as catalysts for reactions involving hydrogen peroxide. However, these three metals ions have different effectiveness as catalysts.

Given the same solutions, **P** and **Q**, describe how you would investigate the effectiveness of Pb^{4+}, Fe^{3+} and Mn^{4+} catalysts by experiment.

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

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..... [4]

[Total: 14]

2 **(a)** In this experiment, you will determine the identities of acids **R** and **S**.

R and **S** each contain one anion which is listed in the qualitative analysis notes on page 12. The two anions are **not** the same.

Select reagents to determine the identity of the anions in each of the acids, **R** and **S**. You should only use the bench reagents provided.

Carry out 3 tests on **R** and the same 3 tests on **S**. One of the tests has been provided for you in Table 2.1. You should test and name any gas evolved.

If no observable change is observed for a test, write 'no observable change'.

If heating is required, a boiling tube must be used.

Table 2.1

* write out the test for the anion

test	observations for **R**	observations for **S**
③ test for chloride ion	no observable change	no observable change
④ test for sulfate ion	no observable change	white ppt
Add about 1cm depth of **R** in a clean boiling tube. Add 2 cm depth of aqueous sodium hydroxide, shake the contents and then add a piece of aluminium foil. Heat the contents carefully. Repeat the test using **S**.	effervescence gas turns damp red litmus paper blue. NH_3 present	no observable change

[4]

(b) Use your observations in Table 2.1 to deduce the formulae of the acids in **R** and **S**.

R is .....

S is ..... [1]

(c) Neutralisation reactions are exothermic.

In this experiment, you will determine the enthalpy change of a neutralisation reaction between a sample of 1.00 mol/dm^3 aqueous potassium hydroxide and acid **S.**

(i) Instructions

- Using a 25 cm^3 measuring cylinder, measure out 25 cm^3 of acid **S**.
- Transfer acid **S** into a clean 250 cm^3 beaker.
- Measure and record the temperature of acid **S**.
- Use the 50 cm^3 measuring cylinder to measure out 25 cm^3 of aqueous potassium hydroxide.
- Add the aqueous potassium hydroxide into the beaker and gently stir the mixture using the thermometer.
- Measure and record the highest temperature of the mixture.
- Record your results in Table 2.2. Calculate the change in temperature for your experiment.

Table 2.2

temperature of acid **S** / °C	
highest temperature of the mixture / °C	
change in temperature / °C	+6.0°C

[2]

(ii) Enthalpy change of a neutralisation reaction can be calculated by the formula below.

$$\text{Enthalpy change } \left(\frac{\text{kJ}}{\text{mol}}\right) = -\frac{V \times 4.2 \times T}{1000\,n}$$

where V = total volume of solution used in cm^3
T = change in temperature in °C
n = no. of moles of aqueous potassium hydroxide

Using the formula above, calculate the enthalpy change for the neutralisation reaction between aqueous potassium hydroxide and acid **S**.

[2]

(iii) The theoretical value of the enthalpy change of neutralisation between aqueous potassium hydroxide and acid **S** is –57.0 kJ.

Explain why there could be a difference between the theoretical value and your calculated value in **(c)(ii)**.

.....

.....

..... [2]

[Total: 11]

3 Ethanedioic acid is used in some stain removal products. In the solid crystals of ethanedioic acid, $C_2H_2O_4$, each molecule is combined with x molecules of water.

The formula of the crystals is $C_2H_2O_4 \bullet xH_2O$ where x is a whole number. You are to determine the value of x given the information below.

A is aqueous ethanedioic acid. 1.00 dm^3 of A contains 8.90 g of $C_2H_2O_4 \bullet xH_2O$.
B is 0.150 mol/dm^3 of sodium hydroxide, NaOH.

25.0 cm^3 of solution **A** was titrated against solution **B** using thymolphthalein indicator and the results are shown in Fig. 2.3.

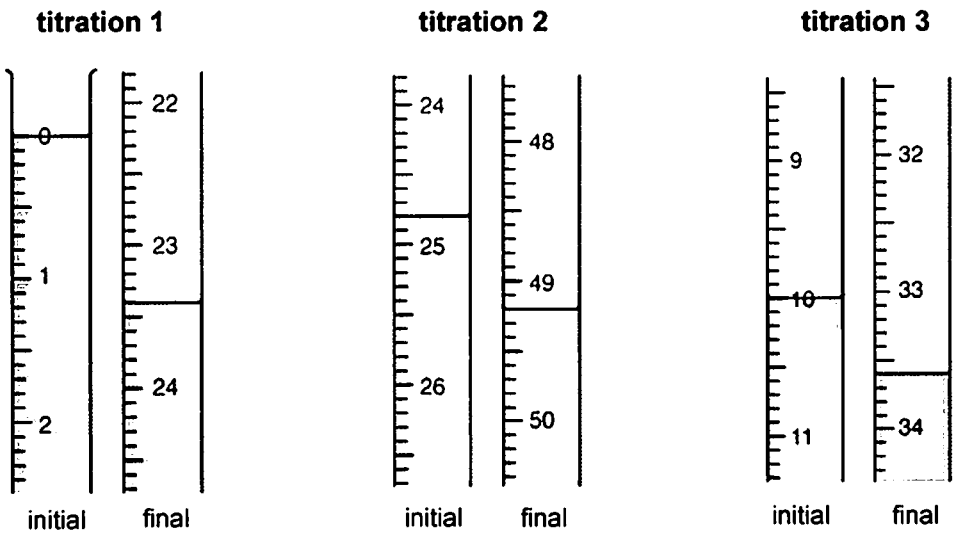

Fig. 2.3

(a) (i) Use the diagrams in **Fig. 2.3** to complete the results table and select the best titration results by indicating a check (✓).

Results

[3]

(ii) Calculate the average volume of **B** required for the titration.

average volume of **B** = ... cm^3 [1]

(b) (i) **B** is 0.150 mol/dm^3 of sodium hydroxide.
Using the titration results, calculate the amount of sodium hydroxide, in moles, used to reach the end-point of the titration. Leave your answers to 3 significant figures.

amount of NaOH in the average volume of **B** = ... mol [1]

(ii) The equation for the titration reaction is shown.

$$C_2H_2O_4 + 2NaOH \rightarrow C_2O_4Na_2 + 2H_2O$$

Using your answer from **(b)(i)** and the equation for the reaction to calculate the number of moles of ethanedioic acid, $C_2H_2O_4$, present in 25.0 cm^3 of **A**. Leave your answers to 3 significant figures.

amount of ethanedioic acid, $C_2H_2O_4$, in 25.0 cm^3 of **A** = ... mol [1]

(iii) Calculate the amount, in moles, of ethanedioic acid, $C_2H_2O_4$, in 1.00dm^3 of **A**. Leave your answers to 3 significant figures.

amount of ethanedioic acid, $C_2H_2O_4$, in 1.00dm^3 of **A** = ... mol [1]

(iv) Calculate the mass of ethanedioic acid, $C_2H_2O_4$, in 1.00 dm^3 of solution **A**. Leave your answers to 3 significant figures.

[A_r: C, 12; H, 1; O, 16]

mass of ethanedioic acid in 1.00 dm^3 of **A** = ... g [1]

(v) The mass of the ethanedioic acid crystals, $C_2H_2O_4 \bullet xH_2O$, that is dissolved in 1.00 dm^3 is 8.90 g.

Use your answer to **(b)(iv)** to calculate the amount, in moles, of water present in 8.90 g of crystals $C_2H_2O_4 \bullet xH_2O$. Leave your answers to 3 significant figures.

[A_r: H, 1; O, 16]

amount of water = ... mol [3]

(vi) Use your answer to **(b)(iii)** and **(b)(v)** to calculate the value of x in the ethanedioic acid crystals, $C_2H_2O_4 \bullet xH_2O$.

value of x = ... [1]

(c) (i) A student completes this experiment. During each titration, the student carelessly dispenses some solution **B** on the walls of the conical flask and attempts to wash them down into the conical flask using some deionised water.

State the explain the effect, if any, that this would have on the volume of **B** required to reach the end-point of the titration.

.....

.....

..... [1]

(ii) Another student performs one of the titrations but realised midway that he had forgotten to add the indicator.

Describe and explain what the student can do to determine if the titration reaction has reached its end-point.

.....

.....

.....

..... [2]

[Total: 15]

End of paper

Practical #3 (2025)

Name:..... Register/Index Number: ..... Class: .....

PRESBYTERIAN HIGH SCHOOL

CHEMISTRY **6092/03**

Paper 3

19 August 2025 **Tuesday** **1 hour 50 minutes**

PRESBYTERIAN HIGH SCHOOL PRESBYTERIAN HIGH SCHOOL PRESBYTERIAN HIGH SCHOOL PRESBYTERIAN HIGH SCHOOL
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2025 SECONDARY FOUR EXPRESS
PRELIMINARY EXAMINATION

Instructions to students:

DO NOT OPEN THIS QUESTION PAPER UNTIL YOU ARE TOLD TO DO SO.

Write in dark blue or black pen in the spaces provided on the Question paper.
You may use a pencil for any diagrams, graphs or rough work.

READ THESE INSTRUCTIONS FIRST

Answer **all** questions.
Write your class, register number and name on all the work you hand in.
You may use pencil for any diagrams, graphs, tables or rough working.
Write in dark blue or black pen.
Do not use staples, paper clips, glue or correction fluid.
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.

Answer **all** questions in the spaces provided on the question paper.

① titration

② QA

③ planning → percentage of water present in a salt.

For Examiner's Use	
1	
2	
3	
Total	

Setter: Mr. Clement Yew
Vetter: Ms. Cynthia Lim

This question paper consists of 9 printed pages.

1. **Q** is an aqueous solution which contains a mixture of sodium carbonate, Na_2CO_3, and sodium hydroxide, NaOH.

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

Instructions

You are to determine by titration, the volume of dilute hydrochloric acid, **P**, needed to neutralize a volume of **Q**, using methyl orange as an indicator, and then calculate the concentration of sodium hydroxide present.

Q is a mixture containing 0.0150 mol/dm^3 of Na_2CO_3 and NaOH.
P is 0.100 mol/dm^3 aqueous hydrochloric acid.

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

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

Add **P** from the burette using the indicator provided.

titration reading.		
26.3	26.4	26.80

Record your titration results in the space provided, repeating the titration as many times as you consider necessary to achieve consistent results. [5]

Results

1. **(a)** **(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**.....[1]

(b) **P** is 0.100 mol/dm^3 hydrochloric acid, HCl.

Using your results, calculate the number of moles of hydrochloric acid present.

moles of hydrochloric acid: ..... mol [2]

(c) The concentration of sodium carbonate, Na_2CO_3, in the mixture **Q** is 0.0150 mol/dm^3.

Calculate the number of moles of sodium carbonate present in the volume of **Q**.

moles of sodium carbonate: ..... mol [2]

(d) Using your answers to **(c)**, deduce the number of moles of hydrochloric acid which react with the sodium carbonate present in your volume of **Q**.

number of moles of hydrochloric acid: ..... mol [2]

1. **(e)** Using your answers to **(b)** and **(d)**, calculate the number of moles of hydrochloric acid which react with the sodium hydroxide in your volume of **Q**.

number of moles of hydrochloric acid:.....mol

(f) Using your answer to **(e)**, calculate the concentration of sodium hydroxide in **Q**.

concentration of sodium hydroxide in Q.....mol/dm^3

(g) A student repeated the experiment and accidentally used a 20.0 cm^3 pipette to measure solution **Q** into the flask in each titration and did not realise it.

Describe and explain the effect this would have on his results.

.....

.....

[Total: 18]

2. A mixture of two solid compounds **D** and **E** was analysed.

Solid **D** was a salt which is soluble in water. Solid **E** was an insoluble metal carbonate. The tests on the mixture and some of the observations are in the following table.

Complete the observations in the table.

	tests	observations
(a)	Add one spatula of solid **D** and solid **E** each in a boiling tube. The mixture was warmed gently.	green solid formed after gentle heating. [1]
(b)	Distilled water was added to the resulting mixture of solids **D** and **E** from part **(a)** to at least one-third of theboiling tube. The contents of the tube were filtered. Keep the residue for part **(c)** and the filtrate for part **(e)**.	green solid formed, insoluble in the mixture. colourless solution collected as the filtrate. green solid collected as the residue. [3]
(c)	Test on residue: Using a spatula, transfer the residuefrom the filter paper into a test-tube. To this test tube, add about 3 cm^3 ofdilute sulfuric acid.	light blue solution formed after adding sulfuric acid. effervescence. gas form white ppt when bubbled into limewater. CO_2 present. [2]
(d)	**(i)** Place 1 cm^3 of the solution from **(c)** to a clean dry test tube. To this test tube, add dilute sodium hydroxide dropwise with shaking, until no further change is observed. **(ii)** Place another 1 cm^3 of the solution from **(c)** to a clean dry test tube. To this test tube, add aqueous ammonia dropwise with shaking, until no further change is observed.	light blue ppt formed, insoluble in excess light blue ppt formed, soluble in excess to form a dark blue solution ☐ light blue ppt turned dark blue ☐ blue ppt dissolves to give dark blue solution [2] ☐

* 3 options given, which one is the correct observation.

(e)	Test on filtrate: The filtrate collected from **(b)** was divided into three approximately equal portions. **(i)** To the first portion, add drops of aqueous sodium hydroxide, until no further change. **(ii)** To the second portion, add excess aqueous ammonia, untilno further change. **(iii)** To the third portion, add a few drops of dilute hydrochloric acid and aqueous barium chloride.	white ppt formed, ppt soluble in excess to form a colourless solution. white ppt formed, ppt soluble in excess to form a colourless solution. white ppt formed. [3]

(f) What conclusions can you draw about the identity of solid **D**?

Provide evidence to explain your answer.

.....

.....

.....

.....[2]

(g) What conclusions can you draw about the identity of the cation in solid **E**?
Provide **two** pieces of evidence to explain your answer.

.....

.....

.....

.....[3]

[Total:16]

3. Washing soda are crystals of hydrated sodium carbonate, $Na_2CO_3.10H_2O$.

When exposed to the air, some of the water is lost from the crystals and a new substance is formed.

This process occurs faster in hotter climates. Plan an experiment to determine percentage of water by mass present in the new substance.

You are provided with common laboratory apparatus.

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.....[6]

End of Paper

QUALITATIVE ANALYSIS NOTES

Tests 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 precipitate
iodide (I^-) [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	yellow precipitate
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 precipitate

Tests for aqueous cations

cation	*effect of aqueous sodium hydroxide*	*effect of aqueous ammonia*
aluminium (Al^{3+})	white precipitate, soluble in excess, giving a colourless solution	white precipitate, insoluble in excess
ammonium (NH_4^+)	ammonia produced on warming	-
calcium (Ca^{2+})	white precipitate, insoluble in excess	no precipitate
copper(II) (Cu^{2+})	light blue precipitate, insoluble in excess	light blue precipitate, soluble in excess, giving a dark blue solution
iron(II) (Fe^{2+})	green precipitate, insoluble in excess	green precipitate, insoluble in excess
iron(III) (Fe^{3+})	red-brown precipitate, insoluble in excess	red-brown precipitate, insoluble in excess
zinc (Zn^{2+})	white precipitate, soluble in excess, giving a colourless solution	white precipitate, soluble in excess, giving a colourless solution

Tests for gases

gas	*test and test result*
ammonia (NH_3)	turns damp red litmus paper blue
carbon dioxide (CO_2)	gives white precipitate with limewater (precipitate 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

Practical #4 (2025)

Name:	Class:	Class Register Number:

中正中学

CHUNG CHENG HIGH SCHOOL (MAIN)

PRELIMINARY EXAMINATION 2025
SECONDARY 4

CHEMISTRY

6092/03

Paper 3 Practical

22 August 2025

1 hour 50 minutes

Candidates answer on the Question Paper.
Additional Materials: As listed in the Confidential Instructions

READ THESE INSTRUCTIONS FIRST

Write your name, class and register number clearly 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 an 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.

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 8.

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	/ 40

① energy change
② QA
③ planning

This document consists of **8** printed pages.

1 The general formula of monobasic acids can be represented by the formula H*A*.

The reaction between H*A* and an alkali is exothermic. By investigating the temperature rises which occur when different volumes of the two solutions are mixed, the results can be used to determine the molar mass of the acid H*A*.

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

Instructions

You are going to carry out seven experiments.

P is a strong monobasic acid made by dissolving 20.0 g of H*A* in 250.0 cm^3 of water.

Q is aqueous 1.20 mol/dm^3 sodium hydroxide.

(a) Experiment 1

- Place a Styrofoam cup into a 250 cm^3 beaker.
- Put **P** in 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 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.

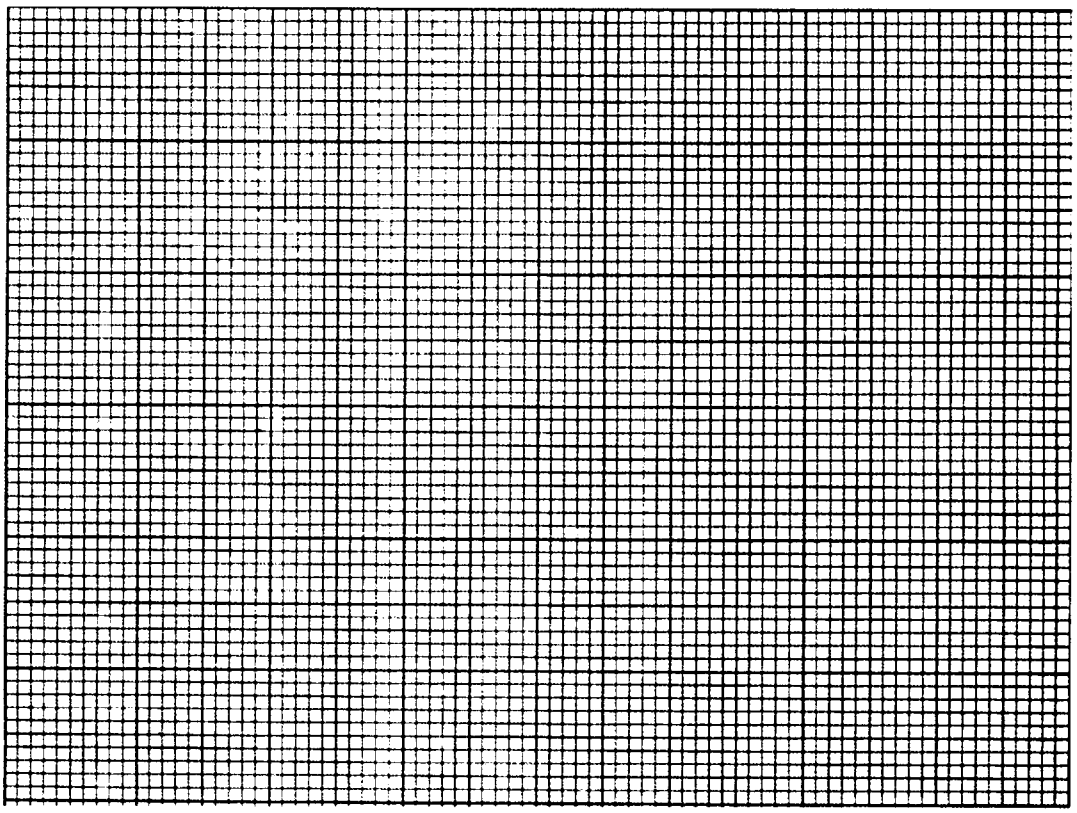
Complete the table by calculating the temperature rise for each experiment.

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) Use your graph to determine the volume of **Q** where the two lines intersect.
Show clearly **on the graph** how you obtained your answer.

..... cm^3 [1]

(d) Calculate the number of moles of sodium hydroxide present in the volume of **Q** in **(c)**.

..... mol [1]

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

..... cm^3 [1]

(f) Calculate the concentration of H*A* in **P**, in mol/dm^3.

.....mol/dm^3 [2]

(g) Calculate the molar mass of H*A*.

[3]

(h) Suggest how the accuracy of molar mass of **P** can be improved.

.....

.....[1]

[Total: 17]

annotate on the question first before you refer to the answer for the observation.

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

You are provided with a sample of salt **R**, dilute acid **S** and aqueous sodium chlorate(I), NaC*l*O, labelled **T**.

Instructions

Carry out the following tests on **R** and **S**. Test 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, unless referring to drops of solution, are approximate and should be estimated rather than measured.

	test	*observations*
(a)	Heat the sample of **R** until no further change. Keep the contents for part **(c)**.	[3]
(b)	Add about 2 cm depth of **T** in a clean test tube. Add an equal volume of **S**. Warm the mixture. Test for any gas evolved.	[2]
(c)	Transfer the contents of the test-tube in part **(a)** into a beaker. Add all of the remaining **S** into the beaker. Stir the mixture. This is solution **X**.	[1]
(d)	Add about 2 cm depth of **X** into a clean test tube. Add aqueous sodium hydroxide slowly with shaking until no further change is seen. Add a piece of aluminium into the mixture. Warm the mixture.	[2]
(e)	Add about 2 cm depth of **X** into a clean test tube. Add aqueous ammonia slowly with shaking until no further change is seen.	[1]

(f)	Add about 2 cm depth of **X** into a clean test tube. Add an equal volume dilute nitric acid followed by a few drops aqueous silver nitrate.	[1]
(g)	Add about 2 cm depth of **X** into a clean test tube. Add an equal volume dilute nitric acid followed by a few drops aqueous barium nitrate.	[1]

(h) Deduce the identity of **R** and **S**. Explain your deductions using evidence from your observations.

.....

.....

.....

.....

.....

.....[5]

(i) Is **S** an oxidising or reducing agent? Explain your answer from the observations.

.....

.....[1]

[Total: 17]

3 Sea water contains many cations and anions, with high concentrations of sodium, magnesium, chloride and sulfate ions. The concentration of chloride ions in sea water can be determined by precipitating it using aqueous silver nitrate:

$$Ag^+ (aq) + Cl^- (aq) \rightarrow AgCl (s)$$

Describe a method to determine the concentration of chloride ions in 100 cm^3 of sea water provided.

In your method, you should include:

- assumptions made
- the apparatus you would use
- the measurements you would take
- an explanation of how you would use your results to determine the concentration of chloride ions in mol/dm^3.

You can assume that all apparatus normally found in a school laboratory are available.

[A_r: Ag 108, Cl 35.5]

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.....[6]

Practical #5 (2025)

TANJONG KATONG GIRLS' SCHOOL
PRELIMINARY EXAMINATION
SECONDARY FOUR EXPRESS

CANDIDATE NAME

CLASS 4

INDEX NUMBER

CHEMISTRY
Paper 3 Practical Test

6092/03
5 August 2025
1 hour 50 minutes

Candidates answer on the Question Paper.

READ THESE INSTRUCTIONS FIRST

Write your name, class and register number on all the work you hand in.
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.

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 **13**.

The number of marks is given in brackets [ ] at the end of each question or part question.

Shift
Laboratory

① weight of ppt
② energy change
③ QA

For Examiner's Use	
1	
2	
3	
Total	

1 You are going to investigate the reaction between aqueous copper(II) nitrate and aqueous sodium carbonate.

Step 1: Label the test-tubes 1, 2, 3, 4 and 5 and place them in order in the test-tube rack.

Step 2: Use the measuring cylinder to pour 5.0 cm^3 of the 1 mol/dm^3 of aqueous copper(II) nitrate into each of the five test-tubes.

Step 3: Using another measuring cylinder, add 1.0 cm^3 of 1 mol/dm^3 of aqueous sodium carbonate to test-tube 1. Using the glass rod, carefully stir the contents of the test-tube. **Repeat for steps 4 to 7**. Rinse the glass rod with distilled water before stirring it in each test-tube.

Step 4: Add 2.0 cm^3 of 1 mol/dm^3 of aqueous sodium carbonate to test-tube 2.

Step 5: Add 3.0 cm^3 of 1 mol/dm^3 of aqueous sodium carbonate to test-tube 3.

Step 6: Add 4.0 cm^3 of 1 mol/dm^3 of aqueous sodium carbonate to test-tube 4.

Step 7: Add 5.0 cm^3 of 1 mol/dm^3 of aqueous sodium carbonate to test-tube 5.

Leave the contents of the test-tubes to stand for 15 minutes.

You should start Question 2 while you are waiting for the solid formed in the test-tubes to settle.

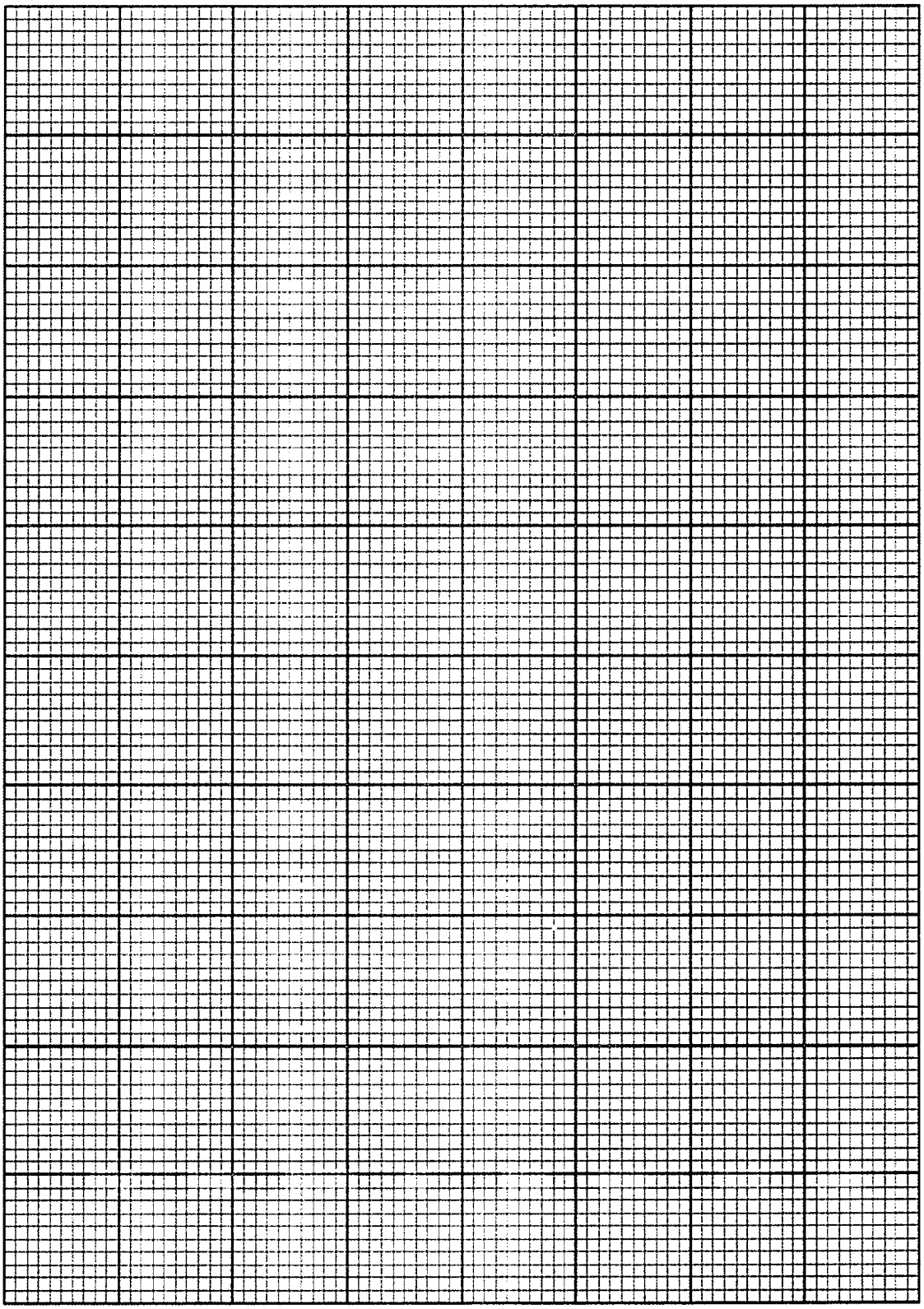
(a) After 15 minutes, use a ruler to measure the height of the solid formed in each test-tube. In Table 1, record the volume of 1 mol/dm^3 of aqueous sodium carbonate added, and the height (in cm) of the solid formed in each test-tube. Include appropriate headings in Table 1.

Table 1

test-tube number		
1	1.0	1.5
2	2.0	2.2
3	3.0	4.5
4	4.0	5.2
5	5.0	7.0

[4]

(b) On the grid provided, plot a graph of height of solid against volume of aqueous sodium carbonate added.



[4]

(c) Describe the trend in the height of the solids formed in test-tubes 1 to 5.

.....

.....[1]

(d) From the graph, deduce the height of the solid formed when 0.0045 moles of aqueous sodium carbonate are added to 0.005 moles of copper(II) nitrate.

.....[1]

(e) Suggest two improvements that can be made in order to improve the accuracy of the results.

.....

.....

.....[2]

[Total: 12]

2 Water of crystallisation refers to the water molecules bonded to the lattice structure of ionic compounds.

You are going to investigate the enthalpy change, ΔH_{hyd}, when anhydrous sodium carbonate, Na_2CO_3, converts to hydrated sodium carbonate, $Na_2CO_3.10H_2O$.

One way to determine the enthalpy change is to measure the changes in temperature when samples of anhydrous sodium carbonate and hydrated sodium carbonate are added separately to excess hydrochloric acid.

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

Instructions

You are going to carry out two experiments.

X is 2.2 g of anhydrous sodium carbonate, Na_2CO_3.

Y is 5.5 g of hydrated sodium carbonate, $Na_2CO_3.10H_2O$

Z is 1.50 mol/dm^3 hydrochloric acid, HC*l*.

(a) Experiment 1

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

Transfer 25.0 cm^3 of **Z** into the cup using the 25 cm^3 measuring cylinder. Measure the temperature of **Z** and record the value in the table.

Pour all of **X** into the acid in the cup. Stir, using the thermometer, and measure the highest or lowest temperature reached. Record this temperature in the table.

Experiment 2

Repeat *Experiment* 1 using the Styrofoam cup, but use **Y** in place of **X**.

Complete Table 2 and calculate the temperature change for each experiment.

Table 2

experiment	initial temperature of **Z** /°C	highest or lowest temperature of **Z** /°C	temperature change /°C
1	30.0	38.5	
2	30.0	21.0	

[3]

(b) **(i)** The amount of heat transferred in the experiments can be calculated using the expression shown.

Heat transferred (J) = mass of solution (g) x maximum temperature change (°C) x 4.2

Use this expression to calculate, in J, the amount of heat transferred in each experiment.

Assume that 1.0 cm^3 of solution has a mass of 1.0 g.

Experiment 1 with X: heat transferred = ...J

Experiment 2 with Y: heat transferred = ...J [2]

(ii) Calculate the enthalpy change, ΔH, in kJ/mol, when all the solid reacts with hydrochloric acid in each experiment.

[M_r: Na_2CO_3, 106, $Na_2CO_3.10H_2O$, 286]

$$\text{Enthalpy change, } \Delta H = \frac{\text{Heat transferred in kJ}}{\text{Number of moles of solid}}$$

Experiment 1 with X: ΔH_1 = ... kJ/mol

Experiment 2 with Y: ΔH_2 = ... kJ/mol [2]

(iii) The enthalpy change of hydration, ΔH_{hyd}, can be calculated using the expression:

$$\Delta H_{hyd} = \Delta H_1 - \Delta H_2$$

Use your answers from **(b)(ii)** to calculate the enthalpy change of hydration, ΔH_{hyd}.

ΔH_{hyd} = ... kJ/mol [1]

(iv) Another way to determine the hydration of anhydrous sodium carbonate can be shown in a two-step chemical equation as shown.

step 1: Na_2CO_3 (s) + $10H_2O$ (*l*) → Na_2CO_3 (s) + $10H_2O$ (g)
step 2: Na_2CO_3 (s) + $10H_2O$ (g) → $Na_2CO_3.10H_2O$ (s)

Using your knowledge of Kinetic Particle Theory, explain if **step 1** is an endothermic or exothermic process.

.....

.....

.....[2]

(v) Explain why it is necessary to stir the mixture in the cup before measuring the highest or lowest temperature reached.

.....

.....[1]

(vi) State one source of error and suggest one improvement that can made to reduce this error.

error.....

.....

improvement.....

.....[2]

(vii) A student carrying out the experiment with an anhydrous sodium carbonate, **X**, could not find 1.50 mol/dm^3 hydrochloric acid. The student used the same volume of 0.750 mol/dm^3 sulfuric acid instead.

Predict and explain the effect on the change in temperature obtained by the student. Assume the same mass of **X** was used.

.....

.....

.....[2]

[Total: 15]

3 **Read all the instructions carefully before starting the experiments in Question 3.**

You are provided with a mixture of two solids, **J** and **K**, which are both salts. **J** is soluble and **K** is insoluble in water.

Carry out the following tests and record your observation. You should test and name any gas evolved. If no change is observed for a test, write 'no observable change'.

Instructions

(a) Add 3 spatulas of the mixture to a boiling tube. Add a 6 cm depth of distilled water to the mixture. Stopper the boiling tube with a rubber bung and shake the mixture for a minute.

Filter the mixture and keep the residue for tests later.

Tests on filtrate
Divide the solution into two equal portions in two test-tubes.

test	observations
Test 1 To the first portion of the solution, add about 1 cm depth of aqueous sodium hydroxide and shake the contents. Heat the contents carefully and test any gas evolved with damp litmus paper.	
Test 2 To the second portion of the solution, add a 1cm depth of dilute nitric acid into a test-tube. Add a few drops of aqueous silver nitrate.	

Test on residue

test	observations
Test 3 Use a spatula to transfer some of the residue into a test-tube. Add dilute hydrochloric acid to a depth of approximately 3 cm. To the solution formed, add about 1 cm depth of dilute sulfuric acid.	

[4]

(b) Deduce the formulae of the cation and anion present in solid **J**.

cation: .....

anion: .....

[2]

(c) Using your knowledge on solubility rules, suggest the identity of solid **K**. Use your observations to explain how you reached the conclusion.

solid **K** .....

.....

..... [2]

(d) A farmer would like to fertilise his soil with the fertiliser ammonium sulfate, $(NH_4)_2SO_4$. He took a sample of the soil and would like to find out the amount of ammonium sulfate fertiliser already present in the soil.

You are **not** to use precipitation method.

With the help of a chemical equation, outline a method to determine the mass of sulfate ions present in the soil.

.....

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.....[5]

[Total: 13]

Practical #6 (2025)

O

ANDERSON SECONDARY SCHOOL
Preliminary Examination 2025
Secondary Four Express

CANDIDATE NAME:

CLASS: / INDEX NUMBER:

CHEMISTRY **6092/03**

Paper 3 Practical **02 September 2025**

1 hour 50 minutes

Candidates answer on the Question Paper

Additional Materials: Nil

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 an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, highlighters, glue or correction fluid/tape.

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

For Examiner's Use	
1	/13
2	/16
3	/11
Total	/40

① titration
② QA
③ energy change + planning

1 Hydrogen peroxide, H_2O_2, is used in hair bleach and for skin therapies.

The concentration of an aqueous solution of hydrogen peroxide can be expressed in terms of 'percent weight per volume' or % w/v. A bottle of hydrogen peroxide solution labelled as 30% w/v means that it contains 30 g of hydrogen peroxide per 100 cm^3 of solution.

You are going to determine the % w/v of a bottle of commercial hydrogen peroxide solution by performing a titration using aqueous potassium manganate(VII).

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

Instructions

Q is 0.0200 mol/dm^3 potassium manganate(VII).

R is an aqueous solution of hydrogen peroxide. The solution was made by diluting a sample of 50 cm^3 of the commercial hydrogen peroxide solution to 1.00 dm^3 by adding deionised water.

(a) (i) Fill the burette with **Q**.
The colour of **Q** makes it difficult to see the bottom of the meniscus so you should take all your readings using the top of the meniscus.

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

Use a measuring cylinder to add 10 cm^3 of dilute sulfuric acid from the bench reagents to the conical flask.

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

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

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

Results

[5]

(ii) Use your titration results to obtain the average volume of **Q** used.
Show clearly how you obtained this volume.

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

(b) **Q** is 0.0200 mol/dm^3 aqueous potassium manganate(VII).

Calculate the number of moles of potassium manganate(VII) present in the average volume of **Q**.

amount of potassium manganate(VII) = ... mol [1]

(c) Two moles of potassium manganate(VII) react with five moles of hydrogen peroxide.

(i) Calculate the number of moles of H_2O_2 in 1 dm^3 of solution **R**.

amount of H_2O_2 = ... mol [2]

(ii) Calculate the concentration, in g/dm^3, of hydrogen peroxide in solution **R**.
[A_r: H,1; O,16]

concentration of hydrogen peroxide in **R** ..... g/dm^3 [1]

(iii) Using your answer from **(c)(ii)**, calculate % w/v of the commercial hydrogen peroxide solution.

% w/v of the commercial hydrogen peroxide solution ..... % w/v [1]

(iv) State the role of **R** on **Q**. Explain your answer using observations seen during the titration.

.....

..... [2]

[Total: 13]

2 You are provided with,
- **S** in a boiling tube and,
- solution **T** in a vial

Under strong heating, **S** decomposes to form an oxide.

You will carry out tests on **S** and **T** and make deductions about their identities and chemical properties.

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

Instructions

(a) Remove the stopper from the sample of **S** in the boiling tube and then find the mass of the boiling tube and its contents.

Heat **S** strongly for 3 minutes until no further changes are seen. During the heating process, withdraw several samples of gas from inside the boiling tube using a teat pipette. Do not allow the teat pipette to touch the sides of the boiling tube. Each time, bubble the gas from the teat pipette through the limewater.

Leave the boiling tube to cool to room temperature.

Record your observations in **(a)(i)**.

Reweigh the boiling tube and its contents and record the mass.

Record all your results in an appropriate format in **(a)(ii)**.

While waiting for the contents of the boiling tube to cool, you may proceed with part **(b)**.

Do not discard the contents in the boiling tube, it is required for part **(a)(iii)**.

(i) Observations

.....

.....

..... [2]

(ii) Results

From your results determine:
the mass of **S** before heating .....g

the change in mass after heating ..... g [3]

(iii) Put about 5 cm depth of deionised water in boiling tube containing the oxide from part **(a)**.
Add two to three drops of calcium hydroxide solution and then add a few drops of Universal Indicator.
Gently heat the mixture until no further change is seen. Do **not** allow it to boil.
Allow the boiling tube to stand and observe the aqueous part of the mixture.

Record your observations.

.....

..... [1]

(iv) Write the formula of the anion present in **S**.

..... [1]

(v) Based on the test in **(iii)**, state the nature of the oxide obtained from the decomposition of **S**. Explain your answer.

.....

.....

..... [2]

(b) In this experiment, you will determine the identity of **T**.

T contains a cation and anion which are listed in the qualitative analysis notes on pg 12.

Select reagents to determine the identity of the ions in **T**. You should only use the bench reagents provided.

Carry out 3 tests on **T**. Only record the positive tests. Test 1 has been provided for you in table 2.1.

You should use about 1 cm depth of solution **T** for each test.

Table 2.1

test	observation
(i) Test 1 Add about 1 cm depth of solution T into a clean test-tube. To this test tube, add three pieces of magnesium strip. Allow the mixture to stand for several minutes.	[1]
Carefully pour off the solution into a clean test-tube to leave the solid behind.	[1]
(ii) Test 2 [1]	[1]

(iii) **Test 3**	
[1]	[1]

(iv) Name **T**.

..... [1]

[Total: 16]

3 Heat released from an exothermic reaction is used to warm the contents of food. The typical reaction involves adding 100 cm^3 of water to a solid mixture containing powdered magnesium, iron, and a salt.

A student investigates the amount of heat released during the reaction.

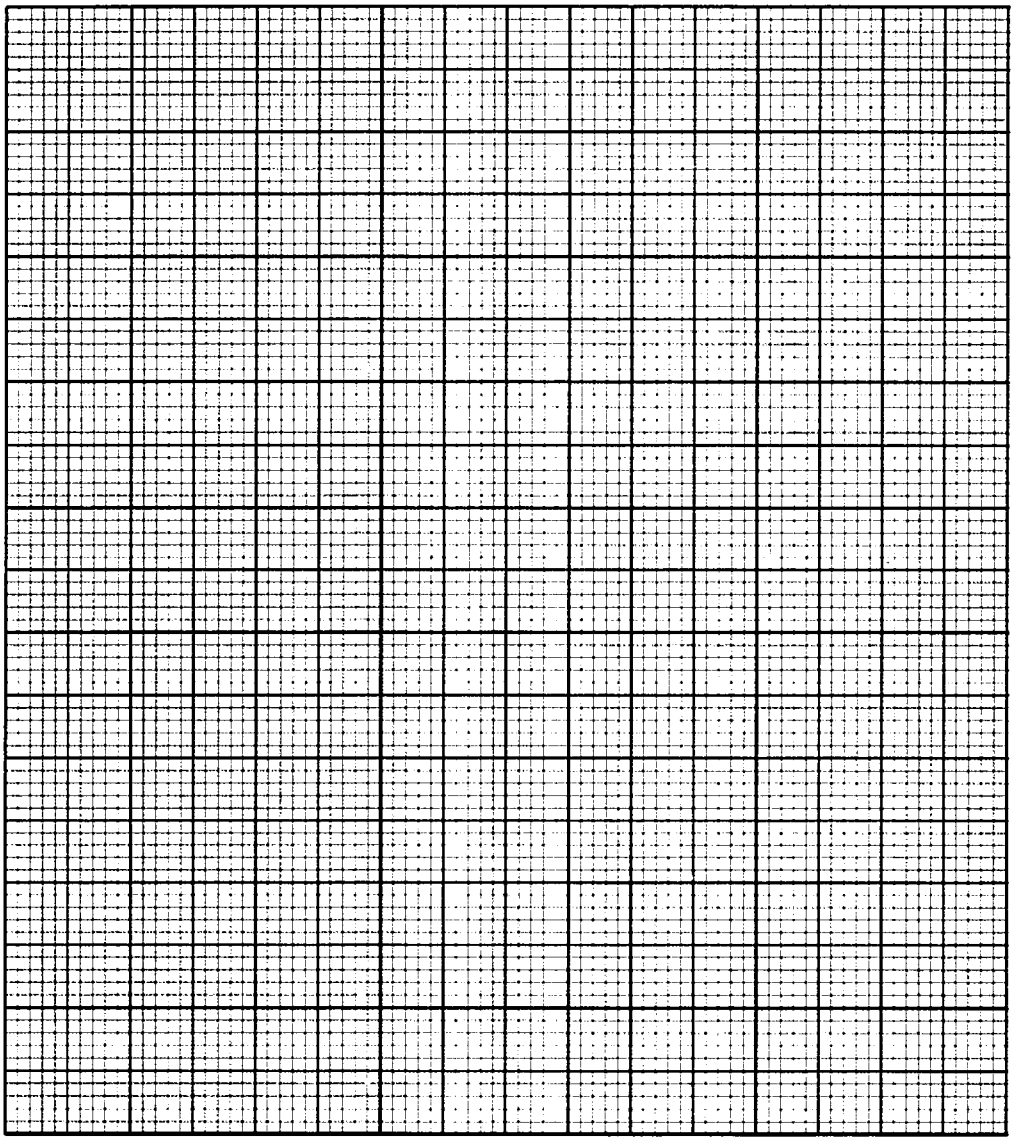
The results obtained are shown in table 3.1.

Table 3.1

time / min	temperature / °C
0	24.0
1	26.0
2	28.0
3	31.0
4	33.0
5	38.0
6	
7	39.0
8	36.0
9	35.0
10	32.0
11	30.0
12	28.0

(a) (i) Plot a graph of temperature against time on the grid.

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



[4]

(ii) Use your lines from **(b)(i)** to determine the maximum rise in temperature.

maximum rise in temperature = ... [2]

(b) Describe the procedure for this experiment. The procedure should include suitable apparatus and the measurements that need to be taken.

You can assume that all apparatus normally found in a school laboratory is available.

You may use a labelled diagram to illustrate your answer.

You do **not** need to explain how you would use your results to obtain the graph.

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..... [3]

(b) Another student performed the experiment with some changes in conditions and had a much lower rise in temperature.
Suggest two changes in conditions that can cause this result.

.....

..... [2]

[Total: 11]