



**TANJONG KATONG GIRLS' SCHOOL
PRELIMINARY EXAMINATION
SECONDARY FOUR EXPRESS**

CANDIDATE
NAME

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CLASS

4		
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INDEX
NUMBER

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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

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.

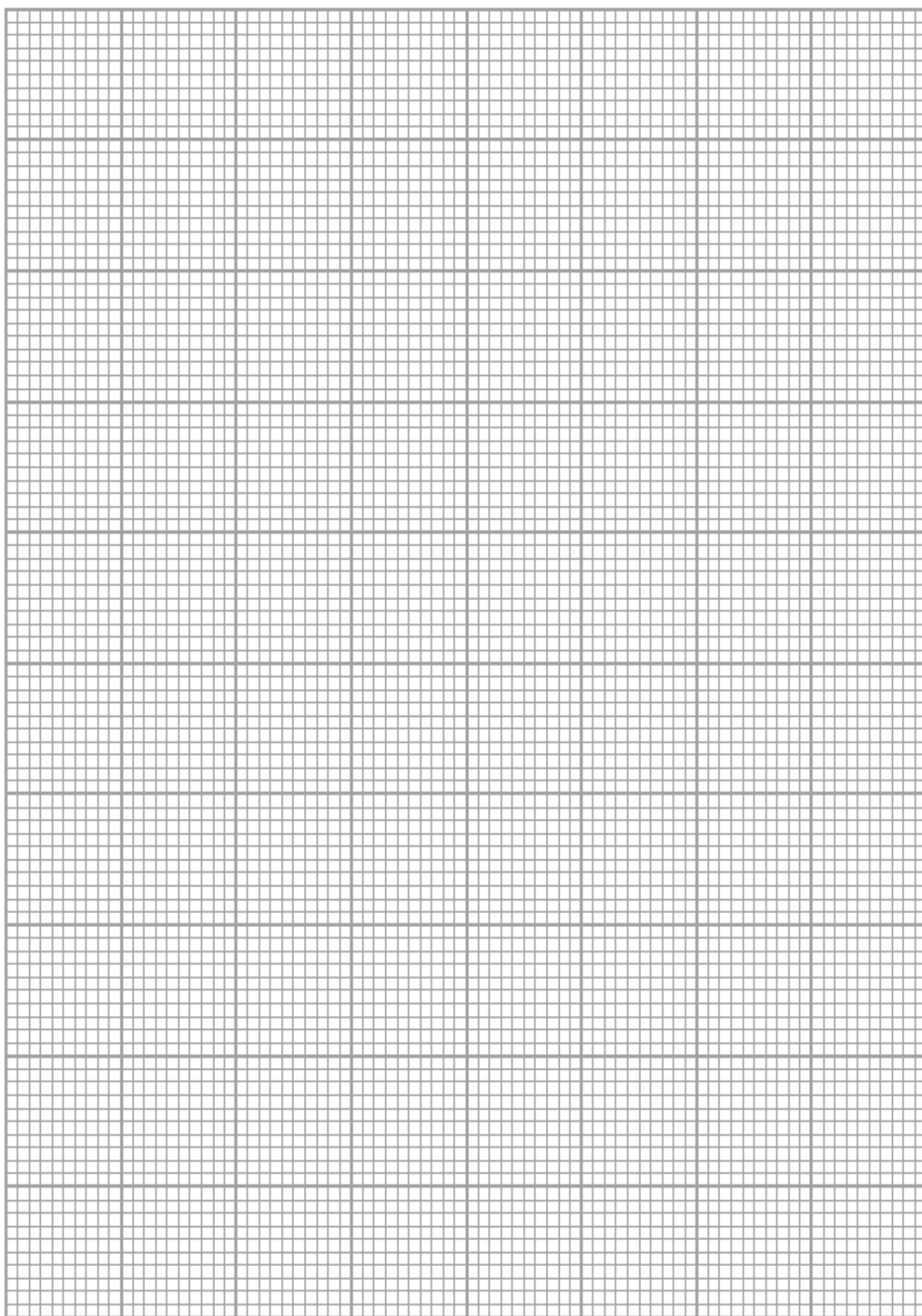
- (a) After 15 minutes, use a ruler to measure the height of the solid formed in each test-tube. In Table 1, record the volume of 1 mol/dm^3 of aqueous sodium carbonate added, and the height (in cm) of the solid formed in each test-tube. Include appropriate headings in Table 1.

Table 1

test-tube number		
1		
2		
3		
4		
5		

[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, $\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$.

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, $\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$

Z is 1.50 mol/dm³ hydrochloric acid, HCl.

(a) Experiment 1

Place a Styrofoam cup into a 250 cm³ beaker.

Transfer 25.0 cm³ of **Z** into the cup using the 25 cm³ 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			
2			

[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 cm³ 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, $\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$, 286]

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

Experiment 1 with X: $\Delta H_1 = \dots\dots\dots$ kJ/mol

Experiment 2 with Y: $\Delta H_2 = \dots\dots\dots$ kJ/mol [2]

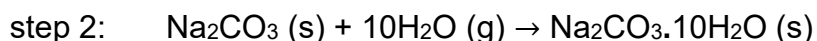
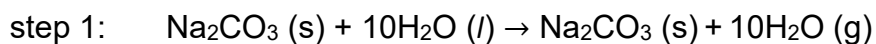
- (iii) The enthalpy change of hydration, ΔH_{hyd} , can be calculated using the expression:

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

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

$\Delta H_{\text{hyd}} = \dots\dots\dots$ 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.



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, $(\text{NH}_4)_2\text{SO}_4$. 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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.....

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.....

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.....

.....

.....[5]

[Total: 13]

NOTES FOR QUALITATIVE ANALYSIS

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 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.

Tests 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

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

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Preparation list

Question 1:	
Apparatus for each candidate: • 1 x test-tube rack • 5 x test-tubes • 1 x test-tube holder • 1 x glass rod • 2 x droppers • 1 x wash bottle with distilled water • 2 x 10 cm³ measuring cylinder • 1 x black marker • 1 x filter funnel • 1 x 15 cm ruler	Chemicals for each candidate: • 100 cm³ of 1 mol/dm³ aqueous sodium carbonate • 100 cm³ of 1 mol/dm³ aqueous copper(II) nitrate

Question 2	
Apparatus for each candidate: • 1 x 250 cm³ beaker • 1x thermometer (-10°C to +110°C) • 1 x Styrofoam cup • 1 x 25 cm³ measuring cylinder	Chemicals for each candidate: • anhydrous sodium carbonate (labelled X) Provide 2.2 ± 0.1 g of Na₂CO₃ in a stoppered container • hydrated sodium carbonate (labelled Y) Provide 5.5 ± 0.1 g of Na₂CO₃ · 10H₂O in a stoppered container • 1.5 mol/dm³ hydrochloric acid (labelled Z) 70 cm³ per student

Question 3:**Apparatus for each candidate:**

- 1 x test-tube rack
- 3 x test-tubes
- 1 x lighter
- 1 x test-tube holder
- 3 x spatula
- 1 x glass rod
- 1 x dropper
- 1 x wooden splint
- litmus papers (1 bottle each)
- 1 x wash bottle with distilled water
- 1 x 10 cm³ measuring cylinder
- 2 x boiling tubes
- 1 x stopper for boiling tube
- 2 x filter papers
- 1 x filter funnel
- 1 x delivery tube

Chemicals for each candidate:

- Aqueous sodium hydroxide
- Dilute hydrochloric acid
- Dilute sulfuric acid
- Dilute nitric acid
- Aqueous silver nitrate
- Aqueous barium nitrate
- Aqueous ammonia
- Limewater
- 1 vial of mixture of ammonium chloride and barium carbonate about 3.0 g.