Mrs Ng's results (Shift 3)

XINMIN SECONDARY SCHOOL
新民中学
SEKOLAH MENENGAH XINMIN

Preliminary Examination 2024

CANDIDATE NAME

CLASS INDEX NUMBER

CHEMISTRY **6092/03**

Secondary 4 Express **14 Aug 2024**

Setter: Mr Lim Boon Ping
Vetters: Mrs Annie Ng / Ms Tiffany Lim **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 9.

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
3
Laboratory

For Examiner's Use	
1	/ 16
2	/ 18
3	/ 6
Total	/ 40
Parent's Signature	

This document consists of **10** printed pages.

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

1 You are going to investigate the temperature changes when two solids, **C** and **D**, dissolve in water.

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

Instructions

You are going to do two experiments.

(a) Experiment 1

1. Put the polystyrene cup into the 250 cm^3 beaker for support.
2. Use the measuring cylinder to pour 40 cm^3 of deionised water into the polystyrene cup.
3. Measure the initial temperature of the deionised water and record it in the first row of the table.
4. Add the 5 g sample of solid **C** to the polystyrene cup and stir the solution with the thermometer.
5. Measure and record the temperature of the solution after 1 minute.
6. Calculate and record the temperature change, including whether the temperature increased (+) or decreased (–).
7. Pour the solution away and rinse out the polystyrene cup with deionised water.
8. Repeat the procedure using the 7 g and 8 g samples of solid **C**. Record your results and the temperature change, including whether the temperature increased (+) or decreased (–), in the appropriate row of the table.

mass of solid **C** / g	initial temperature of the water / °C	temperature of the solution after 1 min / °C	temperature change / °C
5	31.0	28.0	-3.0
7	31.0	27.0	-4.0
8	31.0	26.5	-4.5

[2]

1. initial **AND** final **AND** temperature change boxes completed correctly **AND** temperatures recorded to 1 decimal place
2. temperature change values ascending in magnitude **AND at least 2** within 1.0 °C of supervisor's

(b) **Experiment 2**
Repeat Experiment 1 but using the 3 g, 4 g, 6 g and 8 g samples of solid **D**.

Record your results in a table.

In your table, calculate and record the temperature changes in each case, including whether the temperature increased (+) or decreased (–).

Results:

mass of solid D / g	initial temperature of the water / °C	temperature of the solution after 1 min / °C	temperature change / °C	Mr Lim's results
3	31.0	35.0	+ 4.0	+ 3.0
4	31.0	36.0	+ 5.0	+ 4.5
6	31.0	39.0	+ 8.0	+ 8.0
8	31.0	42.0	+ 11.0	+ 10.5

1. table with appropriate headings **AND** units
2. initial **AND** final temperature **AND** temperature change boxes completed correctly **AND** all temperature **AND** temperature changes recorded to the same number of decimal places
3. temperature change values ascending in magnitude **AND at least 2** within 1.0 °C of supervisor's

[3]

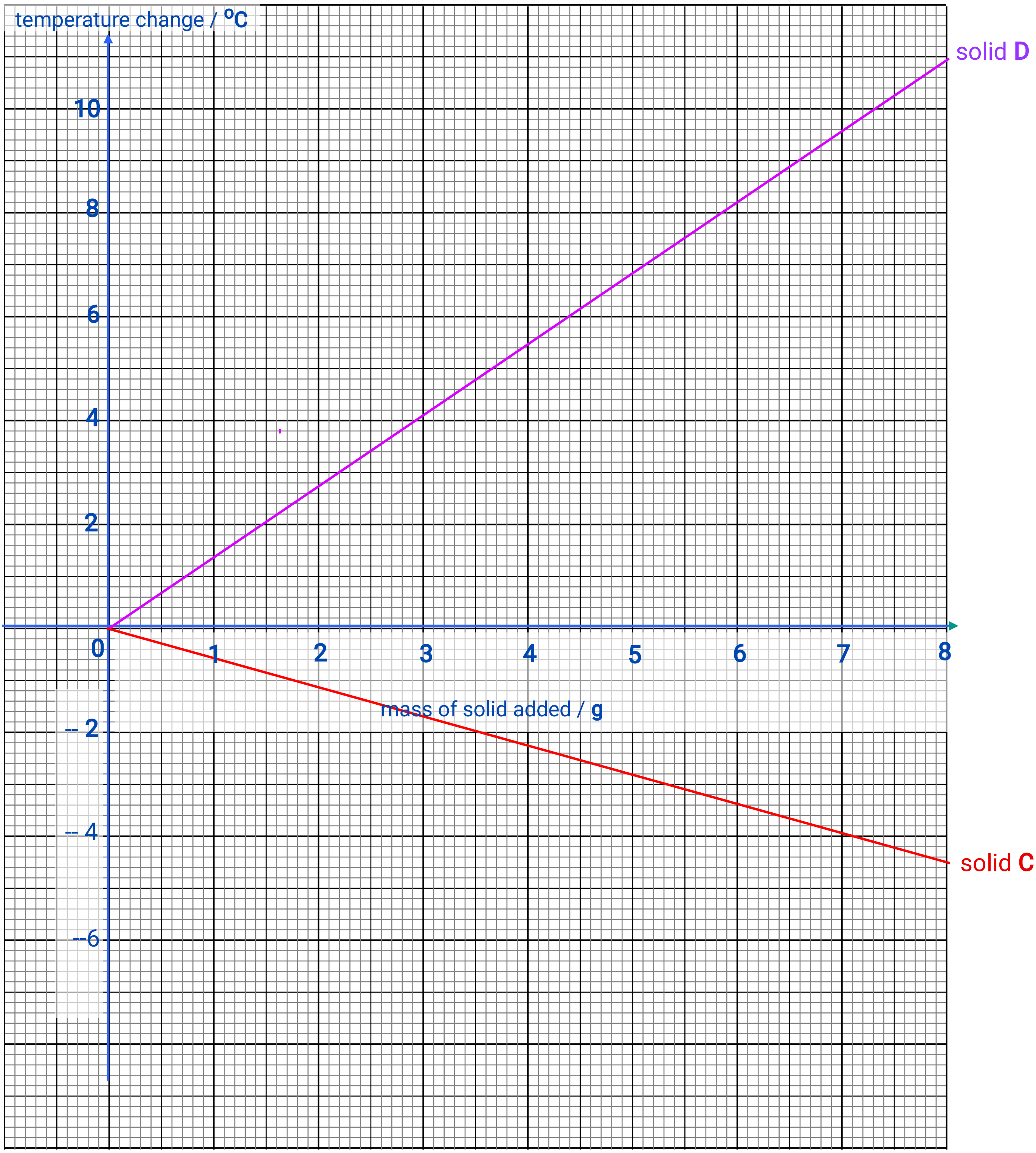
(c) Use your results for Experiments 1 and 2 to plot a graph of *temperature change* against *mass of solid added* on the grid provided in the next page.

You should include the origin (0,0).

Draw **two** straight lines of best fit and label each graph clearly.

1. labelled axes and units
2. 7 data points
3. best fit straight line graphs **(origin included)**
4. both lines correctly labelled

penalize 1 if axes are reversed


temperature change / °C
10
8
6
4
2
0
– 2
– 4
–6
1
2
3
4
5
6
7
8
mass of solid added / g
solid D
solid C

[4]

(d) **Use your graph** to estimate the temperature change after 1 minute if 6 g of solid **C** were added to 40 cm^3 of deionised water.

……………… °C [ACCEPT value from graph] [1]

(e) State whether *ΔH,* the enthalpy change that occurs when solid **C** dissolves in water, has a positive or negative value. Explain your answer.

positive (no mark), as reaction is endothermic / absorbs heat

…………………………………………………………………………………… [1]

(f) Use your experimental data to suggest the temperature of the solution containing 8 g of solid **D**, if the solution were left for 2 hours.

……………… °C [initial temperature of water for 8g] [1]

(g) Suggest how the temperature changes measured after 1 minute would differ if the experiments were repeated using 80 cm^3 instead of 40 cm^3 of deionised water in **each** case.

[2] change in T/^{o}C is **halved** for both cases

[1] change in T/^{o}C is **lower/lesser/decrease** for both or one of the cases

…………………………………………………………………………………… [2]

(h) Suggest **one** change you could make to the experiments to obtain more accurate results.

Explain how this change would make the results more accurate.

change [example] use a pipette / burette in measuring volume of deionised water

explanation [example] a pipette / burette has measures volume more accurately

Alternatively: change: use a lid to cover the polystyrene cup

explanation: this reduces the heat loss / gain from the surrounding, and temperature change will be more accurate [2]

[Total: 16]

change : [change in **apparatus** or **method**]

explanation: Suggested apparatus has **better accuracy** than measuring cylinder

OR change in method **reduces heat loss / gain**

2 You are provided with solutions **R** and **S**.

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

Instructions

(a) Carry out the following tests. You should test and identify any gases evolved.

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

Record your observations in the table. If there are no observable changes, write '**no observable change**'.

test	observations
Test 1 Test a sample of **R** with both red and blue litmus paper.	1. red litmus turns blue (no change to colour of blue litmus)
Test 2 To 1 cm depth of aqueous zinc sulfate in a clean test-tube, add **R** slowly with mixing until no further change occurs.	2. white ppt 3. soluble in excess (**R**), producing a colourless solution
Test 3 To 1 cm depth of aqueous chromium(III) chloride in a clean test-tube, add **R** slowly with mixing until no further change occurs.	4. green ppt [**ACCEPT** all shades of green] 5. insoluble in excess (**R**)
Test 4 Gently warm 2 cm depth of **R** in a clean test-tube.	(pungent gas produced) 6. <u>moist / damp / wet</u> red litmus turns blue 7. ammonia gas produced **[must have point 6 to earn this point]**
Test 5 **(i)** To 1 cm depth of aqueous sodium chloride in a clean test-tube, add a few drops of aqueous silver nitrate. **(ii)** To the mixture from **(i)**, add **R** until no further change occurs.	8. white ppt (with aqueous silver nitrate) 9. (white ppt) dissolves in excess (**R**) (producing colourless solution)
Test 6 **(i)** To 1 cm depth of aqueous potassium iodide in a clean test-tube, add an equal volume of dilute sulfuric acid and then one or two drops of **S**. **(ii)** To the mixture from **(i)** add an equal volume of **S** and allow to stand for a few minutes.	10. (colourless) solution turns <u>yellow</u> 11. <u>black</u> ppt / solid forms on standing

test	observations
Test 7 To 2 cm depth of acidified aqueous potassium manganate(VII) in a clean test-tube, add an equal volume of **S**.	12. purple (acidified) potassium manganate(VII) turns colourless / decolourised 13. effervescence / (rapid) bubbling observed 14. glowing splint relights / rekindles 15. oxygen gas produced **[must have point 14 to earn point 15]**
Test 8 **(i)** To 1 cm depth of aqueous iron(II) sulfate in a clean test-tube, add an equal volume of **S**. **(ii)** Add **R** to the mixture from **(i)** until no further change occurs.	16. (pale green / colourless) solution turns yellow / brown. 17. effervescence / bubbling observed 18. glowing splint relights / rekindles 19. oxygen gas produced **[must have point 18 to earn point 19]** 20. (reddish) brown ppt (insoluble in excess **R**)

[15]

(b) Use the results of your tests to identify the compound present in **R**.

Ammonia REJECT: ammonium (ion) [1]

(c) Deduce the role of **S** in **Test 7**. Explain your answer.

[1] **S** is a reducing agent.

[1] (Purple) potassium manganate(VII) turns colourless.

[observation of $KMnO_4$ turning colourless must be recorded in Test 7 to support this answer]

[2]

[Total: 18]

3 A toothpaste contains:

- sodium fluoride
- calcium carbonate
- silicon dioxide
- a mint flavouring soluble in water

Task 1 (**maximum 3 marks**) :

Task 2: (**maximum 3 marks**)

Plan an investigation to find the percentage by mass of calcium carbonate and the percentage by mass of silicon dioxide in the toothpaste.

In your answer, you should include the apparatus you would use and how you would calculate **each** percentage. [1] list **minimum** 2 **else deduct 1 mark**

You may assume that the apparatus normally found in a school laboratory is available.

[A_r: Na: 23; F: 19; Ca: 40; C: 12; O: 16; Si: 28]

1. weigh a sample of the toothpaste using **electronic balance** [m_1 g]
2. add (dilute) hydrochloric acid until excess / until no more fizzing in a conical flask

No credit if answer did not clearly specify which acid to use (due to H_2SO_4)

REJECT use of sulfuric acid as H_2SO_4 reacts with $CaCO_3$ forming insoluble $CaSO_4$

To obtain %mass of $CaCO_3$:

3. assumption: mint does not react with acid
4. collect and measure volume of (carbon dioxide) gas with a **gas syringe** [V cm^3]
5. moles of CO_2 = V / 24 000
6. moles of calcium carbonate = moles of CO_2 (or show by means of an equation)
7. mass of calcium carbonate = moles x M_r of $CaCO_3$ [M_r of $CaCO_3$ = 100]

% mass of calcium carbonate = (mass of $CaCO_3$ / initial mass of sample, m_1) × 100%

To obtain %mass of SiO_2:

(continue from step 7)

8. filter using a **filter funnel** and **filter paper**
9. wash residue / silicon dioxide (with water)
10. and dry
11. weigh residue / silicon dioxide [m_2 g]

[6]

% mass of SiO_2 = (mass of **dry** residue, m_2 / initial mass of sample, m_1) × 100%

[Total: 6]

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 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

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

End of paper