

233/3

— CHEMISTRY —

Paper 3



(PRACTICAL)

Apr. 2021 – 2¼ hours

Name Index Number

Candidate's Signature Date

Instructions to candidates

- Write your name and index number in the spaces provided above.
- Sign and write the date of examination in the spaces provided above.
- Answer **all** the questions in the spaces provided in the question paper.
- You are **not** allowed to start working with the apparatus for the first 15 minutes of the 2¼ hours allowed for this paper. This time is to enable you to read the question paper and make sure you have all the chemicals and apparatus that you may need.
- All working **must** be clearly shown where necessary.
- Non-programmable** silent electronic calculators and KNEC mathematical tables may be used.
- This paper consists of 8 printed pages.**
- Candidates should check the question paper to ascertain that all the pages are printed as indicated and that no questions are missing.
- Candidates should answer the questions in English.

For Examiner's Use Only

Question	Maximum Score	Candidate's Score
1	21	
2	10	
3	09	
Total Score	40	



1. You are provided with:

- 5.3 g **solid A**, sodium carbonate;
- **Solution B**, hydrochloric acid.

You are required to determine the:

- Molar heat of the solution of **solid A**;
- Concentration of the hydrochloric acid, **solution B**.

PROCEDURE I

Using a burette, place 30.0 cm³ of distilled water in a 100 ml plastic beaker. Stir the water with a thermometer and measure its temperature after every half-minute interval. Record the readings in **Table 1**.

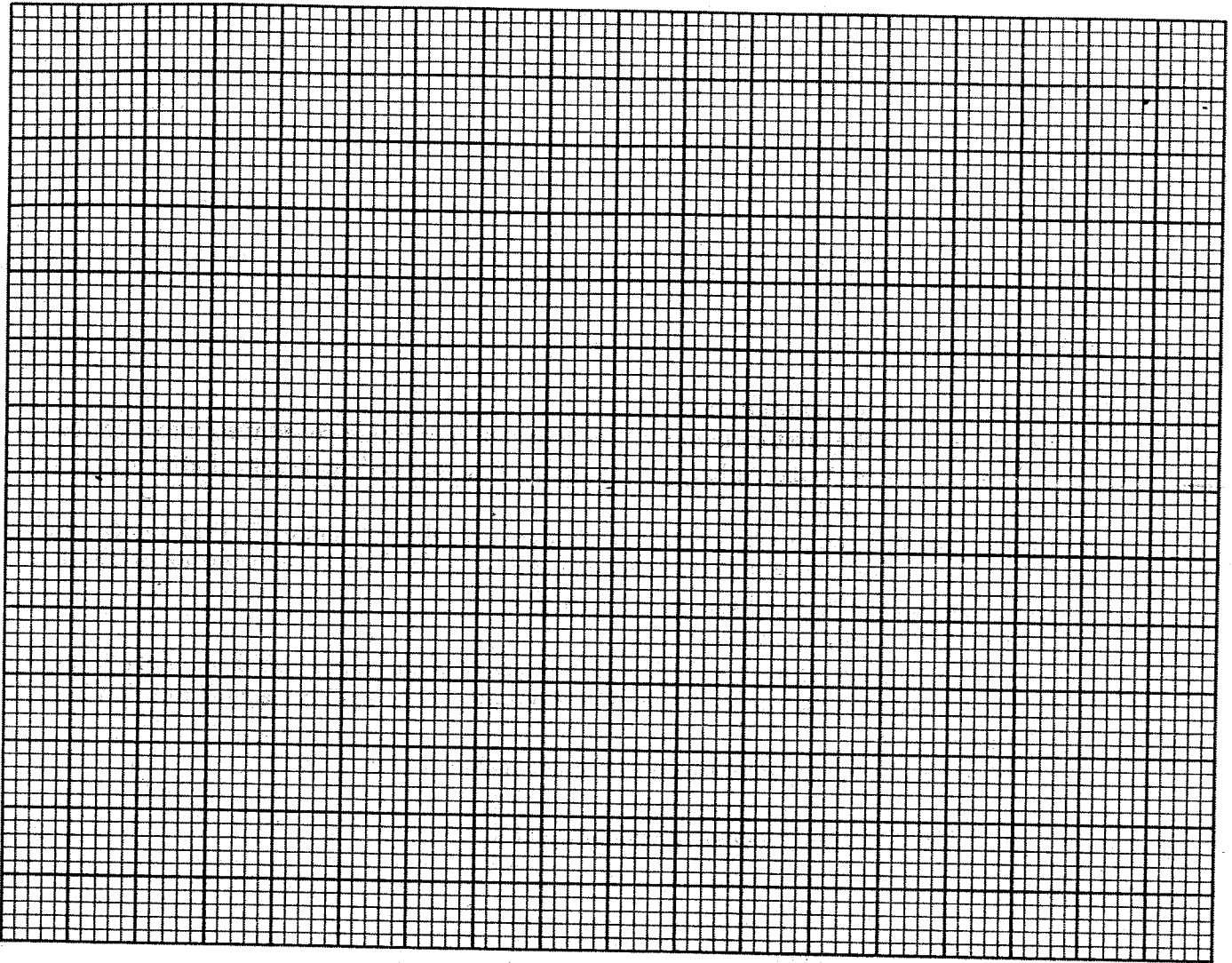
At exactly 2 minutes, add **all** of solid **A** to the water at once. Stir well and continue measuring the temperature of the mixture after every half-minute interval. Record the readings in **Table 1**. **Retain the mixture in the beaker for use in Procedure II.**

(a) **Table 1**

Time (minutes)	0	$\frac{1}{2}$	1	$1\frac{1}{2}$	2	$2\frac{1}{2}$	3	$3\frac{1}{2}$	4	$4\frac{1}{2}$	5
Temperature (°C)	19	18	18	18	X	26	28	29	29	29	28

(3 marks)

(b) On the grid provided, plot a graph of temperature (vertical axis) against time.



- (c) Determine from the graph, the temperature change, ΔT . (3 marks)
(1 mark)

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- (d) Calculate the:

- (i) number of moles of **solid A** used. (RFM = 106) (1 mark)

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- (ii) molar enthalpy of solution, ΔH_{soln} and show the sign of ΔH_{soln} .
 (Assume that for the solution, density = 1.0 g cm^{-3} and specific heat capacity = $4.2 \text{ J g}^{-1} \text{ K}^{-1}$) (2 marks)
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PROCEDURE II

- (i) Fill a burette with **solution B**.
- (ii) Transfer all of the mixture in the 100 ml plastic beaker from **procedure I** into a 250 ml volumetric flask. Add distilled water to make up to the mark and shake. Label the mixture as **solution A**.
- (iii) Using a pipette and pipette filler, place 25.0 cm^3 of **solution A** into a 250 ml conical flask. Add two or three drops of phenolphthalein indicator and titrate with **solution B**. **Do not pour out the contents of the conical flask.**

Record the readings in **Table 2**

Add two or three drops of methyl orange indicator to the contents of the conical flask. Titrate the mixture with **solution B** and record the readings of this second titration in **Table 3**.

Repeat **Procedure II**, step (iii) and complete **Tables 2** and **3**.

- (e) (i) **Table 2**, using phenolphthalein indicator.

	I	II
Final burette reading	23.0	23.0
Initial burette reading	0.0	0.0
Volume of solution B used, cm^3	23.0	23.0

(3 marks)

$$\text{Average volume, } V_1, \text{ of solution B used} = \frac{(23.0 + 23.0)}{2} \text{ cm}^3 = 23.0 \text{ cm}^3 \quad \left(\frac{1}{2} \text{ mark}\right)$$

- (ii) **Table 3**, using methyl orange indicator.

	I	II
Final burette reading	25.0	25.0
Initial burette reading	0.0	0.0
Volume of solution B used, cm^3	25.0	25.0

(3 marks)

$$\text{Average volume, } V_2, \text{ of solution B used} = \frac{(25.0 + 25.0)}{2} \text{ cm}^3 = 25.0 \text{ cm}^3 \quad \left(\frac{1}{2} \text{ mark}\right)$$

(f) Calculate the:

- (i) concentration, in moles per litre, of sodium carbonate in **solution A**. (1 mark)
RFM = 106

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- (ii) number of moles of sodium carbonate in 25.0 cm³ of **solution A**. (1 mark)

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- (iii) number of moles of hydrochloric acid in the total volume, $V_1 + V_2$, of **solution B**. (1 mark)

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- (iv) concentration, in moles per litre, of hydrochloric acid in **solution B**. (1 mark)

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2. You are provided with **solid C**. Carry out the following tests. Write the observations and inferences in the spaces provided.

Place **all** of **solid C** in a boiling tube. Add about 20 cm³ of distilled water and shake until all of the solid dissolves. Label the solution as **solution C**. Use about 2 cm³ of **solution C** in a test tube for each of the following tests.

- (a) Add aqueous sodium hydroxide dropwise until in excess.

Observations	Inferences

(1 mark)

(2 marks)

- (b) Add **three** drops of aqueous sodium sulphate.

Observations	Inferences

(1 mark)

(1 mark)

- (c) Add **three** drops of aqueous barium nitrate.

Observations	Inferences

(1 mark)

(2 marks)

- (d) Add three drops of aqueous lead(II) nitrate. Heat the mixture.

Observations	Inferences

(1 mark)

(1 mark)

3. You are provided with an organic compound, **solid D**. Carry out the following tests. Record the observations and inferences in the spaces provided.

- (a) Describe the appearance of **solid D**. (1 mark)

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- (b) Divide **solid D** into four portions.

- (i) Place the first portion of **solid D** on a watch glass and burn it with a Bunsen burner flame.

Observations	Inferences

(1 mark)

(1 mark)

- (ii) Place the second portion of **solid D** in a test tube. Add about 3 cm³ of aqueous sodium hydroxide and shake.

Observations	Inferences

(1 mark)

(1 mark)

- (iii) Place the third portion of **solid D** in a test tube. Add about 3 cm³ of distilled water. Heat the mixture and add **three** drops of acidified potassium manganate(VII).

Observations	Inferences

(1 mark)

(1 mark)

- (iv) Place the fourth portion of **solid D** in a test tube. Add about 3 cm³ of distilled water. Heat the mixture and add **all** the solid sodium hydrogen carbonate provided.

Observations	Inferences

(1 mark)

(1 mark)

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