

233/2

— **CHEMISTRY** —  
(THEORY)

Paper 2



Mar. 2021 – 2 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 this booklet.
- Non-programmable** silent electronic calculators and KNEC mathematical tables may be used.
- All working **must** be clearly shown where necessary.
- This paper consists of 15 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.

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Question	Maximum Score	Candidate's Score
1	13	
2	14	
3	13	
4	12	
5	14	
6	14	
<b>Total Score</b>	<b>80</b>	



1. Crude oil is a mixture of hydrocarbons which are separated by fractional distillation. One of the components obtained contains an alkane **A**, with eleven carbon atoms.

(a) Write the molecular formula of **A**. (1 mark)

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(b) Pentane can be obtained from compound **A** as shown.



(i) Give the name of this conversion process. (1 mark)

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(ii) State the conditions used in this process. (1 mark)

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(iii) Give the name of compound **B**. (1 mark)

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(c) Draw and name **two** isomers of pentane. (4 marks)

Isomer 1	Structure	Name
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**Isomer 2****Structure****Name**

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- (d) Incomplete combustion of pentane may result in air pollution. Write an equation to illustrate this combustion. (1 mark)

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- (e) The main component in natural gas is methane. Describe how methane in natural gas is formed. (2 marks)

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- (f) In the laboratory, methane can be prepared from salts of alkanolic acids. Describe how methane is prepared from sodium ethanoate. (2 marks)

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2. (a) (i) State what is meant by the term 'dynamic equilibrium'. (1 mark)

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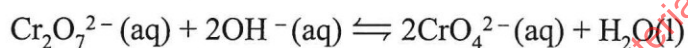
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- (ii) Dichromate(VI) ions are orange in colour while chromate(VI) ions are yellow. Consider the following equilibrium.



State and explain the observation that will be made if sulphuric(VI) acid is added to the mixture. (2 marks)

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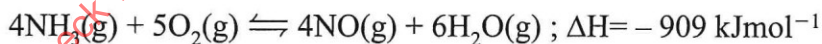
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- (b) One of the reactions in the manufacture of nitric(V) acid involves catalytic oxidation of ammonia as shown in the equation.



The reaction is carried out at a pressure of 10 atmospheres and a temperature of 900 °C

- (i) Other than nitric(V) acid, name another product that is formed. (1 mark)

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(ii) State and explain the effect on the position of equilibrium if the reaction is carried out:

**I.** at 10 atmospheres pressure and 450°C; (2 marks)

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**II.** at 900 °C and 20 atmospheres pressure; (2 marks)

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**III.** in the absence of a catalyst. (1 mark)

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(c) State and explain the effect on the rate of the reaction if the reaction is carried out at 10 atmospheres and 450°C. (2 marks)

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- (d) A factory uses 100 kg of ammonia each day to produce 160 kg of nitrogen(II) oxide. Calculate the percentage yield of nitrogen(II) oxide. (3 marks)

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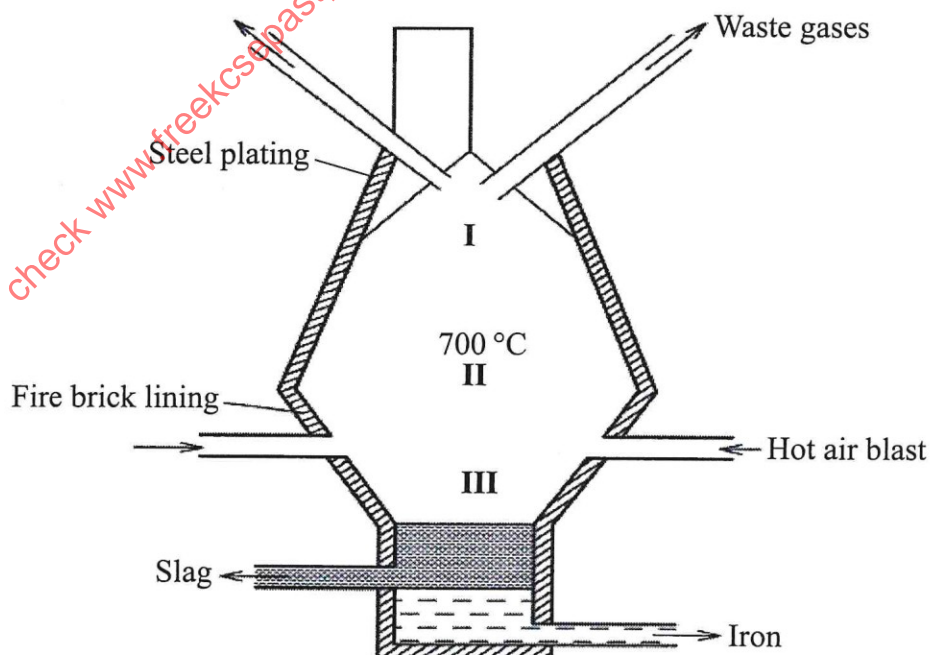
3. (a) One of the ores of iron is haematite,  $\text{Fe}_2\text{O}_3$ . Give the name and formula of **two** other ores of iron. (2 marks)

Name	Formula
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(i) .....

(ii) .....

- (b) In a certain factory, iron is extracted from the haematite ore using the blast furnace as shown in **Figure 1**. The other raw materials are coke, limestone and air. The melting and boiling points of iron are  $1535^\circ\text{C}$  and  $3000^\circ\text{C}$ , respectively.



**Figure 1**

- (i) State how the temperature in region **I** compares with that in region **II**. Give a reason. (1 mark)

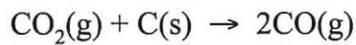
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- (ii) The main reducing agent in the furnace is carbon(II) oxide formed by the reaction:



Write **two** equations to show how carbon(IV) oxide is formed in the furnace. (2 marks)

**I.** .....

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**II.** .....

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- (iii) Suggest a value for the temperature in region **III**. Give a reason. (2 marks)

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- (iv) Name the main component in the slag. (1 mark)

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- (v) State **one** role that slag plays in the blast furnace. (1 mark)

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(vi) The iron produced in the blast furnace is brittle due to presence of impurities.

I. Name the main impurity in this iron. (1 mark)

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II. State **one** use of this iron. (1 mark)

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(vii) Recycling is one method used to reduce production costs. State and explain the by products that can be recycled in this factory. (2 marks)

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4. **Table 1** shows the elements in period 3 of the periodic table. Study it and answer the questions that follow.

**Table 1**

Element	Na	Mg	Al	Si	P	S	Cl	Ar
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(a) Write the formulae of **two** oxides, for each of the following:

(i) sodium: Oxide I ..... Oxide II ..... (1 mark)

(ii) chlorine Oxide I ..... Oxide II ..... (1 mark)

(b) The products of the reaction between phosphorus and chlorine depend on the conditions used. Write the equation for the reaction when chlorine reacts with excess phosphorus. (1 mark)

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(c) Identify the element with the highest electrical conductivity. Give a reason. (2 marks)

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(d) Describe an experiment that can be used to illustrate the variations in reaction of sodium, magnesium and aluminium with water. (3 marks)

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(e) State and explain the differences in the melting points of:

(i) chlorine and argon. (2 marks)

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(ii) magnesium oxide and silicon(IV) oxide. (2 marks)

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5. Table 2 gives standard reduction potentials for some half cells.

Table 2

Half cell	Half cell equation	$E^\theta / V$
I	$Fe^{3+}(aq) + e \rightarrow Fe^{2+}(aq)$	+ 0.77
II	$K^+(aq) + e \rightarrow K(s)$	- 2.92
III	$Ag^+(aq) + e \rightarrow Ag(s)$	+ 0.80
IV	$Pb^{2+}(aq) + 2e \rightarrow Pb(s)$	- 0.13
V	$I_2(aq) + 2e \rightarrow 2I^-(aq)$	+ 0.54

- (a) State the standard conditions of an electrochemical cell. (2 marks)

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- (b) An electrochemical cell was constructed using half-cells III and IV.

- (i) Complete Figure 2 by labelling the parts of the cells indicated as  $A_1 - A_4$ . (2 marks)

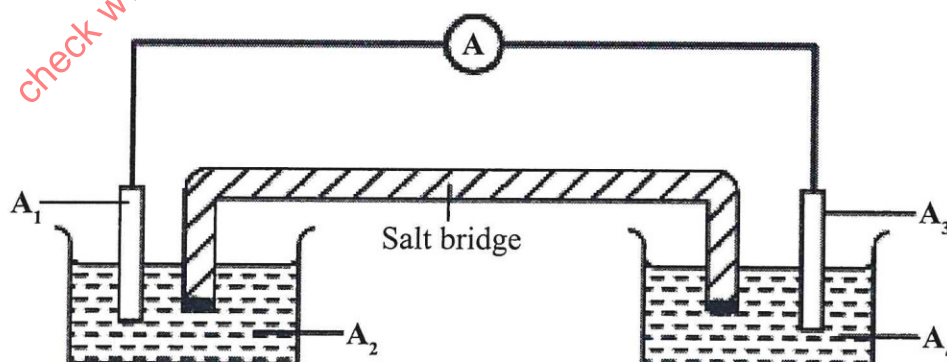


Figure 2

A<sub>1</sub> .....

A<sub>2</sub> .....

A<sub>3</sub> .....

A<sub>4</sub> .....

(ii) Write an equation for the cell reaction and calculate the e.m.f. of the cell.

Equation (1 mark)

.....

.....

e.m.f. (1 mark)

.....

.....

(iii) The salt bridge helps in completing the circuit. Explain why a saturated solution of potassium chloride is **not** suitable for use in the salt bridge in this electrochemical cell.

(1 mark)

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(c) State why it is **not** possible to construct a similar electrochemical cell using half-cells **II** and **III**. (1 mark)

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6. (a) Water containing hydrogen carbonate,  $\text{HCO}_3^-$ , and calcium  $\text{Ca}^{2+}$  ions, is said to be hard water.

(i) Describe **one** way in which  $\text{HCO}_3^-$  ions get into river water. (1 mark)

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(ii) Explain the disadvantage of using this type of water in boilers. (2 marks)

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(b) Analysis of a river water sample showed the presence of the following ions:  
 $\text{Ca}^{2+}$ ,  $\text{Na}^+$ ,  $\text{Cl}^-$ ,  $\text{NO}_3^-$ .

(i) Name the type of water hardness present in the sample. (1 mark)

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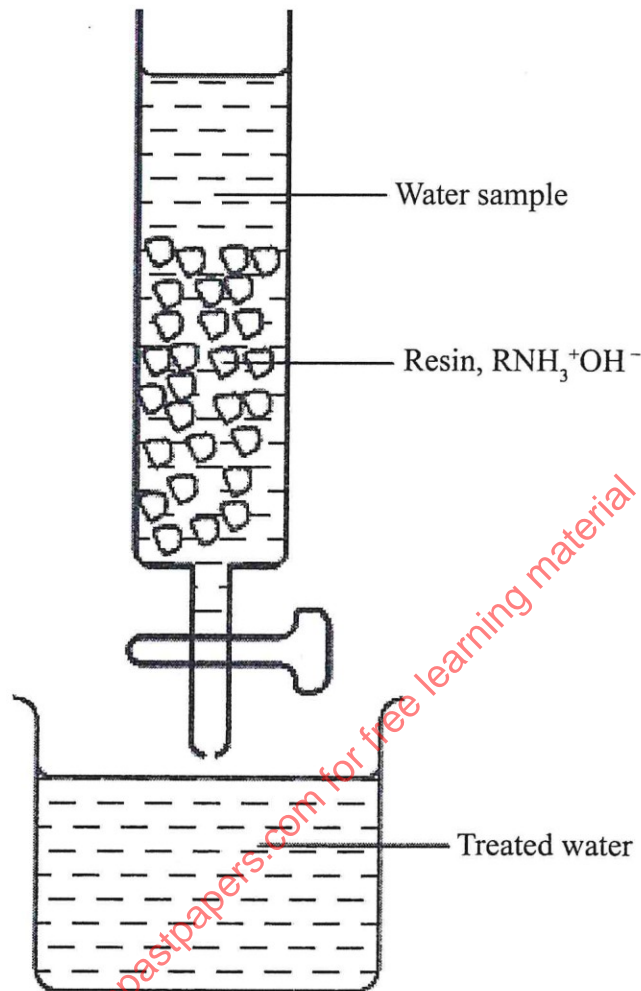
(ii) Describe **one** precipitation method that can be used to soften the water. (2 marks)

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- (iii) The water sample was passed through a resin as shown in **Figure 3**.



**Figure 3**

- I.** Write an equation for a reaction that took place in the column. (1 mark)

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- II.** Complete treatment of the water sample required passing it through another resin. Give the formula of this resin. (1 mark)

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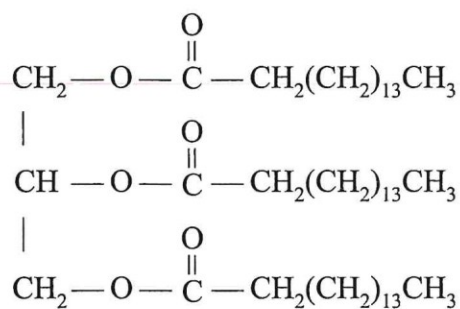
- III.** Explain why a river water sample that has been treated using resins may still require boiling to make it safe for drinking. (2 marks)

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- (c) Compound C was used to prepare a potassium soap.



Compound C

- (i) Give the formula of the potassium soap obtained. (1 mark)

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 .....

- (ii) State **one** difference in the properties of potassium and sodium soaps. (1 mark)

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- (d) A soapless detergent has the formula  
 $\text{CH}_3(\text{CH}_2)_{10}\text{CH}_2\text{OSO}_3\text{Na}$

With reference to this formula, identify the hydrophobic and the hydrophilic parts of the detergent.

Hydrophobic (1 mark)

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Hydrophilic (1 mark)

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233/3

— **CHEMISTRY** —  
(PRACTICAL)

**Paper 3**



**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	
<b>Total Score</b>	<b>40</b>	



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 cm<sup>3</sup> 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.**

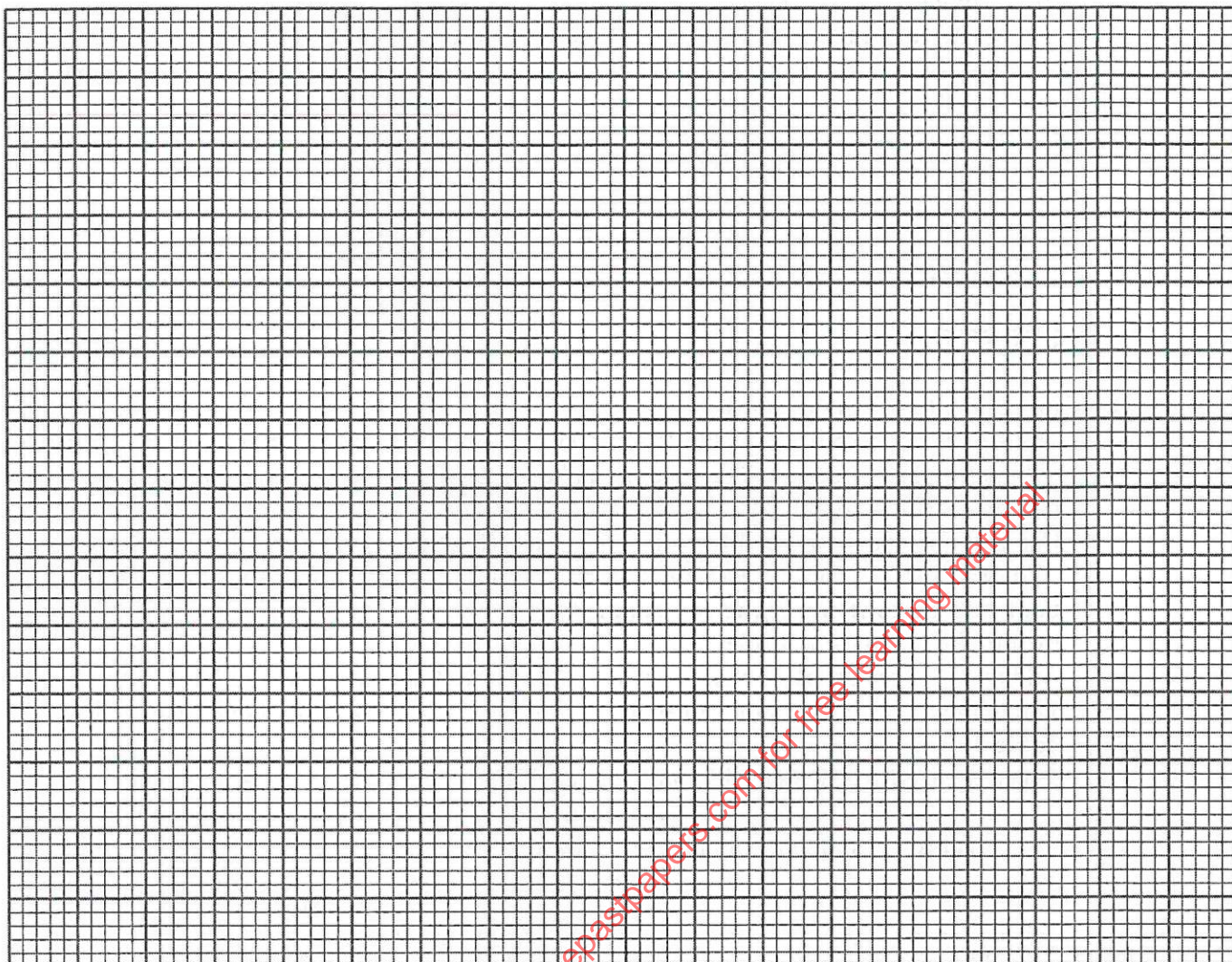
(a) **Table 1**

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)	25	25	25	25	X	32	33	34	34	34	34

(3 marks)

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





(3 marks)

- (c) Determine from the graph, the temperature change,  $\Delta T$ .

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

### 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  $25.0 \text{ cm}^3$  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	12.2 ml	12.2 ml
Initial burette reading	0.0 ml	11.0 ml
Volume of <b>solution B</b> used, $\text{cm}^3$	12.2 ml	12.6 $\text{cm}^3$

(3 marks)

Average volume,  $V_1$ , of **solution B** used = ..... ( $\frac{1}{2}$  mark)

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

	I	II
Final burette reading		
Initial burette reading		
Volume of <b>solution B</b> used, $\text{cm}^3$		

(3 marks)

Average volume,  $V_2$ , of **solution B** used = ..... ( $\frac{1}{2}$  mark)



(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 cm<sup>3</sup> 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 cm<sup>3</sup> of distilled water and shake until all of the solid dissolves. Label the solution as **solution C**. Use about 2 cm<sup>3</sup> 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 cm<sup>3</sup> 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 cm<sup>3</sup> 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 cm<sup>3</sup> 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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