FORM TP 2022056

TEST CODE **01212020**

MAY/JUNE 2022

CARIBBEAN EXAMINATIONS COUNCIL

CARIBBEAN SECONDARY EDUCATION CERTIFICATE® EXAMINATION

CHEMISTRY

Paper 02 – General Proficiency

2 hours 30 minutes

READ THE FOLLOWING INSTRUCTIONS CAREFULLY.

1. This paper consists of SIX questions in TWO sections. Answer ALL questions.
2. Write your answers in the spaces provided in this booklet.
3. Do NOT write in the margins.
4. Where appropriate, ALL WORKING MUST BE SHOWN in this booklet.
5. You may use a silent, non-programmable calculator to answer questions.
6. If you need to rewrite any answer and there is not enough space to do so on the original page, you must use the extra lined page(s) provided at the back of this booklet. **Remember to draw a line through your original answer.**
7. **If you use the extra page(s) you MUST write the question number clearly in the box provided at the top of the extra page(s) and, where relevant, include the question part beside the answer.**

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO.

NOTHING HAS BEEN OMITTED.

SECTION A

Answer ALL questions.

DO NOT spend more than 30 minutes on Question 1.

1. An experiment was carried out to determine the energy change for the reaction of magnesium metal and hydrochloric acid. The procedure is given below.

Procedure

1. 100 cm^3 of 0.500 mol dm^{-3} hydrochloric acid was measured and placed in a calorimeter.

2. Sandpaper was used to clean a strip of magnesium ribbon until shiny and 0.48g was weighed using a balance.

3. The temperature of the hydrochloric acid in the calorimeter was measured every minute for 5 minutes until a constant temperature was obtained.

4. The magnesium strip was then added to the calorimeter with hydrochloric acid. While stirring gently with the thermometer, the temperature was recorded every 15 seconds for 2 minutes.

5. Figure 1 shows the first five temperature readings taken during the experiment.

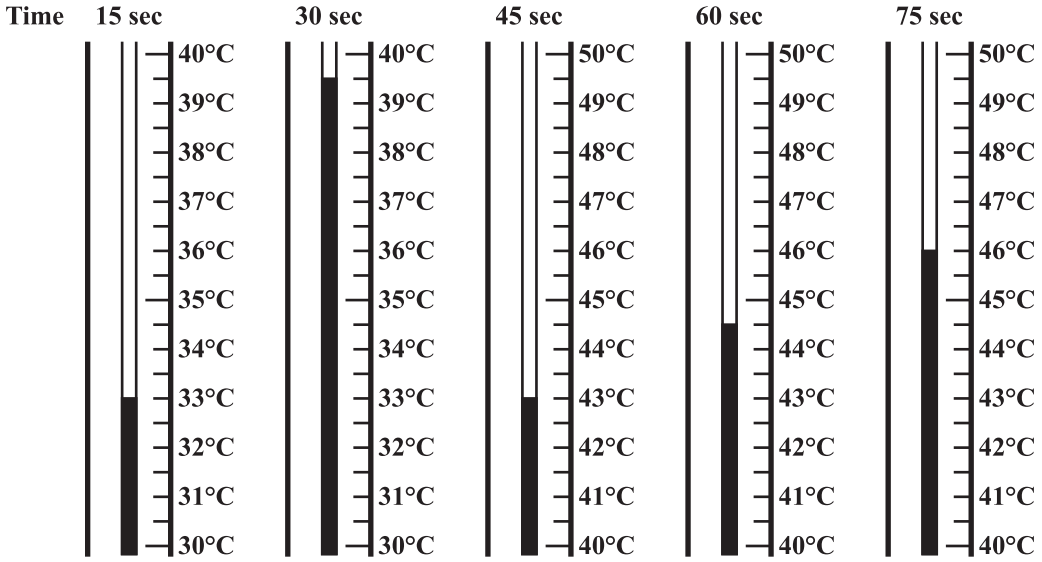

Figure 1. The first five temperature readings taken during the experiment

(a) (i) Complete Table 1 by recording the temperature readings shown in Figure 1.

TABLE 1: TEMPERATURE READINGS

Time (seconds)	Temperature (°C)
0	25
15	
30	
45	
60	
75	
90	45.5
105	45.5
120	45

(5 marks)

(ii) Using the grid provided **on page 7**, plot a graph of temperature against time using the data in Table 1. Draw the best curve through the points.

(5 marks)

(iii) Using your graph, determine the temperature change, ΔT, for the reaction.

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(1 mark)

(iv) State ONE difference between endothermic and exothermic reactions.

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(2 marks)

(v) State whether the reaction between magnesium and hydrochloric acid is endothermic or exothermic.

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(1 mark)

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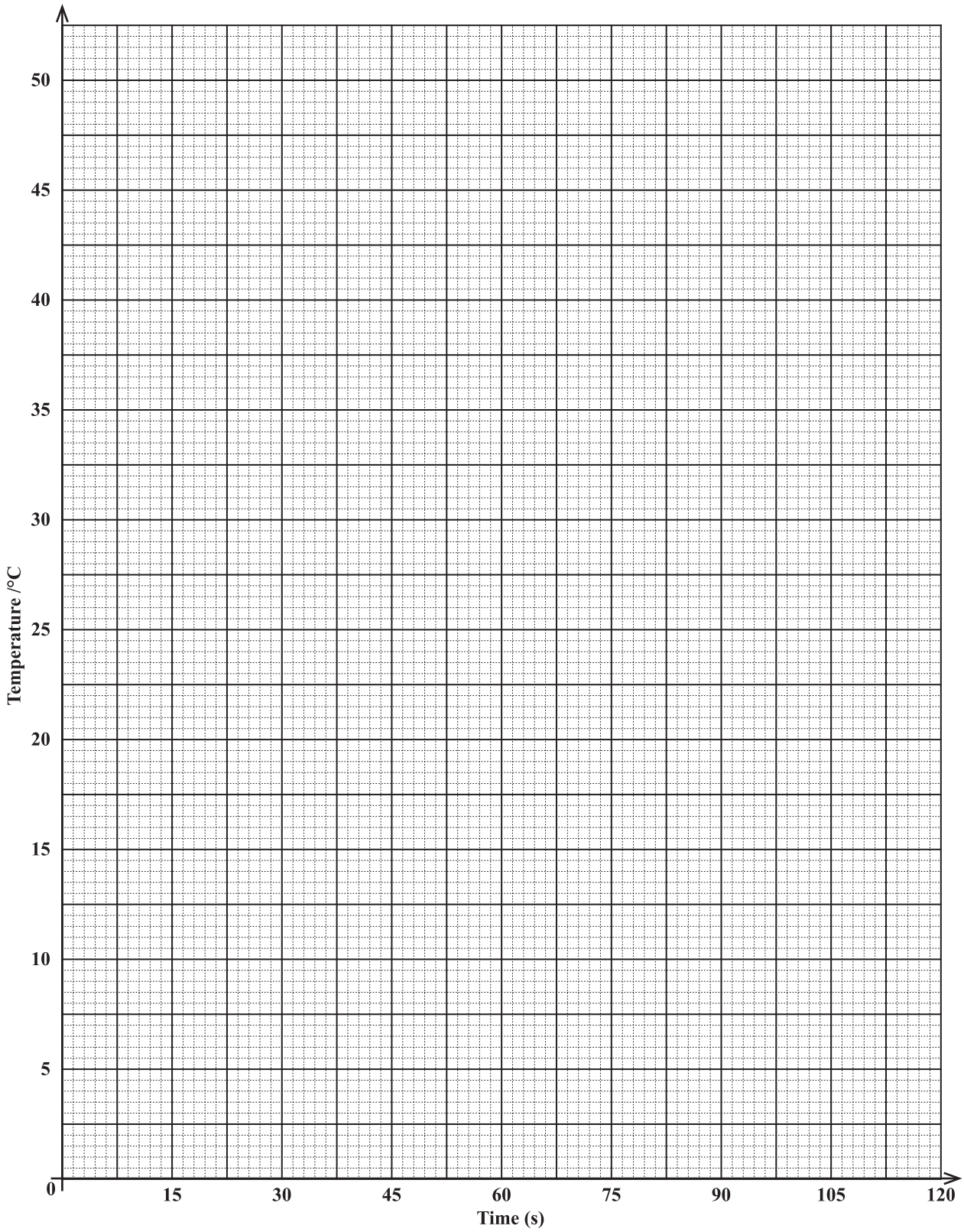

Figure 2. Graph of temperature against time

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(b) (i) Write a balanced chemical equation, including state symbols, for the reaction between magnesium metal and hydrochloric acid.

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(3 marks)

(ii) Calculate the number of moles of magnesium used in the reaction.
(RAM of Mg = 24)

.....

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(1 mark)

(iii) Determine the volume of gas that would be collected if the reaction took place at STP.
[Molar volume at STP = 22 400 cm^3].

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(3 marks)

(c) (i) Calculate the energy change for the reaction between magnesium and hydrochloric acid.

[Assume the specific heat capacity of the solution is 4.2J $g^{-1} C^{-1}$ and the density of the solution is 1 g cm^{-3}, $\Delta H = m \times c \times \Delta T$]

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(3 marks)

(ii) Hence, determine the energy change per mole of magnesium.

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(1 mark)

Total 25 marks

2. (a) Steels are alloys widely used in industry in place of iron metal.

(i) Define the term 'alloy'.

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(1 mark)

(ii) Name TWO types of steel.

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.....

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(2 marks)

(iii) State TWO enhanced properties of steel.

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(2 marks)

(b) Many metal nitrates undergo thermal decomposition. The relative ease of decomposition and products formed can help determine their place in the reactivity series. Table 2 below shows the products formed from the heating of the nitrates of five different metals, V, W, X, Y and Z respectively.

TABLE 2: PRODUCTS FORMED FROM THERMAL DECOMPOSITION OF METAL NITRATES

Metal Nitrate	Products Formed
V, X, Y	Metal oxide, nitrogen dioxide and oxygen
W, Z	Metal nitrite and oxygen

(i) Using the information from Table 2, state which metals would be the more reactive metals and which metals would be the less reactive metals.

More reactive metals .....

Less reactive metals .....

(2 marks)

GO ON TO THE NEXT PAGE

(ii) If one of the more reactive metals was identified as sodium, write a balanced chemical equation for the decomposition of sodium nitrate.

.....

.....

(2 marks)

(iii) Further tests were carried out with metals V, X and Y. Each metal was the oxides of the other metals in displacement reactions.

- V did not react with any of the metal oxides.
- X reacted with the oxides of metal V and metal Y, successfully displacing the metals.
- Y reacted with the oxide of metal V, successfully displacing the metal.

Use this information to deduce the order of reactivity of the metals V, X and Y from the most reactive to the least reactive.

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(2 marks)

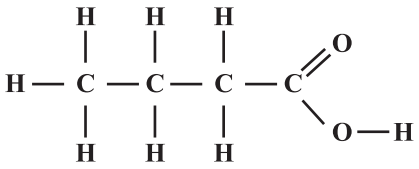
(c) Tests were carried out on Solution A to determine the cations present. The observations are presented in Table 3. Complete the table by inserting the inferences based on the observations.

TABLE 3: OBSERVATIONS AND INFERENCES

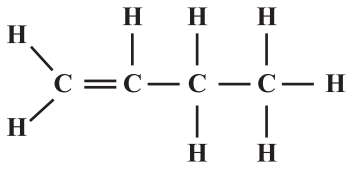
Test	Observation	Inference
• A few drops of dilute sodium hydroxide were added to a small portion of Solution A in a test tube.	• Green precipitate formed	• ....
	• Green precipitate darkened when left to stand and turned orange at the top of the test tube	• .... **(2 marks)**
• A few drops of dilute sodium hydroxide were added to a small portion of Solution A in a test tube. The test tube was heated gently	• Colourless gas evolved with a pungent odour. Gas turned damp red litmus paper blue	• ....
	• Colourless solution formed	• .... **(2 marks)**

Total 15 marks

3. Figure 3 shows Compound A and Compound B which are from different homologous series.



Compound A



Compound B

Figure 3. Compound A and Compound B

(a) (i) State the homologous series to which Compound A belongs.

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(1 mark)

(ii) State the functional group of Compound A.

.....

(1 mark)

(iii) State the name of Compound A.

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(1 mark)

(iv) State whether Compound A will undergo a condensation reaction or addition polymerization reaction with alcohols.

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(1 mark)

(b) (i) State the homologous series to which Compound B belongs.

.....

(1 mark)

(ii) Write the functional group of Compound B.

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(1 mark)

(iii) State the name of Compound B.

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(1 mark)

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(c) Figure 4 shows Compound C which has structural isomers.

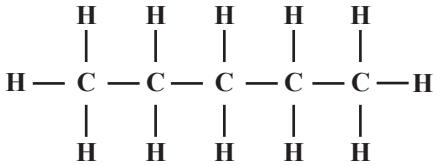

Figure 4. Compound C

(i) Define the term 'structural isomers'.

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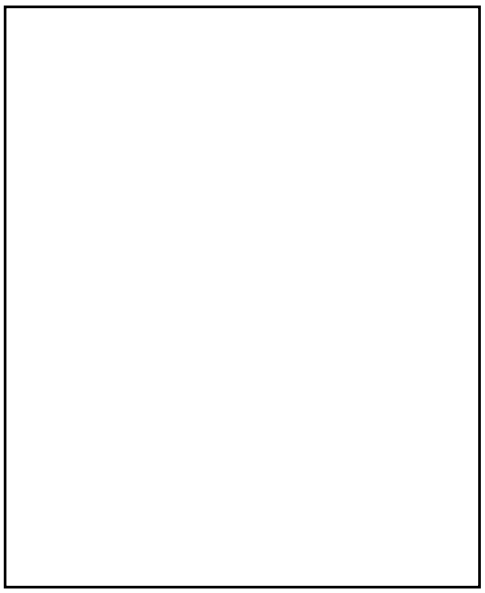
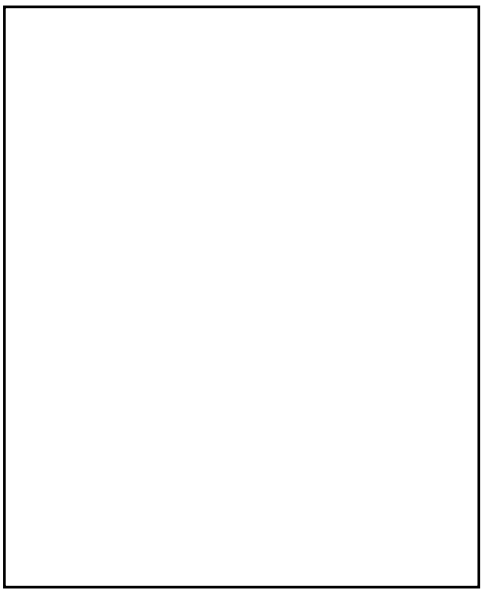
(2 marks)

(ii) Draw the FULLY displayed structure of two structural isomers of Compound C.



Isomer 1



Isomer 2

(4 marks)

(iii) Write the names of the two structural isomers you have drawn in part (c) (ii)

Name of Isomer 1 .....

Name of Isomer 2 .....

(2 marks)

Total 15 marks

SECTION B

Answer ALL questions.

4. Figure 5 shows a line diagram representing the electrolytic cell used in the electrolysis of aqueous copper(II) sulfate solution using copper electrodes.

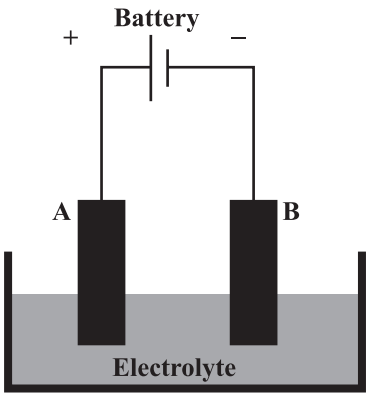


Figure 5. Diagram of the electrolytic cell

(a) (i) State whether the electrodes used are active or inert. Give a reason for your answer.

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(2 marks)

(ii) Describe what occurs at the cathode and anode in an electrolytic cell.

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(2 marks)

(iii) State which electrode in Figure 5 **on page 16**, is the cathode and which electrode is the anode.

Electrode A .....

Electrode B .....

(2 marks)

(b) (i) Identify the ions that will migrate to the cathode and anode.

Ions at cathode .....

Ions at anode .....

(2 marks)

(ii) Write half equations to show the substances produced at the cathode and the anode.

Cathode .....

Anode .....

(2 marks)

(c) (i) Using your answer in part (b) (ii), explain why a redox reaction took place during the electrolysis of the copper(II) sulfate.

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(2 marks)

(ii) Suggest ONE change that is likely to be observed at the cathode.

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(1 mark)

(d) Explain how the electrolytic cell can be modified to plate copper onto a small piece of steel.

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(2 marks)

Total 15 marks

5. (a) (i) State FOUR general characteristics of a homologous series.

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(4 marks)

(ii) Write the general formula of the alcohol homologous series and the molecular formula of the 5th member of the homologous series.

General formula .....

5th member .....

(2 marks)

(b) Figure 6 shows the fully displayed structure of Compound D. Circle ANY TWO functional groups shown on this structure.

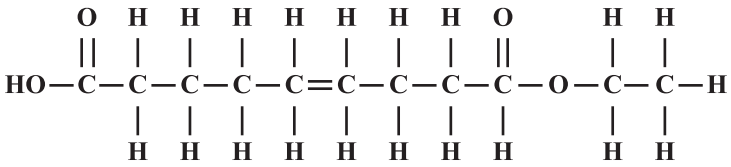

Figure 6. Fully displayed structure of Compound D

(2 marks)

(c) Experiments were carried out on two hydrocarbon gas samples E and F to determine which gas is ethane and which gas is ethene. Table 4 presents the experiment and observations.

TABLE 4: EXPERIMENTS AND OBSERVATION

Experiment	Observation	
	Hydrocarbon E	**Hydrocarbon F**
Each hydrocarbon was bubbled through bromine water.	Orange bromine water becomes colourless.	No reaction.

(i) State the difference between alkanes and alkenes.

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(1 mark)

(ii) Using the observations in Table 4, identify Hydrocarbons E and F.

Hydrocarbon E .....

Hydrocarbon F .....

(2 marks)

(iii) State the conditions under which an alkane would react with bromine.

.....

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(1 mark)

(iv) Write a balanced chemical equation, including state symbols, for the burning of ethene gas in air.

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(3 marks)

Total 15 marks

GO ON TO THE NEXT PAGE

6. (a) A chemical factory produces pesticides, fertilizers and plastics using synthetic raw materials. The factory has been in operation for the past five years and is located near agricultural lands in a small rural community. Recently, the residents of the community have reported significant loss in plant and animal life due to increases in air pollutants, non-biodegradable solid waste, and algal growth in the nearby waterways. The increased toxicity has impacted the local agricultural economy.

(i) State TWO examples of air pollutants.

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(2 marks)

(ii) Suggest THREE substances found in the products produced by the chemical factory that may have contributed to the increased algal growth in the waterways.

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(3 marks)

(b) (i) Define the term 'green chemistry'.

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(1 mark)

(ii) List THREE principles of green chemistry.

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(3 marks)

(iii) Explain how ANY THREE principles of green chemistry can be used by the factory to minimize the impact of pollution on the local agricultural economy.

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(6 marks)

Total 15 marks

END OF TEST

IF YOU FINISH BEFORE TIME IS CALLED, CHECK YOUR WORK ON THIS TEST.