

**CARIBBEAN EXAMINATIONS COUNCIL****CARIBBEAN SECONDARY EDUCATION CERTIFICATE®
EXAMINATION****CHEMISTRY****Paper 02 – General Proficiency****READ THE FOLLOWING INSTRUCTIONS CAREFULLY.**

1. This paper consists of SIX questions in TWO sections.
2. Answer ALL questions.
3. Write your answers in the spaces provided in this booklet.
4. Do NOT write in the margins.
5. Where appropriate, ALL WORKING MUST BE SHOWN in this booklet.
6. You may use a silent, non-programmable calculator to answer questions.
7. 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.**
8. **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.

SECTION A

Answer ALL questions.

Do NOT spend more than 30 minutes on Question 1.

1. The concentration of a solution of sodium hydroxide, in gdm^{-3} , was determined via the method of thermometric titration with a strong acid. The following procedure was used.
1. Transfer 25 cm^3 of NaOH solution (unknown concentration) into a styrofoam cup.
 2. Take the initial temperature of the solution.
 3. Add 5 cm^3 of H_2SO_4 (0.10 M) from the burette into the cup. Immediately stir the mixture and record its temperature.
 4. Repeat the procedure, adding 5 cm^3 aliquots of H_2SO_4 until a total of 30 cm^3 of H_2SO_4 (0.10 M) is added.

Figure 1 shows the thermometer readings of the acid-base reactions after the additions of 5 cm^3 , 15 cm^3 and 25 cm^3 of H_2SO_4 .

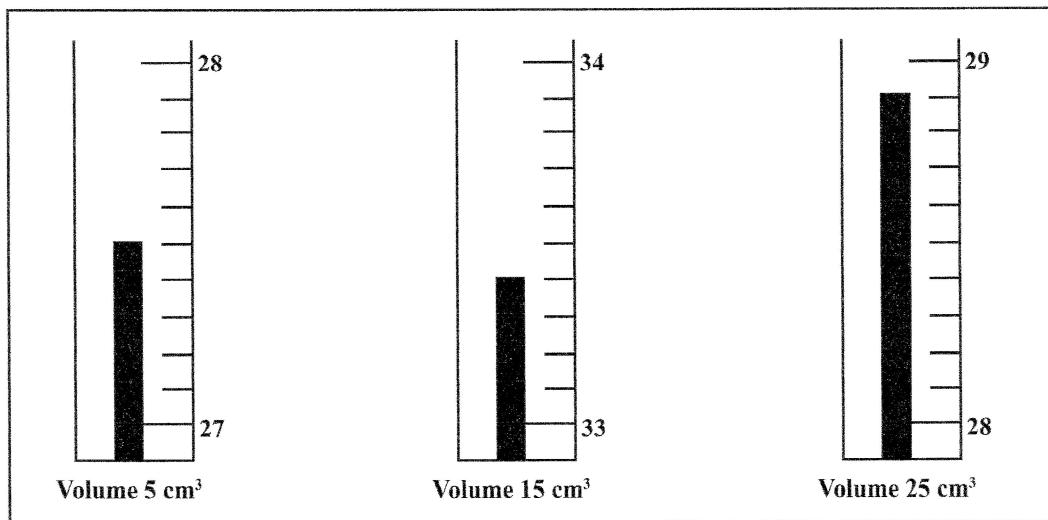


Figure 1. Thermometer readings for acid-base reaction

- (a) Using the thermometer readings in Figure 1, **on page 5**, complete Table 1 by recording the temperatures for the additions of 5 cm³, 15 cm³ and 25 cm³ of H₂SO₄.

TABLE 1: EXPERIMENTAL RESULTS

Volume of H ₂ SO ₄ Added (cm ³)	Temperature (°C)
0	25.0
5	
10	30.5
15	
20	32.5
25	
30	26.0

(3 marks)

- (b) (i) Using the axes provided in Figure 2, **on page 7**, plot the graph of temperature against volume of acid added. **(4 marks)**
- (ii) Draw two lines of best fit through the points on the graph, one where the temperature is increasing and the other where the temperature is decreasing. **(2 marks)**
- (iii) On your graph, show the end point of the reaction. Record the corresponding volume below.

End point of the reaction = cm³

(2 marks)

- (c) Distinguish between a ‘strong acid’ and a ‘weak acid’.

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(2 marks)

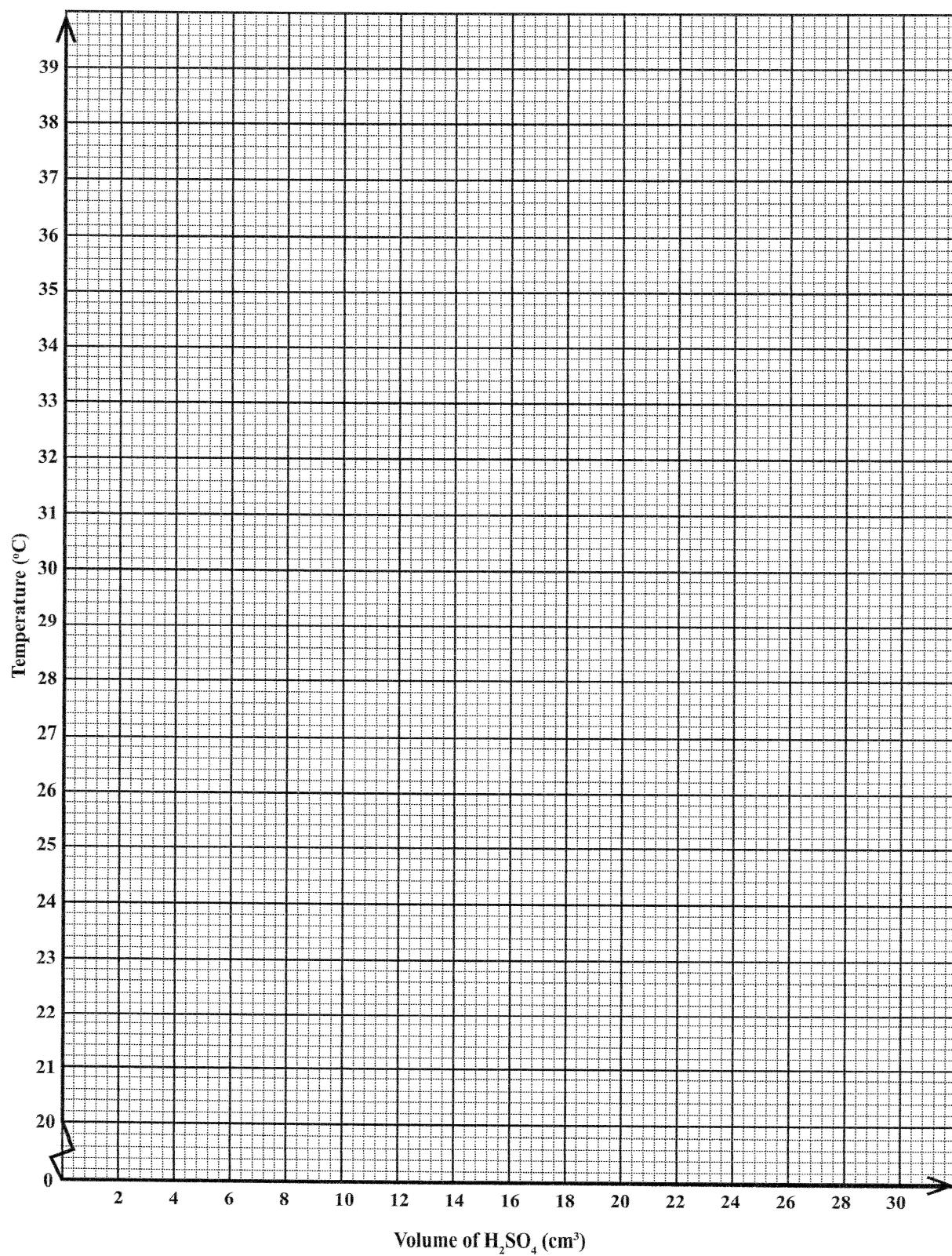
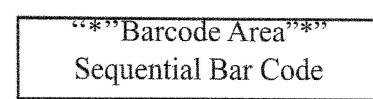


Figure 2. Temperature against volume of H_2SO_4

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- (d) Write a balanced chemical equation for the reaction between NaOH and H₂SO₄.

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(2 marks)

- (e) Calculate the number of moles of H₂SO₄ used in the reaction.

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(2 marks)

- (f) Calculate the number of moles of NaOH in 25 cm³ of the solution.

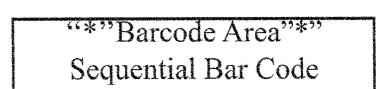
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(2 marks)

- (g) Calculate the concentration of NaOH, in mol dm⁻³.

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(2 marks)



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- (h) Calculate the concentration of NaOH, in gdm^{-3} , given the molar mass of NaOH = 40 gmol^{-1} .

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(1 mark)

- (i) State whether the reaction that took place in the styrofoam cup was exothermic or endothermic. Explain your answer.

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(2 marks)

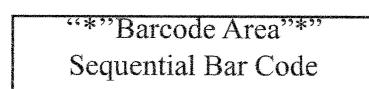
- (j) State ONE safety precaution which should have been taken during the experiment.

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(1 mark)

Total 25 marks

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2. (a) R and S are two allotropes of carbon.

R is a black opaque solid, which can be described as flaky with a melting point of 3925 °C.

S is a reflective, colourless solid with a melting point of 3823 °C.

- (i) Define the term ‘allotrope’.

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(1 mark)

- (ii) Identify the names of R and S.

R

S

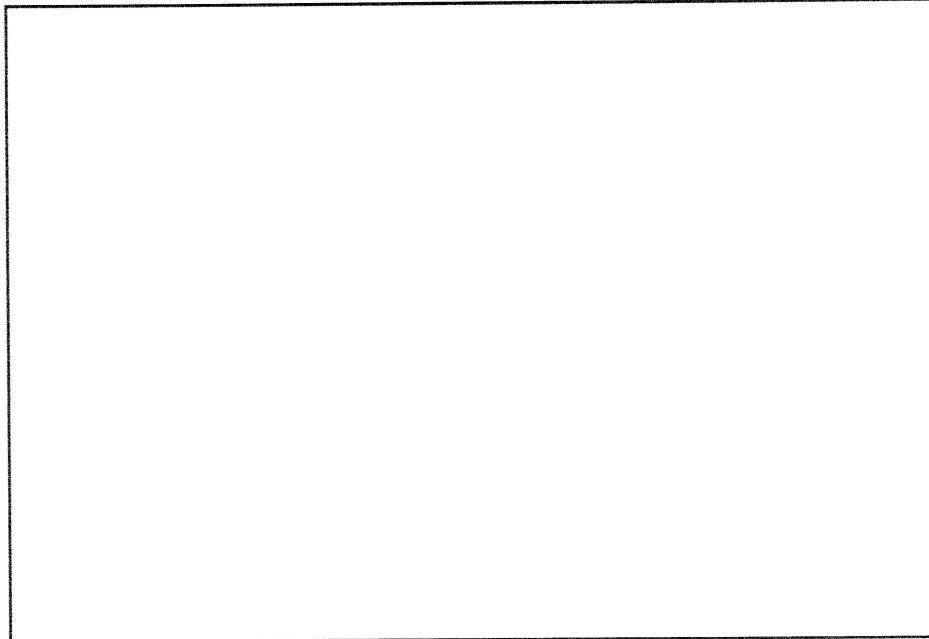
(2 marks)

- (iii) State whether R is an ionic, simple covalent or giant covalent structure.

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(1 mark)

- (iv) In the space below, sketch the structure of R, using solid lines (—) to show strong bonds and dotted lines (• • • • •) to show weak bonds.



(3 marks)

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- (v) Explain why R conducts electricity but S does not conduct electricity.

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(2 marks)

- (b) Another solid, T, is white in colour with a melting point of 801 °C. It conducts electricity when molten but not in the solid state.

- (i) Deduce the type of bonding present in Solid T.

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(1 mark)

- (ii) State the appearance that Solid T is expected to have.

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(1 mark)

- (c) Solids, liquids and gases are easily converted from one state to another.

- (i) Compare the arrangement of particles in solids with the arrangement of particles in liquids.

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(2 marks)

- (ii) When solid iodine is heated, a purple coloured gas is observed. State the process which occurs and give ONE example of another compound which undergoes the same process.

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(2 marks)

Total 15 marks

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3. (a) 2-methylbutane and pentane are structural isomers with molecular formula C₅H₁₂.

- (i) Define the term 'structural isomerism'.

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(2 marks)

- (ii) Draw the fully displayed structure of 2-methylbutane.

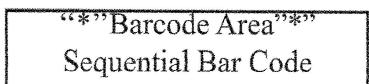
(2 marks)

- (iii) Draw and name ONE **other** structural isomer of C₅H₁₂.

Name

(3 marks)

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- (b) Ethanol can undergo various reactions. Depending on the reagents and conditions of the reaction, products with different functional groups can be formed.

- (i) What is the functional group of ethanol, $\text{CH}_3\text{CH}_2\text{OH}$?

(1 mark)

- (ii) Table 2 summarizes the conditions and products of two reactions of ethanol. Complete Table 2 by inserting the reaction conditions and drawing the fully displayed structure of the products which would be formed. Take note that the type of product to be formed is given in the table.

TABLE 2: REACTIONS OF ETHANOL

Total 15 marks

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SECTION B

Answer ALL questions.

4. (a) Atoms are the smallest particles of elements; however, they are made up of three distinct subatomic particles.

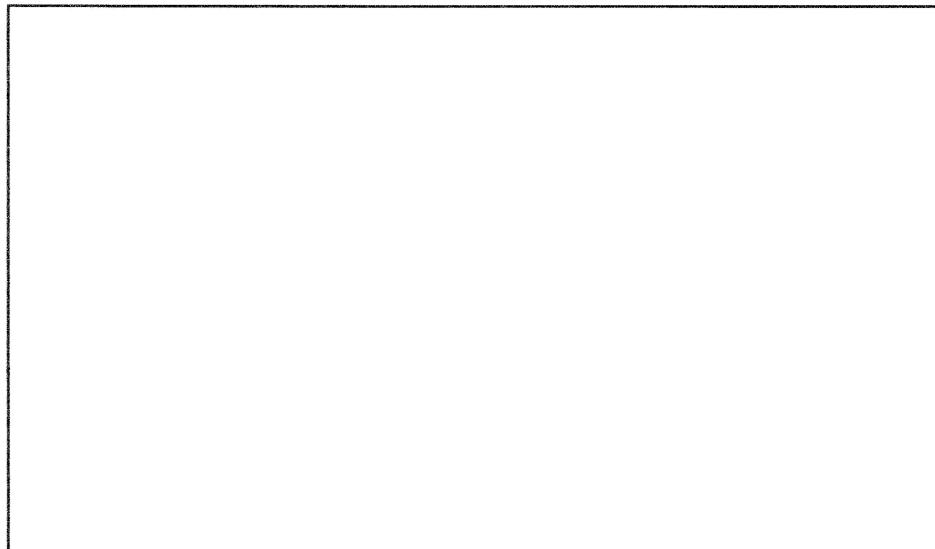
- (i) Complete Table 3 which shows the three subatomic particles and their properties.

TABLE 3: SUBATOMIC PARTICLES AND THEIR PROPERTIES

Particle	Mass	Charge
Electron		-1
	1	

(4 marks)

- (ii) Consider the notation of an atom of an unknown element, $^{29}_{14}A$. Draw a labelled diagram to illustrate the location, arrangement and number of EACH type of subatomic particle in Element $^{29}_{14}A$.



(5 marks)

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- (b) Calculate the number of atoms in 80.0 g of calcium.

[Relative atomic mass of Ca = 40; Avogadro's constant 6.0×10^{23}]

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(2 marks)

- (c) The following observations were made by some students in a Home Economics class.

Observation 1: Cucumber slices release water when salt is added to them.

Observation 2: Peas swell when soaked in water.

- (i) Explain the chemical process that can account for these observations.

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(3 marks)

- (ii) State ONE other example that demonstrates this process.

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(1 mark)

Total 15 marks

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5. Figure 3 refers to the following reaction scheme involving four compounds, A, B, C and D. Carefully consider the reaction scheme in Figure 3 and answer the questions that follow.

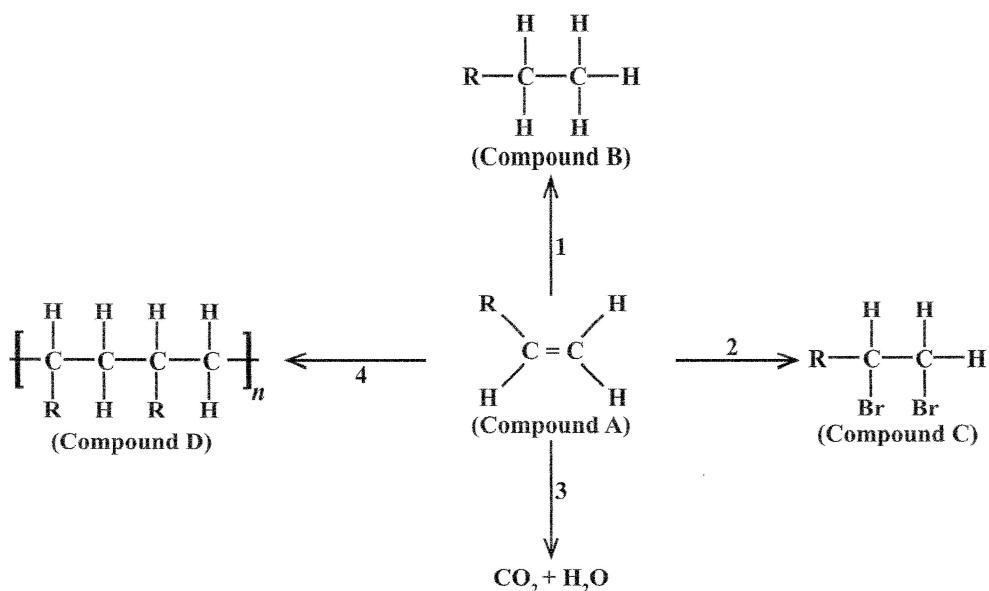


Figure 3. Reaction scheme

- (a) Identify the types of reactions numbered 1, 2, 3 and 4 in Figure 3 above.

Reaction 1

Reaction 2

Reaction 3

Reaction 4

(4 marks)

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- (b) Identify suitable reagents and reaction conditions which could be used for EACH of the following conversions.

- (i) Compound A to Compound B via Reaction 1.

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(2 marks)

- (ii) Compound A to Compound C via Reaction 2.

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(2 marks)

- (c) (i) Given that R is an ethyl group, state the molecular formula for Compound A.

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(1 mark)

- (ii) Hence, write a balanced chemical equation for Reaction 3.

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(2 marks)

- (d) Describe a chemical test that can be used to distinguish Compound A from Compound B.

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(4 marks)

Total 15 marks

6. Some students investigated the action of dilute hydrochloric acid using a sample of solid sodium hydrogen carbonate.

- (a) (i) One of the students suggested that the reaction would yield a gaseous product. Describe a test that could be used to identify the gaseous product formed.

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(2 marks)

- (ii) A sample of the gas was collected in the laboratory by downward delivery. State the physical property of the gas which supports this method of collection.

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(1 mark)

- (iii) Write a chemical equation, including state symbols, for the reaction between hydrochloric acid and sodium hydrogen carbonate.

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(2 marks)

- (b) Some metals react with dilute acids to produce a salt and a gaseous product. Write an **ionic** equation for the reaction of magnesium with dilute hydrochloric acid.

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(2 marks)

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- (c) (i) Some non-metals are important to the agricultural industry. Nitrogen is used to manufacture fertilizers such as ammonium sulfate. Some farmers use ammonium sulfate fertilizers in the presence of a base. Explain why this is NOT a good practice.

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(3 marks)

- (ii) Phosphorus and silicon are two other useful non-metals. List TWO uses of silicon and ONE use of phosphorus.

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(3 marks)

- (iii) Sulfur is a non-metal that burns in air to produce a gas product that dissolves in water to give a colourless solution. Identify the gas formed and state the effect that the solution would have on blue litmus paper.

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(2 marks)

Total 15 marks

END OF TEST

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

