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 compulsory questions in TWO sections.
2. Write your answer to EACH question in the space provided in this answer booklet.
3. Do NOT write in the margins.
4. Where appropriate, ALL WORKING MUST BE SHOWN in this booklet.
5. Return this booklet at the end of the examination.
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.**

SECTION A

Answer ALL questions.

Write your answers in the spaces provided in this booklet.

Do NOT spend more than 30 minutes on Question 1.

1. The solubility of a solid, X, in water at various temperatures is determined by the procedure described below. This procedure comprises a series of experiments numbered 1 to 5. Some of the data are recorded in Table 1.

Procedure:

- In Experiment 1, 2 g of X is added to 4 cm^3 of water in a boiling tube.
- The tube is heated while stirring in a water bath until **all** of X has dissolved.
- The solution is then allowed to cool and the temperature at which the crystals of X **first** appear is noted and recorded in Table 1.
- In each of Experiments 2 to 5, the **same** mass of X (2 g) is added to a **different** volume of water as indicated in Table 1.
- In each case, the temperature at which the crystals of X **first reappear** is displayed on the relevant thermometer in Figure 1.

TABLE 1: DETERMINATION OF THE SOLUBILITY OF X AT VARIOUS TEMPERATURES

Experiment Number	Mass of X (g)	Volume of Water (cm^3)	Temperature at which Crystals Reappear (°C)	Solubility of X (g/100 g water)
1	2	4	91	50
2	2	8	57	
3	2	12		
4	2	16		
5	2	20		

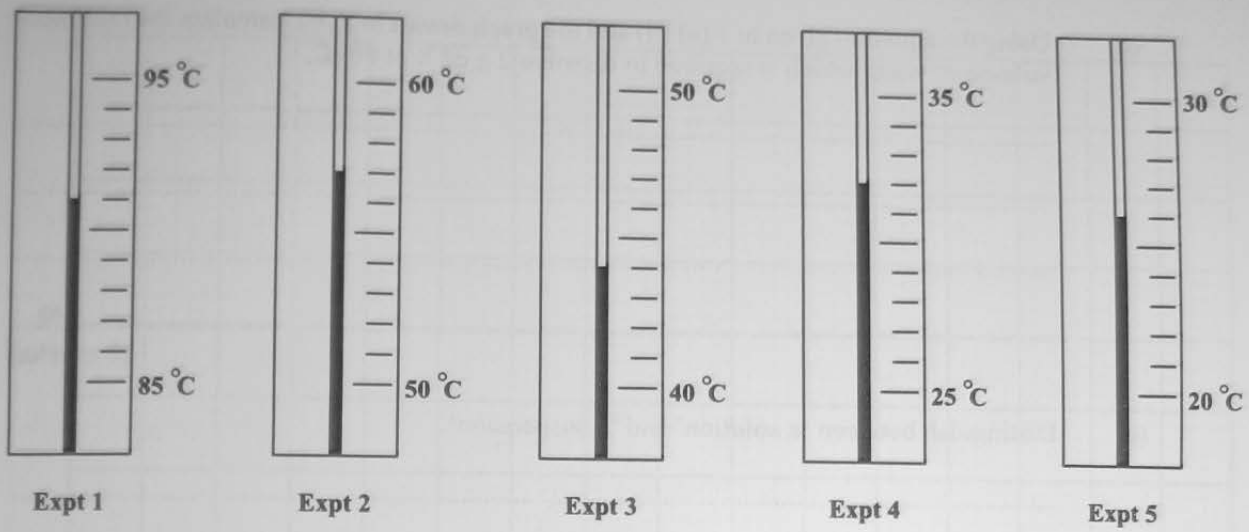

Figure 1. Temperature at which crystals of X first reappear

(a) Complete Table 1 by

(i) recording the temperatures at which the crystals of X reappear in EACH experiment using the information in Figure 1 **(3 marks)**

(ii) determining and recording the corresponding values for the solubility of X.

[At each temperature, Solubility of X = $\frac{\text{mass of X}}{\text{mass of water}} \times 100$; assume 1 cm^3 water = 1 g.] **(3 marks)**

(b) Using the axes on the grid provided on page 5, plot a graph of solubility of X (g/100 g water) against temperature in °C.

Draw a best-fit curve through the points plotted. **(4 marks)**

(c) What deduction about the solubility of X can be made from the graph drawn in 1 (b) above?

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(1 mark)

(d) Using the equation given in 1 (a) (ii) and the graph drawn in 1 (b), calculate the minimum volume of water which is required to dissolve 2 g of X at 60 °C.

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(3 marks)

(e) Distinguish between 'a solution' and 'a suspension'.

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(2 marks)

(f) Besides temperature, state TWO **other** factors that affect the rate at which a solute dissolves.

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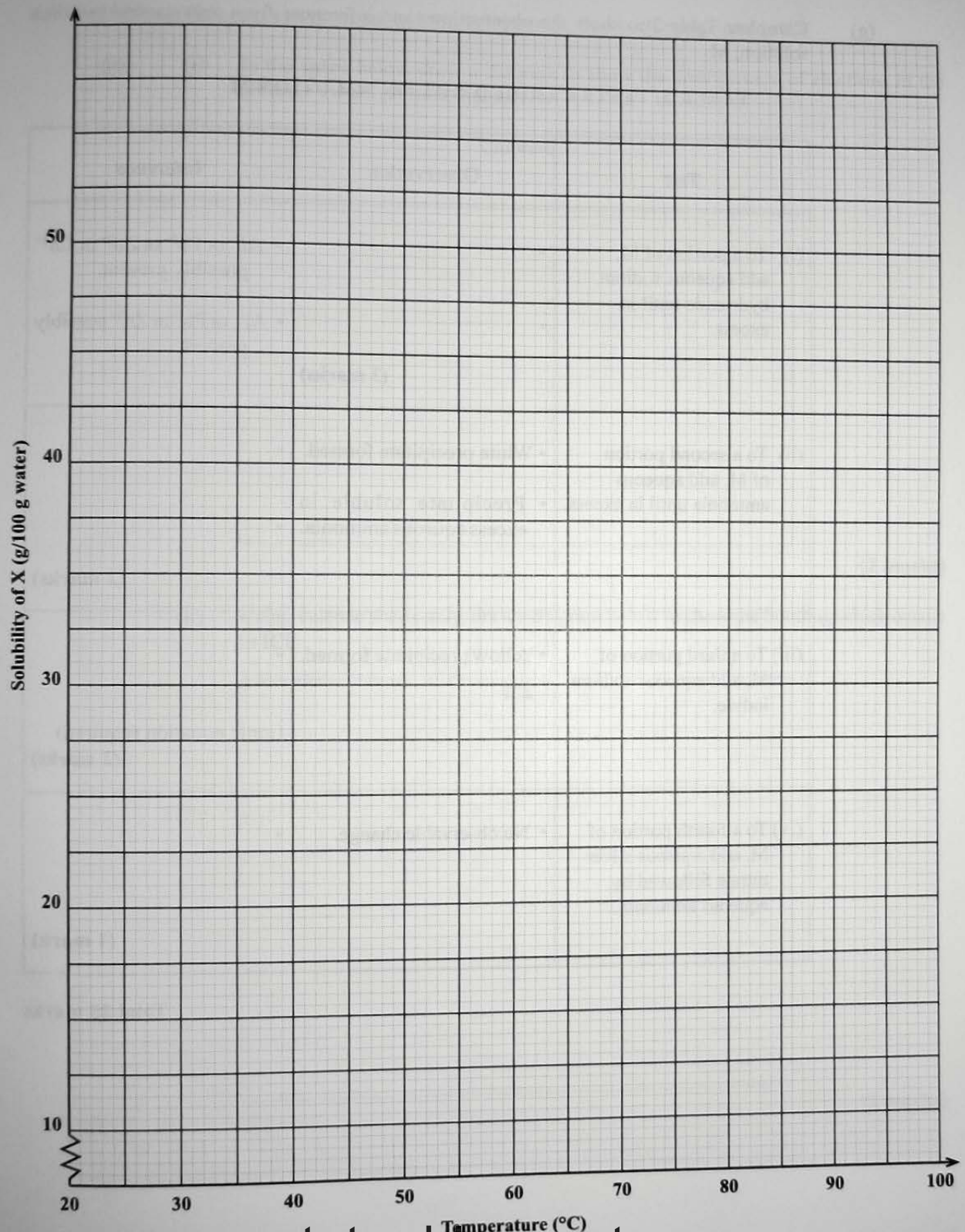
(2 marks)



(g) Complete Table 2 to show the observations and inferences from tests carried out on a solution, M.

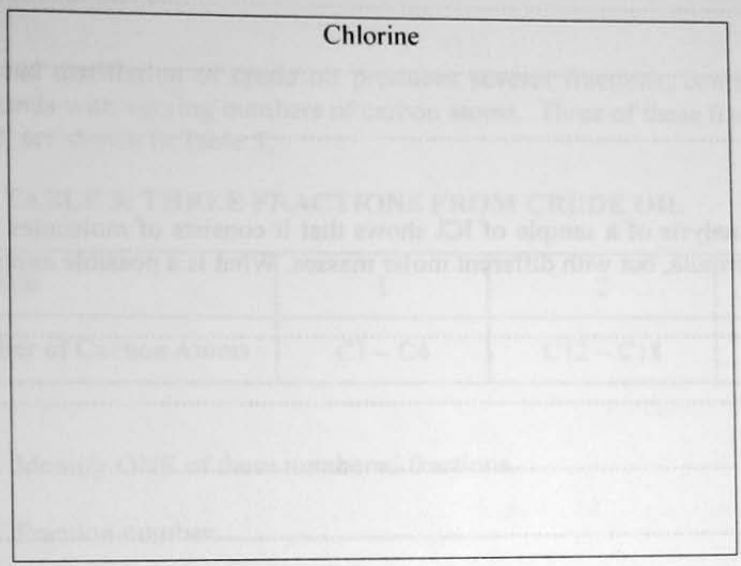
TABLE 2: TESTS CARRIED OUT ON SOLUTION M

Test	Observation	Inference
(i) To a portion of M, add aqueous sodium hydroxide until in excess.	• • **(2 marks)**	• Al^{3+} or Pb^{2+} or Zn^{2+} or Ca^{2+} possibly present. • Al^{3+} or Pb^{2+} or Zn^{2+} possibly present.
(ii) To a second portion of M, add aqueous ammonia until in excess.	• White precipitate formed. • Precipitate soluble in excess aqueous ammonia.	• • **(2 marks)**
(iii) To a third portion of M, add aqueous sodium iodide.	• Yellow precipitate formed.	• (ionic equation required) **(2 marks)**
(iv) To a fourth portion of M, add aqueous silver nitrate followed by aqueous ammonia.	• No observable change.	• **(1 mark)**

Total 25 marks

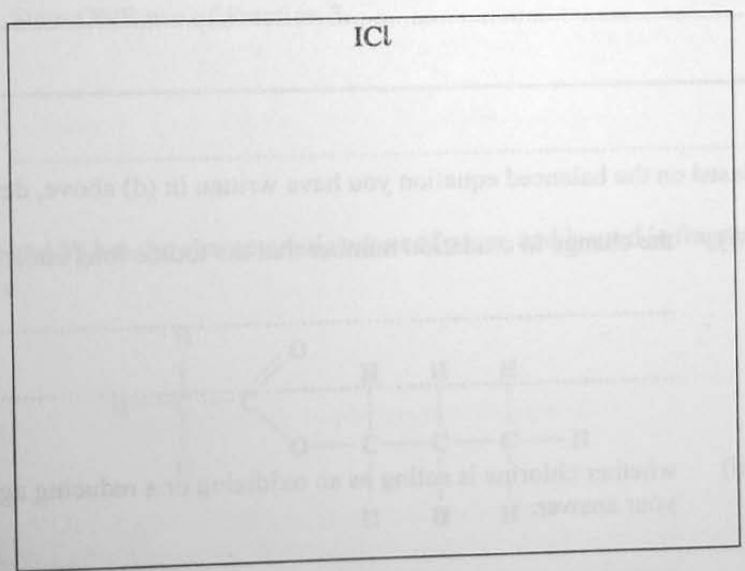
2. Different halogens can combine to form compounds. One such compound is ICl.

(a) (i) In the space below draw a diagram to show the arrangement of electrons in the chlorine atom. [Atomic number = 17]



(2 marks)

(ii) Using valence shells only, draw a diagram below to show the bonding which occurs in ICl.



(2 marks)

(b) State TWO reasons why ICl is expected to have a low melting point.

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(2 marks)

(c) Analysis of a sample of ICl shows that it consists of molecules of the same molecular formula, but with different molar masses. What is a possible explanation for this?

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(3 marks)

(d) Write a balanced equation for the reaction which occurs when chlorine is reacted with aqueous potassium iodide.

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(2 marks)

(e) Based on the balanced equation you have written in (d) above, determine

(i) the change in oxidation number that the iodide ions undergo

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(2 marks)

(ii) whether chlorine is acting as an oxidizing or a reducing agent. State a reason for your answer.

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(2 marks)

Total 15 marks

3. (a) State TWO natural sources of hydrocarbons.

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(2 marks)

(b) Fractional distillation of crude oil produces several fractions, containing a range of compounds with varying numbers of carbon atoms. Three of these fractions, labelled 1, 2 and 3, are shown in Table 3.

TABLE 3: THREE FRACTIONS FROM CRUDE OIL

Fraction	1	2	3
Number of Carbon Atoms	C1 – C4	C12 – C18	C20 – C40

(i) Identify ONE of these numbered fractions.

Fraction number: .....

Fraction name : .....

(1 mark)

(ii) State ONE use of Fraction 3.

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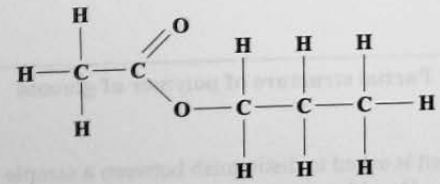
(1 mark)

(c) Compound **W** has the characteristic odour of pears, and is used in fragrances and as a food additive.



Compound W

(i) Identify the homologous series to which Compound **W** belongs.

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(1 mark)

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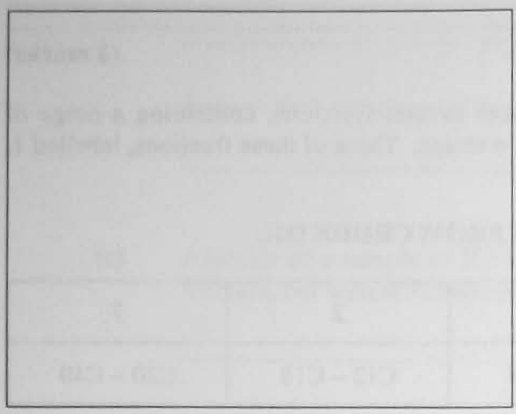
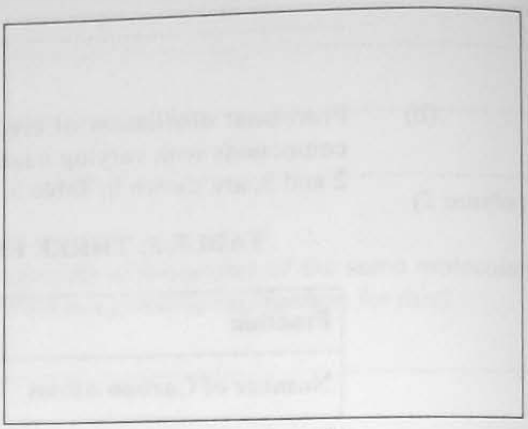
(ii) Write the FULLY DISPLAYED structural formulae of the two molecules that are produced when Compound **W** is hydrolysed by dilute hydrochloric acid, and state the name of any ONE of the structures.



Structure A



Structure B

(2 marks)

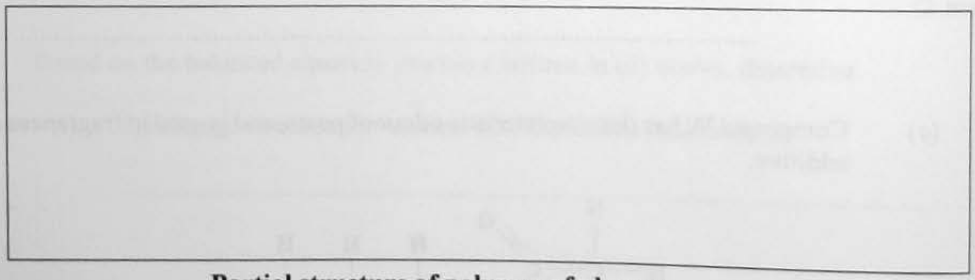
Structure .....; Name: .....

(1 mark)

(d) (i) Glucose, a monosaccharide, can be represented by the HO—⬭—OH unit. State the name of a polymer of glucose, and using THREE glucose units, draw the partial structure of this named polymer in the space provided.

Polymer of glucose: .....

(1 mark)



Partial structure of polymer of glucose

(2 marks)

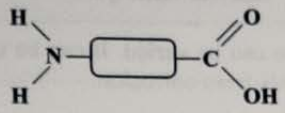
(ii) A student is asked to distinguish between a sample of glucose and a sample of its polymer. He adds water to separate portions of glucose and its polymer, and stirs. State the expected observations in EACH case.

Glucose: .....

Polymer: .....

(2 marks)

(e) The monomer shown below undergoes condensation polymerization. Name the type of polymer formed and give ONE use of this polymer.



Type of polymer formed: .....

(1 mark)

Use: .....

(1 mark)

Total 15 marks

SECTION B

Answer ALL questions.

4. The applications of electrolysis can be varied. It can be used to extract some metals from their compounds and to protect metals from corrosion.

(a) (i) Define the term 'electrolysis'. **(2 marks)**

(ii) Describe what happens during the electrolysis of molten sodium chloride. Support your answer with relevant balanced ionic equations. **(4 marks)**

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(ii) .....

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(b) Aqueous sodium chloride can be electrolysed using inert electrodes. Discuss the effect that the position of ions in the electrochemical series has on the products of this electrolysis.

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(3 marks)

(c) Aluminium is made corrosion resistant by anodizing it. Using a labelled diagram and equations, explain what happens during the anodizing of aluminium.

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(6 marks)

Total 15 marks

5. (a) The acid anhydride of sulfuric acid is produced as an intermediate product in the manufacture of sulfuric acid from sulfur.

(i) State the name of the anhydride and describe how it is produced. **(5 marks)**

(The conditions for the reactions are necessary but there is no need to write the equations.)

(ii) Using balanced chemical equations, with state symbols, explain how the anhydride is converted to sulfuric acid in the manufacturing process. **(4 marks)**

(iii) Suggest why the anhydride is NOT directly added to water to produce sulfuric acid. **(2 marks)**

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(b) Iron and its compounds are important in the manufacturing industry and in biological systems.

(i) Suggest TWO reasons why the alloy, stainless steel, is preferred to pure iron when making cooking utensils. **(2 marks)**

(ii) In humans, iron is found in haemoglobin which is responsible for the transfer of oxygen throughout the body. Suggest how a lack of iron in the human diet could affect the body. **(2 marks)**

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(ii) .....

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Total 15 marks

6. Both the availability of mineral nutrients and soil acidity play an important role in healthy plant growth.

(a) (i) Identify ONE element that is essential for plant growth and state ONE effect of its deficiency. **(2 marks)**

(ii) Design an experiment to investigate the effect of the deficiency stated in (a) (i) above on plant growth. **(4 marks)**

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(ii) .....

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(b) To reduce the problems caused by acidic soils, lime is usually added.

(i) State ONE problem associated with acidic soils. **(1 mark)**

(ii) Use a balanced ionic equation to explain how the addition of lime can increase the pH of acidic soils. **(2 marks)**

(iii) Lime can also cause nitrogen to be lost from soils. State a reason for this. Include a balanced ionic equation with state symbols in your answer. **(3 marks)**

(i) .....

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(ii) .....

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(iii) .....

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(c) Hydroponics is an alternative method of growing crops, but there are some disadvantages with its use.

Identify TWO such disadvantages and suggest ONE way to address ONE of these disadvantages.

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(3 marks)

Total 15 marks

END OF TEST

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