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General Certificate of Education
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Centre Number
71
Candidate Number

Chemistry

Assessment Unit AS 2

assessing

Module 2: Organic, Physical
and Inorganic Chemistry

[AC121]



THURSDAY 20 JANUARY, AFTERNOON

TIME

1 hour 30 minutes.

INSTRUCTIONS TO CANDIDATES

Write your Centre Number and Candidate Number in the spaces provided at the top of this page.

Answer **all seventeen** questions.

Answer **all ten** questions in **Section A**. Record your answers by marking the appropriate letter on the answer sheet provided. Use only the spaces numbered 1 to 10. Keep in sequence when answering.

Answer **all seven** questions in **Section B**. Write your answers in the spaces provided in this question paper.

INFORMATION FOR CANDIDATES

The total mark for this paper is 100.

Quality of written communication will be assessed in question **17(b)**.

In Section A all questions carry equal marks, i.e. **two** marks for each question.

In Section B the figures in brackets printed down the right-hand side of the pages indicate the marks awarded to each question or part question. A Periodic Table of Elements (including some data) is provided.

For Examiner's use only	
Question Number	Marks
Section A	
1–10	
Section B	
11	
12	
13	
14	
15	
16	
17	

Total Marks	
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6854

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Section A

For each of the following questions only **one** of the lettered responses (A–D) is correct.

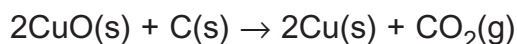
Select the correct response in each case and mark its code letter by connecting the dots as illustrated on the answer sheet.

- 1 Which one of the following colours do barium ions give in a flame test?
- A Blue–green
 - B Green
 - C Red
 - D Yellow
- 2 Which one of the following represents a propagation step in the chlorination of methane?
- A $\text{CH}_4 + \text{Cl}_2 \rightarrow \text{CH}_3\text{Cl} + \text{HCl}$
 - B $\text{CH}_4 + \text{Cl}^\bullet \rightarrow \text{CH}_3^\bullet + \text{HCl}$
 - C $\text{CH}_3^\bullet + \text{Cl}^\bullet \rightarrow \text{CH}_3\text{Cl}$
 - D $\text{CH}_4 + \text{Cl}^\bullet \rightarrow \text{CH}_3\text{Cl} + \text{H}^\bullet$
- 3 CFC–114, used as a refrigerant, contains 14.0% carbon, 44.4% fluorine and the remainder is chlorine. Which one of the following is the empirical formula of CFC–114?
- A CFCI
 - B CF_2Cl
 - C $\text{C}_2\text{F}_4\text{Cl}_5$
 - D $\text{C}_3\text{F}_6\text{Cl}_4$
- 4 A solution of a sulphate gave a white precipitate when both sodium hydroxide and ammonia solutions were separately added to it. The white precipitate was soluble in excess of both sodium hydroxide and ammonia solutions. Which one of the following is the sulphate?
- A $\text{Al}_2(\text{SO}_4)_3$
 - B MgSO_4
 - C Na_2SO_4
 - D ZnSO_4

5 Which one of the following molecules can exist as *cis* and *trans* (E–Z) isomers?

- A $\text{CH}_2=\text{CHCH}(\text{CH}_3)\text{CH}_3$
- B $\text{CH}_2=\text{CHCH}_2\text{CH}_2\text{CH}_3$
- C $\text{CH}_3\text{CH}=\text{CHCH}_2\text{CH}_3$
- D $\text{CH}_3\text{C}(\text{CH}_3)=\text{CHCH}_3$

6 Copper can be extracted by heating copper(II) oxide with carbon.



Which one of the following is the atom economy of the reaction?

- A 40.0%
 - B 69.5%
 - C 74.4%
 - D 80.0%
- 7 Which one of the following represents the standard enthalpy change for the formation of ethanol?
- A $2\text{C}(\text{g}) + 6\text{H}(\text{g}) + \text{O}(\text{g}) \rightarrow \text{C}_2\text{H}_5\text{OH}(\text{g})$
 - B $2\text{C}(\text{s}) + 3\text{H}_2(\text{g}) + \text{O}(\text{g}) \rightarrow \text{C}_2\text{H}_5\text{OH}(\text{l})$
 - C $2\text{C}(\text{s}) + 3\text{H}_2(\text{g}) + \frac{1}{2}\text{O}_2(\text{g}) \rightarrow \text{C}_2\text{H}_5\text{OH}(\text{g})$
 - D $2\text{C}(\text{s}) + 3\text{H}_2(\text{g}) + \frac{1}{2}\text{O}_2(\text{g}) \rightarrow \text{C}_2\text{H}_5\text{OH}(\text{l})$

- 8 The following table shows the enthalpy change of neutralisation for some reactions:

Acid	Base	Enthalpy change of neutralisation/ kJ mol^{-1}
HCl	NaOH	-57.2
X	NaOH	-55.2
HCl	Y	-52.2
HNO_3	KOH	Z

The identities of X, Y and Z are:

- | | X | Y | Z |
|---|----------------|------------------|-------|
| A | ethanoic acid | ammonia solution | -57.2 |
| B | sulphuric acid | ammonia solution | -55.2 |
| C | ethanoic acid | sodium hydroxide | -52.2 |
| D | sulphuric acid | sodium hydroxide | -57.2 |
- 9 Which one of the following alcohols will give a positive result in the iodoform test?

- A $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{OH}$
 B $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}(\text{OH})\text{CH}_3$
 C $\text{CH}_3\text{CH}_2\text{CH}(\text{OH})\text{CH}_2\text{CH}_3$
 D $\text{CH}_3\text{C}(\text{CH}_3)_2\text{CH}_2\text{OH}$

- 10 The standard enthalpies of combustion for carbon, hydrogen and ethyne, C_2H_2 , are given below.

	Standard enthalpy of combustion (kJ mol^{-1})
$\text{C}(\text{s}) + \text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g})$	-394
$\text{H}_2(\text{g}) + \frac{1}{2}\text{O}_2(\text{g}) \rightarrow \text{H}_2\text{O}(\text{l})$	-286
$\text{C}_2\text{H}_2(\text{g}) + 2\frac{1}{2}\text{O}_2(\text{g}) \rightarrow 2\text{CO}_2(\text{g}) + \text{H}_2\text{O}(\text{l})$	-1300

Which one of the following is the standard enthalpy of formation of ethyne?

- A -226 kJ mol^{-1}
 B $+226 \text{ kJ mol}^{-1}$
 C -620 kJ mol^{-1}
 D $+620 \text{ kJ mol}^{-1}$

Section B

Answer **all seven** questions in this section.

- 11 (a) Airbags used in cars contain sodium azide, NaN_3 . During a crash the airbag rapidly fills with nitrogen gas from the following reaction:



ΔH for the reaction is positive.

- (i) What name is given to reactions in which ΔH is positive?

_____ [1]

- (ii) Label the axes below and draw an enthalpy level diagram for the reaction.



[3]

- (iii) When fully inflated the airbag contains 50 dm^3 of nitrogen at 20°C and one atmosphere pressure. What mass of sodium azide is needed to produce this volume of nitrogen?

_____ [3]

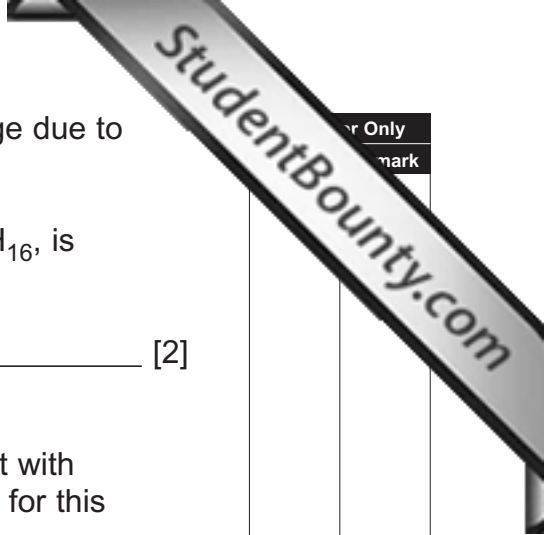
(b) Catalytic converters help to reduce environmental damage due to vehicle exhaust emissions.

(i) Give an equation to show how unburnt heptane, C_7H_{16} , is removed from the exhaust emissions.

_____ [2]

(ii) In the catalytic converter, carbon monoxide can react with nitrogen(II) oxide to form nitrogen. Write an equation for this reaction.

_____ [2]



... Only
... mark

12 Magnesium, calcium and barium are found in Group II of the Periodic Table.

(a) Explain why the Group II elements are regarded as s-block elements.

_____ [1]

(b) (i) Write an equation, including state symbols, for the first ionisation energy of magnesium.

_____ [2]

(ii) State and explain the change in the value of the first ionisation energy from magnesium to barium.

_____ [3]

(c) Calcium hydroxide can be decomposed by heating.

(i) Write an equation for the decomposition of calcium hydroxide.

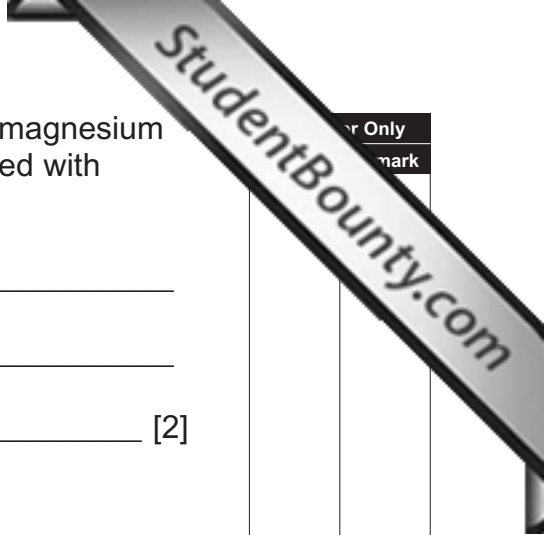
_____ [1]

(ii) Compare and explain the thermal stability of magnesium hydroxide with barium hydroxide.

_____ [3]

(iii) Explain the difference in pH value when 0.1 mole of magnesium hydroxide and 0.1 mole of barium hydroxide are stirred with separate 100 cm³ portions of water.

[2]



For Only
mark

13 Crude petroleum is the source of hydrocarbons such as alkanes.

(a) How are alkanes obtained from crude petroleum?

_____ [1]

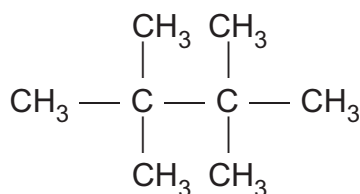
(b) Octane, C_8H_{18} , is an alkane which is a constituent of petrol.

(i) Octane is a saturated hydrocarbon.

What is meant by the terms **saturated** and **hydrocarbon**?

_____ [2]

(ii) Give the systematic name for the isomer of octane shown below.



_____ [1]

(c) Alkenes, such as propene, can be obtained from alkanes such as octane.

(i) What name is given to the process of forming alkenes from alkanes?

_____ [1]

(ii) State **one** condition which is necessary for this process.

_____ [1]

(iii) Write an equation for the formation of propene from octane.

_____ [1]

- (iv) Describe a chemical test for an unsaturated hydrocarbon such as propene.

[2]

- (v) Write an equation for the reaction involved in the test described in part (iv).

[1]

- (d) Explain why alkenes are more reactive than alkanes.

[1]

- (e) Alkenes such as propene react with hydrogen bromide.

- (i) Use a flow diagram to suggest the mechanism for the reaction between an alkene and hydrogen bromide.

You may represent the alkene as: $\begin{array}{c} \diagdown \quad \diagup \\ \text{C}=\text{C} \\ \diagup \quad \diagdown \end{array}$

[3]

- (ii) What name is given to the type of reaction between propene and hydrogen bromide?

[2]

14 Some “ice packs” used to treat sports injuries contain ammonium nitrate and water. A capsule containing the water is broken, the ammonium nitrate dissolves and the temperature falls.

(a) The following results were obtained when ammonium nitrate was added to some water.

Mass of water = 100 g
 Mass of ammonium nitrate = 5.0 g
 Initial temperature = 25.0 °C
 Final temperature = 24.1 °C

Specific heat capacity of water = 4.2 J g⁻¹ °C⁻¹

(i) Calculate the enthalpy change taking place.

_____ [2]

(ii) How many moles of ammonium nitrate were used?

_____ [1]

(iii) Calculate the molar enthalpy change for dissolving the ammonium nitrate in 100g of water.

_____ [1]

(b) One manufacturer makes an “ice pack” containing 120g of water. What mass of ammonium nitrate will be needed to produce a temperature fall of 25.0 °C?

 _____ [2]

- 15 The Birkeland-Eyde process for the manufacture of nitric acid was developed in 1903. In the first step of the process nitrogen and oxygen react as follows:



Explain the effect, if any, of each of the following changes on the **yield** of nitrogen(II) oxide and on **the rate of the reaction**.

- (a) Increasing the temperature.

[3]

- (b) Adding more nitrogen.

[3]

- (c) Increasing the pressure.

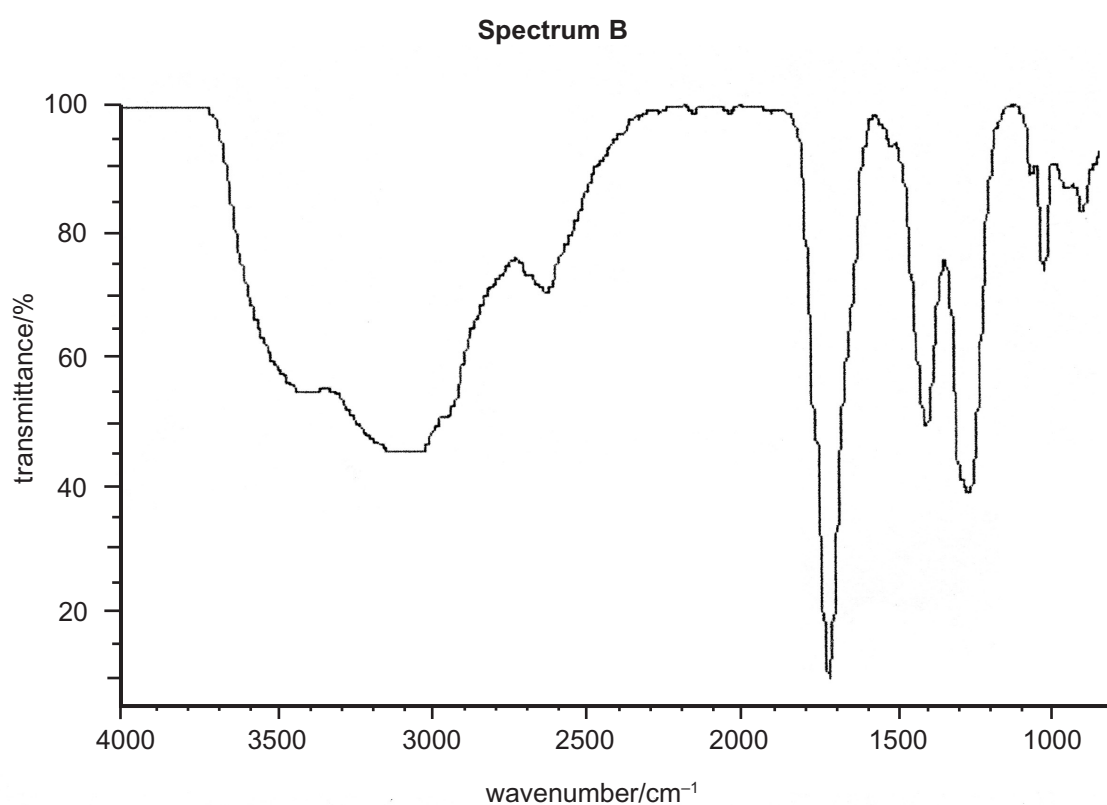
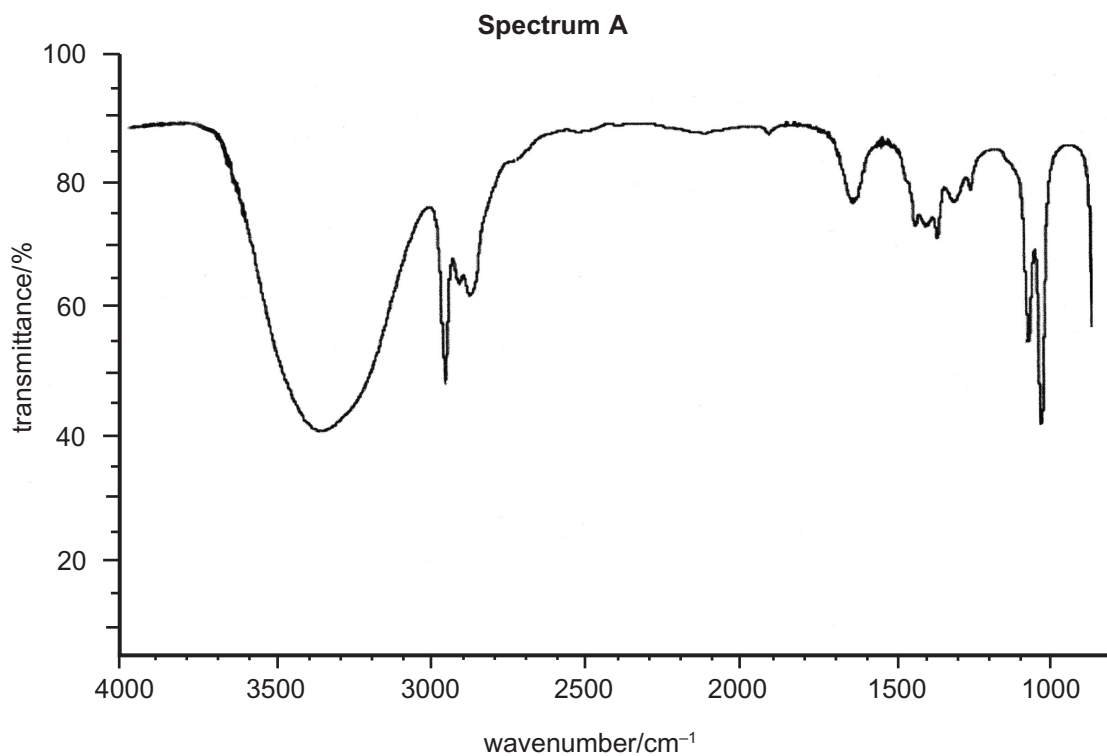
[3]

- (d) Adding a catalyst.

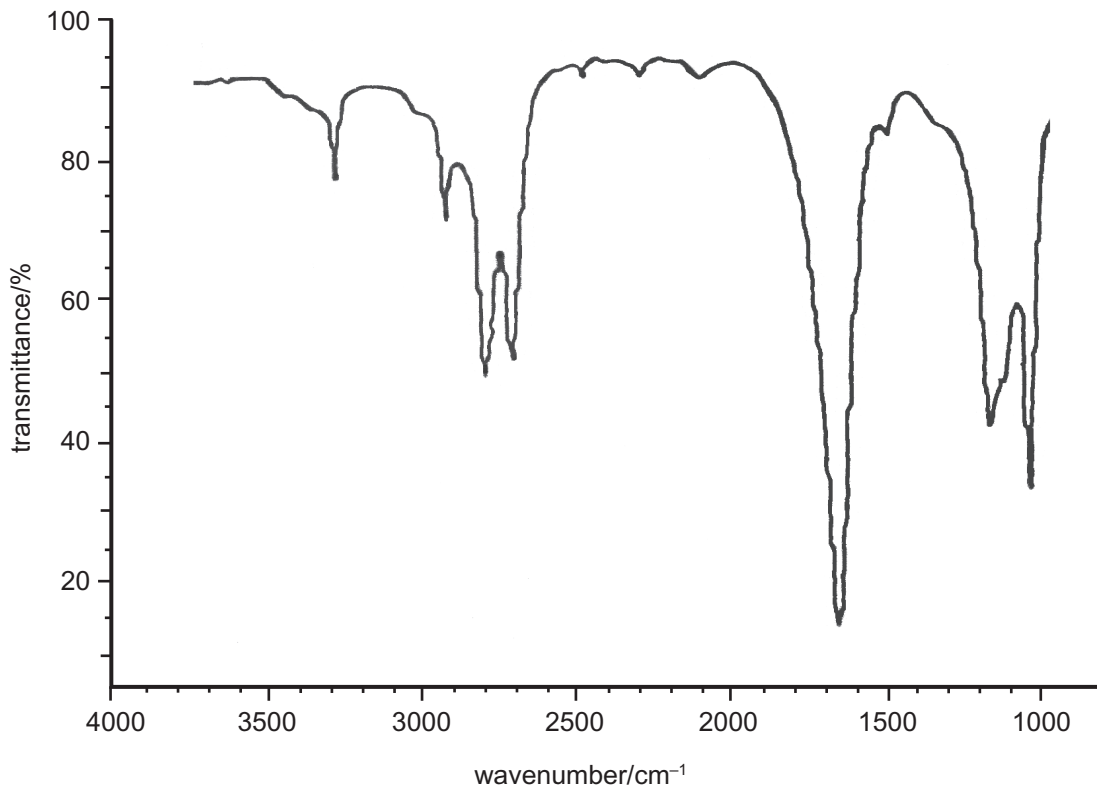
[2]

16 Some wine is thought to be contaminated by ethanal and ethanoic acid.

- (a) A sample of the wine was subjected to infra-red spectroscopy and the results compared to the spectra for ethanol, ethanal and ethanoic acid. The infra-red spectra for ethanol, ethanal and ethanoic acid are shown below (not necessarily in that order).



Spectrum C



(i) Explain how the absorption of infra-red radiation arises in molecules.

[1]

(ii) The table below gives some infra-red absorption data.

Bond	Wavenumber/cm ⁻¹
C — H	2850–3300
C = C	1620–1680
C = O	1680–1750
C — O	1000–1300
(alcohols) O — H	3230–3550
(acids) O — H	2500–3000

Use this data to identify the absorptions at:

Spectrum A: (broad) 3000 cm⁻¹ _____

Spectrum C: 1000 cm⁻¹ _____ [2]

(iii) Identify the molecule responsible for:

Spectrum B: _____

Spectrum C: _____ [2]

(b) Ethanol can be oxidised to ethanal or ethanoic acid depending on the experimental technique used.

(i) Name a suitable oxidising agent.

_____ [1]

(ii) Give the formula of the ion formed by reduction of this oxidising agent.

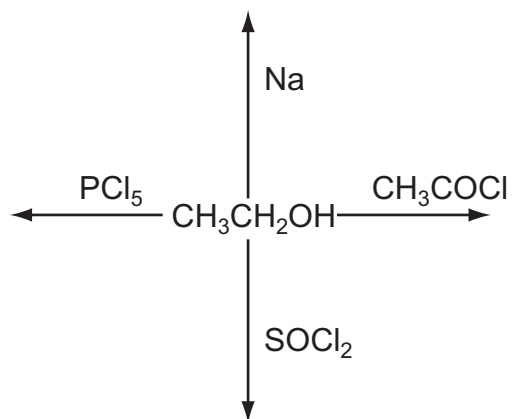
_____ [1]

(iii) Give the experimental techniques required to form

Ethanal: _____ [1]

Ethanoic acid: _____ [1]

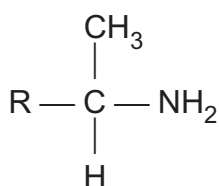
(c) Complete the diagram below giving the formula of the organic compound formed in each case.



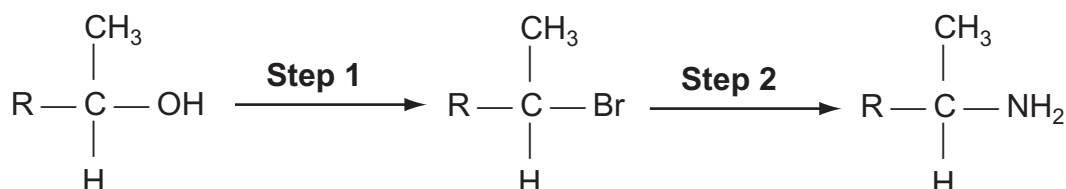
[4]

17 Amphetamines were once used to treat obesity, mild depression and some behavioural disorders.

The general formula for an amphetamine can be represented as:



Amphetamines can be synthesised in the following steps.



(a) (i) Suggest a suitable reagent for **Step 1**.

_____ [1]

(ii) What type of reaction is taking place in **Step 1**?

_____ [2]

(iii) Suggest a suitable reagent and conditions for carrying out **Step 2**.

_____ [2]

(b) The liquid product obtained from **Step 1** is impure. Giving experimental details explain how it can be separated, dried and purified.

[4]

Quality of written communication

[2]

THIS IS THE END OF THE QUESTION PAPER

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