FORM TP 2013156

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CARIBBEAN EXAMINATIONS COUNCIL

CARIBBEAN ADVANCED PROFICIENCY EXAMINATION®

CHEMISTRY

UNIT 2 – Paper 02

2 hours 30 minutes

READ THE FOLLOWING INSTRUCTIONS CAREFULLY.

1. This paper consists of SIX questions in two sections. Answer ALL questions.
2. For Section A, write your answers in the spaces provided in this booklet.
3. For Section B, write your answers in the spaces provided at the end of each question in this booklet.
4. ALL working MUST be shown.
5. You may use a silent, non-programmable calculator to answer questions.
6. A data booklet is provided.

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

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SECTION A

Answer ALL questions in this section.

Write your answers in the spaces provided in this booklet.

MODULE 1

THE CHEMISTRY OF CARBON COMPOUNDS

1. (a) Figure 1 shows two reactions of Compound X, a vegetable oil.

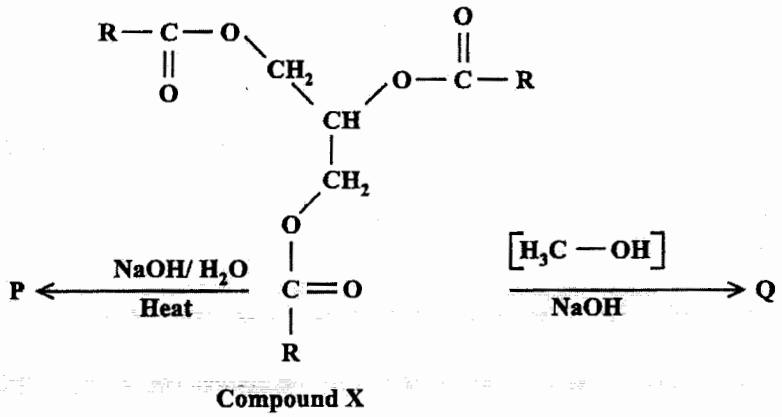


Figure 1. Reaction of Compound X

(i) Draw the products formed at P.

[2 marks]

(ii) Draw the products formed at Q.

[2 marks]

(iii) Identify the process which leads to the formation of the products at

a) P _____

b) Q _____

[2 marks]

(iv) State a use of the non-alcoholic product formed at

a) P _____

b) Q _____

[2 marks]

(b) (i) A student was asked to identify the organic compound, Z. Table 1 shows the student's incomplete record of tests conducted on Z. Complete the student's record by writing the correct observation or inference in the appropriate space.

TABLE 1: RECORD OF TESTS ON COMPOUND Z

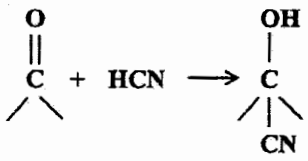
Test	Observation	Inference
To 1.0 cm^3 Z in a test tube add 2,4 – DNPH.	a)	Z is a carbonyl compound.
To 1.0 cm^3 of Z in a test tube add acidified $KMnO_4$ and heat.	b)	Z reduces $KMnO_4$.
To 1.0 cm^3 of Z in a test tube add Tollen's reagent.	A silver mirror appears.	c)
To 1.0 cm^3 of Z in a test tube add Fehling's solution.	No reaction	d)

[4 marks]

(ii) Draw the LIKELY structure for Compound Z.

[1 mark]

(c) The reaction between carbonyl compounds and HCN occurs via nucleophilic addition.



Outline the mechanism for the reaction, using curved arrows to show the movement of electrons.

[2 marks]

Total 15 marks

MODULE 2

ANALYTICAL METHODS AND SEPARATION TECHNIQUES

2. (a) State TWO characteristics of a molecule which make it suitable for analysis by infrared spectroscopy (IR).

_____

_____

_____

_____

[2 marks]

(b) Give TWO examples of the use of IR spectroscopy.

_____

_____

_____

_____

[2 marks]

(c) The IR spectra in Figures 2, 3 and 4 belong to the compounds 2-propanol ($CH_3CH(OH)CH_3$), butanoic acid ($CH_3CH_2CH_2COOH$) and acetone (CH_3COCH_3). Identify EACH of the compounds A, B and C in Figures 2, 3 and 4 respectively from the IR spectra provided. Justify your choice by indicating which band on the spectra was used to verify the identity of the compounds and indicate the functional group responsible for the band in EACH case.

(i)

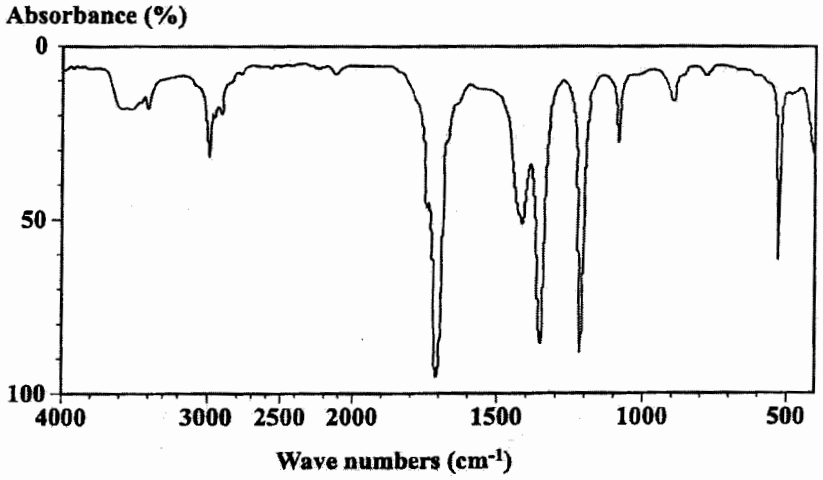


Figure 2. Compound A

a) Identity of Compound A _____

b) Band used for identification and functional group

_____

_____

[2 marks]

(ii)

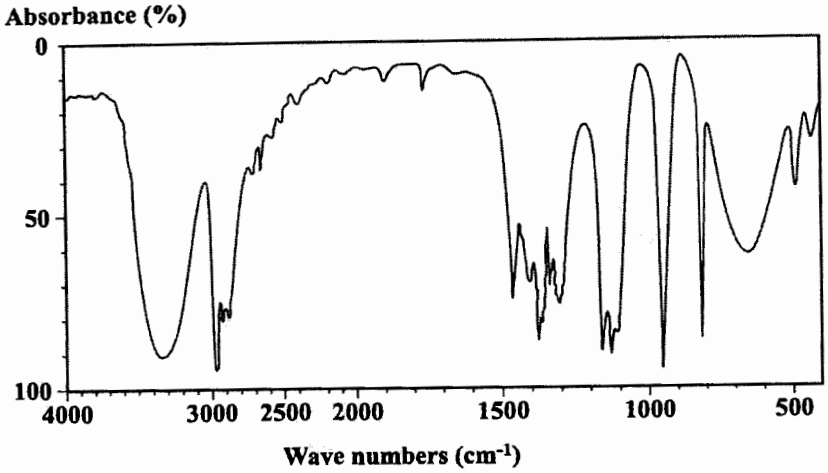


Figure 3. Compound B

a) Identity of Compound B _____

b) Band used for identification and functional group

_____

_____

[2 marks]

(iii)

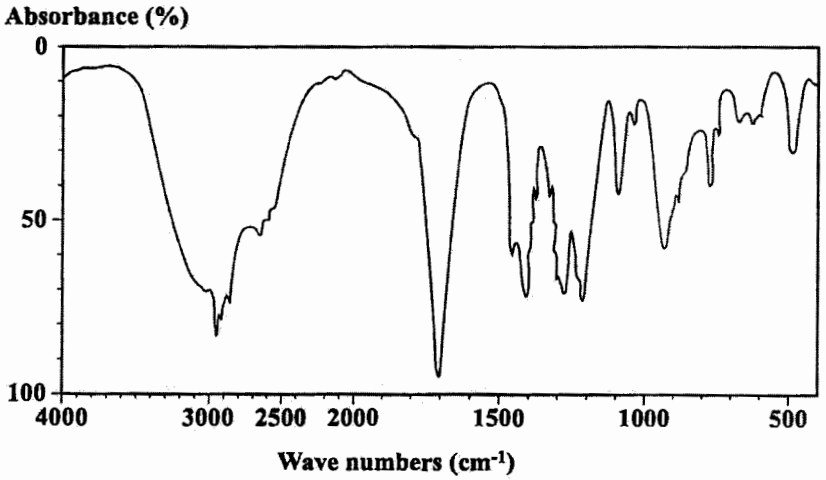


Figure 4. Compound C

a) Identity of Compound C _____

b) Band used for identification and functional group

_____

_____

[2 marks]

(d) A student is asked to prepare a solid sample for analysis using IR spectroscopy.

(i) Describe FOUR steps to be taken by the student in preparing the sample and analysing it.

[4 marks]

(ii) Why are the plates used for IR spectroscopy made from NaCl?

[1 mark]

Total 15 marks

MODULE 3

INDUSTRY AND THE ENVIRONMENT

3. (a) A stream which flows through an agricultural community is also used for domestic washing. Samples taken from a site downstream after a heavy rainfall were found to contain a number of pollutants.

(i) State the process that may have resulted in pollutants being present in the stream.

_____

[1 mark]

(ii) Identify TWO sources of the pollutants (other than fertilizers) that are MOST likely to be present in the stream.

_____

_____

[2 marks]

(b) Analysis of the samples revealed excessive quantities of nitrates and phosphates.

Describe how the presence of these pollutants can be identified in a laboratory.

(i) Nitrates

Reagents:

_____

Observations:

_____

_____

[2 marks]

(ii) Phosphates

Reagents:

_____

Observations:

_____

_____

[2 marks]

GO ON TO THE NEXT PAGE

(c) (i) State TWO ways by which oxygen enters waterways.

_____

_____

_____

_____

[2 marks]

(ii) Dissolved oxygen is essential for maintaining good water quality and the preservation of aquatic life.

Explain why the process of eutrophication leads to poor water quality.

_____

_____

_____

_____

[2 marks]

(iii) Explain why dissolved oxygen must be removed from water before it is used in industrial processes.

_____

_____

_____

[2 marks]

(d) State TWO steps involved in the treatment of water in order to make it potable.

_____

_____

_____

[2 marks]

Total 15 marks

SECTION B

Answer ALL questions.

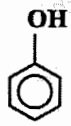
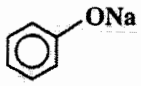
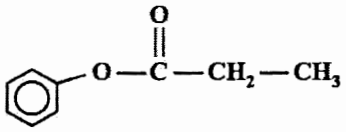
Write your answers in the spaces provided at the end of each question.

MODULE 1

THE CHEMISTRY OF CARBON COMPOUNDS

4. (a) Table 2 shows some reactions of phenol. Identify the reagents and structures needed to complete the table correctly. **(Write your answers in the space provided on page 14.)**

TABLE 2: REACTIONS OF PHENOL

Phenol	Reagents	Structure of Organic Product Formed
	(i)	
	$Br_2(aq)$	(ii)
	(iii)	

[3 marks]

(b) Figure 5 shows the formation of 3-bromoaniline from benzene in three steps labelled I, II and III.

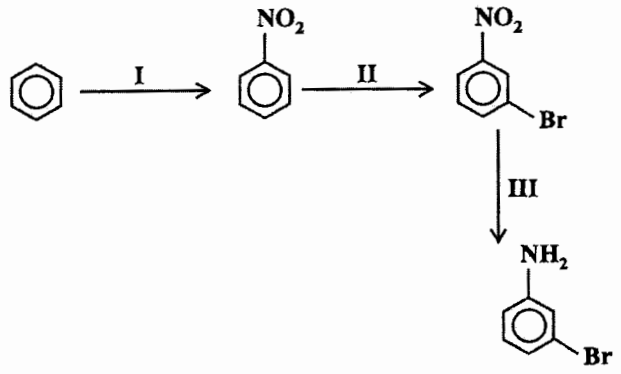


Figure 5. Formation of 3-bromoaniline from benzene

(i) State the reagents and conditions to be used in EACH of the reactions at Steps I, II and III. **[3 marks]**

(ii) Outline the reaction mechanism for the reaction in Step I, using curved arrows to show the movement of electrons. **[3 marks]**

(iii) State the reaction mechanism outlined in (b) (ii) above. **[1 mark]**

(iv) For Step II, explain why the bromo substituent occupies its position on the molecule. **[1 mark]**

(c) Benzene, nitrobenzene and methylbenzene will react with chlorine, in the presence of a catalyst, to form aromatic substituted compounds. The three reactions take place at different rates.

(i) Arrange the reagents benzene, nitrobenzene and methylbenzene in order of INCREASING ease of reactivity with chlorine. **[1 mark]**

(ii) For EACH reaction, draw the MAJOR mono-substituted aromatic product that is formed. **[3 marks]**

Total 15 marks

Write the answer to Question 4 here.

(a) (i) Reagent: _____

(ii) Structure:

(iii) Reagent _____

MODULE 2

ANALYTICAL METHODS AND SEPARATION TECHNIQUES

5. (a) Define the term 'partition coefficient'. **[2 marks]**

(b) When butanedioic acid was shaken with a mixture of water and ether, 10 cm^3 of water was found to contain 0.854 g of the acid while a similar volume of ether contained 0.159 g.

In a separate experiment, 10 cm^3 of water and 20 cm^3 of ether were shaken together with 1 g of the acid.

Calculate the mass of the acid found in the aqueous layer. **[4 marks]**

(c) Suggest an appropriate method for separating the components of EACH of the following:

(i) Eucalyptus oil from an aqueous suspension of its leaves

(ii) Penicillin (organic solid) from an aqueous solution

(iii) Components of a coal tar residue

(iv) Ethoxyethane from an impure source **[4 marks]**

(d)

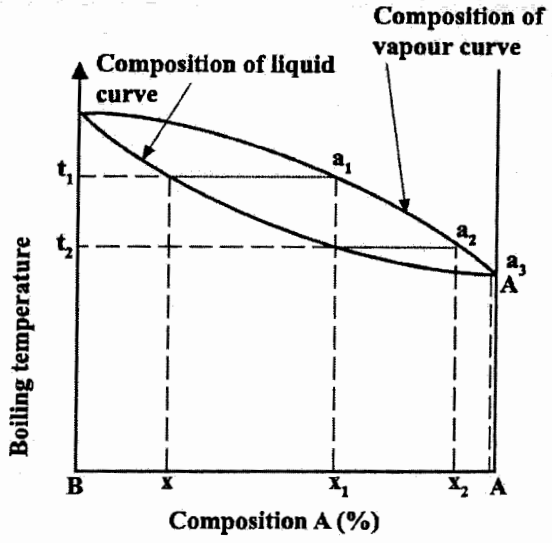


Figure 6. Boiling point – composition curve for ideal mixture of liquids

Use the boiling point – composition curve in Figure 6 to explain the principles of fractional distillation, starting with a liquid of composition *x*. **[5 marks]**

Total 15 marks

MODULE 3

INDUSTRY AND ENVIRONMENT

6. (a) Describe the process of extracting aluminium oxide from its ore. Include TWO relevant equations in your answer. **[7 marks]**

(b) (i) Name a pollutant formed as a by-product of the process in (a).

(ii) Describe TWO environmental consequences resulting from the named pollutant in (b) (i). **[3 marks]**

(c) Aluminium is extracted by electrolysis of its oxide.

(i) Write equations to show the reactions occurring at the electrodes. **[2 marks]**

(ii) a) Outline ONE reason for the high cost associated with this method of extraction.

b) Suggest TWO reasons why the recycling of aluminium is important. **[3 marks]**

Total 15 marks

Write the answer to Question 6 here.