

FORM TP 2008169



TEST CODE 22212020

MAY/JUNE 2008

CARIBBEAN EXAMINATIONS COUNCIL

**ADVANCED PROFICIENCY EXAMINATION**

**CHEMISTRY**

**UNIT 2 – PAPER 02**

*2 hours 30 minutes*

**READ THE FOLLOWING INSTRUCTIONS CAREFULLY.**

1. This paper consists of SIX **compulsory** questions in TWO sections.
2. Section A consists of THREE structured questions, ONE from each Module. Section B consists of THREE extended response questions, ONE from each Module.
3. For Section A, write your answers in the spaces provided in this booklet. For Section B, write your answers in the separate answer booklet provided.
4. ALL working MUST be shown.
5. The use of non-programmable calculators is permitted.
6. A data booklet is provided.

SECTION A

Answer ALL questions.

Write your answers in the spaces provided in this booklet.

MODULE 1

THE CHEMISTRY OF CARBON COMPOUNDS

1. (a) Figure 1 shows the formation of compounds derived from benzene.

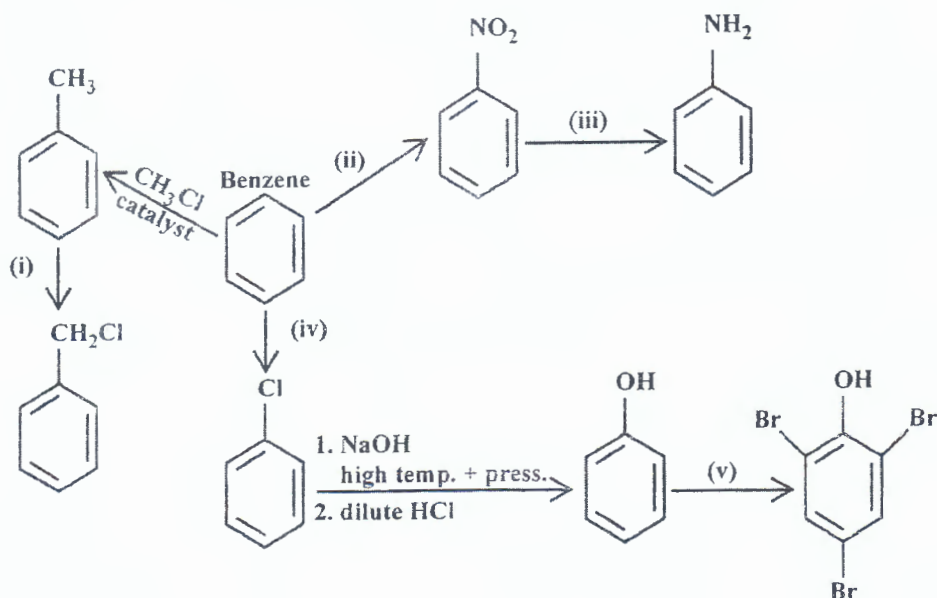


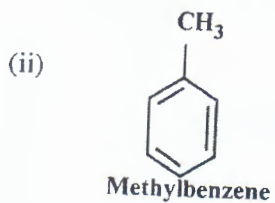
Figure 1. Compounds derived from benzene

Suggest reagents to be used in EACH of the transformations, (i), (ii), (iii), (iv) and (v).

- (i) \_\_\_\_\_
- (ii) \_\_\_\_\_
- (iii) \_\_\_\_\_
- (iv) \_\_\_\_\_
- (v) \_\_\_\_\_

[ 5 marks ]

(b) Draw structures for the monosubstituted products formed from the reaction of chlorine with EACH of the following:



[ 4 marks]

(c) Suggest a reason for the position of the chlorine on the benzene ring in EACH of the products drawn in (b) above.

(i) \_\_\_\_\_

\_\_\_\_\_

(ii) \_\_\_\_\_

\_\_\_\_\_

(iii) \_\_\_\_\_

\_\_\_\_\_

[ 3 marks]

- (d) List the compounds, benzene, methylbenzene and nitrobenzene, in order of increasing ease of reactivity with chlorine (**least** reactive first), and explain your answer.

Order:

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Explanation:

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[ 3 marks]

**Total 15 marks**

## MODULE 2

### ANALYTICAL METHODS AND SEPARATION TECHNIQUES

2. (a) Sodium hydrogen carbonate ( $\text{NaHCO}_3$ ) is sometimes used as a primary standard, yet its molecular mass is only  $84 \text{ g mol}^{-1}$ .

State **THREE** reasons why  $\text{NaHCO}_3$  can be used as a primary standard and **ONE** reason why sodium hydroxide ( $\text{NaOH}$ ) may **NOT** be used.

$\text{NaHCO}_3$ :

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$\text{NaOH}$ :

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[ 4 marks]

(b) A student standardized a solution of sulphuric acid, using sodium hydrogen carbonate as the primary standard, and found the concentration of the acid to be  $6.00 \text{ mol dm}^{-3}$ .

(i) Write the balanced equation for the reaction between sodium hydrogen carbonate and sulphuric acid.

\_\_\_\_\_

[ 2 marks]

(ii) Calculate the mass in grams of sodium hydrogen carbonate that the student used to neutralise the acid if  $23.00 \text{ cm}^3$  of the acid were used from the burette.

**Show all your working.**

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[ 4 marks]



- (b) (i) Suggest TWO reasons why farmers need to use chemical fertilisers in crop production.

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[ 2 marks]

- (ii) Explain how fertilisers cause water pollution.

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[ 2 marks]

- (c) Describe a simple laboratory test that would confirm the presence of EACH of  $\text{Pb}^{2+}$  and  $\text{NO}_3^-$  ions in a sample of water.

$\text{Pb}^{2+}$  : 

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$\text{NO}_3^-$  : 

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[ 6 marks]

**Total 15 marks**

**SECTION B**

Answer ALL questions.

Write your answers in the answer booklet provided.

**MODULE 1**

**THE CHEMISTRY OF CARBON COMPOUNDS**

4. (a) Phenols, alcohols and carboxylic acids all contain hydrogen in their structure but they exhibit different acidities. To illustrate these differences their reactivity with sodium and its compounds, sodium hydroxide (NaOH) and sodium carbonate ( $\text{Na}_2\text{CO}_3$ ) may be compared.

Copy Table 1 in your answer booklet. Predict the outcome of the following reactions by completing Table 1 in your answer booklet.

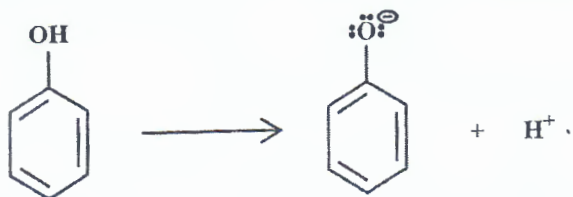
**TABLE 1: REACTIONS OF ETHANOL, PHENOL AND ETHANOIC ACID**

	$\text{Na}_2\text{CO}_3$	Na	NaOH
<b>Ethanol</b>		sodium ethoxide and hydrogen	
<b>Phenol</b>			sodium phenoxide and water
<b>Ethanoic acid</b>	sodium ethanoate, carbon dioxide and water		

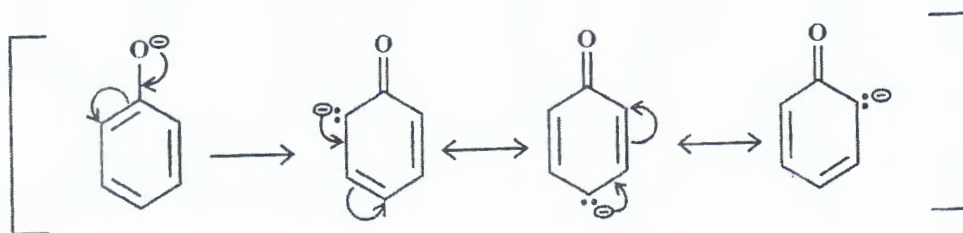
[ 6 marks]



- (b) The loss of a proton by phenol results in the formation of the phenoxide ion.



The phenoxide ion is stabilised via resonance as shown below.



The alkoxide ion is formed from the loss of a proton by an alcohol.



(R = alkyl group)

With reference to the Lewis structure and resonance forms of the phenoxide ion and the Lewis structure of the alkoxide ion, compare and explain the difference in acidity between alcohols and phenols. [ 4 marks ]

- (c) Give TWO characteristics of a homologous series. [ 2 marks ]
- (d) (i) What is meant by the term 'structural isomerism'? [ 1 mark ]
- (ii) Using the molecular formula, C<sub>3</sub>H<sub>8</sub>O, draw the displayed formulae of TWO structural isomers. [ 2 marks ]

**Total 15 marks**

MODULE 2

ANALYTICAL METHODS AND SEPARATION TECHNIQUES

5. (a) Figure 2 is a drawing of a mass spectrometer.

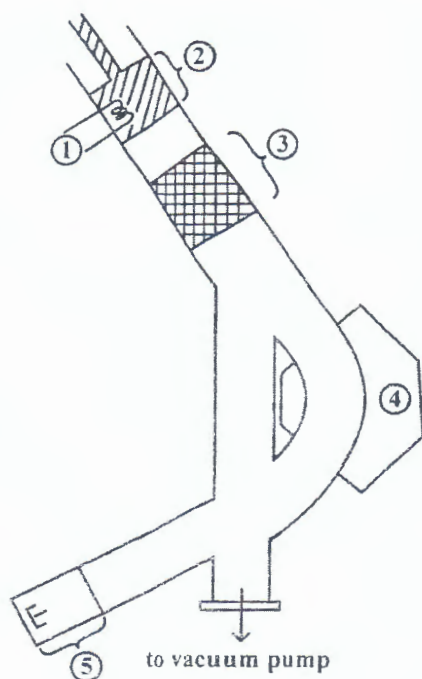


Figure 2. Mass spectrometer

- (i) Identify the parts of the mass spectrometer numbered ②, ③, ④, and ⑤ in Figure 2. [4 marks]
- (ii) What is the purpose of the heated filament, ①? [2 marks]
- (b) The mass spectrum of an element allows for the identification and determination of the relative abundance of each isotope.

Data from the mass spectrum of the halogen, bromine, atomic number 35 are provided below.

Mass number of isotope	79	81
% relative abundance	50.5	49.5

Calculate to 3 significant figures the relative atomic mass of bromine. [2 marks]

- (c) (i) Copy Figure 3 in your answer booklet. Sketch, in your answer booklet, the spectrum of bromine vapour in the  $m/e$  region indicated in Figure 3.

[ 4 marks]

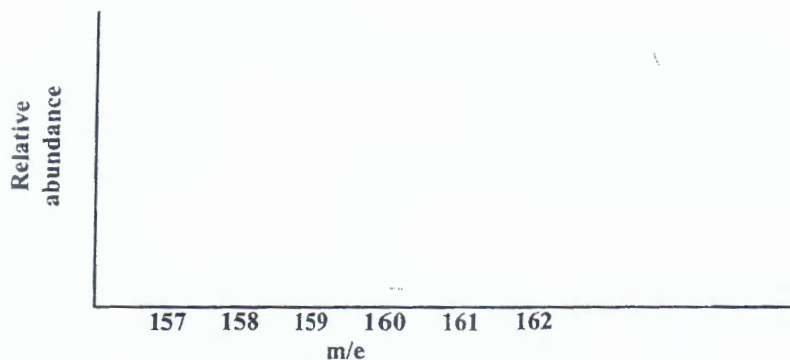


Figure 3. Mass spectrum

- (ii) What is the origin of EACH of the THREE peaks in your spectrum?

[ 3 marks]

Total 15 marks

### MODULE 3

#### INDUSTRY AND THE ENVIRONMENT

6. (a) Name TWO substances which can be fermented to produce alcohol. [ 2 marks]
- (b) Outline, using relevant equations, the process by which sucrose is converted to ethanol. [ 4 marks]
- (c) The harmful effects of alcohol are due to its oxidation to ethanal. Write an equation for the oxidation of alcohol (ethanol) to ethanal. [ 2 marks]
- (d) Identify TWO physiological changes in the body which result from the abuse of alcohol consumption. [ 2 marks]
- (e) (i) Outline THREE economic benefits of ethanol (alcohol) production. [ 3 marks]
- (ii) Suggest TWO measures that can be used to reduce the negative social effects of alcohol abuse. [ 2 marks]

Total 15 marks

END OF TEST