FORM TP 2016169

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MAY/JUNE 2016

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. Write your answers in the spaces provided in this booklet.
3. Do NOT write in the margins.
4. Where appropriate, ALL WORKING MUST BE SHOWN in this booklet.
5. A data booklet is provided.
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.

MODULE 1

THE CHEMISTRY OF CARBON COMPOUNDS

1. (a) Define the term 'structural isomerism'.

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[1 mark]

(b) 60 cm^3 of oxygen were mixed with 10 cm^3 of a gaseous hydrocarbon, X, C_xH_y. After exploding and cooling to room temperature, 40 cm^3 of gas were left. On shaking with aqueous sodium hydroxide, 10 cm^3 of oxygen remained. (All measurements were made at the same temperature and pressure.) The combustion of X can be represented by the following equation:

$$C_xH_y + (x + \frac{y}{4})\, O_2 \longrightarrow x\, CO_2 + \frac{y}{2}\, H_2O$$

(i) Calculate the formula of the hydrocarbon, X.

[4 marks]

(ii) Hence, write its displayed formula.

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[1 mark]

GO ON TO THE NEXT PAGE

(c) There are four alcohols with the molecular formula $C_4H_{10}O$. The formulae for two of them are:

$CH_3CH_2CH_2CH_2OH$ and $CH_3CH_2CHOHCH_3$

Butan-1-ol Butan-2-ol

(i) Write the name and displayed formula for EACH of the other two alcohols.

Displayed Formula	Displayed Formula
Name:	Name: .....

[2 marks]

(ii) When butan-2-ol is heated with phosphoric acid, a mixture of alkenes is produced. One of these alkenes exhibits isomerism.

Write the names and displayed formulae of the two isomers of this alkene.

Displayed Formula	Displayed Formula
Name:	Name: .....

[2 marks]

(d) Table 1 shows two pairs of compounds. Complete the table by describing simple laboratory tests to distinguish between EACH pair of compounds.

TABLE 1: DISTINGUISHING COMPOUNDS

Compound	Test	Observation
$CH_3CH(OH)CH_3$ $CH_3CH_2CH_3OH$	**[2 marks]**	**[1 mark]**
$CH_3CH(OH)CH_3$ $CH_3CCH_3(OH)CH_3$	**[1 mark]**	**[1 mark]**

[5 marks]

Total 15 marks

MODULE 2

ANALYTICAL METHODS AND SEPARATION TECHNIQUES

2. (a) Explain the origin of infrared (IR) absorption by compounds.

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[3 marks]

(b) State the properties of compounds which absorb IR radiation.

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[2 marks]

(c) The IR spectrum of an organic compound, Y, has major absorption peaks in the regions 3350–3500 cm^{-1} and 1680–1800 cm^{-1} respectively. Y has a relative molecular mass of 75 and forms an aqueous solution which is neutral.

(i) Identify the groups responsible for the above absorptions.

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[2 marks]

(ii) State the name of Compound Y and draw its displayed formula.

Name: .....

[1 mark]

Displayed Formula

[2 marks]

(d) Describe the steps taken in the preparation of a solid sample for IR analysis.

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[4 marks]

(e) State ONE limitation of IR spectroscopy.

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[1 mark]

Total 15 marks

MODULE 3

INDUSTRY AND THE ENVIRONMENT

3. (a) Sulfur dioxide and sulfur trioxide are toxic compounds and if allowed to escape during the Contact Process can cause acid rain. Write an equation to represent the formation of acid rain by ONE of these compounds.

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[2 marks]

(b) Outline TWO ways in which other industrial chemicals lead to water pollution.

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[2 marks]

(c) Explain how a named pollutant affects

(i) the quality of water for human consumption

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[2 marks]

(ii) the aquatic environment.

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[2 marks]

(d) (i) Complete Table 2 by outlining simple laboratory tests that would confirm the presence of Pb^{2+} and NO_3^- in a sample of water.

TABLE 2: CONFIRMATORY TESTS

Ion	Test	Observation
Pb^{2+}	• **(1 mark)**	• **(1 mark)**
NO_3^-	• • **(2 marks)**	• **(1 mark)**

[5 marks]

(ii) Write the ionic equation to represent the test on Pb^{2+} in Table 2.

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[2 marks]

Total 15 marks

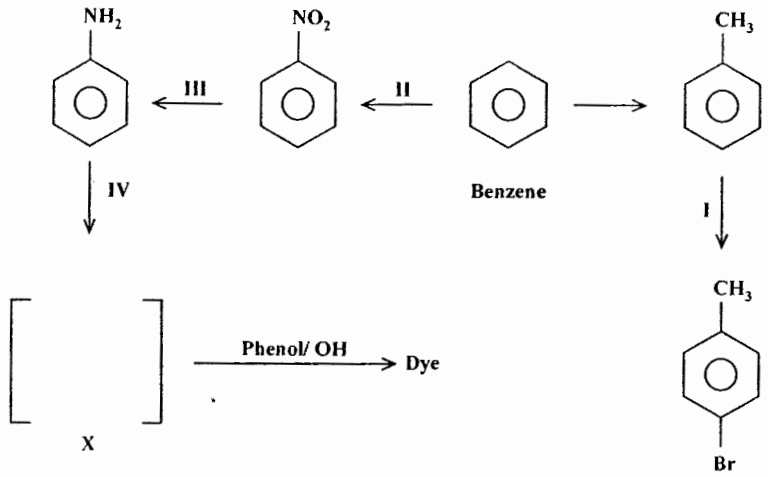
SECTION B

Answer ALL questions.

MODULE 1

THE CHEMISTRY OF CARBON COMPOUNDS

4. The following diagram represents some of the reactions of benzene.



(a) State the type of reaction labelled I and IV.

Reaction I:

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Reaction IV:

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[2 marks]

(b) List the reagents and conditions required for Reactions II and IV.

Reaction II

Reagents: .....

Conditions: .....

Reaction IV

Reagents: .....

Conditions: .....

[4 marks]

(c) Draw the displayed formula for Compound X.

[1 mark]

(d) Outline the mechanism for Reaction I using curved arrows to indicate the movement of electrons, being careful to identify the various steps involved.

[4 marks]

(e) Write the structural formula for the products formed when phenol is treated with

(i) aqueous bromine

(ii) sodium hydroxide

(iii) ethanoyl chloride.

[3 marks]

(f) Write the equation for the reaction in (e) (iii).

[1 mark]

Total 15 marks

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MODULE 2

ANALYTICAL METHODS AND SEPARATION TECHNIQUES

5. (a) (i) State Raoult's law for an ideal mixture of two liquids.

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[2 marks]

(ii) List TWO characteristics of an ideal solution.

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[2 marks]

(b) A and B are components of a liquid which forms an azeotropic mixture.

(i) Define the term 'azeotropic mixture'.

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[1 mark]

(ii) State ONE reason why azeotropes are NOT compounds.

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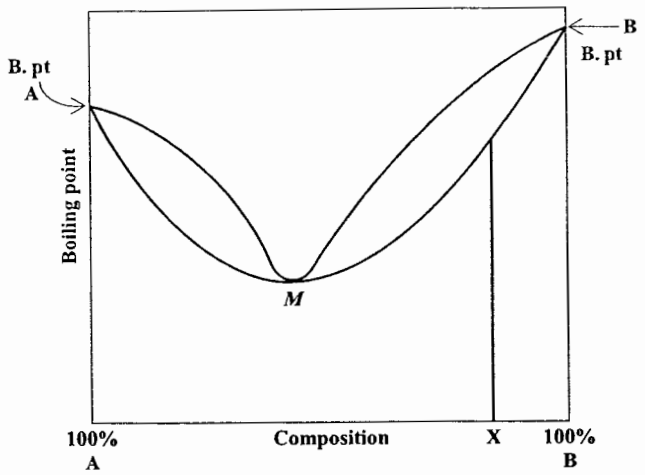
[1 mark]

(iii) The following graph shows the composition of a minimum boiling point mixture.



Using the graph, explain clearly the result of distilling a mixture of Composition X as indicated.

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[6 marks]

(c) An aqueous solution contains 2.5 g of a compound in 50 cm^3 of solution. The partition coefficient of the compound between water and an organic solvent is 0.200.

Calculate the mass of the compound extracted by shaking 100 cm^3 of aqueous solution with 25 cm^3 of the solvent.

[3 marks]

Total 15 marks

MODULE 3

INDUSTRY AND THE ENVIRONMENT

6. (a) (i) Describe the process involved in the production of aluminium from alumina. (Include appropriate equations.)

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[4 marks]

(ii) State the effect of the production of oxygen on the process.

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[1 mark]

(iii) Write an equation to represent the effect in (a) (ii).

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[1 mark]

(b) Suggest THREE factors which would influence the location of a bauxite plant.

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[3 marks]

(c) (i) Define the term 'recycling'.

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[1 mark]

(ii) Describe how aluminum is recycled.

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[2 marks]

(d) Suggest THREE ways in which recycled aluminium can be used.

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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.