

FORM TP 2008169



TEST CODE **02212020**

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 answer booklet provided.
4. ALL working must be shown.
5. The use of non-programmable calculators is permitted.
6. A data booklet is provided.

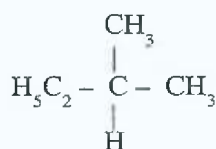
SECTION A

Answer ALL questions in this section.
Write your answers in the spaces provided in this booklet.

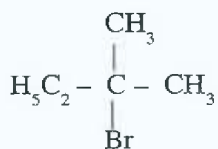
MODULE 1

THE CHEMISTRY OF CARBON COMPOUNDS

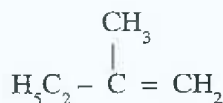
1. A – D represent the structures of four different organic molecules.



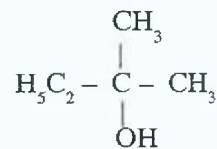
A



B



C



D

- (a) Complete Table 1 by writing the reagent, condition and reaction mechanism for EACH of the following conversions.

TABLE 1

	Reagent	Condition	Reaction mechanism
A → B	_____	_____	_____
C → A	_____	_____	Electrophilic addition
C → B	_____	_____	_____

[7 marks]

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- (b) B may be converted to D by reacting with ethanolic sodium hydroxide. Using curved arrows to show the movement of electrons, write the mechanism for the conversion of B to D.

[4 marks]

- (c) Complete Table 2 by writing the observation and expected product for any reaction of alcohol and $\text{K}_2\text{Cr}_2\text{O}_7/\text{H}^+$.

TABLE 2

	Reaction with $\text{K}_2\text{Cr}_2\text{O}_7$	
	Observation	Expected product (if any)
Primary alcohol	Colour change from orange to green	
Secondary alcohol		
Tertiary alcohol		

[4 marks]

Total 15 marks

MODULE 2

ANALYTICAL METHODS AND SEPARATION TECHNIQUES

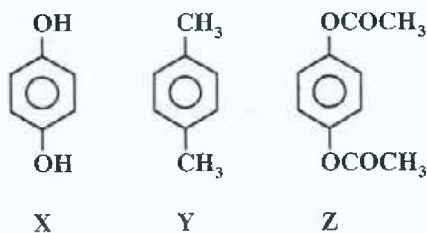
2. (a) Explain the theoretical principle on which chromatographic separation methods are based and give ONE example of its use.

Theoretical principle:

Use of chromatographic methods:

[2 marks]

- (b) A student is given the task of separating Compounds X, Y and Z below using thin-layer chromatography (TLC).



- (i) What is the function of EACH of the following in TLC?

- a) Mobile phase

[1 mark]

- b) Stationary phase

[1 mark]

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- (b) (ii) What property of the Compounds X, Y and Z should be considered in the selection of a suitable mobile phase for the separation?

_____ [1 mark]

- (iii) Figure 1 is a diagram of the TLC plate showing the expected order of separation of X, Y and Z, using an alcohol-based solvent system.

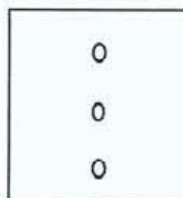


Figure 1

- a) Label on the diagram the position of X, Y and Z. [1 mark]
b) Illustrate on the diagram of the TLC plate how the R_f value of any ONE component could be determined. [3 marks]

- (c) Gas-liquid chromatography, GLC, could also be applied in the separation of X, Y and Z in the mixture.

- (i) Which of the TWO, gas or liquid, is the mobile phase? _____
stationary phase? _____ [2 marks]

- (ii) Give ONE example EACH of a substance which could be used as the mobile phase _____
stationary phase. _____ [2 marks]

- (iii) Predict the order of retention times for X, Y and Z if the mixture is separated by GLC.
_____ [1 mark]

- (iv) What feature of the mixture would dictate the area of the peak for each component in the GLC trace?

_____ [1 mark]

Total 15 marks

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MODULE 3

INDUSTRY AND THE ENVIRONMENT

3. A potable water supply is suspected to be contaminated with Pb^{2+} and NO_3^- ions and you are required to test if this is true.

(a) Suggest a precaution you would take to ensure there is no external contamination of your water sample.

_____ [1 mark]

(b) (i) Name ONE reagent EACH you would use to confirm or disprove the claim of contamination.

For Pb^{2+} : _____

For NO_3^- : _____

[2 marks]

(ii) State the expected results of the tests using the reagents named in (b) (i) above, if the water is contaminated by Pb^{2+} and NO_3^- .

Pb^{2+} : _____

NO_3^- : _____

[2 marks]

(c) (i) Name any THREE steps involved in the production of potable water.

[3 marks]

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- (ii) State ONE advantage and ONE disadvantage of using chlorine in the production of potable water.

Advantage:

Disadvantage:

[2 marks]

- (iii) Suggest ONE method, OTHER THAN chlorination, of purifying water.

[1 mark]

- (d) An electric power station is observed discharging warm water into a nearby river.

- (i) What is the name of this type of pollution?

[1 mark]

- (ii) Suggest TWO effects this discharge may have on the river and their potential impact on the organisms inhabiting the river.

[2 marks]

- (iii) Suggest a corrective action that could be taken by the power station to rectify the problem.

[1 mark]

Total 15 marks

SECTION B

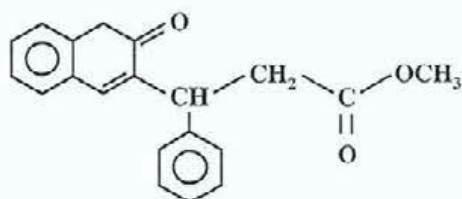
Answer ALL questions in this section.

Write your answers in the answer booklet provided.

MODULE 1

THE CHEMISTRY OF CARBON COMPOUNDS

4. (a) Compound A below is similar in structure to warfarin which is used to control rodents.



Compound A

- (i) Identify THREE functional groups in the structure of A. [3 marks]
- (ii) Specific functional groups in Compound A react with the following reagents:
- I – HCN
- II – Bromine in an organic solvent

Identify ONE functional group that reacts with EACH reagent and show the change that occurs to the structure. [4 marks]

- (b) Free radical reactions occur frequently in nature in photochemical processes.
- Using the reaction between methane and chlorine, explain the mechanism of free radical substitution. [3 marks]
- (c) Illustrate the reaction mechanism for electrophilic substitution, using the reaction between benzene and a **named** electrophile. [5 marks]

Total 15 marks

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MODULE 2

ANALYTICAL METHODS AND SEPARATION TECHNIQUES

5. Ethanol and water form an azeotropic mixture (containing 95.6% ethanol) which boils at a temperature of 78.2°C.
- (a) Describe the principles on which fractional distillation is based. [3 marks]
- (b) Using the boiling points of ethanol and water as 78.5 °C and 100.0 °C respectively, sketch a boiling point composition curve for the two-component system. [5 marks]
- (c) 25 g of a mixture of ethanol and water containing 20 g of ethanol is subjected to fractional distillation.
- (i) Explain why ethanol and water mix readily. [2 marks]
- (ii) Calculate the percentage by mass of ethanol in the mixture. [2 marks]
- (d) Suggest what happens on distilling a mixture containing 70% ethanol and water. [2 marks]
- (e) Give ONE example of an industry in which fractional distillation is used. [1 mark]

Total 15 marks

MODULE 3

INDUSTRY AND THE ENVIRONMENT

6. In 1912 the German chemist, Fritz Haber, developed a process for synthesizing ammonia directly from nitrogen and hydrogen. A major problem Haber encountered was a decrease in the equilibrium constant, K_{eq} , with an increase in operating temperature.
- (a) Write an equation for the production of ammonia from nitrogen and hydrogen, and give ONE large-scale use of ammonia. [3 marks]
- (b) (i) An increase in the operating temperature resulted in a decrease in K_{eq} . Why was this unacceptable to Haber? [1 mark]
- (ii) Explain how liquefying the ammonia, as soon as it is made, affects the yield of ammonia **and** state the principle on which the effect is based. [2 marks]
- (iii) Outline TWO steps taken by Haber to increase the yield of ammonia and explain how these modifications led to the improvement in ammonia production. [6 marks]
- (c) (i) State ONE factor which influences the siting of an ammonia plant. [1 mark]
- (ii) Suggest TWO safety precautions that should be taken for the protection of the workers in the operation of an ammonia plant. [2 marks]

Total 15 marks

END OF TEST