**02 JUNE 2014 (p.m.)**

FILL IN ALL THE INFORMATION REQUESTED CLEARLY AND LEGIBLY.

**TEST CODE** 02212020  
**SUBJECT** CHEMISTRY – UNIT 2 – Paper 02  
**REGISTRATION NUMBER**

### FOR CXC® USE ONLY

<table>
<thead>
<tr>
<th>QUESTION NUMBER</th>
<th>MODULE 1</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td></td>
<td></td>
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<tr>
<td>04</td>
<td></td>
<td></td>
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<tr>
<td>TOTAL</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>MODULE 2</td>
<td>TOTAL</td>
</tr>
<tr>
<td>02</td>
<td></td>
<td></td>
</tr>
<tr>
<td>05</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>MODULE 3</td>
<td>TOTAL</td>
</tr>
<tr>
<td>03</td>
<td></td>
<td></td>
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<tr>
<td>06</td>
<td></td>
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<td>TOTAL</td>
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</table>

**SCHOOL/CENTRE NUMBER**

**NAME OF SCHOOL/CENTRE**

**CANDIDATE’S FULL NAME**

**DATE OF BIRTH**

*Day* | *Month* | *Year*  

**SEX**  
MALE [ ]  
FEMALE [ ]

**SIGNATURE**

BELOW THIS LINE FOR CXC® USE ONLY

**FOLDER NUMBER**
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.
SECTION A

Answer ALL questions.

Write your answers in the spaces provided in this booklet.

MODULE 1

THE CHEMISTRY OF CARBON COMPOUNDS

1. (a) Methane reacts with bromine in the presence of UV radiation to produce a number of substitution products, one of which is bromomethane.

   (i) State the role of the UV radiation in the reaction.

   [1 mark]

   (ii) Write equations to show the steps occurring in the propagation stage for the formation of dibromomethane from bromomethane.

   [2 marks]

(b) (i) Given the general formula for an aliphatic amine to be RNH₂, write the expression for the basic dissociation constant, K_b.

   [2 marks]

(ii) The pK_b values for ethylamine and phenylamine are 3.27 and 9.38 respectively. State which of these compounds is the stronger base.

   [1 mark]
(iii) State TWO reasons for the difference between the two $pK_a$ values in (b) (ii).

[2 marks]

(c) (i) Suggest a value for $K_b$ for ethanamide, $\text{CH}_3\text{CONH}_2$.

[1 mark]

(ii) State a reason for your answer in (c) (i) above.

[1 mark]
A student performed a number of tests to identify various functional groups.

Table 1 shows an incomplete laboratory record of the investigation.

Complete the record by inserting the appropriate observations.

**TABLE 1: LABORATORY RECORD**

<table>
<thead>
<tr>
<th>Test</th>
<th>Functional Group</th>
<th>Observation</th>
</tr>
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<tbody>
<tr>
<td>(i)</td>
<td>Add SOCl₂ very cautiously.</td>
<td><img src="image" alt="Functional Group" /></td>
</tr>
<tr>
<td>(ii)</td>
<td>Add AgNO₃(aq) and boil gently.</td>
<td><img src="image" alt="Functional Group" /></td>
</tr>
<tr>
<td>(iii)</td>
<td>Add Br₂(aq).</td>
<td><img src="image" alt="Functional Group" /></td>
</tr>
<tr>
<td>(iv)</td>
<td>Add Br₂(aq).</td>
<td><img src="image" alt="Functional Group" /></td>
</tr>
</tbody>
</table>

Total 15 marks
MODULE 2

ANALYTICAL METHODS AND SEPARATION TECHNIQUES

2. Figure 1 represents a sketch of the electromagnetic spectrum with regions labelled A, B and C. Radiation is characterised by its wavelength (\(\lambda\)) and frequency (\(v\)).

```
Visible
radiation
A  B  C
Violet  Red
```

**Figure 1. Electromagnetic spectrum**

(a) (i) Use an arrow to indicate, below the sketch, the direction of increasing frequency. [1 mark]

(ii) Identify the region (A, B or C) where EACH of the following forms of radiation may be found.

Infrared

X-rays

[2 marks]

(b) Calculate the wavelength of electromagnetic radiation with frequency of \(4.5 \times 10^{15}\) Hz. (Velocity of light = \(3.0 \times 10^8\) m s\(^{-1}\)) [2 marks]
(c) State ONE example of the use of gravimetric analysis in quality control.

(d) Below is an excerpt from the laboratory report of the method used by a student to prepare a substance, S, for gravimetric analysis.

Step 1: Two solutions were mixed to produce a precipitate of S.

Step 2: S was obtained by quickly filtering the suspension from Step 1. S was then washed with THREE consecutive 20-cm³ volumes of distilled water.

Step 3: S was strongly heated for 15 minutes and then allowed to cool to room temperature.

Step 4: Step 3 was repeated until constant mass was achieved.

(i) State the purpose for performing:

Step 1:  

Step 4:  

(ii) State TWO pieces of apparatus that should be used in Step 2.

(iii) State the apparatus that should be used in Step 3.
(e) Washing soda is hydrated sodium sulfate, \( \text{Na}_2\text{SO}_4 \cdot x \text{H}_2\text{O} \).

A sample of washing soda was heated in a crucible to constant mass.

The following observations were made:

- Mass of crucible = 34.25 g
- Mass of crucible and washing soda = 40.69 g
- Mass of crucible and washing soda after heating = 37.09 g

Calculate the value of \( x \) in the formula \( \text{Na}_2\text{SO}_4 \cdot x \text{H}_2\text{O} \).

\[ \text{(RAM: Na} = 23; \ S = 32; \ O = 16; \ H = 1) \]

[4 marks]

Total 15 marks
3. Ammonia is manufactured from its elements by the Haber process.

(a) (i) Write the equation for the process. [2 marks]

(ii) Indicate the conditions of temperature and pressure. [1 mark]

(iii) State the process by which nitrogen is produced for the production of ammonia. [1 mark]

(iv) State TWO factors which should influence the location of an ammonia industrial plant. [2 marks]

(b) With reference to Le Chatelier’s Principle, explain the effect on the yield of ammonia by raising the temperature [2 marks]

(ii) raising the pressure. [2 marks]
Figure 2 is a flow diagram showing the manufacture of ammonia which involves a number of experimental processes including A, B, C and D.

![Flow diagram]

**Figure 2. Flow diagram showing the manufacture of ammonia**

(i) Identify the process occurring at

A

B

D [3 marks]

(ii) State the condition necessary at C.

[1 mark]

(iii) What is the physical state of ammonia after the process at D?

[1 mark]

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) Explain the terms 'primary', 'secondary' and 'tertiary' as applied to halogenoalkanes. [2 marks]

(b) Compound A is one of two straight chain bromoalkanes which can exist in two isomeric forms having a molar mass of 137.

(i) Write the name of Compound A. [1 mark]

(ii) Explain the nature of the isomerism exhibited by Compound A. [2 marks]

(iii) Draw the structural formulae of the isomers showing the relationship between them. [2 marks]

(c) Another bromoalkane, B, with the same molar mass when refluxed with aqueous sodium hydroxide produces an organic compound, C, and an aqueous solution, D.

It was found that the rate of the reaction is determined only by the concentration of B.

(i) State the name of the compound, B. [1 mark]

(ii) Outline the mechanism for this reaction using curved arrows to indicate the movement of electrons. [5 marks]

(d) (i) Describe the reaction between a solution of D and aqueous silver nitrate. [1 mark]

(ii) Write the equation for this reaction. [1 mark]

Total 15 marks
Write the answer to Question 4 here.

(a) 

(b) (i) 

(ii) 

(iii)
Write the answer to Question 4 here.

(c) (i) 

(ii) 

(d) (i) 

(ii)
5. (a) Describe how EACH of the following components of a mass spectrometer is used in the analysis of an organic compound.

(i) Electron beam [2 marks]
(ii) Magnetic field [2 marks]
(iii) Recorder [2 marks]

(b) Explain the importance of the (M + 1) peak in mass spectra. [2 marks]

(c) Figure 3 shows the mass spectrum of a sweet-smelling organic compound, X.

![Figure 3. Mass spectrum of Compound X](image)

Deduce the following:

(i) M/z ratio of the molecular ion [1 mark]
(ii) M/z ratio of the base peak [1 mark]
(iii) Formulae of the ion fragments of M/z ratios 15, 29 and 43 [3 marks]
(iv) Structural formula of Compound X [1 mark]

(d) Write the structural formula of an isomer possessing similar physical properties as X. [1 mark]

Total 15 marks
Write the answer to Question 5 here.

(a) (i) 

(ii) 

(iii) 

(b) 

GO ON TO THE NEXT PAGE

02212020/CAPE 2014
Write the answer to Question 5 here.

(c) (i) ____________________________________________________________

(ii) _____________________________________________________________

(iii) _____________________________________________________________

(iv) _____________________________________________________________

(d) _____________________________________________________________
MODULE 3

INDUSTRY AND THE ENVIRONMENT

6. (a) Destruction is one of the processes involved in the maintenance of the levels of ozone in the stratosphere.

   (i) Explain, with the aid of relevant equations, the destruction of stratospheric ozone. [5 marks]

   (ii) Identify a man-made activity which contributes to stratospheric ozone destruction. [1 mark]

   (iii) State TWO effects of stratospheric ozone destruction on human life. [2 marks]

(b) (i) Describe, with the aid of an equation, the reaction which occurs during the fermentation process in the production of ethanol. [3 marks]

   (ii) State the process used to obtain ethanol of concentration above 95% from a fermentation batch. [1 mark]

(c) "The production of ethanol is a major contributor to the economies of Caribbean countries."

   Comment on the statement above stating TWO reasons in support. [3 marks]

Write the answer to Question 6 here.

(a) (i) __________________________________________________________

________________________________________________________

________________________________________________________

________________________________________________________

________________________________________________________

________________________________________________________

________________________________________________________

________________________________________________________

________________________________________________________

(c) __________________________________________________________
Write the answer to Question 6 here.

(a) (ii) 


(b) (i) 


(ii) 


GO ON TO THE NEXT PAGE
Write the answer to Question 6 here.

(c)

END OF TEST

IF YOU FINISH BEFORE TIME IS CALLED, CHECK YOUR WORK ON THIS TEST.