

FORM TP 2009159



TEST CODE **02212020**

MAY/JUNE 2009

**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.

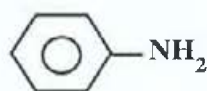
## SECTION A

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

### MODULE 1

#### THE CHEMISTRY OF CARBON COMPOUNDS

1. Phenylamine is a highly toxic compound used in the production of dyes.



Phenylamine

- (a) Phenylamine can be produced in a two-stage process. The reaction scheme is illustrated in Figure 1.



Figure 1. Reaction scheme for production of phenylamine

- (i) Draw the structural formula for the intermediate, X.

[ 1 mark ]

- (ii) State the condition required for Stage I.

[ 1 mark ]

- (iii) State the reagent required for Stage II.

[ 1 mark ]

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(b) Phenylamine is a weak base.

(i) Write a general equation showing the basic property of phenylamine.

[ 2 marks]

(ii) a) Is phenylamine more basic or less basic than ammonia?

\_\_\_\_\_

b) Explain your answer in terms of availability of lone pairs, and hydrogen bonding.

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

[ 5 marks]

(c) Dyes can be made from phenylamine in a two-stage process as outlined in Figure 2.

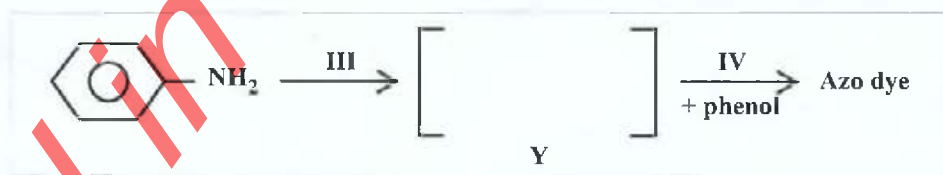


Figure 2. Reaction scheme for production of azo dye

(i) Write the formula of the intermediate, Y.

[ 1 mark ]

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- (ii) For Stage III, state the reagents and condition required.

Reagents: \_\_\_\_\_

Condition: \_\_\_\_\_

[ 2 marks ]

- (iii) Name the reagent used to dissolve the phenol in Stage IV.

\_\_\_\_\_

[ 1 mark ]

- (iv) State the colour of the azo dye when phenol is used in Stage IV.

\_\_\_\_\_

[ 1 mark ]

Total 15 marks

## MODULE 2

### ANALYTICAL METHODS AND SEPARATION TECHNIQUES

2. Titration is the method used in volumetric analysis to determine the concentration of a solution.

- (a) Define EACH of the following terms:

- (i) Equivalence point \_\_\_\_\_

\_\_\_\_\_

[ 1 mark ]

- (ii) End point \_\_\_\_\_

\_\_\_\_\_

[ 1 mark ]

- (b) The concentration of a solution of barium chloride can be determined using sodium carbonate solution, by the technique of 'back titration'.

Use the example of barium chloride given above to explain the technique of back titration.

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

[ 2 marks ]

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- (c) 25 cm<sup>3</sup> of a solution containing barium chloride is placed in a beaker and the barium ions quantitatively (completely) precipitated by boiling with an excess of sodium carbonate solution containing 0.005 moles.

After filtration, the remaining sodium carbonate solution needed 0.004 moles of hydrochloric acid for neutralization.

- (i) Write the equation for the precipitation of barium ions.

[ 2 marks ]

- (ii) Calculate the number of moles of Na<sub>2</sub>CO<sub>3</sub> remaining after filtration.

[ 2 marks ]

- (iii) Deduce the number of moles of BaCl<sub>2</sub> which reacted with the sodium carbonate solution.

[ 1 mark ]

- (iv) Calculate the concentration of barium ions in mol dm<sup>-3</sup>.

[ 1 mark ]

- (d) (i) List FOUR steps a student must follow to successfully standardize a solution of potassium manganate(VII) by titration using an oxalic acid solution.

[ 4 marks ]

- (ii) Identify the indicator in the titration in (d) (i) above.

[ 1 mark ]

**Total 15 marks**

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MODULE 3

INDUSTRY AND THE ENVIRONMENT

3. (a) The nitrogen cycle may be described as the flow of nitrogen from the atmosphere to the earth and back to the atmosphere via fixation processes.

(i) Define the term 'nitrogen fixation'.

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[ 2 marks]

(ii) State TWO ways by which nitrogen fixation can occur.

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[ 2 marks]

- (b) Write ONE balanced equation involving nitrogen in the production of acid rain.

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[ 2 marks]

- (c) Suggest TWO human activities which may contribute to the disruption of the atmospheric equilibrium.

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[ 2 marks]

- (d) Suggest TWO reasons why governments are reluctant to take actions to reduce atmospheric pollution.

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[ 2 marks]

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- (e) An exhibit at a Science Fair included a model of the process for the purification of aluminium oxide,  $\text{Al}_2\text{O}_3$  from its bauxite ore. Figure 3 shows an outline of the process.

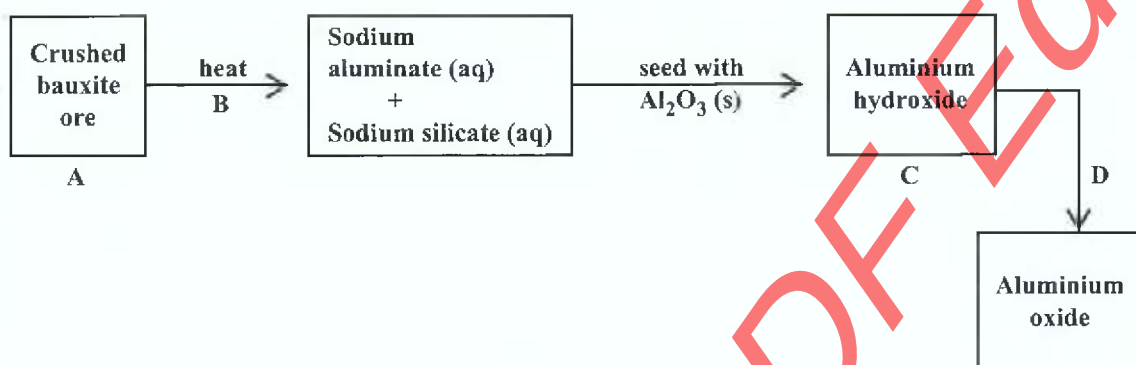


Figure 3. Outline of the process of the purification of  $\text{Al}_2\text{O}_3$  from bauxite

- (i) State the colour of the bauxite ore at A.
- \_\_\_\_\_
- [ 1 mark ]
- (ii) Name the reagent, B.
- \_\_\_\_\_
- [ 1 mark ]
- (iii) State the colour and appearance of the aluminium hydroxide at C.
- Colour: \_\_\_\_\_
- Appearance: \_\_\_\_\_
- [ 2 marks]
- (iv) State ONE process occurring at D.
- \_\_\_\_\_
- [ 1 mark ]

Total 15 marks

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## SECTION B

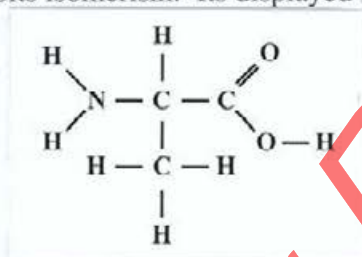
Answer ALL questions in this section.

Write your answers in the answer booklet provided.

### MODULE 1

#### THE CHEMISTRY OF CARBON COMPOUNDS

4. (a) Alanine (2-amino propanoic acid) is one of the 20 naturally occurring amino acids. It is a white solid which exhibits isomerism. Its displayed formula is illustrated below.



Alanine

- (i) Define EACH of the following terms:
- a) Stereoisomerism
  - b) Chiral centre [ 2 marks ]
- (ii) Copy the displayed formula of alanine in your answer booklet. Place an asterisk (\*) to identify the chiral centre AND state the type of isomerism exhibited. [ 2 marks ]
- (iii) Write the displayed formulae of the two isomers. [ 2 marks ]
- (iv) In an aqueous solution of alanine, the species present is dependent on the pH. Write the displayed formula of the species present in solutions of
- a) pH = 2
  - b) pH = 13
  - c) pH = 7 [ 4 marks ]
- (b) The most important property of amino acids is their ability to polymerise. The formation of a dipeptide molecule involving a peptide link is the first stage in this process.
- (i) State the type of polymerisation involved in the formation of the dipeptide molecule. [ 1 mark ]
  - (ii) Write the equation, using displayed formulae, to show the formation of the dipeptide molecule AND circle the peptide link. [ 3 marks ]
  - (iii) Name the functional group represented by the peptide link. [ 1 mark ]

Total 15 marks

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## MODULE 2

### ANALYTICAL METHODS AND SEPARATION TECHNIQUES

5. (a) Infrared (IR) spectroscopy is an important technique in determining the structures of molecules.
- (i) State TWO principles upon which IR spectroscopy is based. [ 2 marks]
  - (ii) State the TWO categories of molecular vibrations exhibited by molecules. [ 2 marks]
  - (iii) Outline the steps in the preparation of a solid compound for examination in an IR spectrometer. [ 2 marks]
- (b) Figure 4 is a reproduction of the IR spectrum of an organic molecule, Y, of molecular mass 60.

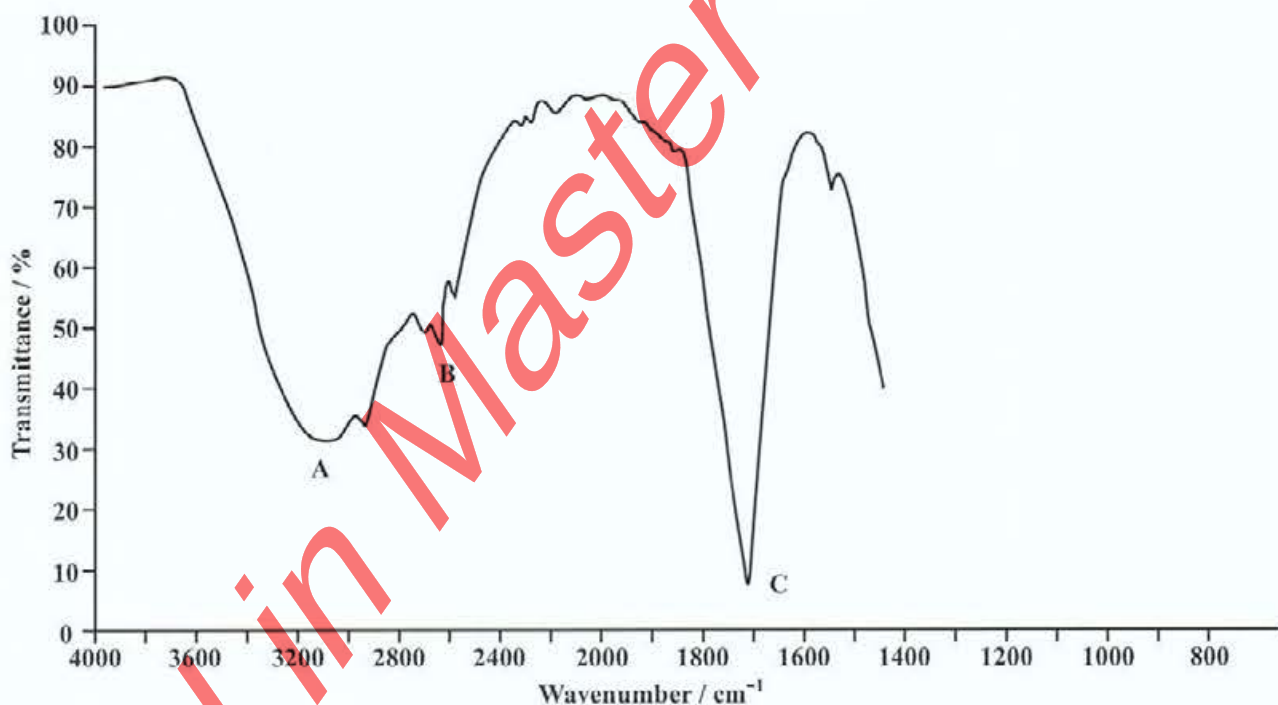


Figure 4. IR spectrum of Molecule Y

- (i) Use the information in the data booklet provided to identify the bonds represented by the peaks, A, B and C in Figure 4. [ 3 marks]
- (ii) Suggest the structure of Y. [ 1 mark ]

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- (c) Figure 5 shows the apparatus for the extraction of eugenol from clove using steam distillation.

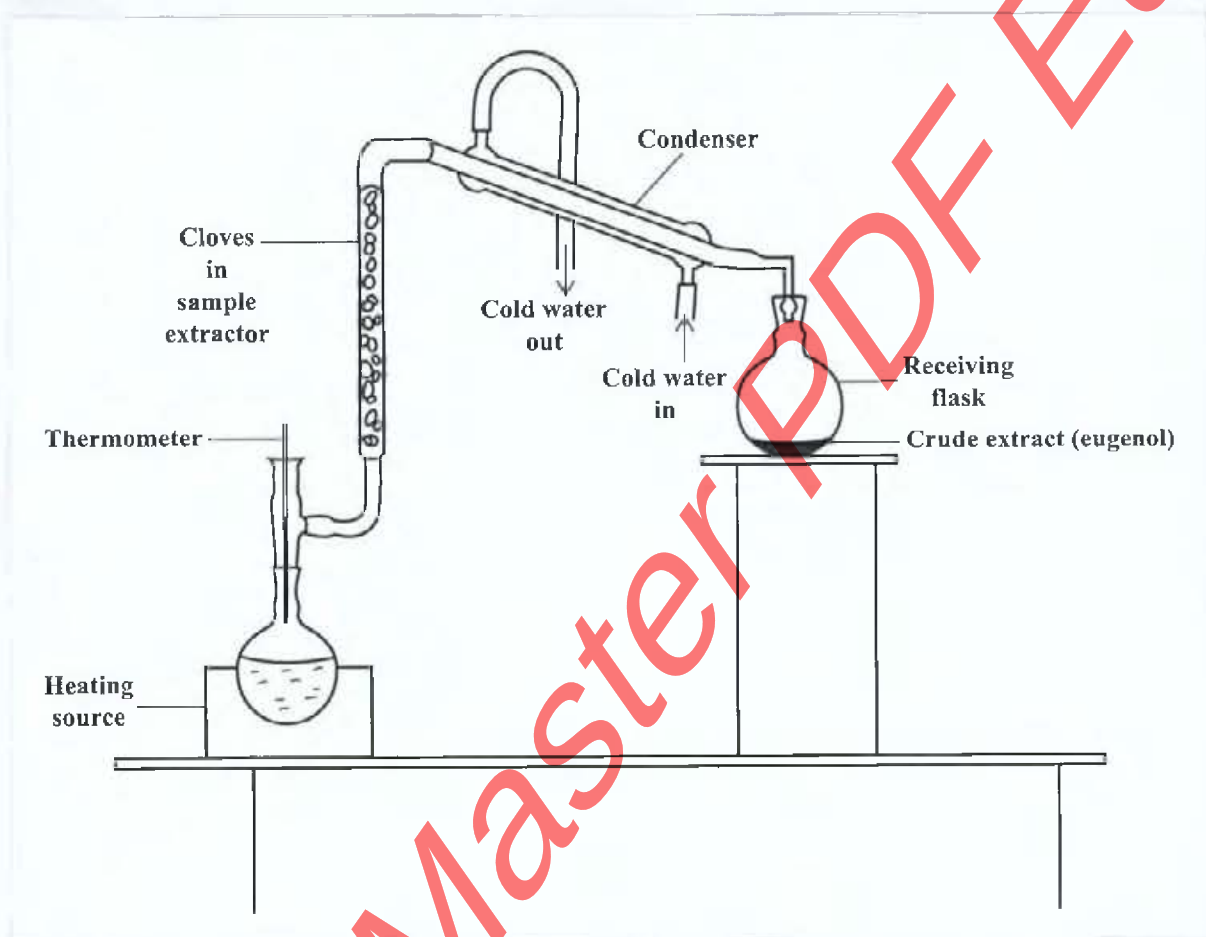


Figure 5. Steam distillation of clove

- (i) Suggest TWO advantages and ONE disadvantage of using steam for the extraction process illustrated in Figure 5. [ 3 marks]
- (ii) Explain what effect the length of the extractor in Figure 5 will have on the distillation process. [ 2 marks]

Total 15 marks

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**MODULE 3**

**INDUSTRY AND THE ENVIRONMENT**

6. (a) The chlor-alkali industry brings high economic benefits to the countries in which it is situated.
- (i) List THREE substances produced by the chlor-alkali industry. [ 3 marks]
- (ii) One of the methods employed by the chlor-alkali industry is the use of the diaphragm cell. Describe the chemical processes involved in the production of TWO of the substances listed in (a) (i) above, when the diaphragm cell is in operation. Your answer must include the
- a) type of chemical reaction taking place
- b) equations representing the chemical reactions. [ 6 marks]
- (b) Chlorine is used in the manufacture of a large number of compounds.
- State THREE categories of compounds for which chlorine is used in their manufacture. [ 3 marks]
- (c) Both chlorine and sulphur dioxide are used in the food industry. Chlorine is used as a sterilizing agent, while sulphur dioxide is used in food preservation.
- Discuss the function of  $\text{SO}_2$  in food preservation. Your answer must include ONE disadvantage. [ 3 marks]

**Total 15 marks**

**END OF TEST**