



## 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.**

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SECTION A

Answer ALL questions.

MODULE 1

THE CHEMISTRY OF CARBON COMPOUNDS

1. (a) State THREE characteristic properties of a homologous series of compounds.

.....  
.....  
.....

[3 marks]

- (b) On analysis, one gram of Compound A (containing carbon, hydrogen and oxygen only) provided 0.40 g of carbon and 0.54 g of oxygen. Compound A has a molecular mass of 60 and effervesces readily with calcium carbonate.

Calculate the

- (i) empirical formula of A

[2 marks]

- (ii) molecular formula of A.

[1 mark]



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- (c) (i) Write the general formula of the homologous series of which A is a member.

.....  
[1 mark]

- (ii) Draw the structural formula of the chlorosubstituted compound of A.

[1 mark]

- (d) Comment on the relative  $pK_a$  values of A and its related compound in (c) (ii).

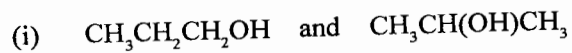
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[2 marks]

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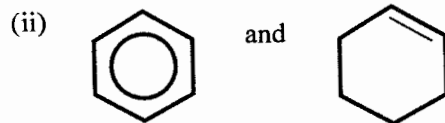


(e) Describe a simple laboratory test to distinguish between EACH of the following pairs of compounds:



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[3 marks]



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[2 marks]

Total 15 marks

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MODULE 2

ANALYTICAL METHODS AND SEPARATION TECHNIQUES

2. (a) Define EACH of the following terms:

(i) Accuracy

.....  
.....  
.....

[2 marks]

(ii) Precision

.....  
.....  
.....

[2 marks]

(b) Suggest a separating technique that would be MOST effective in the extraction of eugenol (oil) from cloves (plant) in its natural source.

.....

[1 mark]

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(c) Figure 1 shows a number of pieces of apparatus which could be found in a chemical laboratory.

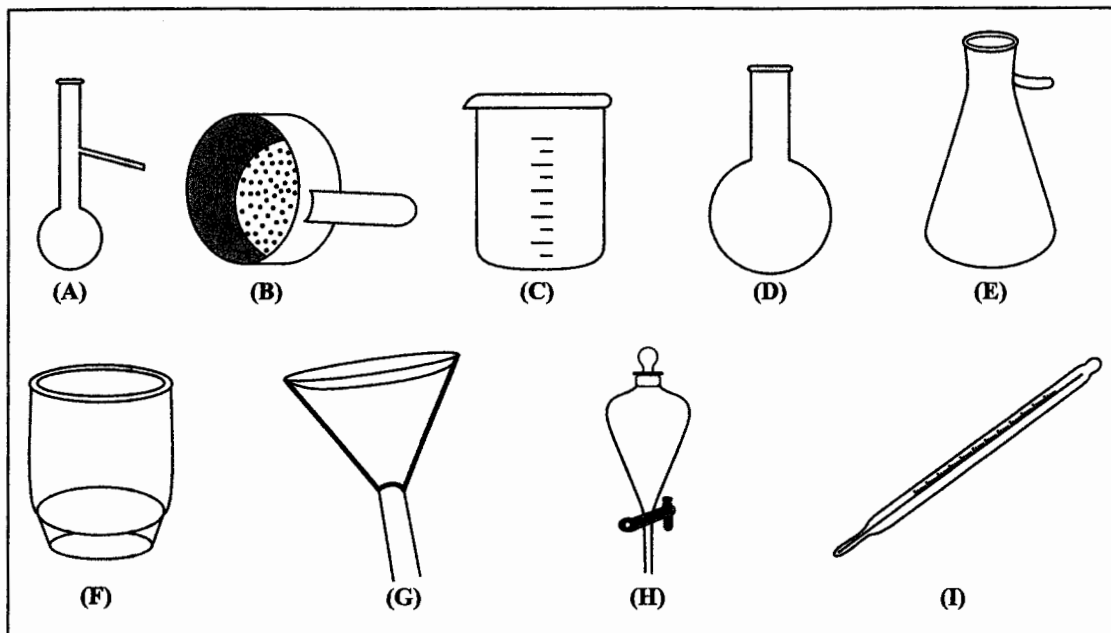


Figure 1. Pieces of apparatus which could be found in a chemical laboratory

List the appropriate pieces of apparatus, using the corresponding letter from Figure 1, that could be used in the following processes.

(i) Solvent extraction – THREE pieces

.....  
.....

[3 marks]

(ii) Gravimetric analysis – TWO pieces

.....  
.....

[2 marks]



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(d) A gravimetric analysis was performed to estimate the percentage of  $\text{Ca}^{2+}$  in a sample. A sample containing 0.496 g of limestone,  $\text{CaCO}_3$ , was dissolved in an acidic solution. The calcium was then precipitated as hydrated calcium oxalate,  $\text{CaC}_2\text{O}_4 \cdot \text{H}_2\text{O}$ , and the dry precipitate was found to have a mass of 0.619 g.

(i) Write the equation for the formation of the **dry** calcium oxalate precipitate.

.....  
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.....

[1 mark]

(ii) Calculate the percentage of  $\text{Ca}^{2+}$  in the sample.

.....

[4 marks]

**Total 15 marks**

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**MODULE 3**

**INDUSTRY AND THE ENVIRONMENT**

3. (a) (i) State the reason why the presence of ozone in the stratosphere is beneficial to humans.

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.....  
[1 mark]

- (ii) Write the relevant equations which show the formation of ozone in the stratosphere.

.....  
.....  
.....  
.....  
[4 marks]

- (b) (i) Ozone in the troposphere is harmful to humans and is therefore considered to be a pollutant. List TWO effects of the harmful presence of ozone on humans.

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.....  
.....  
.....  
[2 marks]

- (ii) The internal combustion engine of motor vehicles is responsible for the production of ozone in the troposphere.

Describe, with relevant equations, the production of ozone as a result of the use of these engines.

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[3 marks]

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- (c) A student is required to test a sample of water for various pollutants using simple laboratory reagents. Table 1 is an incomplete copy of the laboratory report.

Complete Table 1 by inserting the relevant test and inferences in order to identify the pollutants.

**TABLE 1: INCOMPLETE COPY OF LABORATORY REPORT**

No.	Test	Observation	Inference
1.	[2 marks]	A pungent smelling gas is evolved on heating which turns moist litmus paper blue.	[1 mark]
2.	Add dilute hydrochloric acid and heat.	A white precipitate is formed which dissolves on heating.	[1 mark]
3.	Add alkaline $\text{FeSO}_4(\text{aq})$ and boil. Add dilute $\text{HCl}$ followed by $\text{FeCl}_3(\text{aq})$ .	A colourless solution formed which produces a blue ppt.	[1 mark]

**Total 15 marks**

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**SECTION B**

**Answer ALL questions.**

**MODULE 1**

**THE CHEMISTRY OF CARBON COMPOUNDS**

4. (a) Define the terms 'primary', 'secondary' and 'tertiary' as applied to alcohols. Give relevant examples using structural formulae.

Primary alcohol

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.....  
.....

Secondary alcohol

.....  
.....  
.....

Tertiary alcohol

.....  
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.....

[6 marks]

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(b) Two isomeric phenyl alcohols, **A** and **B**, ( $C_8H_{10}O$ ), on treatment with concentrated sulfuric acid produced Compound **D**, which decolourized a solution of bromine in an organic solvent. Oxidation of the isomers with acidified potassium dichromate(VI) produced compounds **E** and **F** which both gave yellow precipitates with 2, 4-DNP reagent. However, only Compound **F** formed a silver mirror with a solution of silver nitrate.

(i) State the type of reaction which produced Compound **D** and write its structural formula.

Type of reaction: .....

Structural formula of Compound **D**: .....

[2 marks]

(ii) Explain the reactions which led to the production of Compounds **E** and **F**.

[2 marks]

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(c) Deduce the structural formulae of compounds

(i) E and F

[2 marks]

(ii) A and B.

[2 marks]

(d) Comment on the reaction of A and B to plane polarized light.

.....  
.....  
.....

[1 mark]

Total 15 marks

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**MODULE 2**

**ANALYTICAL METHODS AND SEPARATION TECHNIQUES**

5. (a) (i) List THREE characteristics of a primary standard.

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.....

**[3 marks]**

- (ii) State whether sodium hydroxide can be considered a primary standard and suggest a reason for your answer.

.....  
.....  
.....

**[2 marks]**

- (b) A student standardized an unknown solution of an acid,  $H_2A$ , by adding successive  $5\text{ cm}^3$  portions of the acid to  $25\text{ cm}^3$  of a solution of sodium hydrogen carbonate of concentration  $0.25\text{ mol dm}^{-3}$ . The temperature was taken after each addition. From the data collected, a graph of temperature versus volume of acid added was plotted as shown in Figure 2 on page 16.

Explain **fully** the shape of the graph.

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**[4 marks]**

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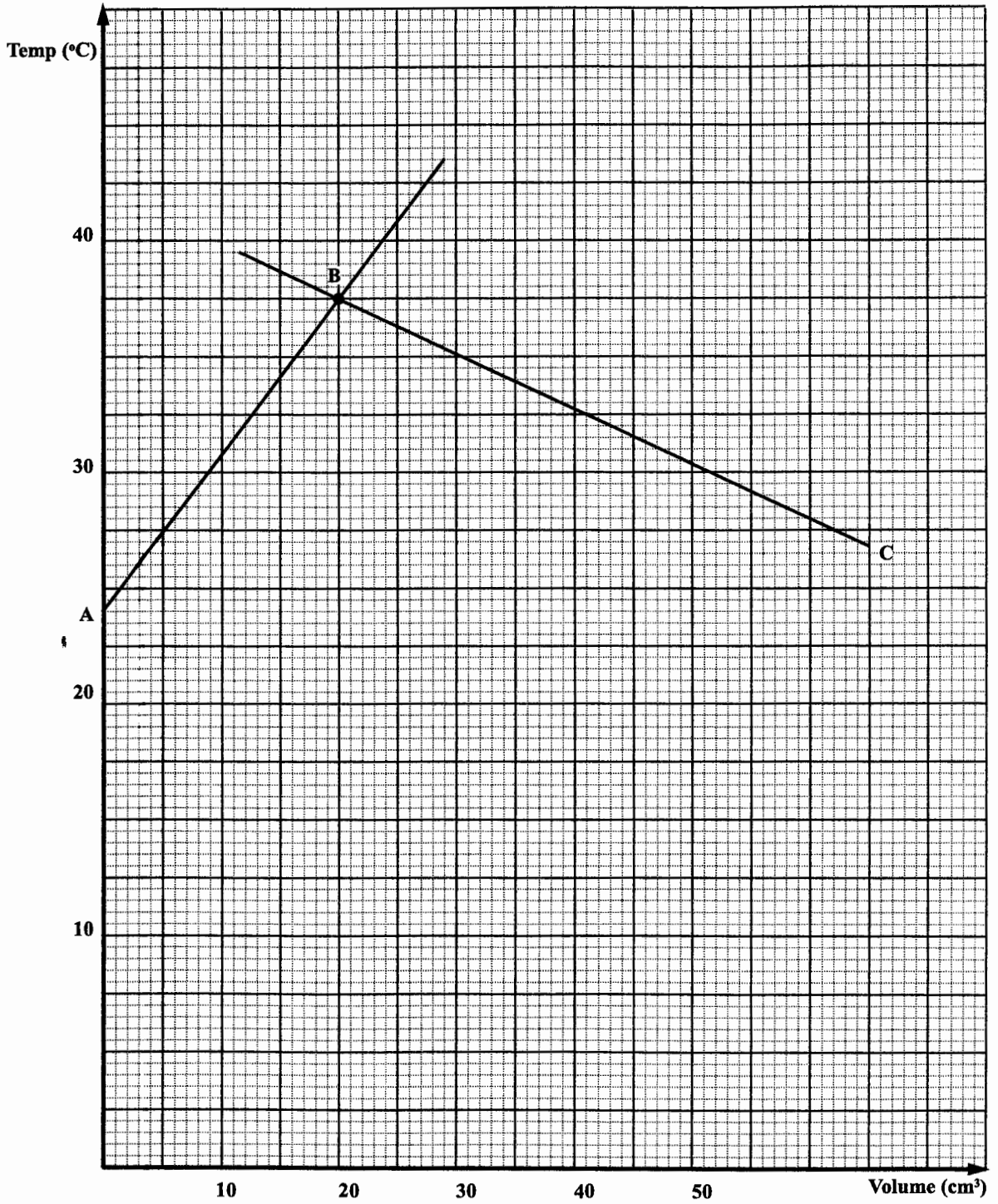


Figure 2. Temperature versus volume of acid added

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(c) Calculate

(i) the number of moles of carbonate used

[1 mark]

(ii) the number of moles of acid reacted

[2 marks]

(iii) the concentration of the acid.

[1 mark]

(d) State ONE **other** titrimetric method that could be used without an indicator by the student in (b).

.....  
.....  
.....

[1 mark]

(e) Identify the responding variable involved in the method stated in (d).

.....  
.....

[1 mark]

**Total 15 marks**

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MODULE 3

INDUSTRY AND THE ENVIRONMENT

6. (a) Define EACH of the following terms as applied to petroleum chemistry:

(i) Cracking

.....  
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.....

[2 marks]

(ii) Reforming

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[2 marks]

(b) Using an appropriate equation, apply the principles of chemical equilibrium to deduce the theoretical conditions for the production of ammonia.

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[4 marks]



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