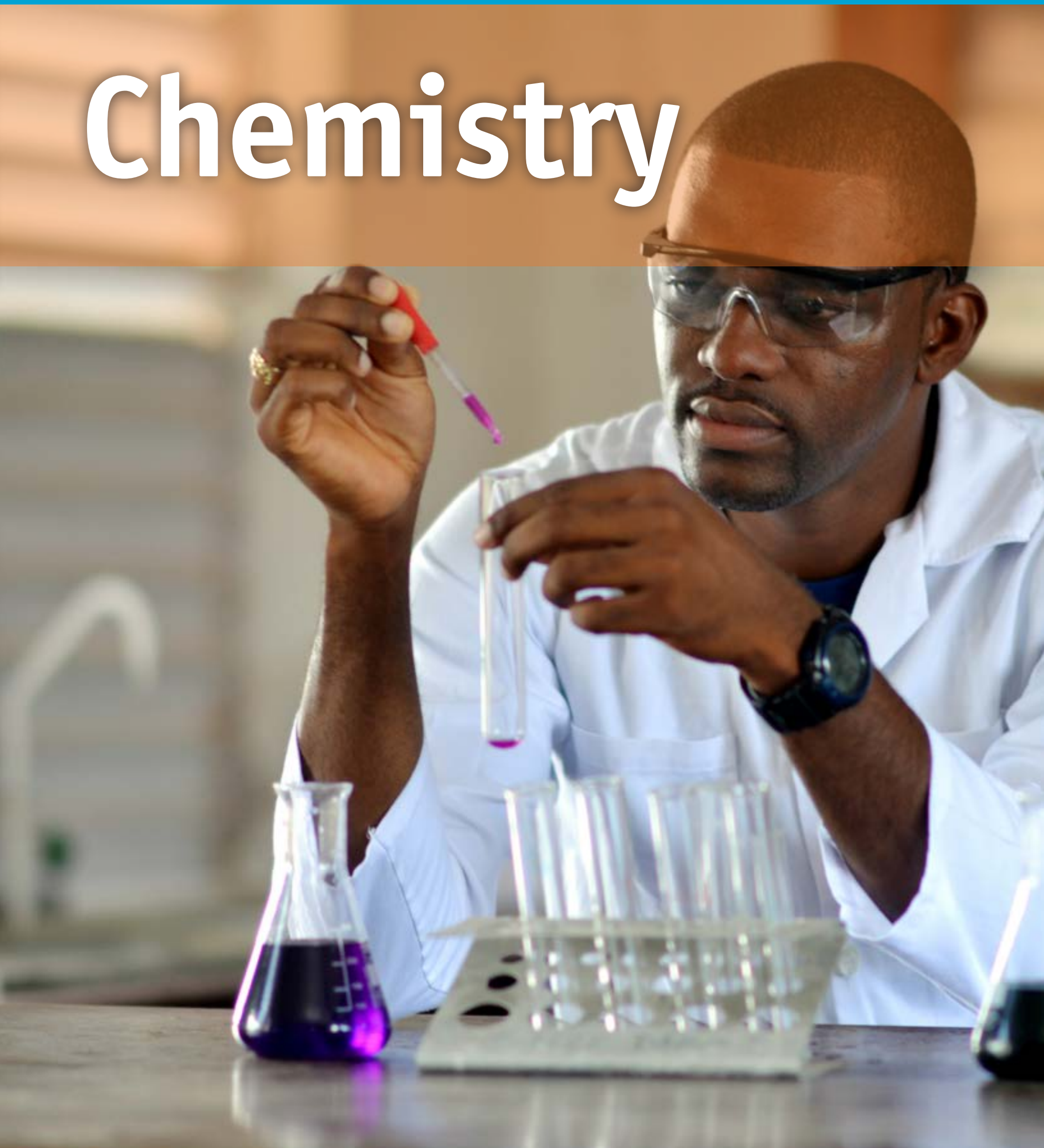
CARIBBEAN EXAMINATIONS COUNCIL

Chemistry



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CAPE® Chemistry Past Papers

LIST OF CONTENTS

TEST CODE **02112010**

FORM TP 2005177

MAY/JUNE 2005

CARIBBEAN EXAMINATIONS COUNCIL

ADVANCED PROFICIENCY EXAMINATION

CHEMISTRY

UNIT 1 – PAPER 01

1 hour 45 minutes

Candidates are advised to use the first 15 minutes for reading through this paper carefully. Writing may begin during this time.

READ THE FOLLOWING INSTRUCTIONS CAREFULLY

1. This paper consists of NINE questions.
2. There are THREE questions from each Module. Answer ALL questions.
3. Write answers in this booklet.
4. ALL working must be shown in this booklet.
5. The use of non-programmable calculators is permitted.
6. A Data Booklet is provided.

MODULE 1

Answer ALL questions.

1. A chemist is given 1.08 g of a compound labelled X, and is asked to determine the molecular formula and the empirical formula. Analysis of X by mass spectrometry gives a relative molecular mass of 108. Elemental analysis shows that compound X contains carbon, hydrogen and one other element. Among the products obtained when X is burnt completely in oxygen are1340 cm^3 of CO_2 and 448 cm^3 of NO_2. [Volumes of gases are measured at s.t.p.]

(a) Define the following terms:

(i) Empirical formula

[1 mark]

(ii) Molecular formula

[1 mark]

(b) Give an example of a compound for which the molecular formula is different from the empirical formula. [You must write the respective formulae.]

[2 marks]

(c) Use the data given on page 2 to determine the molecular formula of X.

[6 marks]

Total 10 marks

2. Dry cells (batteries) provide a portable source of energy for many modern appliances. Figure 1 shows some of the components of a dry cell.

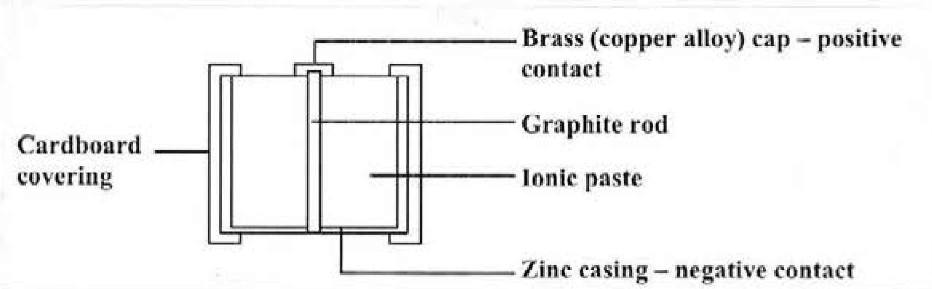


Figure 1. Components of a dry cell

(a) Referring to the information in Figure 1, explain why the chemical reaction occurring in batteries is described as a redox reaction.

[2 marks]

GO ON TO THE NEXT PAGE

(b) When sulphur dioxide gas is bubbled through acidified potassium chromate (VI), the redox reaction which occurs can be represented by the following half-equations.

$$SO_2(g) + 2H_2O\,(\ell) \rightarrow SO_4^{2-}(aq) + 2e^- + 4H^+\,(aq).$$

$$Cr_2O_7^{2-}(aq) + 6e^- + 14H^+ \rightarrow 2\,Cr^{3+}(aq) + 7\,H_2O(\ell).$$

(i) Write the balanced ionic equation for the reaction that occurs.

[2 marks]

(ii) State the change in oxidation number in any ONE identified reagent in the reaction.

[2 marks]

(c) Select THREE named elements and describe an experiment, including observations, to show how the elements selected can be listed in order of oxidizing or reducing ability.

[4 marks]

Total 10 marks

3. The kinetic theory was developed to explain the behaviour of gases.

(a) State the behaviour of gases that is described by

(i) Boyle's law

[1 mark]

(ii) Charles' law.

[1 mark]

(b) (i) State TWO assumptions made when the kinetic theory is used to explain the behaviour of gases.

[2 marks]

(ii) Describe how the kinetic theory explains EITHER Boyle's law OR Charles' law.

[2 marks]

(c) A certain mass of gas occupies a volume of 1.00 dm^3 at a given pressure and a temperature of 25°C. If the gas behaves ideally, what is its volume at 30°C? State any assumptions that you make in obtaining your answer.

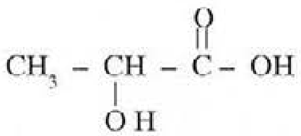
[4 marks]

Total 10 marks

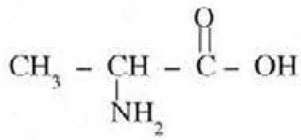
MODULE 2

Answer ALL questions.

4. (a) Some organic compounds contain more than one functional group. Identify ANY TWO functional groups that are present in the following natural products.

(i) 

(lactic acid)

(ii) 

(alanine)

____

[2 marks]

(b) Distinguish between the following terms:

(i) Electrophiles and nucleophiles

____

____

[2 marks]

(ii) Homolytic and heterolytic bond fission

____

____

[2 marks]

(c) 2-chloro-2-methylpropane ($(CH_3)_3$ C Cl) reacts with sodium hydroxide in an aqueous solution to give 2-methylpropan-2-ol and sodium chloride.

(i) Write the chemical equation for this reaction.

[2 marks]

GO ON TO THE NEXT PAGE

(ii) Outline the steps involved in the reaction in (c) (i) on page 6, by referring to the

a) bond-breaking step

[1 mark]

b) bond-forming step.

[1 mark]

Total 10 marks

5. Benzene is unreactive with concentrated sulphuric acid even when warmed at 50°C. Its reaction with concentrated nitric acid is slow. However, benzene reacts with a mixture of concentrated nitric acid and concentrated sulphuric acid to produce a good yield of nitrobenzene.

(a) (i) Suggest an explanation for the difference in behaviour of benzene under the stated conditions.

____

____

____

[2 marks]

(ii) Write an equation to illustrate the reaction between sulphuric acid and nitric acid.

____

[2 marks]

(b) (i) Illustrate the reaction mechanism for the nitration of benzene.

[4 marks]

(ii) What is the name given to the mechanism outlined in (b) (i)?

____

[1 mark]

(c) Nitrobenzene reacts with tin and concentrated hydrochloric acid. State the product formed.

____

[1 mark]

Total 10 marks

6. (a) Ethanol and ethanoic acid are weak organic acids. The pK_a values of ethanoic acid and ethanol are 4.76 and 15.9 respectively.

(i) State the meaning of the term pK_a.

____

[1 mark]

(ii) Explain the significance of the given pK_a values.

____

____

____

[2 marks]

(iii) Describe the features of EACH of the organic molecules that account for the difference in pK_a values.

[2 marks]

(b) The amino acids are colourless, crystalline, high-melting solids that are moderately soluble in water. L-threonine ($CH_3 - CHOH - CHNH_2 - COOH$) is an essential amino acid which is found in animal protein, for example, eggs and milk.

(i) Give the displayed formula of the amino acid, L-threonine, in an acidic solution.

[2 marks]

(ii) Explain why L-threonine has a high melting point and is soluble in water.

[3 marks]

Total 10 marks

MODULE 3

Answer ALL questions.

7. (a) The application of mass spectrometry in the analysis of unknown compounds involves the vaporization, ionization, separation and detection of the sample. Briefly explain how EACH of these processes is achieved in the mass spectrometer unit.

____

____

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____

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[4 marks]

(b) A student synthesizes an organic compound by reacting an acyl halide with an alcohol. The sample is analysed using mass spectrometry and the spectrum obtained is shown in Figure 2.

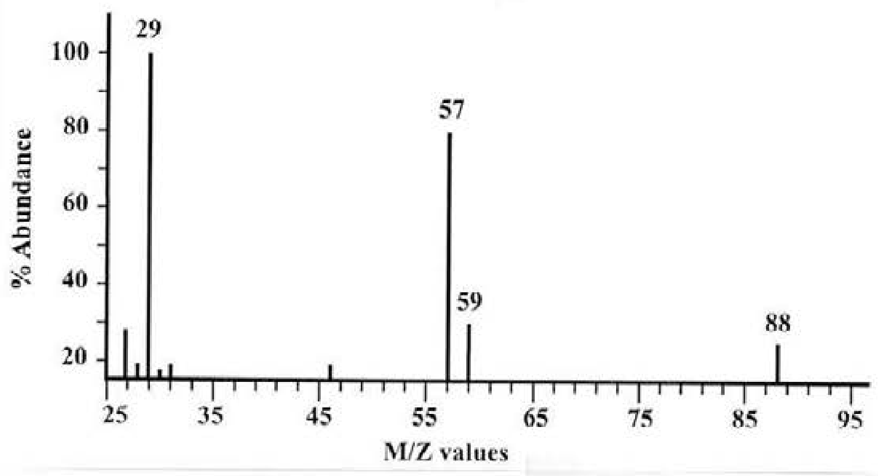


Figure 2. Spectrum

(i) Give the m/z values of the molecular ion peak and the peak representing the most stable fragment in the spectrum.

____

____

[2 marks]

GO ON TO THE NEXT PAGE

(ii) Suggest possible structures for the fragments with m/z values of 29, 57 and 59.

[3 marks]

(iii) Deduce the structure of the product of the reaction described in (b) on page 10.

[1 mark]

Total 10 marks

8. Nuclear magnetic resonance (NMR) spectroscopy has become an invaluable tool in the structure elucidation of organic compounds. The underlying principle of this spectroscopic method of analysis is the behaviour of certain nuclei to the application of an external magnetic field.

(a) (i) Describe the property of the nuclei that allows them to be detected in NMR analysis.

____

____

[1 mark]

(ii) Give the symbols for the TWO main nuclei found in organic molecules that are detected by NMR analysis.

____

[1 mark]

(iii) In the acquisition of a NMR spectrum the sample is first subjected to the external magnetic field and then exposed to radio wave signals.
State the changes that occur in the molecules of the sample on this treatment.

____

____

____

____

[2 marks]

GO ON TO THE NEXT PAGE

(b) An organic compound of formula $C_9H_{10}O$ is subjected to NMR analysis to determine its structure. The NMR spectrum for the hydrogen atoms displays the following chemical signals:

Chemical Shift (δ)

7.5 (5H)
3.0 (2H)
1.2 (3H)

(i) Which TWO functional groupings are indicated by the chemical shift values? Explain your reasoning.

____

____

____

____

____

____

[3 marks]

(ii) Suggest a structure for the organic compound.

[3 marks]

Total 10 marks

9. Organic reactions can result in a mixture of products, by-products and starting materials. Solvent extraction is often the method applied to isolate the product from the reaction mixture.

(a) (i) Suggest a type of solvent that could be used to isolate an organic product from an aqueous reaction mixture.

[1 mark]

(ii) Describe TWO properties the solvent should have for this extraction method to work.

[2 marks]

(iii) Briefly explain ONE principle on which solvent extraction is based.

[2 marks]

(b) Plant material is often the source of base material for drug development and natural product preparations. The method of extraction used to obtain the base material should minimize damage to the natural organic molecules and allow for easy collection.

(i) Suggest a method that would be suitable to extract the natural organic compounds from the plant material.

[1 mark]

(ii) Give TWO features of the method suggested in (b)(i) that allow the stated objectives of the extraction to be achieved.

[2 marks]

(iii) Explain why the features mentioned in (b)(ii) above are essential.

[2 marks]

Total 10 marks

END OF TEST

FORM TP 2005178

TEST CODE **02112020**

MAY/JUNE 2005

CARIBBEAN EXAMINATIONS COUNCIL

ADVANCED PROFICIENCY EXAMINATION

CHEMISTRY

UNIT 1 – PAPER 02

2 hours 15 minutes

Candidates are advised to use the first 15 minutes for reading through this paper carefully. Writing may begin during this time.

READ THE FOLLOWING INSTRUCTIONS CAREFULLY

1. This paper consists of NINE questions.
2. Section A consists of THREE questions, ONE question from each Module. Answer ALL questions in this section. Answers for this section must be written in this booklet.
3. Section B consists of SIX questions. Answer ONLY THREE questions from this section, ONE question from EACH Module. Answers for this section must be written in the booklet provided.
4. ALL working MUST be CLEARLY shown.
5. The use of non-programmable calculators is permitted.

Materials provided:

- A Data Booklet
- Graph paper
- Answer Booklet

SECTION A

Answer ALL questions in this section.

MODULE 1

1. (a) Substances labelled A and B are solids at room temperature (30°C). A student is asked to determine the melting point (m.p.) of a sample of A, using apparatus that is available in the school laboratory.

Describe FULLY the procedure that the student would follow in order to obtain the measurement.

[4 marks]

(b) Based on the m.p. data obtained, the student concludes that A is a covalent compound. Another student, who has been given a sample of B, decides that B is not a covalent compound. Further analysis of A and B reveals that A is soluble in tetrachloro-methane but that B is not, and that neither A nor B dissolves in water.

(i) Suggest the type of forces of attraction that exist between particles of A and describe how they are formed.

[3 marks]

(ii) Name and describe the forces of attraction present in B.

[3 marks]

Total 10 marks

GO ON TO THE NEXT PAGE

MODULE 2

2. (a) An analyst is given the task of identifying an organic liquid (Z) contained in an unlabelled vial. Table 1 shows the analyst's incomplete record of the tests conducted. Complete the analyst's record by filling in the blank spaces.

TABLE 1: INCOMPLETE RECORD

	Test	Observation	Inference
	Test on separate 1 cm^3 portions of Z.		
(i)	Add 5 cm^3 of distilled water.	A colourless solution formed.	
(ii)	Add 1 cm^3 conc. H_2SO_4 and 1 cm^3 glacial ethanoic acid. Warm this mixture, then pour into cold water.		Ester formed.
(iii)	Warm with 5 cm^3 potassium chromate(VI) solution acidified with H_2SO_4.	The solution turns green.	
(iv)	Add phosphorus pentachloride (very carefully).	A very vigorous reaction.	

[4 marks]

(b) Suggest a displayed formula for Z, given that Z has a relative molecular mass of 46.

[1 mark]

(c) Write the formula of the organic product formed in (a) (ii) in Table 1.

____

[1 mark]

(d) Suggest a reagent that can be used to identify the gas liberated in (a) (iv) in Table 1 and state the observations that would be recorded.

____

____

[2 marks]

GO ON TO THE NEXT PAGE

(e) Suggest the reagent and conditions necessary to obtain Z from the product of the reaction in (a) (ii) in Table 1.

[2 marks]

Total 10 marks

MODULE 3

3. A student is given the task of determining the percentage of active agent, salicylic acid, in aspirin tablets. A titrimetric method is suggested to the student.

(a) Salicylic acid is an organic acid. Suggest a suitable titrant (reagent) for this estimation.

[1 mark]

(b) Describe the steps involved in preparing the titrant (reagent) suggested in (a) for the practical estimation of the salicylic acid present in each tablet.

[6 marks]

(c) Figure 1 shows the pH change as salicylic acid is titrated with the titrant selected.

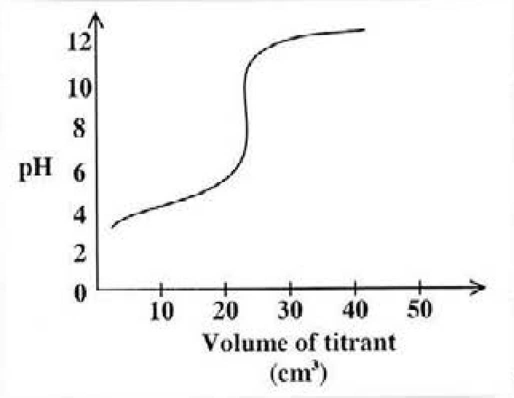


Figure 1. pH change

Table 2 gives a list of indicators and their pH ranges. Select the indicator that would be most suitable for this titrimetric analysis and use the graph to explain your reasoning.

TABLE 2: INDICATORS AND pH RANGES

Indicator	pH range
Methyl orange	2.9 – 4.6
Thymol blue	1.2 – 2.8
Phenolphthalein	8.3 – 10.0
Methyl red	4.2 – 6.3

Indicator: ____________________

Reason: ____________________

____

[3 marks]

Total 10 marks

GO ON TO THE NEXT PAGE

SECTION B

Answer THREE questions from this section, ONE question from EACH module.

MODULE 1

Answer EITHER Question 4 OR Question 5.

4. (a) Figure 2 shows the concentration of products and reactants for a chemical reaction that achieves a state of dynamic equilibrium.

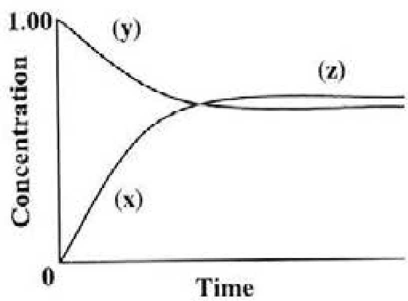


Figure 2. Graph of chemical reaction

Describe the features of a system that exists in a state of dynamic equilibrium and explain which of the features are illustrated by the graph in Figure 2. **[5 marks]**

(b) K_c, K_a and K_p are terms that are associated with reactions that achieve a state of dynamic equilibrium, and can be experimentally determined.

(i) What is meant by the terms K_c, K_a and K_p? **[3 marks]**

(ii) The equation below represents an equilibrium system.

$$C_2H_5OH(l) + CH_3COOH(l) \rightleftharpoons CH_3COOC_2H_5(l) + H_2O(l)$$

Write an expression for K_c for the reaction.

[2 marks]

(iii) Ethanol and ethanoic acid are reacted together and allowed to achieve a state of equilibrium. The reaction is 'frozen' in order to obtain the equilibrium concentrations. Some data from this practical activity are presented in Table 3. Copy Table 3 in your answer booklet and write in the missing values using the equation in (b) (ii) on page 6.

TABLE 3: DATA FROM PRACTICAL ACTIVITY

	C_2H_5OH	CH_3COOH	$CH_3COOC_2H_5$	H_2O
Initial concentration mol/dm³	1	2		
Equilibrium concentration mol/dm³			0.70	

[5 marks]

(iv) Use the data in Table 3 and the expression for K_c in (b) (ii) on page 6 to calculate a value for K_c. **[2 marks]**

(c) (i) Write the equilibrium constant expression for the following reaction:

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$$

[1 mark]

(ii) The product of the reaction in (c) (i) above is used in the industrial manufacture of sulphuric acid. However, the value of the equilibrium constant is very small (less than 1).

Explain the meaning of this low value and suggest how the industry can continue to operate and to be viable, in spite of this low value. **[2 marks]**

Total 20 marks

5. (a) Explain the meaning of the term 'enthalpy (enthalpy change) of a reaction'. [2 marks]

(b) With reference to energy profile diagrams and bond energies, explain the difference between exothermic reactions and endothermic reactions. [6 marks]

(c) Hydrazine (N_2H_4), which is a liquid and is used as a rocket fuel, reacts with chlorine to produce hydrogen chloride and nitrogen.

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

(ii) Given that ΔH for the reaction in (i) is -420 kJ mol^{-1}, calculate the enthalpy change when 12.7 g of hydrazine reacts completely with chlorine. [2 marks]

(iii) Hydrazine also reacts with oxygen as illustrated in the equation below:

$$N_2H_4\,(\ell) + O_2(g) \rightarrow N_2(g) + 2H_2O(g) \quad \Delta H = -534 \text{ kJ mol}^{-1}$$

Use the equation and the information given below to calculate the enthalpy of reaction if water is produced in the liquid state.

The molar enthalpy of vaporization is the amount of heat absorbed when 1 mole of liquid at constant pressure changes to a gas.

$$H_2O(\ell) \rightarrow H_2O(g) \quad \Delta H\text{ vap} = 40.7 \text{ kJ mol}^{-1}$$

$$\Delta H_{\text{condensation}} = -\Delta H_{\text{vaporization}}$$

[4 marks]

(d) The enthalpy change for the formation of CO: $C(s) + \frac{1}{2}\,O_2(g) \rightarrow CO(g)$ cannot be obtained experimentally.

(i) Suggest a reason for this. [1 mark]

(ii) Show by means of an energy cycle diagram how knowledge of the standard heat of combustion of carbon and of carbon dioxide could be used to obtain the standard enthalpy of formation for carbon monoxide. [3 marks]

Total 20 marks

(e) Nylon 6, 6 is formed when the diamine, $H_2N - (CH_2)_6 - NH_2$ reacts with the dicarboxylic acid, $HO - \underset{\displaystyle O}{\underset{||}{C}} - (CH_2)_4 - \underset{\displaystyle O}{\underset{||}{C}} - OH$.

(i) Write the displayed structure of the repeat unit of nylon 6,6. **[3 marks]**

(ii) What is the common structural feature exhibited by the natural polymer-proteins- and synthetic nylon 6,6? **[1 mark]**

Total 20 marks

7. (a) Explain EACH of the following terms:

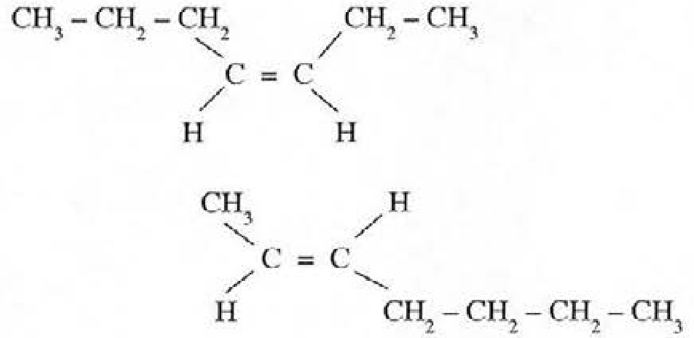
(i) Stereoisomerism **[1 mark]**

(ii) Structural isomerism **[1 mark]**

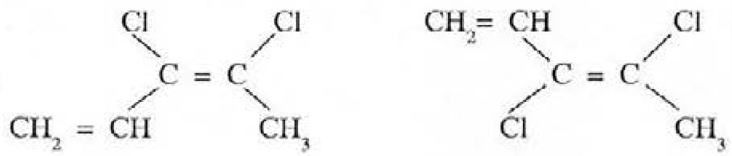
(b) (i) Label EACH of the following pairs of structures as structural isomers, as geometric isomers, or as the same compound. State reasons for your answer.

a) 

[2 marks]

b) 

[2 marks]

c) 

[2 marks]

(ii) Name EACH of the isomers in (b) (i) a) and b) above. **[3 marks]**

(c) Two isomeric compounds, A and B, containing only carbon, hydrogen and oxygen are subjected to combustion analysis. One gram (1.0 g) of each compound on complete combustion gives 2.3 g of carbon dioxide and 0.93 g water. The relative molecular mass of each compound is 58.

(i) Calculate the empirical and molecular formulae of A and B. **[6 marks]**

(ii) Deduce the structural formulae of A and B. **[2 marks]**

(iii) State the type of isomerism exhibited by A and B. **[1 mark]**

Total 20 marks

MODULE 3

Answer EITHER Question 8 OR Question 9.

8. A laboratory technician analyses water samples for degree of hardness, which is expressed in parts per million (ppm) of calcium carbonate. Table 4 gives the results for ten samples.

TABLE 4: DEGREE OF HARDNESS OF WATER SAMPLES

Sample number	$CaCO_3$ / ppm
1	250
2	245
3	265
4	300
5	225
6	230
7	248
8	295
9	235
10	220

(a) (i) Calculate the mean and standard deviation of the values. **[4 marks]**
[Relevant formulae must be shown]

(ii) What does the standard deviation value obtained in (a) (i) above indicate about the variability in the degree of hardness? **[1 mark]**

(iii) The ten samples of water are taken from ten different sites. How can the reliability of the data obtained from each sample be improved? **[1 mark]**

(b) Another laboratory technician analyses Sample 1 and obtains a hardness value of 290 ppm.

(i) Compare the TWO results in terms of precision and suggest a reason for the difference. **[2 marks]**

(ii) What additional information would be required to comment on the accuracy of the results at this site? **[1 mark]**

(c) In the practical determination of hardness, 100 cm^3 samples of water were measured and titrated with EDTA using Erichrome black as the indicator.

By reference to apparatus available in the school laboratory, discuss the importance of using appropriate equipment in the quantitative analysis as described above.

[5 marks]

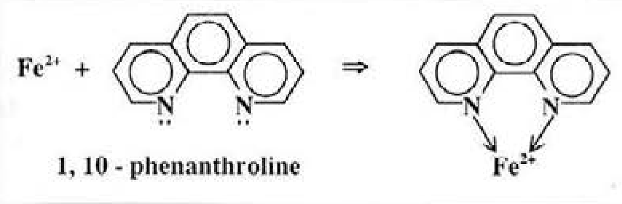
(d) Describe the steps required to determine the accurate volume delivered by a pipette.
[6 marks]

Total 20 marks

9. The quantitative determination of minute quantities of analytical samples can be achieved using ultraviolet/visible spectroscopy.

(a) State the principles on which ultraviolet/visible spectroscopy is based. **[5 marks]**

(b) An experiment is carried out to determine the concentration of iron (II) (Fe^{2+}) found in water samples taken from a well. A measured volume of the water sample is treated with a buffer and the reducing agent hydroxylamine, followed by the reagent 1,10 - phenanthroline, shown below. The resultant solution is then topped up to a volume of 50 cm^3. The solution is subsequently analysed in a cuvette, of side 1 cm, at a wavelength of 510 nm in the UV/Vis spectrophotometer.



(i) What would be observed on the addition of the 1,10 - phenanthroline? **[1 mark]**

(ii) What properties of the organic reagent make it suitable for this analysis? **[3 marks]**

(iii) Suggest a reason for selecting a wavelength of 510 nm for analysis. **[1 mark]**

(iv) Describe how a calibration curve could be obtained for this analysis. **[3 marks]**

(c) An aqueous solution containing iron (II) (Fe^{2+}) at a concentration of 2.5×10^{-3} mg cm^{-3} is subjected to the above treatment and measures an absorbance of 0.524. A water sample of unknown iron (II) (Fe^{2+}) concentration is similarly treated and measures an absorbance of 0.350.

(i) Calculate the concentration of the known iron (II) solution in moles dm^{-3} of iron (II). **[3 marks]**

(ii) Apply the Beer's law to calculate the molar absorptivity of the known iron (II) solution. **[3 marks]**

(iii) Calculate the concentration of iron (II) in the unknown sample in mol dm^{-3}. **[1 mark]**

Total 20 marks

END OF TEST

FORM TP 2005179

TEST CODE **02212010**

MAY/JUNE 2005

CARIBBEAN EXAMINATIONS COUNCIL

ADVANCED PROFICIENCY EXAMINATION

CHEMISTRY

UNIT 2 – PAPER 01

1 hour 45 minutes

Candidates are advised to use the first 15 minutes for reading through this paper carefully. Writing may begin during this time.

READ THE FOLLOWING INSTRUCTIONS CAREFULLY

1. This paper consists of NINE questions.
2. There are THREE questions from each Module. Answer ALL questions.
3. Write answers in this booklet.
4. ALL working must be shown in this booklet.
5. The use of non-programmable calculators is permitted.
6. A Data Booklet is provided.

MODULE 1

Answer ALL questions.

1. (a) Explain how the following factors may affect the rate of a chemical reaction:

(i) Surface area

____

____

____

[2 marks]

(ii) Catalysts

____

____

____

[2 marks]

(b) The reaction between peroxodisulphate ($S_2O_8^{2-}$) and iodide (I^-) ions yields the species I_3^- in accordance with the following equation:

$$S_2O_8^{2-} + 3\,I^- \rightarrow 2SO_4^{2-} + I_3^-$$

Table 1 gives some experimental data from an investigation of the rate of reaction between peroxodisulphate ions and iodide ions. The rate equation can be represented as Rate $= k\,[\,S_2O_8^{2-}\,]^m\,[\,I^-\,]^n$.

TABLE 1: EXPERIMENTAL DATA FOR THE REACTION BETWEEN $S_2O_8^{2-}$ and I^-

Experiment number	Initial concentrations (mol dm^{-3})		Initial rate of reaction (mol dm^{-3} s^{-1})
	$[S_2O_8^{2-}]$	$[\,I^-\,]$	
1	0.05	0.10	$R_1 = 1.5 \times 10^{-5}$
2	0.10	0.10	$R_2 = 3.0 \times 10^{-5}$
3	0.10	0.05	$R_3 = 1.5 \times 10^{-5}$

GO ON TO THE NEXT PAGE

Use the data in Table 1 on page 2 to determine EACH of the following:

(i) The order of reaction with respect to both $S_2O_8^{2-}$ and I^-

[4 marks]

(ii) The overall order of the reaction

____

____

[2 marks]

Total 10 marks

2 (a) State Le Châtelier's principle.

____

____

[2 marks]

(b) Using the equation, $2\,SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$, explain the effect of EACH of the following on the equilibrium system:

(i) Change in pressure

____

____

____

[2 marks]

GO ON TO THE NEXT PAGE

(ii) A catalyst

[4 marks]

(c) The equation for the decomposition of limestone can be represented as:
$CaCO_3(s) \rightleftharpoons CaO(s) + CO_2(g)$.

(i) Write the equilibrium constant for this system in terms of partial pressures.

[1 mark]

(ii) What is the effect on the equilibrium system of adding a small quantity of solid calcium carbonate?

[1 mark]

Total 10 marks

3. Gypsum ($CaSO_4 \cdot 2H_2O$) is a common calcium mineral that is found worldwide. It is slightly soluble in water, and ground water that is in contact with gypsum often contains some calcium sulphate ($CaSO_4$).

(a) (i) Write the equation which represents the equilibrium between $Ca^{2+}(aq)$ and $SO_4^{2-}(aq)$, and undissolved $CaSO_4$.

[1 mark]

(ii) Explain the meaning of the term 'solubility product'.

[2 marks]

(iii) State ONE physical factor which affects the value of the solubility product constant.

____

[1 mark]

(b) In bronzing and ornamental work requiring a golden colour, lead iodide (PbI_2), which can be described as a dense, golden yellow "insoluble" solid, is used.

Calculate the solubility of lead iodide in water at 25 °C, using the solubility product constant (K_{sp}) = 7.1×10^{-9} mol^3 dm^{-9}.

[5 marks]

(c) How is the solubility of a slightly soluble ionic compound affected when a second solute that furnishes a common ion is added?

____

____

[1 mark]

Total 10 marks

MODULE 2

Answer ALL questions.

4. The pH of the oxides of the Period 3 elements are given in Table 2.

TABLE 2

	Na	Mg	A1	Si	P	S
Typical pH of aqueous solution of the oxide	13	8	7	7	2	3

(a) Account for the difference in pH of the aqueous solutions of the oxides of Na and Mg.

[4 marks]

(b) Describe the trend in acid / base character of the oxides of Period 3.

[1 mark]

(c) (i) Explain in terms of bonding why aluminium oxide is described as an amphoteric oxide and NOT as a neutral oxide.

[3 marks]

(ii) Write ONE chemical equation to illustrate either the acidic or basic character of aluminium oxide.

[2 marks]

Total 10 marks

5. (a) A solid compound Y is analysed qualitatively by reaction of its aqueous solution with NaOH (aq) and the results are recorded in Table 3. Complete Table 3 by inserting the inferences that may be made, based on the observations given.

TABLE 3: RESULTS OF TESTS ON COMPOUND Y

	Test	Observation	Inference
(i)	A small quantity of NaOH is added dropwise.	A white precipitate.	[1 mark]
(ii)	More NaOH is added to the mixture from (i), until there is no further change.	Colourless solution.	[1 mark]
(iii)	The mixture from (a) (ii) is warmed.	Gas produced with a pungent smell turns red litmus blue.	[2 marks]

(b) Explain the chemical principles upon which the reactions in (a) (i) and (a) (iii) are based.

(a) (i) ____

____

[2 marks]

(a) (iii) ____

____

[2 marks]

(c) Write the ionic equation for the reaction described in (a) (iii).

____

[2 marks]

Total 10 marks

GO ON TO THE NEXT PAGE

6. Table 4 shows the variation in some properties of the Group IV elements.

TABLE 4: SOME PROPERTIES OF GROUP IV ELEMENTS

Element	**C(d)**	**Si**	**Ge**	**Sn**	**Pb**
m.p. / °C	3550	1410	937	232	328
Electrical conductivity $ohm^{-1}\ m^{-1}$	—	1×10^6	2×10^6	8×10^6	5×10^6
m.p. of XO_2 X = Group IV element	-56	1610	1115	1630	290

C(d) = diamond

(a) (i) Describe the trend in electrical conductivity from silicon to tin.

(ii) Suggest a reason for the trend described in (a) (i) above.

[2 marks]

(b) Account for the variation in the melting points from C to Sn in terms of structure and bonding.

[4 marks]

(c) By reference to the melting point data for the +4 oxides of elements C – Sn, suggest the type of structure and bonding exhibited by the oxides.

[2 marks]

(d) Suggest an explanation for the relatively low melting point value for PbO_2 compared to the oxides of Si – Sn.

[2 marks]

Total 10 marks

MODULE 3

Answer ALL questions.

7. Chlorine is an industrially important chemical, finding use in many manufacturing industries. On an industrial scale, chlorine is produced using the flowing mercury cathode cell. Brine, concentrated NaCl, is electrolysed and products of chlorine, sodium hydroxide and hydrogen gas are obtained.

(a) Figure 1 illustrates the key features of the flowing mercury cathode cell.

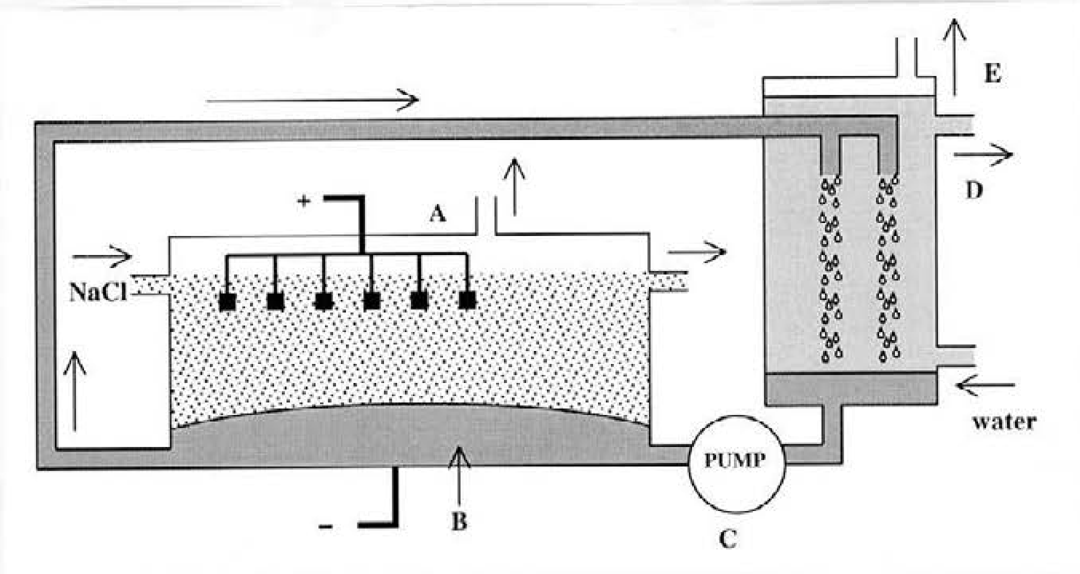


Figure 1. Features of the flowing mercury cathode cell

(i) Identify the substances collected at points A, D and E in the diagram.

____

____

____

[3 marks]

(ii) Identify the component of the cell labelled B.

____

[1 mark]

(iii) What is the purpose of the pump in the cell?

____

____

[1 mark]

GO ON TO THE NEXT PAGE

(iv) Write an equation for the overall process occurring in the cell.

____

[2 marks]

(b) (i) Name ONE manufacturing industry for which the chlorine produced acts as a raw material.

____

[1 mark]

(ii) a) Describe how mercury is released from the sodium-mercury amalgam produced during electrolysis.

____

____

b) Give ONE reason why careful consideration should be given to the siting of such a chlorine-producing plant.

____

____

[2 marks]

Total 10 marks

8. The Haber process for the industrial manufacture of ammonia involves processes of distillation, compression, catalysis, condensation and recycling.

(a) Identify the steps in the production for which EACH of the following processes is relevant.

Distillation: ____

Compression: ____

Catalysis: ____

Condensation: ____

Recycling: ____

[5 marks]

(b) Ammonia is used in the production of the compound urea, NH_2–CO –NH_2, that is used as a fertilizer. Carbon dioxide is also a reactant in the formation of urea, and water is the other product.

(i) Write a balanced equation for the formation of urea from ammonia.

[2 marks]

(ii) Urea is susceptible to the temperature and moisture in the environment and can be hydrolysed by these conditions. State the products of hydrolysis of urea.

[1 mark]

(iii) Describe what would be detected on a plot of land to which urea has been applied during moist, warm weather.

[2 marks]

Total 10 marks

9. Educational institutions discard large masses of paper every academic year. It would be environmentally useful if the administrations of schools, colleges and universities would implement programs to recycle the paper. Students of chemistry departments could devise chemical means of obtaining the glucose molecules from the cellulose fibres and then use the monomers to manufacture other products.

(a) (i) Suggest a chemical treatment for cellulose that would release the glucose monomers. State the reagents and conditions.

[2 marks]

(ii) Give ONE possible product that could be made from the monomers of the cellulose fibres.

[1 mark]

(iii) Suggest ONE OTHER strategy for waste paper management that would be useful for an academic institution.

[1 mark]

(b) Recycling is also used as a strategy in the management of plastic solid waste. Polyethylene terephthalate, PET, is commonly recycled. One process involves heating the plastic under reduced pressure until the polymer is broken down into the monomers.

(i) Suggest a reason for the use of low pressures in the recycling process mentioned.

[1 mark]

(ii) Suggest ONE use for the monomers obtained from the plastic.

[1 mark]

(iii) Describe the advantages of recycling plastic over other methods of management including incineration and biodegradation.

[4 marks]

Total 10 marks

END OF TEST

CARIBBEAN EXAMINATIONS COUNCIL

ADVANCED PROFICIENCY EXAMINATION

CHEMISTRY

UNIT 2 – PAPER 02

2 hours 15 minutes

Candidates are advised to use the first 15 minutes for reading through this paper carefully. Writing may begin during this time.

READ THE FOLLOWING INSTRUCTIONS CAREFULLY

1. This paper consists of NINE questions.
2. Section A consists of THREE questions, ONE question from each Module. Answer ALL questions. Answers for this section must be written in this booklet.
3. Section B consists of SIX questions. Answer ONLY THREE questions from this section, ONE question from EACH Module. Answers for this section must be written in the booklet provided.
4. ALL working MUST be CLEARLY shown.
5. The use of non-programmable calculators is permitted.

Materials provided:

- A Data Booklet
- Graph Paper
- Answer Booklet

SECTION A

Answer ALL questions in this section.

MODULE 1

1. (a) The blood is an important buffer that contains bicarbonate ions (HCO_3^-) (aq) and carbonic acid (H_2CO_3). Suggest how the blood responds in the presence of EACH of the following:

(i) Lactic acid that is produced as a result of

a) mild exercise

b) strenuous exercise.

[4 marks]

(ii) Excess alkalinity

[2 marks]

(b) An on-the-job trainee technician is asked to prepare a buffer solution of known pH. Outline the steps needed to prepare the solution and to determine that the solution is of the pH required.

[4 marks]

Total 10 marks

MODULE 2

2. (a) The labels are accidently removed from the bottles of four Group II metal sulphates (Mg, Ca, Sr, Ba). Outline a plan by which a chemist, who does not have access to flame test rods, could use physical properties to determine the identity of these sulphates.

[6 marks]

(b) The reaction of magnesium in air when heated was used by photographers in days gone by.

(i) Describe the environmental conditions under which the photographer would have decided to use this reaction.

[1 mark]

(ii) Suggest ONE disadvantage of using the reaction described above.

[1 mark]

(iii) Write the chemical equation to illustrate the reaction described above.

[2 marks]

Total 10 marks

MODULE 3

3. Fermentation has been used over the ages to incorporate some alcoholic content in home-made beverages. Many starting materials can be used including potatoes, grapes and corn.

(a) (i) What chemical feature do all of the mentioned starting materials possess?

[1 mark]

(ii) Give TWO differences in home-made alcoholic beverages resulting from the use of different starting materials.

[2 marks]

(iii) Briefly describe a simple laboratory method to determine the relative percentage alcohol in TWO home-made beverages.

[2 marks]

(b) Ethanol is described as the most common drug legally used by adults and illegally used by young people.

(i) Explain why ethanol is classified as a drug.

[1 mark]

(ii) Briefly describe FOUR consequences of alcohol abuse on the social and economic structures of our society.

[4 marks]

Total 10 marks

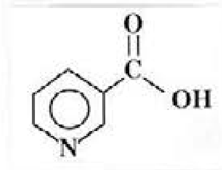
SECTION B

Answer THREE questions from this section, ONE question from EACH module.

MODULE 1

Answer EITHER Question 4 OR Question 5.

4. Niacin, a member of the vitamin B group, has the molecular structure given below.



Niacin is a weak acid and experimental determination shows that a solution of the acid of concentration 0.020 mol dm^{-3} has a pH of 3.26 at 298 K.

(a) By reference to the Bronsted-Lowry theory and the molecular structure of niacin, explain the statement, "Niacin is a weak acid". **[5 marks]**

(b) Use the information provided above to calculate the

(i) concentration of H^+ ions in the 0.020 mol dm^{-3} solution of niacin at 298 K **[3 marks]**

(ii) concentrations of niacin and the conjugate base in solution at 298 K **[3 marks]**

(iii) K_a for niacin at 298 K. **[3 marks]**

(c) (i) What changes in the values of pH and K_a for niacin would be expected if the determination is carried out at 320 K? Suggest a reason for your answer based on molecular structure. **[3 marks]**

(ii) Comment on the suitability of using a weak base to determine the concentration of niacin in solution by titration. **[3 marks]**

Total 20 marks

5. (a) In 1791, Luigi Galvani observed that muscles in frogs' legs contracted when touched simultaneously by two different metals. In 1794, Alessandro Volta showed that electricity could be produced when two metals are immersed in a conducting solution.

(i) Explain the "muscle twitch" observed by Galvani. **[1 mark]**

(ii) Describe with the aid of a diagram the experiment that Volta might have performed using TWO named metals. **[3 marks]**

(iii) Describe how the apparatus in (ii) can be modified to determine the standard electrode potential. **[5 marks]**

(b) Use the data on the standard electrode potentials below to answer the questions that follow:

$$O_3(g) + 2H^+(aq) + 2e^- \rightleftharpoons O_2(g) + H_2O(l) \qquad E^\theta = +2.08\ V$$

$$Cl_2(g) + 2e \rightleftharpoons 2\,Cl^-(aq) \qquad E^\theta = +1.36\ V$$

(i) Stain removers often oxidize the coloured compound to a colourless complex. Suggest ONE reason why inventors believe that an ozone-producing formulation produces brighter, whiter clothes than bleach does. **[2 marks]**

(ii) Comment on the suggestion that chlorine can be produced by bubbling ozone through sea water. **[2 marks]**

(c) One of the most common and useful batteries is the lead-storage battery used in automobiles. The cathode of each cell is composed of lead (IV) oxide (PbO_2), and the anode is composed of lead. The electrolyte used is sulphuric acid.

(i) Use the information in the data booklet to write equations for the reactions occurring at each electrode during discharge. **[2 marks]**

(ii) Calculate the standard cell potential. **[2 marks]**

(d) The fuel cell ($H_2 - O_2$) was a primary source of electrical supply on the Apollo moon flights. The fuel cell uses porous carbon electrodes into which pure streams of Hydrogen (at the cathode) and oxygen (at the anode) are introduced. By reference to standard electrode potentials in the data booklet, deduce the useful by-product of the reaction. Include relevant equations. **[3 marks]**

Total 20 marks

MODULE 2

Answer EITHER Question 6 OR Question 7.

6. (a) The temperature at which the reaction between chlorine and aqueous sodium hydroxide occurs determines the products of the reaction. Explain this phenomenon, using equations to illustrate your answer. **[9 marks]**

(b) Use the redox potential values given to explain the similarities and differences in the behaviour of the halogens with the thiosulphate ($S_2O_3^{2-}$) ion.

$$Cl_2(aq) + 2e \rightleftharpoons 2Cl^-(aq) \qquad E^\theta = +1.36\ V$$

$$Br_2(aq) + 2e \rightleftharpoons 2Br^-(aq) \qquad E^\theta = +1.07\ V$$

$$I_2(aq) + 2e \rightleftharpoons 2I^-(aq) \qquad E^\theta = +0.54\ V$$

$$2\,SO_3^{2-} + 3H_2O + 4e^- \rightleftharpoons S_2O_3^{2-} + 6\,OH^- \qquad E^\theta = +0.58\ V$$

$$S_4O_6^{2-} + 2e \rightleftharpoons 2\,S_2O_3^{2-} \qquad E^\theta = +0.09\ V$$

[8 marks]

(c) Describe how silver nitrate solution can be used to distinguish among the halides Cl^-, Br^- and I^-. **[3 marks]**

Total 20 marks

7. (a) Provide explanations for EACH of the following in terms of the characteristic properties of transition metals and their complexes:

(i) Anhydrous copper (II) sulphate is a white solid that gradually turns blue on the dropwise addition of water. Further addition results in the solid dissolving with the formation of a blue solution. **[4 marks]**

(ii) The gradual addition of a concentrated solution of sodium chloride to aqueous copper (II) sulphate leads to the formation of a green solution. A colour change from green to yellow is observed on further addition of the sodium chloride solution. **[3 marks]**

(b) The complex ion X is obtained on adding a concentrated solution of NaCN to aqueous $NiCl_2$. The ion X has the percentage composition of 36.1 % Ni, 29.5 % C and 34.4 % N.

(i) Determine the formula of the complex ion X. **[4 marks]**

(ii) Draw the shape of the complex ion X. **[1 mark]**

(c) Account for EACH of the following statements: [Use E^0 values provided in the Data Booklet where appropriate]

(i) Haemoglobin has a complex unit that affords the transportation of oxygen to the tissues. However, the carrying capacity of haemoglobin is reduced in the presence of carbon monoxide. **[4 marks]**

(ii) The manganate (VII) ions (MnO_4^-) and dichromate (VI) ions ($Cr_2O_7^{2-}$) are powerful oxidizing agents.

[4 marks]

Total 20 marks

MODULE 3

Answer EITHER Question 8 OR Question 9.

8. Sulphur dioxide is produced by industrial factories during the manufacture of sulphuric acid. Emissions of sulphur dioxide is a major environmental concern because these emissions contribute to the destruction of the environment by modification of the atmosphere.

(a) (i) Describe the Contact Process for the manufacture of sulphuric acid. Include in your description the source of raw materials and the chemistry of the process. **[8 marks]**

(ii) Explain how sulphur dioxide (SO_2) modifies the atmosphere. **[2 marks]**

(b) One method applied in industry to minimise the release of environmentally harmful gases, like SO_2, is the use of scrubbers. A scrubber is a chemical agent that reacts with the gas to extract it from the industrial emission.

(i) $CaCO_3$ is utilized as a chemical scrubber in industry.
Write an equation for the reaction between $CaCO_3$ and SO_2, and explain the underlying principle of the action of the carbonate. **[4 marks]**

(ii) Calculate the mass of $CaCO_3$, in kg, needed in a slurry to extract the SO_2 present in 10 m^3 of industrial waste gases at r.t.p, if SO_2 comprises10 % of this volume. **[6 marks]**

Total 20 marks

GO ON TO THE NEXT PAGE

9. The Montreal Protocol, on substances that deplete the ozone layer, was signed in 1987 by a number of nations with concern about the impact of low ozone levels on human health. The Protocol contains recommendations for phasing out the use of CFCs, chlorofluorocarbons.

(a) (i) Explain the need for concern regarding ozone depletion and human health. **[5 marks]**

(ii) Describe THREE properties of CFCs that contribute to their widespread use. **[3 marks]**

(b) CCl_2F_2 (CFC–12) is a typical chlorofluorocarbon developed to replace ammonia in manufacturing applications.

(i) Suggest TWO properties of ammonia that led to its replacement by CCl_2F_2. **[2 marks]**

(ii) Use CFC–12 as an example to write chemical equations that demonstrate the impact of CFCs on the ozone layer. **[5 marks]**

(c) It has been estimated that every day 3×10^8 tons of stratospheric ozone are formed and an equal mass is destroyed.

(i) Explain the underlying chemical principle in this natural process. **[3 marks]**

(ii) Write chemical equations to represent the natural processes of the formation and destruction of ozone. **[2 marks]**

Total 20 marks

END OF TEST

FORM TP 2006183

TEST CODE **02112010**

MAY/JUNE 2006

CARIBBEAN EXAMINATIONS COUNCIL

ADVANCED PROFICIENCY EXAMINATION

CHEMISTRY

UNIT 1 – PAPER 01

1 hour 45 minutes

Candidates are advised to use the first 15 minutes for reading through this paper carefully. Writing may begin during this time.

READ THE FOLLOWING INSTRUCTIONS CAREFULLY

1. This paper consists of NINE questions.
2. There are THREE questions from each Module. Answer ALL questions.
3. Write answers in this booklet.
4. ALL working must be shown in this booklet.
5. The use of non-programmable calculators is permitted.
6. A data booklet is provided.

MODULE 1

Answer ALL questions.

1. A sample of titanium gives the mass spectrum shown in Figure 1.

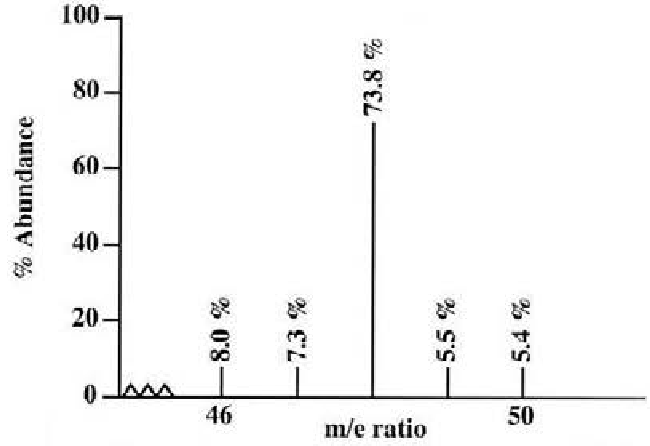


Figure 1

(a) Calculate the relative atomic mass A_r of titanium.

____

____

____

[2 marks]

(b) Use the data booklet and the mass spectrum given above to determine the number of protons and neutrons of the most abundant isotope of titanium.

____

____

[3 marks]

(c) Using s, p, d, f notation, write the electronic configuration of titanium.

____

[1 mark]

(d) Draw the shapes of the orbitals of principal quantum number n = 2 in the titanium atom.

[2 marks]

(e) Another isotope of titanium, ^{51}Ti, decays by β -emission. A β-particle has no mass and a single negative charge. Write an equation to represent the decay of a ^{51}Ti atom.

____

[2 marks]

Total 10 marks

2. Table 1 below gives the bond angles in molecules of ammonia and water, and the boiling point of each of these substances.

TABLE 1: BOND ANGLE AND BOILING POINT OF AMMONIA AND WATER

	Bond angle	**Boiling point / °C**
Ammonia	107°	– 31
Water	104.5°	100

(a) Sketch the shape of BOTH the water and ammonia molecules.

[2 marks]

(b) Explain the difference in the

(i) bond angles of the ammonia and water molecules

____

____

____

[3 marks]

GO ON TO THE NEXT PAGE

(ii) boiling points of water and ammonia.

[2 marks]

(c) (i) Suggest the shape of a molecule of hydrogen sulphide.

[1 mark]

(ii) How would the boiling point of hydrogen sulphide compare with that of ammonia? Explain your answer.

[2 marks]

Total 10 marks

3. (a) Define the term 'enthalpy change of solution'.

[1 mark]

(b) (i) State Hess' Law.

[1 mark]

(ii) Use the data in Table 2 and apply Hess' Law to determine the enthalpy of solution of hydrogen fluoride gas.

TABLE 2: ENTHALPY CHANGES ASSOCIATED WITH DISSOLUTION OF HF GAS

Enthalpy change (Δ H)	**KJ mol^{-1}**
Δ H HF Bond dissociation (BD)	+ 562
Δ H F Electron Affinity (EA)	– 328
Δ H H Ionization Energy (I.E)	+ 1310
Δ H F^- Hydration (Hyd)	– 506
Δ H H^+ Hydration (Hyd)	– 1300

[5 marks]

(iii) Any chemical change involves processes of bond making and bond breaking. Classify EACH process as exothermic or endothermic and, hence, explain the value obtained in (b) (ii) on page 5.

[3 marks]

Total 10 marks

MODULE 2

Answer ALL questions.

4. Aspartame, the structure shown in Figure 2 below, is an artificial sweetener. It is about 200 times sweeter than sucrose.

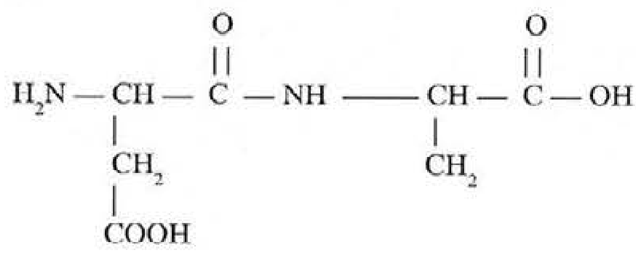


Figure 2

(a) Which of the functional groups present in aspartame would react with

(i) ethanol?

[1 mark]

(ii) dilute hydrochloric acid?

[2 marks]

GO ON TO THE NEXT PAGE

(iii) ethanoyl chloride?

[1 mark]

(b) Name the OTHER chemical that is required for the reaction with ethanol to occur.

[1 mark]

(c) The scheme in Figure 3 shows that the conversion of **A** to **C** occurs in two steps. **A** is converted to **B** on treatment with $SOCl_2$.

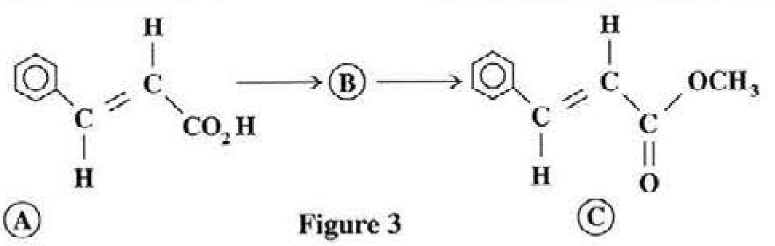


Figure 3

(i) Draw the structural formula of B.

[1 mark]

(ii) State the reagents and conditions required for the conversion of **B** to **C**.

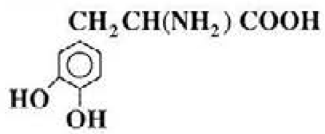
[2 marks]

(iii) State ONE physical property that is characteristic of BOTH Compound **C** and that obtained in the reaction described in (b) above. Explain your answer.

[2 marks]

Total 10 marks

5. Dopa is a naturally occurring amino acid, used in the treatment of Parkinson's disease. A condensed formula, A, of this molecule is shown in Figure 4.



A

Figure 4

(a) State TWO reasons why carbon can form straight chains and rings.

____

____

[2 marks]

(b) Write the molecular formula of Dopa.

____

[1 mark]

(c) Dopa is one isomeric form of the molecular formula in (b) above.

(i) Define the term 'isomerism'.

____

____

[1 mark]

(ii) State TWO types of isomerism which can be exhibited by a molecule with formula A.

Type I : ____________________________________

Type II: ____________________________________

[2 marks]

(iii) Draw the full structural formulae of TWO isomers for each type of isomerism stated in (c) (ii) on page 8.

Type I:

Type II:

[4 marks]

Total 10 marks

6. The sequence of monomer units in a macromolecule is called its primary structure. Part of the primary structure of one macromolecule, **A**, is shown in Figure 5.

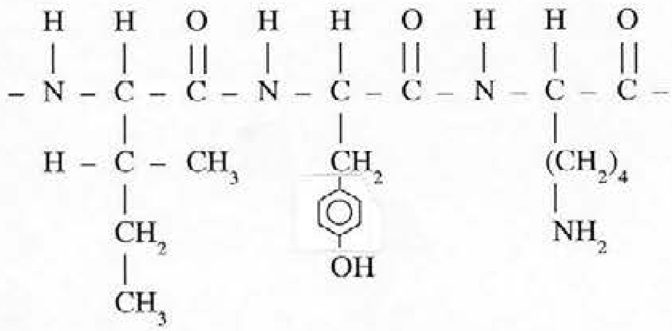


Figure 5

(a) (i) How many monomer units are present in this portion of the macromolecule?

____

[1 mark]

(ii) Draw the displayed structure of two monomers used to make **A**.

[2 marks]

(b) To what class of compounds do the monomers and macromolecule, **A**, belong?

Monomer:

____

Macromolecule **A**:

____

[2 marks]

GO ON TO THE NEXT PAGE

(c) Nylon 6.6 has similar characteristics to **A**.

(i) Name the type of reaction that occurs when nylon 6.6 or **A** is boiled with concentrated hydrochloric acid.

[1 mark]

(ii) Copy the structure of **A** and use it to illustrate the changes that occur during the reaction described in (c) (i) above.

[1 mark]

(iii) Draw the fully displayed structure of ONE product of the reaction described in (c) (i) above.

[1 mark]

(d) State ONE common structural feature and ONE different structural feature in nylon 6.6 and **A**.

[2 marks]

Total 10 marks

MODULE 3

Answer ALL questions.

7. In order to estimate the % of Fe^{2+} in a compound M, a solution of M is titrated against a standard solution of potassium permanganate (manganate (VII)). The permanganate is standardised by titration against the primary standard, ethanedioic acid.

(a) State THREE characteristics of ethanedioic acid that make it a suitable primary standard.

____

____

____

[3 marks]

(b) In preparing the solution of ethanedioic for titration against the permanganate, two pieces of laboratory equipment with a high degree of accuracy are required. Name these TWO pieces of equipment.

____

____

[2 marks]

(c) 25.0 cm^3 of the aqueous solution of M requires 24.80 cm^3 of 0.02 mol dm^{-3} permanganate for complete reaction. The equation for the reaction is

$$5\,Fe^{2+}(aq) + MnO_4^-(aq) + 8H^+(aq) \rightarrow 5\,Fe^{3+}(aq) + Mn^{2+}(aq) + 4H_2O$$

Calculate EACH of the following:

(i) The number of moles MnO_4^- used

[1 mark]

(ii) The number of moles Fe^{2+} in the 25.0 cm^3 of aqueous M

[1 mark]

GO ON TO THE NEXT PAGE

(iii) The number of moles Fe^{2+} in 1.0 dm^3 of M (aq)

[1 mark]

(iv) The mass of Fe^{2+} in 1 dm^3 of M (aq)

[1 mark]

(v) The % Fe^{2+} in the compound [The mass concentration of M is 40.90 g dm^{-3}.]

[1 mark]

Total 10 marks

8. A variety of chromatographic methods can be used to separate mixtures.

(a) (i) What is meant by retention time as applied to gas liquid chromatography (GLC)?

[1 mark]

(ii) Distinguish between a stationary phase and a mobile phase used in chromatography.

[2 marks]

(iii) Give ONE example EACH of commonly used stationary and mobile phases in GLC.

[2 marks]

(b) Samples of TWO different brands of black ink are separated into their constituent parts using paper chromatography. Both samples contain a red dye. In the first sample the solvent travels 7.54 cm, while the red dye travels 4.67 cm. In the second sample the red dye travels 3.31 cm while the solvent travels 5.34 cm.

(i) Calculate the R_f values for the TWO samples.

[2 marks]

(ii) Deduce whether the same red dye is used to make both types of ink. Give TWO reasons for your answer.

[3 marks]

Total 10 marks

9. (a) Infra red (IR) spectroscopy is widely used to determine the structure of molecules. State the principles upon which infra red (IR) spectroscopy is based.

[3 marks]

(b) Even though air consists of 78% N_2 and 21% O_2, these gases do not contribute to global warming. Explain this phenomenon.

[2 marks]

(c) Explain how the IR spectra may be used to distinguish between functional groups in organic compounds.

[1 mark]

(d) The carbonyl group, $\rangle C = O$, has absorption peaks in the region of 1680 to 1750 cm^{-1}, while the peaks for the alkene group, $\rangle C = C\langle$, are manifested in the region of 1610 to 1680 cm^{-1}. What does this say about the bond energies of the $\rangle C = O$ and $\rangle C = C\langle$ functional groups?

[1 mark]

(e) Suggest ONE reason why HCl has only one peak in its IR spectrum.

[1 mark]

(f) (i) The monochromator and sample cell are components of the IR spectrophotometer. Give ONE reason why the monochromator and sample cell are not constructed of glass or quartz.

[1 mark]

(ii) What material may be used instead of quartz or glass?

[1 mark]

Total 10 marks

END OF TEST

FORM TP 2006184

TEST CODE **02112020**

MAY/JUNE 2006

CARIBBEAN EXAMINATIONS COUNCIL

ADVANCED PROFICIENCY EXAMINATION

CHEMISTRY

UNIT 1 – PAPER 02

2 hours 15 minutes

Candidates are advised to use the first 15 minutes for reading through this paper carefully. Writing may begin during this time.

READ THE FOLLOWING INSTRUCTIONS CAREFULLY

1. This paper consists of NINE questions.
2. Section A consists of THREE questions, ONE question from each Module. Answer ALL questions in this section. Answers for this section must be written in this booklet.
3. Section B consists of SIX questions. Answer ONLY THREE questions from this section, ONE question from EACH Module. Answers for this section must be written in the booklet provided.
4. ALL working MUST be CLEARLY shown.
5. The use of non-programmable calculators is permitted.

Materials provided:

- A data booklet
- Graph paper
- Answer booklet

SECTION A

Answer ALL questions in this section.

MODULE 1

1. In an experiment to determine the empirical and molecular formulae of a hydrocarbon, **A**, the hydrocarbon is completely burnt in excess oxygen and the products collected. **A** gave 3.52 g of carbon dioxide and 1.62 g of water, on complete combustion.

$[M_r\ CO_2 = 44;\ M_r\ H_2O = 18]$

(a) Calculate the mass of

(i) carbon in 3.52 g of carbon dioxide

[1 mark]

(ii) hydrogen in 1.62 g of water.

[1 mark]

(b) Use the answers obtained in (a) (i) and (a) (ii) to calculate the empirical formula of **A**.

[2 marks]

GO ON TO THE NEXT PAGE

(c) The molar mass of **A** is 114 g mol^{-1}. Calculate its molecular formula.

[2 marks]

(d) Describe simple tests that could be used to confirm that the products of the combustion of **A** are water and carbon dioxide (You must include in your answer the reagent used and the observation obtained for EACH test).

(i) Water

[2 marks]

(ii) Carbon dioxide

[2 marks]

Total 10 marks

2. (a) An organic compound, X, is subjected to chemical analysis and mass spectrometry to determine its structural formula. Some of the results of the chemical analysis are recorded in Table 1 below. Complete the table by writing the observations and inference that have been omitted.

TABLE 1: RESULTS OF TESTS ON COMPOUND X

Test	Observation	Inference
An alkaline solution of silver nitrate is added to a few cm^3 of X. The mixture is warmed.	(i)	Aldehyde
Iodine and X are warmed with some NaOH in a test tube.	(ii)	Methylketone
X is added to a few cm^3 of bromine in tetrachloro-methane.	(iii)	Alkene
X is added to dilute HCl	White crystals are produced.	(iv)

[4 marks]

(v) Suggest a value for the pH of a solution of X.

[1 mark]

(vi) The mass spectrum of X reveals that it has a RMM of 203. A prominent peak is also observed in the mass spectrum at m/z 77. Use this information and the results of your chemical analysis as recorded in Table 1 above to draw a displayed structure for X.

[1 mark]

GO ON TO THE NEXT PAGE

(b) An organic compound **Y** is also subjected to chemical analysis. Some of the results are presented in Table 2. Complete Table 2 by writing the tests and inference that have been omitted.

TABLE 2: RESULTS OF TESTS ON COMPOUND Y

Test	Observation	Inference
Acidified $KMnO_4$ is added to a few cm^3 of Y, and the mixture is warmed.	Colour changes from purple to colourless.	(i)
(ii)	White precipitate produced.	Phenol present.
(iii)	Gas evolves which forms white fumes with $NH_3(g)$.	Carboxylic acid group

[3 marks]

(iv) The molecular formula for **Y** is found to be $C_9H_{10}O_4$. Suggest a structural formula for **Y**.

[1 mark]

Total 10 marks

GO ON TO THE NEXT PAGE

3. A student synthesizes a crude organic product in the laboratory. The process of purification is outlined in the flow diagram in Figure 1 below.

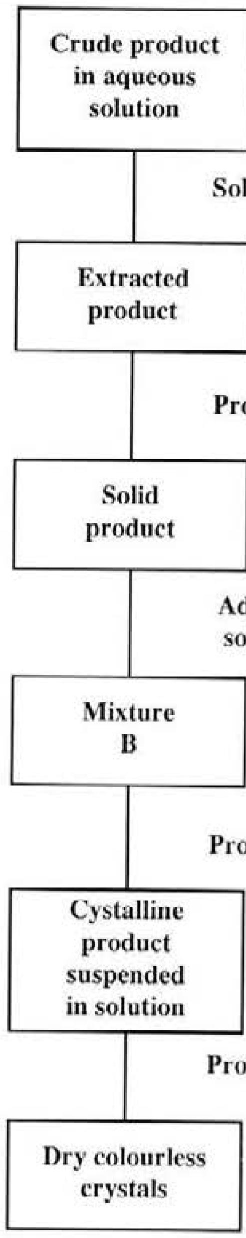


Figure 1.

(a) Identify EACH of the processes 1, 2 and 3 in Figure 1.

____

____

____

[3 marks]

(b) (i) Suggest the name of Solvent **A** and explain why the solvent suggested is suitable.

[3 marks]

(ii) Describe Mixture **B**

[1 mark]

(c) Suggest a suitable piece of equipment which could be used to obtain the

(i) extracted product

[1 mark]

(ii) dry crystals.

[1 mark]

(d) Mixture **B** shows some discolouration and an additional step is required before Process 2.

Name the purifying agent necessary in this step.

[1 mark]

Total 10 marks

SECTION B

Answer THREE questions from this section, ONE question from EACH module.

MODULE 1

Answer EITHER Question 4 OR Question 5.

4. (a) (i) Describe the features of a chemical system in a state of dynamic equilibrium. **[4 marks]**

(ii) Define the term 'equilibrium constant'. **[1 mark]**

(iii) Iodine gas is purple and hydrogen iodide gas is colourless. Hydrogen and iodine, in the gaseous state, react according to the equation:

$$H_2(g) + I_2(g) \rightleftharpoons 2\,HI(g)$$

Describe and explain, with reference to changes in colour, the observations made when hydrogen gas is reacted with iodine gas at constant temperature until equilibrium is achieved. **[5 marks]**

(iv) Table 3 shows some data for the system given in (iii) above. (Assume that the volume of the vessel is 1 dm^3 and the temperature remains constant.)

TABLE 3: DATA FOR THE SYSTEM ABOVE

Species	H_2	I_2	HI
Initial concentration (mol dm^{-3}) Equilibrium concentration (mol dm^{-3})	1 .67	2	0

a) Use the information in Table 3 and the equation in (a) (iii) above to calculate the number of moles of hydrogen reacting.

b) Complete the table by inserting the equilibrium concentrations of I_2 and HI. **[3 marks]**

(v) Write an equation for K_p for the reaction in (iii) above. **[2 marks]**

(b) The terms K_a, pK_a and pH can be used to indicate the relative strength of weak acids. The general equation for the equilibrium of a weak acid is given below:

$$HA(aq) \rightleftharpoons H^+(aq) + A^-(aq)$$

(i) Write an expression for EACH of the following terms:

a) K_a

b) pK_a

c) pH **[3 marks]**

GO ON TO THE NEXT PAGE

(ii) Given that K_a for acid HP is 3.0×10^{-5} mol dm^{-3}, predict the relative size of K_a for a stronger acid HQ. Explain your reasoning. **[2 marks]**

Total 20 marks

5. (a) Explain EACH of the terms 'oxidation' and 'reduction', in terms of

(i) loss and or gain of electrons **[2 marks]**

(ii) change in oxidation number. **[2 marks]**

(b) Hydrogen peroxide, H_2O_2, can act as both an oxidising agent and a reducing agent, and chloric (I) acid (HOCl) can act as an oxidizing agent.

$$O_2 + 2H^+ + 2e^- \rightarrow H_2O_2$$

$$\frac{1}{2} H_2O_2 + H^+ + e^- \rightarrow H_2O$$

$$HOCl + H^+ + e^- \rightarrow \frac{1}{2} Cl_2 + H_2O$$

(i) Use the appropriate half equations (from those above) to write a balanced equation to show the reaction between hydrogen peroxide and chloric (I) (hypochlorous) acid. **[2 marks]**

(ii) By making reference to the change in oxidation numbers of the elements in both the hydrogen peroxide AND the chloric (I) acid, determine which reactant is reduced and which is oxidised. **[6 marks]**

(c) In an experiment to determine whether iron or nickel is a better reducing agent, a strip of each metal is placed in an aqueous solution of a salt of the other metal. A reaction occurs in the container in which iron is placed in the aqueous solution of the nickel salt.

(i) State what type of chemical reaction occurs and write an ionic equation for the reaction. **[3 marks]**

(ii) Which element has the greater reducing ability? Explain your answer, using a suitable half equation. **[4 marks]**

(iii) Tin shows no reaction with solutions of EITHER iron or nickel salts. Place the elements, tin, iron and nickel in order of INCREASING reducing ability. **[1 mark]**

Total 20 marks

MODULE 2

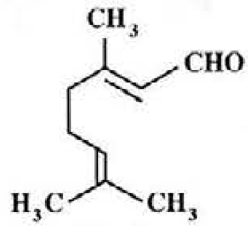
Answer EITHER Question 6 OR Question 7.

6. (a) Describe EACH of the following terms, using appropriate examples:

(i) Homolytic bond fission

(ii) Inductive effect **[6 marks]**

(b) Citral is an oily liquid which contributes to the flavour and aroma of oranges.

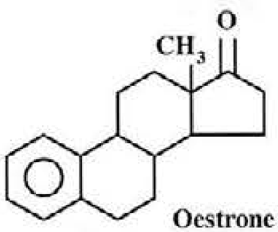


Citral

(i) State TWO types of reaction mechanisms which citral will undergo, identifying the functional group involved in EACH case. **[4 marks]**

(ii) With the use of simple molecules containing the functional groups identified in (b) (i), explain the steps involved in EACH of the mechanisms mentioned in (b) (i). **[8 marks]**

(c) Oestrone, a female sex hormone, reacts with bromine in the presence of iron (III) bromide via a mechanism not mentioned in (b) (ii).



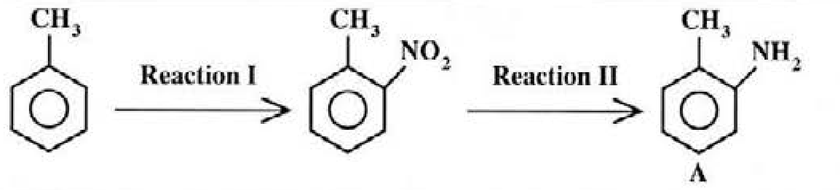
Oestrone

Identify the mechanism and draw the product of this reaction. **[2 marks]**

Total 20 marks

GO ON TO THE NEXT PAGE

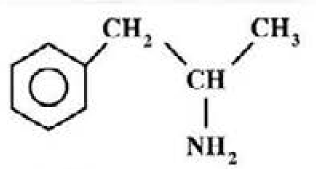
7. The reaction sequence below shows the conversion of methylbenzene to A.



(a) (i) For the reaction sequence given above, state the reagents and conditions needed for Reactions I and II. **[4 marks]**

(ii) Identify ONE OTHER product that could be obtained in Reaction I by changing the conditions. State the condition(s) needed. **[2 marks]**

(b) Amphetamine, like **A**, is an amine. It is a drug that increases the heart rate and causes increased sweating in humans. Its structure is given below:



Structure of Amphetamine

(i) Explain the differences in basic character of A, ammonia and amphetamine. In your explanation make reference to the molecular features of each molecule. State the order of INCREASING basic character of the three molecules.

[8 marks]

(ii) Write an equation to show the basic nature of any ONE of the above substances.

[1 mark]

(iii) The pK_b of **A** is 9.62. Suggest how the pK_b of amphetamine and ammonia should vary relative to that of **A**. **[2 marks]**

(c) The pH of ethanoic acid is 4.76 and of dichloroethanoic acid is 1.29.

(i) Predict pH values for difluoroethanoic acid and dibromoethanoic acid.

[2 marks]

(ii) Would benzoic acid be a stronger or weaker acid than ethanoic acid?

[1 mark]

Total 20 marks

MODULE 3

Answer EITHER Question 8 OR Question 9.

8. The enthalpy of solution of sodium chloride is determined in a school laboratory. The results of four trials are presented in Table 4 below.

TABLE 4: EXPERIMENTAL RESULTS OF DETERMINATION OF ΔH_{soln} NaCl

Trial	1	2	3	4
ΔH_{soln} (KJ mol^{-1})	4.80	4.65	5.25	4.60

The theoretical value is $+ 5.00$ KJ mol^{-1}.

(a) (i) Calculate the mean of ΔH_{soln} NaCl from the data. **[2 marks]**

(ii) Comment on the precision and accuracy of the results. **[3 marks]**

(iii) Calculate the standard deviation of the data and explain the significance of the value. **[3 marks]**

(b) In the above experiment a top loading balance is used to weigh the sodium chloride sample and a 250 cm^3 beaker is used to measure the volume of water. The thermometer readings are measured within $\pm$ 0.5 °C.

(i) Discuss whether each instrument is appropriate for the measurement taken and suggest possible alternatives where necessary. **[6 marks]**

(ii) Give TWO reasons for calibrating an instrument such as a thermometer and suggest TWO steps involved. **[4 marks]**

(c) The volume of water, at room temperature, displaced by a series of standard weights is recorded. The results are given in Table 5 and the calibration curve is plotted in Figure 2.

TABLE 5: VOLUME OF WATER DISPLACED

Mass of standard (g)	Volume of H_2O displaced (cm^3)
2	0.75
4	1.5
8	3.0
12	4.5
16	6.0

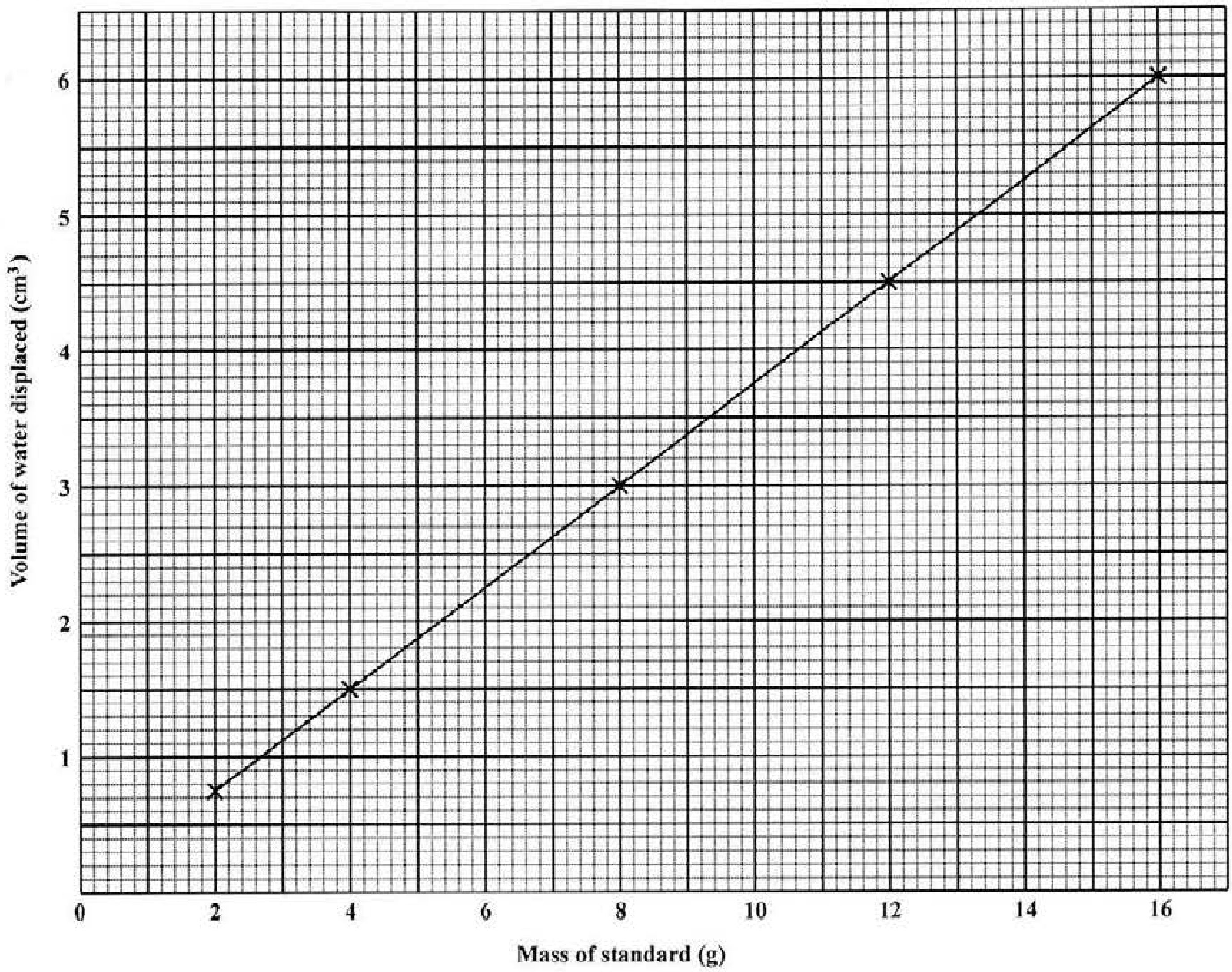


Figure 2.

Use the calibration curve in Figure 2 to determine the density of a block of metal that displaces a volume of 4.0 cm^3. **[2 marks]**

Total 20 marks

GO ON TO THE NEXT PAGE

9. Different types of distillation, for example, simple distillation, fractional distillation and steam distillation, are used to separate mixtures. The physical properties of three compounds, W, X and Y are given in Table 6.

TABLE 6: PHYSICAL PROPERTIES OF W, X AND Y

Compound	m.p./ °C	b.p / °C	Solubility in water
W	– 97.7	64.5	Soluble
X	– 6.2	84	Immiscible
Y	801	1465	Soluble

(a) State which type of distillation is BEST suited for separating EACH compound from a mixture of the compound in water. **[3 marks]**

(b) A fourth compound, Z, (b.p = 97.2°C) forms a non-ideal mixture with water which boils at 88.1°C at 0.43 mole fraction of Z.

(i) Construct the b.p / composition curve for the mixture of Z in water. Include in your diagram all data given, and label the two phases present. **[5 marks]**

(ii) Use the diagram drawn in (b) (i) to explain why this mixture cannot be completely separated using fractional distillation. **[8 marks]**

(c) Steam distillation is used in the extraction of essential oils from plant materials. Suggest

(i) ONE advantage and ONE disadvantage of carrying out the distillation under increased pressure **[2 marks]**

(ii) TWO industries that utilize the process. **[2 marks]**

Total 20 marks

END OF TEST

FORM TP 2006185

TEST CODE **02212010**

MAY/JUNE 2006

CARIBBEAN EXAMINATIONS COUNCIL

ADVANCED PROFICIENCY EXAMINATION

CHEMISTRY

UNIT 2 – PAPER 01

1 hour 45 minutes

Candidates are advised to use the first 15 minutes for reading through this paper carefully. Writing may begin during this time.

READ THE FOLLOWING INSTRUCTIONS CAREFULLY

1. This paper consists of NINE questions.
2. There are THREE questions from each Module. Answer ALL questions.
3. Write answers in this booklet.
4. ALL working must be shown in this booklet.
5. The use of non-programmable calculators is permitted.
6. A data booklet is provided.

MODULE 1

Answer ALL questions.

1. Lead (II) chloride ($PbCl_2$) is a sparingly soluble salt.

   (a) Write an expression for the solubility product of lead (II) chloride.

   ____

   [2 marks]

   (b) A saturated solution of $PbCl_2$ contains 0.025 mol dm^{-3} at 25 °C. Calculate the $K_{s.p.}$ of $PbCl_2$.

   [3 marks]

(c) A student finds that on adding $NaCl(aq)$ to a saturated solution of $PbCl_2$ a white precipitate forms.

Explain this observation.

____

____

____

____

____

____

[5 marks]

Total 10 marks

2. When stung by an ant, a potent mixture containing an organic acid, methanoic acid (HCOOH), is injected into the skin. Typically, organic acids are weak acids.

(a) (i) Explain the meaning of the term 'weak acid'.

____

____

[2 marks]

(ii) Account for the sensation that occurs when stung by an ant.

____

____

[2 marks]

(b) A sample of the mixture responsible for the sting is extracted from the ants and analysed to determine the pH and acid concentration. The pH of the sample is 2.4.

(i) Suggest a simple method of determining pH.

____

[1 mark]

(ii) The acid concentration is determined by titrating the sample with a 0.05 mol dm^{-3} sodium hydroxide solution. 10 cm^3 of sodium hydroxide reacts completely with 5 cm^3 of the sample. Given that the equation for the reaction between sodium hydroxide and methanoic acid is

$NaOH(aq) + HCOOH(aq) \rightarrow HCOO\,Na(aq) + H_2O(l)$

a) Suggest a suitable indicator for this titration.

____

[1 mark]

b) Calculate the concentration of the acid in the sample.

[1 mark]

c) Use your answer to (ii) b) above and the pH value of the sample to calculate the value of K_a for the acid.

____

____

____

____

____

[3 marks]

Total 10 marks

3. (a) The standard hydrogen electrode is the reference electrode with which other electrodes are compared to determine standard electrode potentials.

(i) Draw a labelled diagram to show how the standard electrode potential for the Zn^{2+} (aq) / Zn (s) electrode can be found by combining it with the standard hydrogen electrode.

[3 marks]

(ii) Which of the half cells is the positive electrode?

____

[1 mark]

(iii) Using arrows, indicate on the diagram drawn in (i) above, the direction in which the electrons flow through the external circuit. [1 mark]

(b) A Zn^{2+} (aq) / Zn (s) half cell is connected to a Ag^{+}(aq) / Ag (s) half cell as shown below

Zn (s) / Zn^{2+} (aq) : : Ag^{+} (aq) / Ag (s)

(i) Write the equations for the reactions occurring at each half cell, using electrode potentials given in the data booklet.

Positive electrode ______________________________

Negative electrode ______________________________

[2 marks]

(ii) Calculate the standard e.m.f. of the cell.

____

____

[1 mark]

(iii) A student sets up the Ag^+ (aq)/ Ag (s) half cell in (b) page 5, using a solution of 0.1 mol dm^{-3} Ag^+ ions instead of 1 mol dm^{-3} Ag^+ ions. Suggest how this would affect the e.m.f. of the cell. Give a reason for your answer.

____

____

____

[2 marks]

Total 10 marks

MODULE 2

Answer ALL questions.

4. The Group II elements, beryllium to barium (Be to Ba), and their compounds show distinct trends / patterns in properties and behaviour.

(a) Write an equation for the first ionization energy of beryllium (Be).

____

[1 mark]

(b) Using the data booklet provided, explain the trend in the first ionization energy with atomic radii for the Group II elements.

____

____

____

____

____

____

[2 marks]

(c) Write an equation for the reaction between ONE of the Group II elements and water.

____

[2 marks]

(d) Using standard electrode potentials, explain why the reaction in (c) would occur more vigorously with barium (Ba) than beryllium (Be), given

[$Be^{2+} + 2e^- \rightleftharpoons Be$ $E^\theta = -1.85$ V].

[2 marks]

(e) Explain the variation in the solubility of the sulphates of Group II elements as the group is descended.

[3 marks]

Total 10 marks

5. (a) Part of the periodic table is shown in Figure 1 below.

	Mg		Al				Cl	
K		Fe						
							I	
	Ba			Pb				

Figure 1

Write an ion of an element shown in Figure 1, which will react with EACH of the following substances:

(i) Acidified aqueous silver nitrate to form a white precipitate

____

(ii) Aqueous lead (II) nitrate to form a yellow precipitate

____

(iii) Aqueous potassium hydroxide to form a red-brown precipitate

____

(iv) Aqueous sodium carbonate to form a white precipitate

____

[4 marks]

(b) X is a powdered mixture containing a soluble and an insoluble salt. A sample of X is treated in the following manner:

I. Water is added to X and the mixture is filtered.

II. The residue reacts completely with dilute nitric acid and a colourless gas evolves, which forms a white precipitate with aqueous calcium hydroxide. The resulting solution reacts with both aqueous ammonia and sodium hydroxide to form a white precipitate, that does not dissolve in excess of the reagents.

III. One sample of the filtrate reacts with acidified barium chloride to form a white precipitate. Another sample reacts with aqueous ammonia and sodium hydroxide to form a white precipitate which is soluble in excess of the reagents.

(i) Using the information given on page 8, deduce the possible ions present in the

a) residue

____

[2 marks]

b) filtrate.

____

[2 marks]

(ii) Write a balanced ionic equation for the reaction between nitric acid and the residue.

____

[2 marks]

Total 10 marks

6. (a) Transition elements exhibit special characteristics, which distinguish them from Group I and Group II metals. For example, transition elements exhibit variable oxidation states.

(i) Determine the oxidation state of vanadium in VO_3^- and VO^{2+}.

____

____

[2 marks]

(ii) State TWO OTHER characteristics of transition elements.

____

____

____

____

[2 marks]

(b) Complete the electronic configuration of a

(i) chromium atom, Cr

$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6$ ______________________________

[1 mark]

(ii) chromium ion, Cr^{3+}.

$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6$ ______________________________

[1 mark]

GO ON TO THE NEXT PAGE

(c) In an aqueous solution of chromium (III) chloride ($CrCl_3(aq)$), chromium forms the complex ion $[Cr(H_2O)_4 Cl_2]^+ (aq)$.

Deduce the likely shape and the bond angles in this complex ion.

Shape: ____

[1 mark]

Bond angle: ____

[1 mark]

(d) It has been observed that a solution of aqueous chromium (III) ions, $[Cr(H_2O)_6]^{3+}(aq)$ is weakly acidic. Suggest an explanation for this observation.

____

____

____

____

[2 marks]

Total 10 marks

MODULE 3

Answer ALL questions.

7. Charles Hall and Paul Heroult independently developed the method for the large-scale production of aluminium from alumina. On application of the extraction procedure, 1900 kg of alumina (Al_2O_3), 70 kg of cryolite, 450 kg of carbon and 5.6×10^9 J yield 1000 g of aluminium metal.

(a) Describe and explain the use of EACH of the following in the Hall-Heroult process.

(i) Cryolite

____

____

____

[2 marks]

(ii) Carbon

____

____

____

[2 marks]

(b) Account for the requirement of 5.6×10^9J of energy to produce 1000 kg of aluminium metal.

____

____

____

[2 marks]

GO ON TO THE NEXT PAGE

(c) (i) Calculate the theoretical yield of aluminium expected from 1900kg of Al_2O_3. Show all working.

[3 marks]

(ii) Comment on the efficiency of the process in the extraction of aluminium from its ore.

[1 mark]

Total 10 marks

8. Chlorofluorocarbons, CFCs, have found application in a variety of commercial products because of their special properties. However, CFCs can persist in the atmosphere for many years and scientists have provided evidence of their decomposition products in the stratosphere. The resistance has proven to be of concern regarding the impact on human health.

(a) Give TWO commercial products in which CFCs could be found before regulations were implemented.

[2 marks]

(b) State TWO properties of CFCs that make them applicable in the products given in (a).

[2 marks]

(c) CF_2Cl_2 is a typical CFC. Use this molecule as an example and explain the significance of CFCs in the stratosphere. Include relevant equations.

[2 marks]

(d) It has been estimated that a molecule of CF_2Cl_2 persists in the atmosphere for 120 years before it is destroyed.

(i) Suggest a reason for the persistence of this CFC in the atmosphere in terms of its molecular features.

[2 marks]

(ii) Explain the impact of CF_2Cl_2 in the atmosphere on human health.

[2 marks]

Total 10 marks

9. During the 20th century, human activities have contributed to atmospheric pollution by altering the natural concentrations of oxides of nitrogen and of carbon dioxide.

(i) Describe with the aid of an equation how nitrogen dioxide (NO_2) is produced naturally in the atmosphere.

[2 marks]

(ii) Identify ONE human activity that alters the atmospheric concentration of oxides of nitrogen and explain the chemistry involved in the production of the pollutant.

[2 marks]

(iii) Describe, with the aid of an equation, one environmental change that occurs due to the presence of nitrogen dioxide as a pollutant in the atmosphere.

[3 marks]

(iv) Recent newspaper reports indicate that it is no longer possible to complete a surface crossing of the Arctic Ocean from Alaska through the North Pole to Norway because there is insufficient ice. Suggest an explanation for this phenomenon.

[3 marks]

Total 10 marks

END OF TEST

FORM TP 2006186

TEST CODE **02212020**

MAY/JUNE 2006

CARIBBEAN EXAMINATIONS COUNCIL

ADVANCED PROFICIENCY EXAMINATION

CHEMISTRY

UNIT 2 – PAPER 02

2 hours 15 minutes

Candidates are advised to use the first 15 minutes for reading through this paper carefully. Writing may begin during this time.

READ THE FOLLOWING INSTRUCTIONS CAREFULLY

1. This paper consists of NINE questions.
2. Section A consists of THREE questions, ONE question from each Module. Answer ALL questions. Answers for this section must be written in this booklet.
3. Section B consists of SIX questions. Answer ONLY THREE questions from this section, ONE question from EACH Module. Answers for this section must be written in the booklet provided.
4. ALL working MUST be CLEARLY shown.
5. The use of non-programmable calculators is permitted.

Materials provided:

- A data booklet
- Graph paper
- Answer booklet

SECTION A

Answer ALL questions in this section.

MODULE 1

1. (a) The rate equation for the reaction between hydrogen, H_2, and nitrogen monoxide, NO, is as follows:

$$\text{Rate} = k\,[H_{2\,(g)}]\,[NO_{(g)}]^2$$

Predict quantitatively what would happen to the rate of the reaction when the following changes are made. Give a reason for your answer in (i) and (ii).

(i) The concentration of $H_{2(g)}$ is doubled.

Effect on Rate:

____

Reason:

____

[2 marks]

(ii) The concentration of $NO_{(g)}$ is halved.

Effect on rate:

____

Reason:

____

[2 marks]

(iii) The concentration of $H_{2(g)}$ and $NO_{(g)}$ are both tripled.

Effect on rate:

____

[1 mark]

(b) (i) The equation for the reaction between H_2 and NO at 25°C, 1 atm is as follows:

$$2NO_{(g)} + 2H_{2(g)} \rightarrow N_{2(g)} + 2H_2O(l)$$

The rate of the reaction was monitored by measuring the volume of products formed. Sketch a suitable graph representing the data collected.

[2 marks]

(ii) Apart from volume measurement, state ONE other method of monitoring the rate of this reaction.

____

[1 mark]

(iii) Suggest TWO precautions that should be taken when performing the experiment in (b) (ii) above.

____

____

____

____

[2 marks]

Total 10 marks

MODULE 2

2. (a) The products of the reaction between chlorine and aqueous sodium hydroxide depend on temperature and concentration. Chlorine also exhibits variable oxidation states in its many compounds.

(i) Write a balanced equation for the reaction that occurs when chlorine is bubbled through cold aqueous dilute sodium hydroxide.

____

[2 marks]

(ii) Calculate the oxidation number of chlorine in NH_4ClO_4.

____

[1 mark]

(b) State the observation that is made for EACH of the following reactions involving metal halides.

(i) Aqueous chlorine is added to aqueous potassium bromide and the mixture is shaken.

____

[1 mark]

(ii) Aqueous silver nitrate is added to a sample of aqueous sodium chloride followed by ammonia solution.

____

[2 marks]

(iii) Warm concentrated sulphuric acid is added to solid potassium iodide.

____

[1 mark]

(c) Write an ionic equation for the reaction occurring in (b) (i).

____

[2 marks]

(d) What precaution must be taken when performing the reaction in (b) (iii) in the laboratory?

____

[1 mark]

Total 10 marks

GO ON TO THE NEXT PAGE

NOTHING HAS BEEN OMITTED

MODULE 3

3. The raw materials used to obtain the elements nitrogen and hydrogen for the industrial synthesis of ammonia are obtained from varied sources. The industrial synthesis provides ammonia that is subsequently used in the manufacture of nitrogen-based commercial products.

Figure 1 below shows a flow chart of a general scheme for the industrial production of ammonia.

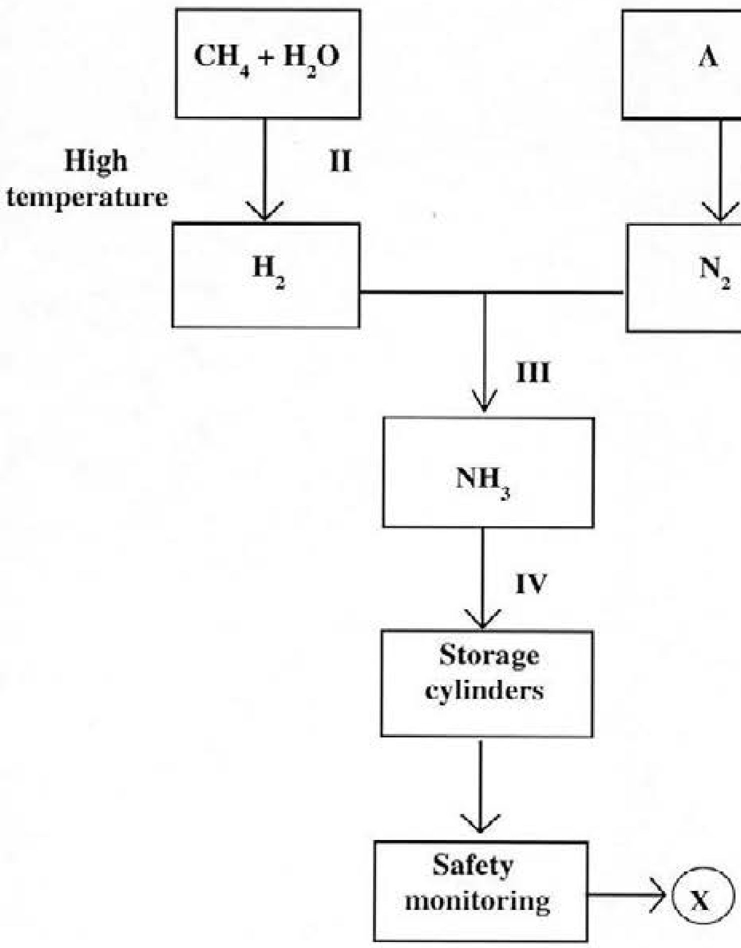


Figure 1

(a) Identify the source **A** and the process **I** used obtain the nitrogen gas.

____

____

[2 marks]

(b) (i) Suggest another condition required at process **II** which is used to yield hydrogen gas.

[1 mark]

(ii) Write a balanced equation for the reaction.

[2 marks]

(c) Identify the condition at **III** that minimizes the time taken to produce a batch of ammonia from the starting materials. Give a reason for your answer.

[2 marks]

(d) Under what conditions would ammonia be held in the storage cylinders?

[2 marks]

(e) Describe a simple laboratory test that could be carried out at point X to test for a leak in a storage cylinder.

[1 mark]

Total 10 marks

SECTION B

Answer THREE questions from this section, ONE question from EACH module.

MODULE 1

Answer EITHER Question 4 OR Question 5.

4. In some chemical reactions, the reactants are not converted completely to products. Instead, an equilibrium system, comprising reactants and products, is formed. One such equilibrium system can be formed in the reaction between $SO_2(g)$ and $O_2(g)$, as shown in the equation below:

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g) \qquad \Delta H = -197 \text{ kJ mol}^{-1}$$

(a) Le Chatelier's principle can be used to predict how the position of an equilibrium may change in a system that is in dynamic equilibrium.

(i) State Le Chatelier's principle. **[2 marks]**

(ii) Give TWO characteristic features of a system in dynamic equilibrium. **[2 marks]**

(iii) Write an expression for the equilibrium constant, K_p, for the equilibrium system described above. **[1 mark]**

(iv) The equilibrium constant, K_p, for this reaction is 4.0×10^{19} Pa^{-1} at 25°C.

Use the value of K_p to comment on the position of equilibrium at 25°C and the relative equilibrium concentration of the reactants and products. **[2 marks]**

(b) Using Le Chatelier's principle, predict how the position of this equilibrium and hence the concentration of reactants and products may be affected by EACH of the following changes.

Explain EACH answer.

(i) The temperature is increased while the pressure is kept constant. **[3 marks]**

(ii) The pressure is increased while the temperature is kept constant. **[3 marks]**

(iii) Using a catalyst. **[2 marks]**

(c) When a 2:1 mixture of $SO_2(g)$ and $O_2(g)$ at a total initial pressure of 5 atm is passed over a catalyst at 425°C, the partial pressure of $SO_3(g)$ at equilibrium is found to be 3 atm.

Calculate the value of K_p. **[5 marks]**

Total 20 marks

5. Buffer solutions are used to provide suitable media for a variety of activities, ranging from those that are recreational to essential life processes. The underlying chemical principles, however, are the same.

(a) Define the term 'buffer solution'. **[2 marks]**

(b) Sodium hydrogen carbonate is often added to the water in swimming pools to act as a buffer.

(i) Suggest a reason for adding a buffer to the pool. **[1 mark]**

(ii) Use the following equation to explain how the aqueous hydrogen carbonate ion acts as a buffer.

$$HCO_3^-(aq) + H_2O(l) \rightleftharpoons H_3O^+(aq) + CO_3^{2-}(aq)$$ **[2 marks]**

(c) (i) Explain how the molecular structure of amino acids relates to their function as buffers in human blood. **[3 marks]**

(ii) State ONE industry in which buffers are used. **[1 mark]**

(d) A buffer solution is made by adding 6.56 g of sodium ethanoate, CH_3COONa, to 1 dm^3 of 0.02 M ethanoic acid, CH_3COOH.

(i) Calculate the concentration of the sodium ethanoate solution in mol dm^{-3}. **[2 marks]**

(ii) K_a for ethanoic acid is equal to 1.8×10^{-5} mol dm^{-3}.

Write the expression for K_a and use it to calculate the pH of the buffer solution. State any assumptions made in the calculation. **[5 marks]**

(e) 0.005 moles of solid sodium hydroxide are added to the buffer solution in part (d). Assuming that there is no change in volume:

(i) Find the new concentrations of the sodium ethanoate and ethanoic acid. **[2 marks]**

(ii) Comment on the pH of the new solution and explain your answer. **[2 marks]**

Total 20 marks

MODULE 2

Answer EITHER Question 6 OR Question 7.

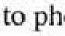
6. The chemistry of the Group IV elements reflects the gradual change in the nature of the elements down the group, and the variation in the properties of their compounds in the +2 and +4 states.

(a) Explain EACH of the following:

(i) The trend in the bonding and acid/base character of the oxides in the + 2 state **[6 marks]**

(ii) The trend in the behaviour of the tetrachlorides on reacting with water **[2 marks]**

(b) (i) A brown solid, J, when heated with concentrated sulphuric acid reacts to give a white solid, K, and a colourless, odourless gas, L, which relights a glowing splint. J reacts with aqueous manganese (II) nitrate in the presence of dilute nitric acid to give a purple solution, M. When dilute hydrochloric acid is added to solution M a white precipitate, O, is formed in the purple solution. O dissolves when the solution is heated and is reformed when the solution is cooled. Identify EACH of the substances, J to O, and state the nature of J. **[6 marks]**

(ii) When acidified potassium chromate (VI) is added to an aqueous chloride, P, it changes from orange to green. P can also be used to change nitrobenzene, $-NO_2$, to phenylamine, $-NH_2$. Identify P and explain its role in both reactions. **[4 marks]**

(iii) Suggest what would be observed when aqueous P reacts with aqueous iron (III) chloride. Explain your answer. **[2 marks]**

Total 20 marks

GO ON TO THE NEXT PAGE

7. Selected physical properties of FIVE inorganic substances are given in Table 1.

TABLE 1: PHYSICAL PROPERTIES OF SUBSTANCES A, TO E

Substance	**Melting point in °C**	**Conductivity**	**Reaction with water at 25°C**
A	2054	Conducts electricity in the molten state	Insoluble
B	101	Does not conduct	Insoluble
C	1410	Does not conduct	Insoluble
D	650	Conducts electricity in the solid state	Insoluble
E	162	Conducts electricity in aqueous solution	Hydrolysis

(i) Suggest the structure for EACH of A to E. **[5 marks]**

(ii) A to E may be a Period 3 element or its oxide or chloride. Suggest the identity of the substances, A to E. **[5 marks]**

(b) (i) Describe the reaction of EACH of the following substances with water:

a) Sodium

b) Magnesium

c) Chlorine **[8 marks]**

(ii) Write an equation for ONE of the reactions described in (b) (i) above. **[2 marks]**

Total 20 marks

MODULE 3

Answer EITHER Question 8 OR Question 9.

8. Synthetic polymeric materials have found widespread use globally and have contributed to difficulties with solid waste management worldwide. PVC, polyvinylchloride and PET, polyethyleneterapthalate (a polyester) are two organic synthetic polymers with varied applications. Methods of recycling these polymers have been developed to provide solutions to solid waste disposal problems.

(a) Give ONE use for EACH of these polymers and suggest why these polymers do not respond to natural degradative processes. **[4 marks]**

(b) Chemical methods of degradation have been developed to allow the waste polymer to be used as feedstock in the development of new materials, including fibres. The chemical process is often referred to as depolymerization.

(i) Suggest the meaning of the term 'depolymerization.' **[1 mark]**

(ii) State TWO chemicals that could be used in the depolymerization of PET and explain the chemical process occurring. **[5 marks]**

(c) In one fibre-producing process, collected PVC material is converted to fine chips and then dissolved in a solvent before conversion into extrusion fibres. The fibres are subsequently used in textile production.

(i) What would be a suitable solvent for this process? **[1 mark]**

(ii) Suggest a reason for the use of fine chips. **[1 mark]**

(iii) Give TWO safety precautions that should be enforced during this recycling process. **[2 marks]**

(iv) Suggest a use or property of any clothing produced from these recycled fibres. **[1 mark]**

(d) Attempts have been made to dispose of PVC material via incineration. Discuss the advantages and disadvantages of using this method of disposal. **[5 marks]**

Total 20 marks

9. (a) Crude oil is a raw material that has many uses in modern society. The two main processes in the initial refining of crude oil and the processing of the fractions are fractional distillation and cracking.

Briefly describe the principles involved in

(i) fractional distillation **[3 marks]**

(ii) cracking. **[2 marks]**

(b) Give a balanced equation to illustrate cracking. **[2 marks]**

(c) Explain the importance of EITHER fractional distillation OR cracking. **[1 mark]**

(d) Suggest ONE adverse effect associated with the extraction of crude oil and comment on the environmental problems that result. **[3 marks]**

(e) Emissions from vehicles contain carbon monoxide, carbon dioxide, nitrogen oxides, water vapour and lead compounds. Because of the health risks associated with the use of leaded petrol, increasing use is being made of unleaded petrol.

(i) State TWO reasons why the use of leaded petrol is hazardous to human health. **[2 marks]**

(ii) Account for the presence of carbon monoxide and nitrogen oxides in the exhaust gases of cars. Write a balanced equation for the formation of ONE oxide of nitrogen. **[5 marks]**

(iii) In order to minimize pollution levels in your country, it would be best to reduce the amount of carbon monoxide and nitrogen oxides in the exhaust fumes of cars. Suggest TWO means by which this may be achieved. **[2 marks]**

Total 20 marks

END OF TEST

TEST CODE **02112020**

FORM TP 2008167

MAY/JUNE 2008

CARIBBEAN EXAMINATIONS COUNCIL

ADVANCED PROFICIENCY EXAMINATION

CHEMISTRY

UNIT 1 – 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

FUNDAMENTALS IN CHEMISTRY

1. The manganate(VII) ion reacts in an acidic medium according to the following half equation:

$$MnO_4^-(aq) + 8H^+(aq) + 5e^- \rightarrow Mn^{2+}(aq) + 4H_2O.$$

(a) (i) Define reduction and oxidation **in terms of oxidation number.**

Reduction: ______________________________

Oxidation: ______________________________

[2 marks]

(ii) Identify the role played by the MnO_4^- ion in the redox reaction above and explain your answer **in terms of oxidation number.**

____

____

____

____

[2 marks]

(b) An aqueous solution of potassium iodide, KI, reacts with acidified MnO_4^- to form a red-brown solution on completion of the reaction.

(i) Identify the species responsible for the red-brown colour.

____

[1 mark]

(ii) Given that iodide ions react according to the following half equation,

$$2I^-(aq) \rightarrow I_2(aq) + 2e^-$$

deduce the balanced equation for the redox reaction between MnO_4^- and I^-.

____

____

____

____

____

[3 marks]

GO ON TO THE NEXT PAGE

(c) Compounds X and Y are tested for their reducing and/or oxidizing properties with MnO_4^-(aq) and I^-(aq) separately. The results are shown in Table 1.

TABLE 1: RESULTS OF TESTS ON COMPOUNDS X AND Y

	X	Y
MnO_4^-(aq)	(i) MnO_4^-(aq) decolourized	(i) MnO_4^-(aq) decolourized
I^-(aq)	(ii) Red-brown solution formed	No visible change

Categorise X and Y in terms of their oxidizing and reducing properties based on the above results.

X (i) : ______________________________

X (ii) : ______________________________

Y (i) : ______________________________

[2 marks]

(d) Complete the following table by filling in the missing observations or inferences.

Test	Observation	Inference
MnO_4^-(aq) is added to a solution containing Fe^{2+}(aq).	(i) • (ii) •	(i) • • Fe^{3+} ions produced
MnO_4^- (aq) is added to a solution containing SO_3^{2-} followed by $BaCl_2$(aq).	(iii) • • White precipitate forms on addition of $BaCl_2$(aq).	• MnO_4^- reduced to Mn^{2+} (iv) •

[5 marks]

Total 15 marks

GO ON TO THE NEXT PAGE

MODULE 2

KINETICS AND EQUILIBRIA

2. (a) Use the following electrochemical data to construct the labelled cell diagram for the combined half-cells.

$Cu^{2+} / Cu \quad E^{\theta} = +0.34\ V$
$Ag^{+} / Ag \quad E^{\theta} = +0.80\ V$

[4 marks]

(b) Write the relevant half-equations for the change taking place at the

(i) anode

____

____

[1 mark]

(ii) cathode.

____

____

[1 mark]

(c) Write the equation for the overall cell reaction.

____

____

[1 mark]

(d) (i) State at which electrode reduction takes place in the above electrochemical cell.

____

[1 mark]

(ii) Give ONE reason for your answer to (d) (i).

____

____

____

[1 mark]

(e) Calculate the cell potential.

[1 mark]

(f) (i) Describe THREE changes you would **observe** if you substituted a zinc half-cell for the Ag half-cell in your cell diagram in (a) on page 4.

$Zn^{2+}/Zn \quad E^{\theta} = -0.76$ V

____

____

____

____

[3 marks]

(ii) Suggest ONE reason for the changes observed in (f) (i) above.

____

____

[1 mark]

(iii) Identify an electrolyte that could be used in the zinc half-cell.

____

[1 mark]

Total 15 marks

MODULE 3

CHEMISTRY OF THE ELEMENTS

3. (a) (i) Both Al^{3+} and Pb^{2+} give the same results on addition of NaOH(aq) and NH_3(aq). Complete Table 2 by filling in the observations.

TABLE 2: TESTS FOR Al^{3+} AND Pb^{2+}

Test	Observation
NaOH(aq) is added gradually until in excess.	
NH_3(aq) is added gradually until in excess.	

[2 marks]

(ii) Describe a test that could be carried out to distinguish between Al^{3+} and Pb^{2+} ions.

Reagent: ______________________________

Observation: ______________________________

Inference: ______________________________

[3 marks]

(b) An accident occurs at a chemical plant that results in a chemical spill. The team of chemists recruited to do the clean-up takes a sample of the spill for analysis.

The results of the analysis are as follows:

A	–	No characteristic colour change is observed on subjecting the sample to a flame test.
B	–	No precipitate is obtained on treatment with $AgNO_3$(aq).
C	–	The pH of the sample is found to be 1.2.
D	–	The addition of acidified barium chloride results in the formation of a white precipitate.

(i) What deduction can be made about the sample, based on the observation in A?

[**1 mark**]

(ii) What does the result in B indicate about the sample?

[**1 mark**]

(iii) Based on the result in C, what type of compound is present in the sample analysed?

[**1 mark**]

(iv) Identify the anion present in the sample.

[**1 mark**]

(v) Suggest the identity of the chemical in the spill as indicated by the results of the analysis.

[**1 mark**]

(c) (i) Identify the products, A and B, in the reaction scheme below.

$$\begin{tikzcd} Cu^{2+}(aq) \arrow[r, "NaOH"] \arrow[d, "Excess\ NH_3(aq)"'] & A \\ B & \end{tikzcd}$$

A: ______________________________

B: ______________________________

[2 marks]

(ii) Write the ionic equation for the formation of B.

[2 marks]

(iii) Name the type of reaction illustrated in the conversion of Cu^{2+} (aq) to B in the reaction scheme in (c) (i) above.

____

[1 mark]

Total 15 marks

GO ON TO THE NEXT PAGE

SECTION B

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

MODULE 1

FUNDAMENTALS IN CHEMISTRY

4. (a) The foul odour of dirty socks may be attributed to caproic acid, an organic acid made of carbon, hydrogen and oxygen. The results of combustion of a 0.450 g sample of caproic acid indicate that it contains 0.279 g of C, 0.0467 g of H, and 0.124 g of O.

(i) Distinguish between 'empirical formula' and 'molecular formula,' using suitable examples. **[3 marks]**

(ii) Calculate the empirical formula and the molecular formula of caproic acid, given that its molar mass is 116 g mol^{-1}. **[6 marks]**

(b) In the standardization of sulphuric acid with anhydrous sodium carbonate, a 1.49 g sample of sodium carbonate is dissolved in distilled water to make 250 cm^3 of solution. Three 25.0 cm^3 portions of this solution are pipetted and titrated against a solution of sulphuric acid of unknown concentration using screened methyl orange as the indicator. The average volume of sulphuric acid used for the titration is found to be 24.65 cm^3.

(i) Give THREE precautions that should be taken to ensure that the sodium carbonate, used as a standard in the above titration, is of accurate concentration. **[3 marks]**

(ii) Calculate the number of moles of sodium carbonate used for each titration, if the concentration of the stock solution is 5.65×10^{-2} mol dm^{-3}. **[1 mark]**

(iii) Calculate the accurate concentration of the standardized sulphuric acid in mol dm^{-3}. **[2 marks]**

Total 15 marks

MODULE 2

KINETICS AND EQUILIBRIA

5. The element calcium forms a number of sparingly soluble salts such as $CaCO_3$ found in limestone and CaC_2O_4 found in kidney stones.

(a) (i) Write the equilibrium constant expression for the dissociation of calcium carbonate in an aqueous solution. [2 marks]

(ii) Write an expression for the solubility product of $CaCO_3$ and explain its significance as it relates to sparingly soluble salts. [2 marks]

(b) A saturated solution of $CaCO_3$, at 25°C, is found to contain Ca^{2+} ions at a concentration of 6.7×10^{-5} mol dm^{-3}.

(i) Calculate K_{sp} (25°C) for $CaCO_3$. [3 marks]

(ii) Describe the effect of adding $Ca(NO_3)_2$ and KNO_3 to separate samples of the saturated solution of $CaCO_3$. [2 marks]

(c) Kidney stones generally consist of partially soluble salts of calcium such as calcium oxalate, CaC_2O_4. Foods rich in oxalate such as chocolate, spinach or celery can trigger the onset of kidney stones.

(i) Write an equation for the formation of calcium oxalate. [2 marks]

(ii) Explain the common ion effect and how it relates to the formation of kidney stones from a diet rich in oxalate, $C_2O_4^{2-}$. [2 marks]

(d) What is meant by 'Le Chatelier's principle'? [2 marks]

Total 15 marks

MODULE 3

CHEMISTRY OF THE ELEMENTS

6. NaX is a sodium halide which gives the following results on testing:

   - Bubbling Cl_2 into an aqueous solution of NaX gives a red-brown solution. On addition of starch a blue-black colour forms.
   - Addition of $AgNO_3$ to NaX(aq) gives a yellow precipitate which is insoluble in aqueous ammonia.

(a) Identify Element X and explain the reaction taking place in EACH of the tests above. Include balanced equations in your explanations. **[5 marks]**

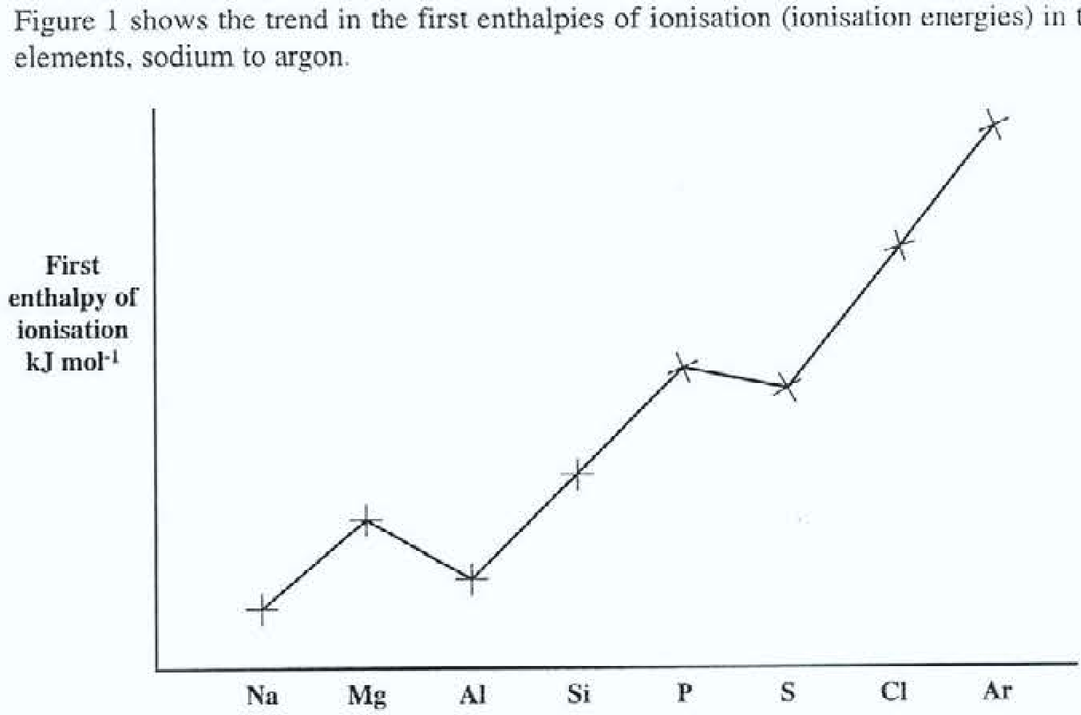
(b) Consider the halogens Cl_2, Br_2 and I_2.

(i) State the trend in their colour intensity. **[1 mark]**

(ii) a) State the trend in volatility of the elements.

b) Account for this trend in volatility, in terms of atomic size and inter-molecular bonding. **[3 marks]**

(c) Figure 1 shows the trend in the first enthalpies of ionisation (ionisation energies) in the elements, sodium to argon.



(i) State the general trend in the first enthalpies of ionisation for the elements Na to Ar as shown in Figure 1. **[1 mark]**

(ii) Explain the differences observed in the first enthalpies of ionisation of the following pairs of elements:

a) Mg and Al

b) P and S

[2 marks]

(iii) Suggest TWO OTHER pairs of elements which should exhibit differences in their first enthalpies of ionisation as those elements given in (c) (ii) above.

[2 marks]

(iv) Describe the relationship between atomic radius and first enthalpy of ionisation.

[1 mark]

Total 15 marks

END OF TEST

FORM TP 2008167

CARIBBEAN EXAMINATIONS COUNCIL

ADVANCED PROFICIENCY EXAMINATION

CHEMISTRY

UNIT 1 – PAPER 02

2 hours 30 minutes

READ THE FOLLOWING INSTRUCTIONS CAREFULLY.

1. This paper consists of SIX **compulsory** questions in TWO sections.
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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

FUNDAMENTALS IN CHEMISTRY

1. (a) (i) Define the term 'standard enthalpy of formation', ΔH_f^θ.

____

____

____

[2 marks]

(ii) The enthalpy of formation of both carbon monoxide and aluminium oxide cannot be determined directly by experimental means.

Suggest ONE reason in EACH case for the above observation.

CO : ____

____

Al_2O_3: ____

____

[2 marks]

(b) Figure 1 shows the energy level diagram for determining the enthalpy of solution of KBr.

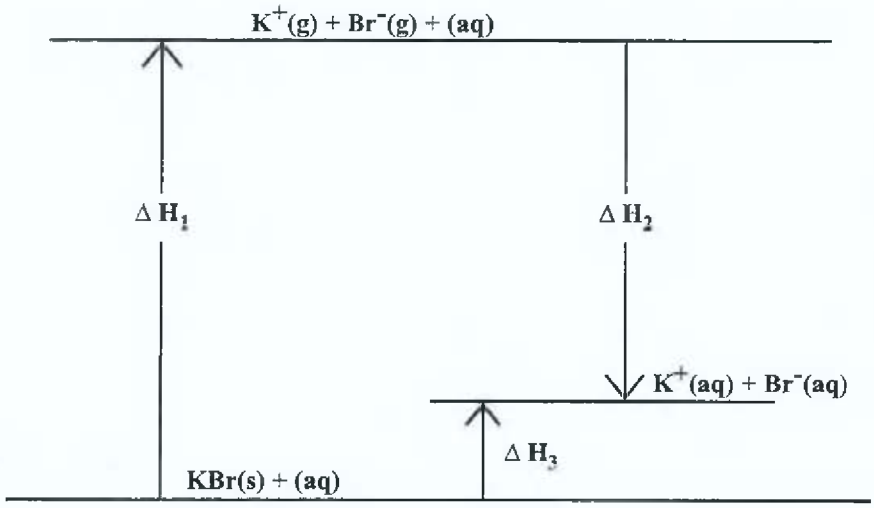


Figure 1. Energy level diagram for determining the enthalpy of solution of KBr

GO ON TO THE NEXT PAGE

(i) Write the enthalpy change represented by ΔH_1, ΔH_2 and ΔH_3 in Figure 1.

ΔH_1 : ______________________________

ΔH_2 : ______________________________

ΔH_3 : ______________________________

[3 marks]

(ii) Calculate the enthalpy of solution for KBr, given the following information.

$\Delta H_1 = +\ 672\ kJ\ mol^{-1}$ $\Delta H_2 = -\ 656\ kJ\ mol^{-1}$

[3 marks]

(c) Table 1 provides data comparing the theoretical and experimental (Born-Haber) lattice energies of the halides of elements, X and Y.

TABLE 1: THEORETICAL AND EXPERIMENTAL LATTICE ENERGIES

Compound	**Theoretical lattice energy/kJ mol^{-1}**	**Experimental lattice energy / kJ mol^{-1}**
XCl	– 766	– 776
XBr	– 731	– 742
XI	– 686	– 699
YCl	– 768	– 890
YBr	– 759	– 877
YI	– 736	– 867

What kind of bonding is present in

(i) halides of X?

____

(ii) halides of Y?

____

[2 marks]

GO ON TO THE NEXT PAGE

(d) A student was required to design the method to be followed in determining the enthalpy of neutralisation of hydrochloric acid and sodium hydroxide.

Below is a reproduction of the student's method.

> Measure 25 cm^3 of hydrochloric acid (1M) into a plastic cup using a measuring cylinder.
> Measure the temperature of the acid.
> Transfer 35 cm^3 of sodium hydroxide (1M) into the plastic cup containing the hydrochloric acid. Stir gently with the thermometer and note the resulting temperature of the mixture.

Identify THREE errors in the above method.

(i) ____

____

(ii) ____

____

(iii) ____

____

[3 marks]

Total 15 marks

NOTHING HAS BEEN OMITTED

MODULE 2

KINETICS AND EQUILIBRIA

2. In order to determine the effect of concentration on reaction rates the reaction between butyl chloride (C_4H_9Cl) and water is investigated.

$$C_4H_9Cl\ (aq) + H_2O\ (l) \rightarrow C_4H_9OH\ (aq) + HCl\ (aq)$$

A 0.100 mol dm^{-3} aqueous solution of butyl chloride is reacted with water and the concentration measured at various time intervals to produce the results in Table 2.

TABLE 2: RESULTS OF REACTION OF BUTYL CHLORIDE WITH WATER

Time, t (s)	$[C_4H_9Cl]$ (mol dm^{-3})	Reaction rate (mol dm^{-3} s^{-1})
0.0	0.100	—
50.0	0.090	1.91×10^{-4}
100.0	0.081	1.70×10^{-4}
150.0	0.074	1.59×10^{-4}
200.0	0.067	1.41×10^{-4}
300.0	0.055	1.22×10^{-4}
500.0	0.037	0.801×10^{-4}
600.0	0.030	0.620×10^{-4}
800.0	0.020	0.561×10^{-4}

(a) On the grid provided on page 7, plot a graph of the concentration of butyl chloride, $[C_4H_9Cl]$ on the y -axis against time in seconds, on the x -axis. **[4 marks]**

(b) Using your graph, estimate the concentration of butyl chloride at t = 400 s.

____

[1 mark]

(c) In addition to concentration, catalysts and temperature also affect reaction rates.

Using suitable well-labelled diagrams, explain how EACH of the following affects reaction rates:

(i) Catalysts

[4 marks]

(ii) Temperature

[4 marks]

(d) Name TWO industrial processes in which catalysts are used.

[2 marks]

Total 15 marks

GO ON TO THE NEXT PAGE

MODULE 3

CHEMISTRY OF THE ELEMENTS

3. (a) (i) Insert arrows in EACH of the boxes in Figure 2 to show the electronic configuration of the species.

		3d					4s
Fe^{2+}	(Ar)						
Mn^{2+}	(Ar)						
Cr	(Ar)						
Cu	(Ar)						
Zn^{2+}	(Ar)						

Figure 2. Electronic configuration of different species

(5 marks)

(ii) Explain EACH of the following statements in terms of electronic configurations.

a) Fe^{2+} ions are readily oxidized to Fe^{3+} ions.

____

____

b) Mn^{2+} ions are NOT readily oxidized to Mn^{3+} ions.

____

____

____

c) Zn is NOT considered to be a transition element.

____

____

[3 marks]

(b) Figure 3 refers to the following reaction scheme.

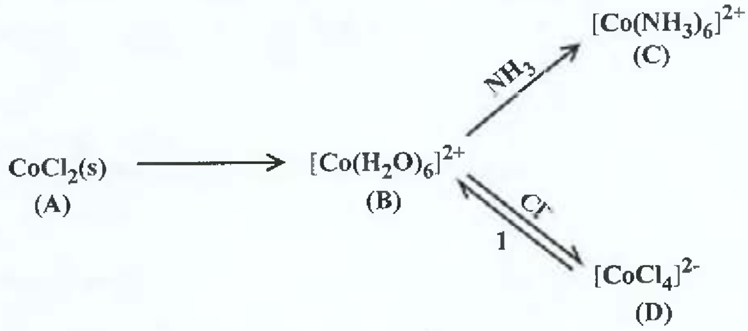


Figure 3. Reaction scheme

(i) Complete the table below by writing the colour of the species labelled A, B, C and D.

Species	A	B	C	D
Colour				

[4 marks]

(ii) State the reagent used for the conversion in Reaction 1 (D $\rightarrow$ B).

[1 mark]

(c) Iron forms a complex ion with cyanide ions (CN^-). The formula of the complex is

$[Fe(CN)_6]^{4-}$.

Explain how an aqueous solution of iron(II) sulphate functions as an antidote for cyanide poisoning.

[2 marks]

Total 15 marks

GO ON TO THE NEXT PAGE

SECTION B

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

MODULE 1

FUNDAMENTALS IN CHEMISTRY

4. (a) List THREE assumptions made about gas molecules in the kinetic theory. **[3 marks]**

(b) The ideal gas equation is

$$PV = nRT.$$

(i) State the TWO conditions under which the ideal gas equation adequately describes the behaviour of gases. **[2 marks]**

(ii) Carefully explain the deviations produced by real gases. **[3 marks]**

(c) Sketch a graph of volume (V) against the inverse of pressure (1/P) for a constant number of moles of an ideal gas at constant temperature. **[1 mark]**

(d) (i) An organic compound, Y, contains carbon, hydrogen and oxygen only. When vapourised at 101 kPa and 373 K, 1.00 g of Y occupies a volume of 667 cm^3.

Calculate the mass in grams of 1 mole of Y.
(Gas constant, $R = 8.314\ J\ K^{-1}\ mol^{-1}$).

[4 marks]

(ii) On combustion in excess oxygen, 1 mole of Y produces carbon dioxide and water in the mole ratio 2:3. Deduce the formula of Y. **[2 marks]**

Total 15 marks

MODULE 2

KINETICS AND EQUILIBRIA

5. Buffer solutions are prepared by mixing a weak acid or a weak base with a salt of that acid or base. A buffer solution is prepared using 0.14 mol dm^{-3} lactic acid ($HC_3H_5O_3$) and 0.12 mol dm^{-3} sodium lactate ($NaC_3H_5O_3$). $K_a = 1.4 \times 10^{-4}$ for lactic acid.

$$HC_3H_5O_3(aq) + H_2O(l) \rightleftharpoons H_3O^+(aq) + C_3H_5O_3^-(aq)$$

(a) With reference to the Bronsted-Lowry theory, explain EACH of the following:

(i) Weak acid

(ii) Strong acid **[2 marks]**

(b) Describe the significance of pH ($-\log [H^+]$) and K_a (acid dissociation constant) values. **[2 marks]**

(c) Calculate the pH of the $HC_3H_5O_3$ / $C_3H_5O_3^-$ buffer solution. **[4 marks]**

(d) With the aid of balanced equations, explain how the $HC_3H_5O_3$ / $C_3H_5O_3^-$ buffer works in maintaining its pH. **[6 marks]**

(e) When preparing a buffer solution of a specific pH, state ONE consideration to be taken into account in selecting a suitable weak acid. **[1 mark]**

Total 15 marks

MODULE 3

CHEMISTRY OF THE ELEMENTS

6. (a) Table 3 gives the atomic radii and melting points of the elements in Period 3.

TABLE 3: SOME PROPERTIES OF ELEMENTS IN PERIOD 3

	Na	**Mg**	**Al**	**Si**	**P**	**S**	**Cl**
Atomic radius / nm	0.157	0.136	0.125	0.117	0.110	0.104	0.099
Melting point / °C	98	651	660	1410	44	114	−101

(i) State and account for the trend in the values of the atomic radii across the period from Na to Cl. **[4 marks]**

(ii) The trend in the melting points of the elements in Table 3 is related to structure and bonding.

Describe the trend in the structure of the elements, and the trend in the bonding of the elements in Table 3. **[5 marks]**

(b) (i) Compare the reaction of the Group II elements, Be and Ca, with water. **[2 marks]**

(ii) Describe what happens when barium is treated with water and write the equation for the reaction. **[3 marks]**

(c) State ONE use of calcium carbonate. **[1 mark]**

Total 15 marks

END OF TEST

TEST CODE **22212020**

FORM TP 2008169

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 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.
Write your answers in the spaces provided in this booklet.

MODULE 1

THE CHEMISTRY OF CARBON COMPOUNDS

1. (a) Figure 1 shows the formation of compounds derived from benzene.

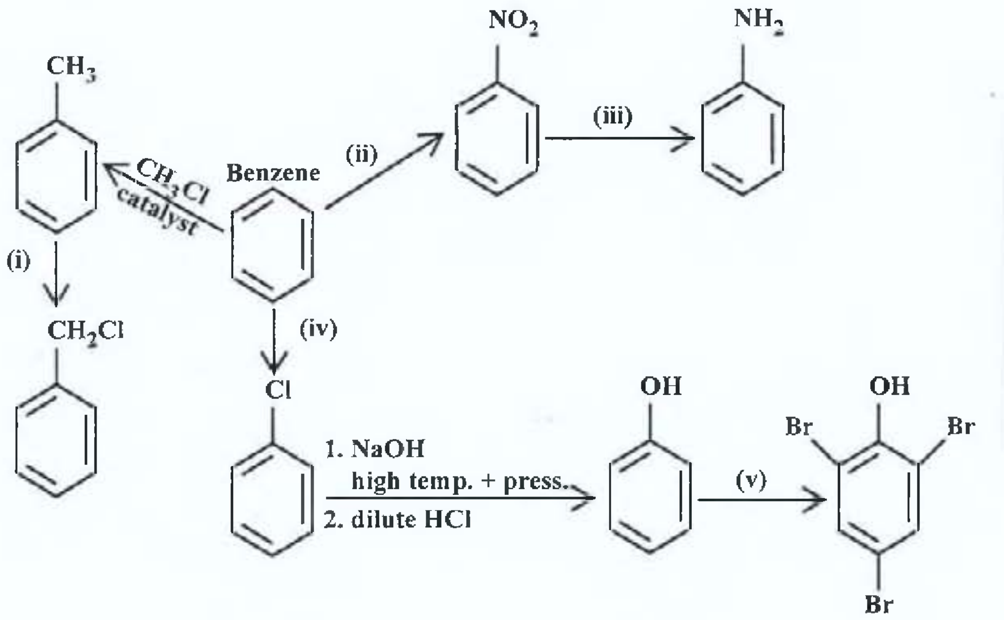


Figure 1. Compounds derived from benzene

Suggest reagents to be used in EACH of the transformations, (i), (ii), (iii), (iv) and (v).

(i) ____________________

(ii) ____________________

(iii) ____________________

(iv) ____________________

(v) ____________________

[5 marks]

GO ON TO THE NEXT PAGE

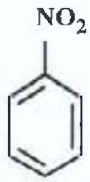
(b) Draw structures for the monosubstituted products formed from the reaction of chlorine with EACH of the following:

(i) 

Benzene

(ii) 

Methylbenzene

(iii) 

Nitrobenzene

[4 marks]

(c) Suggest a reason for the position of the chlorine on the benzene ring in EACH of the products drawn in (b) above.

(i) ____

____

(ii) ____

____

(iii) ____

____

[3 marks]

(d) List the compounds, benzene, methylbenzene and nitrobenzene, in order of increasing ease of reactivity with chlorine (**least** reactive first), and explain your answer.

Order:

____

Explanation:

____

____

____

____

____

[3 marks]

Total 15 marks

MODULE 2

ANALYTICAL METHODS AND SEPARATION TECHNIQUES

2. (a) Sodium hydrogen carbonate ($NaHCO_3$) is sometimes used as a primary standard, yet its molecular mass is only 84 g mol^{-1}.

State THREE reasons why $NaHCO_3$ can be used as a primary standard and ONE reason why sodium hydroxide (NaOH) may NOT be used.

$NaHCO_3$:

____

____

____

NaOH:

____

[4 marks]

(b) A student standardized a solution of sulphuric acid, using sodium hydrogen carbonate as the primary standard, and found the concentration of the acid to be 6.00 mol dm^{-3}.

(i) Write the balanced equation for the reaction between sodium hydrogen carbonate and sulphuric acid.

____

[2 marks]

(ii) Calculate the mass in grams of sodium hydrogen carbonate that the student used to neutralise the acid if 23.00 cm^3 of the acid were used from the burette.

Show all your working.

____

____

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____

[4 marks]

(c) In order to determine the ethanoic acid content of vinegar, a sample of vinegar was titrated using sodium hydroxide solution.

Outline FIVE experimental steps to be carried out in the determination of the ethanoic acid content of the vinegar.

[5 marks]

Total 15 marks

MODULE 3

INDUSTRY AND THE ENVIRONMENT

3. (a) Human activity is greatly responsible for the introduction of harmful substances into the water cycle.

(i) List THREE human activities, OTHER THAN agricultural, which lead to water pollution.

[3 marks]

(ii) State TWO effects of water pollution.

[2 marks]

(b) (i) Suggest TWO reasons why farmers need to use chemical fertilisers in crop production.

[2 marks]

(ii) Explain how fertilisers cause water pollution.

[2 marks]

(c) Describe a simple laboratory test that would confirm the presence of EACH of Pb^{2+} and NO_3^- ions in a sample of water.

Pb^{2+} :

NO_3^- :

[6 marks]

Total 15 marks

SECTION B

Answer ALL questions.

Write your answers in the answer booklet provided.

MODULE 1

THE CHEMISTRY OF CARBON COMPOUNDS

4. (a) Phenols, alcohols and carboxylic acids all contain hydrogen in their structure but they exhibit different acidities. To illustrate these differences their reactivity with sodium and its compounds, sodium hydroxide (NaOH) and sodium carbonate (Na_2CO_3) may be compared.

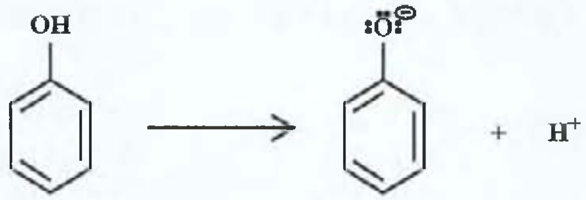
Copy Table 1 in your answer booklet. Predict the outcome of the following reactions by completing Table 1 in your answer booklet.

TABLE 1: REACTIONS OF ETHANOL, PHENOL AND ETHANOIC ACID

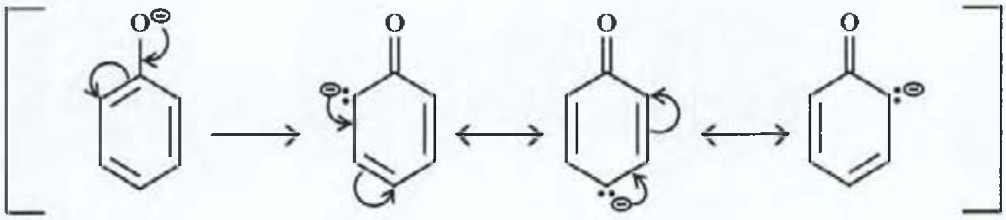
	Na_2CO_3	Na	NaOH
Ethanol		sodium ethoxide and hydrogen	
Phenol			sodium phenoxide and water
Ethanoic acid	sodium ethanoate, carbon dioxide and water		

[6 marks]

(b) The loss of a proton by phenol results in the formation of the phenoxide ion.



The phenoxide ion is stabilised via resonance as shown below.



The alkoxide ion is formed from the loss of a proton by an alcohol.

(R = alkyl group)

With reference to the Lewis structure and resonance forms of the phenoxide ion and the Lewis structure of the alkoxide ion, compare and explain the difference in acidity between alcohols and phenols. **[4 marks]**

(c) Give TWO characteristics of a homologous series. **[2 marks]**

(d) (i) What is meant by the term 'structural isomerism'? **[1 mark]**

(ii) Using the molecular formula, C_3H_8O, draw the displayed formulae of TWO structural isomers. **[2 marks]**

Total 15 marks

MODULE 2

ANALYTICAL METHODS AND SEPARATION TECHNIQUES

5. (a) Figure 2 is a drawing of a mass spectrometer.

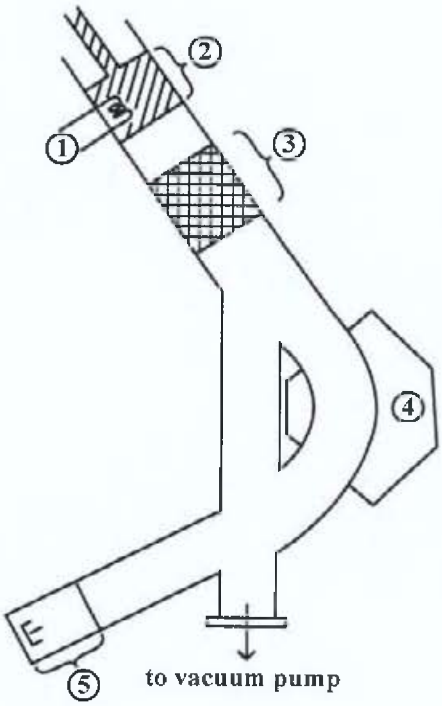


Figure 2. Mass spectrometer

(i) Identify the parts of the mass spectrometer numbered 2, 3, 4 and 5 in Figure 2. **[4 marks]**

(ii) What is the purpose of the heated filament, 1? **[2 marks]**

(b) The mass spectrum of an element allows for the identification and determination of the relative abundance of each isotope.

Data from the mass spectrum of the halogen, bromine, atomic number 35 are provided below.

Mass number of isotope	79	81
% relative abundance	50.5	49.5

Calculate to 3 significant figures the relative atomic mass of bromine. **[2 marks]**

GO ON TO THE NEXT PAGE

(c) (i) Copy Figure 3 in your answer booklet. Sketch, in your answer booklet, the spectrum of bromine vapour in the m/e region indicated in Figure 3.

[4 marks]

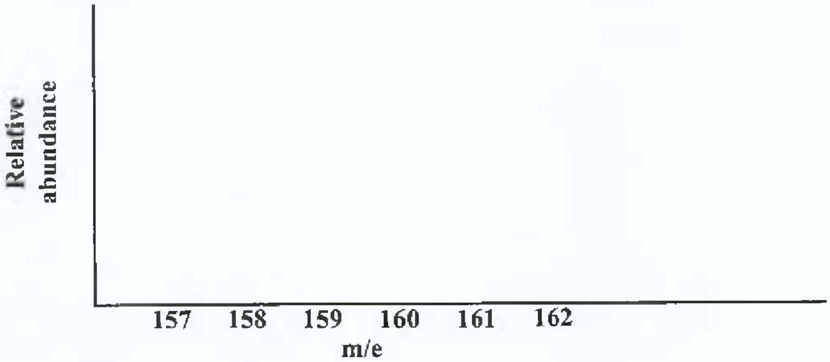


Figure 3. Mass spectrum

(ii) What is the origin of EACH of the THREE peaks in your spectrum?

[3 marks]

Total 15 marks

MODULE 3

INDUSTRY AND THE ENVIRONMENT

6. (a) Name TWO substances which can be fermented to produce alcohol. **[2 marks]**

(b) Outline, using relevant equations, the process by which sucrose is converted to ethanol. **[4 marks]**

(c) The harmful effects of alcohol are due to its oxidation to ethanal. Write an equation for the oxidation of alcohol (ethanol) to ethanal. **[2 marks]**

(d) Identify TWO physiological changes in the body which result from the abuse of alcohol consumption. **[2 marks]**

(e) (i) Outline THREE economic benefits of ethanol (alcohol) production.

[3 marks]

(ii) Suggest TWO measures that can be used to reduce the negative social effects of alcohol abuse. **[2 marks]**

Total 15 marks

END OF TEST

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

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

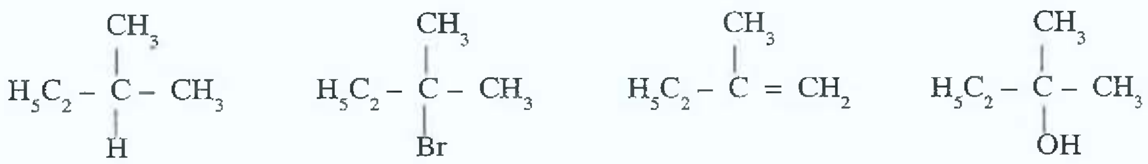
SECTION A

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 diffferent 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]

(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 $K_2Cr_2O_7/H^+$.

TABLE 2

	Reaction with $K_2Cr_2O_7$	
	Observation	**Expected product (if any)**
Primary alcohol	Colour change from orange to green	
Secondary alcohol		
Tertiary alcohol		

[4 marks]

Total 15 marks

GO ON TO THE NEXT PAGE

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:

____

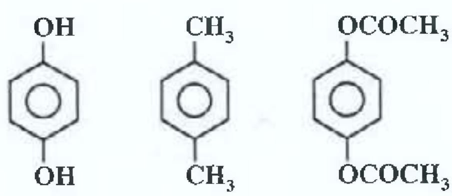
____

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).



X Y Z

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

a) Mobile phase

____

____

[1 mark]

b) Stationary phase

____

____

[1 mark]

GO ON TO THE NEXT PAGE

(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.

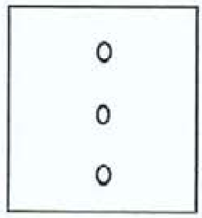


Figure 1

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

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]

GO ON TO THE NEXT PAGE

(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

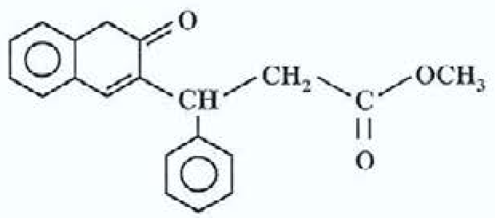
Answer ALL questions in this section.

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

GO ON TO THE NEXT PAGE

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

FORM TP 2009156

TEST CODE **02112020**

MAY/JUNE 2009

CARIBBEAN EXAMINATIONS COUNCIL

ADVANCED PROFICIENCY EXAMINATION

CHEMISTRY

UNIT 1 – PAPER 02

2 hours 30 minutes

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SECTION A

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

MODULE 1

FUNDAMENTALS IN CHEMISTRY

1. (a) Each element has a characteristic 'fingerprint' line emission spectrum. Niels Bohr, in 1913, proposed an explanation for the emission spectrum of the elements.

(i) State the property of elements which is responsible for the characteristic line spectrum of each element.

____

[1 mark]

(ii) Sketch a diagram of the line emission spectrum of hydrogen. On your diagram, indicate the direction of **increasing** frequency and **increasing** wavelength.

[3 marks]

(iii) Explain, in terms of electronic transitions, the origin of the lines in the Balmer series.

____

____

____

____

____

____

[4 marks]

GO ON TO THE NEXT PAGE

(iv) State the region of the electromagnetic spectrum in which the lines in the Balmer series occur.

____

[1 mark]

(v) Calculate the energy (E) of a quantum of radiation with a corresponding frequency (v) of 4.57×10^{14} Hz. ($h = 4 \times 10^{-13}$ kJ s mol^{-1})

____

____

____

____

____

[2 marks]

(b) Figure 1 represents the apparatus assembled by a student for the experimental determination of the heat of combustion of ethanol.

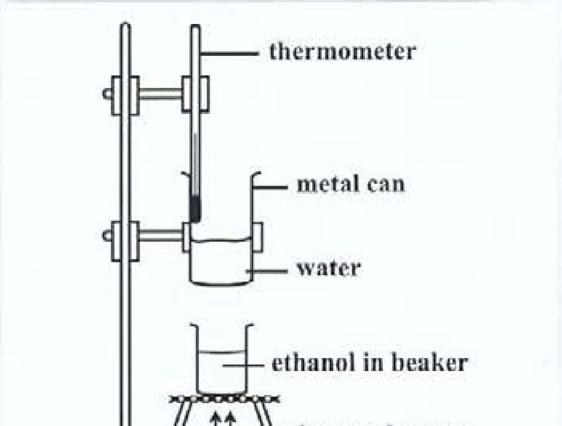


Figure 1. Student's apparatus for determination of heat of combustion of ethanol

Identify FOUR errors in the assembly of the apparatus in Figure 1.

____

____

____

____

[4 marks]

Total 15 marks

MODULE 2

KINETICS AND EQUILIBRIA

2. (a) State TWO factors which affect reaction rates.

____

____

[2 marks]

(b) The data in Table 1 were obtained for the decomposition of nitrogen dioxide at 673 K.

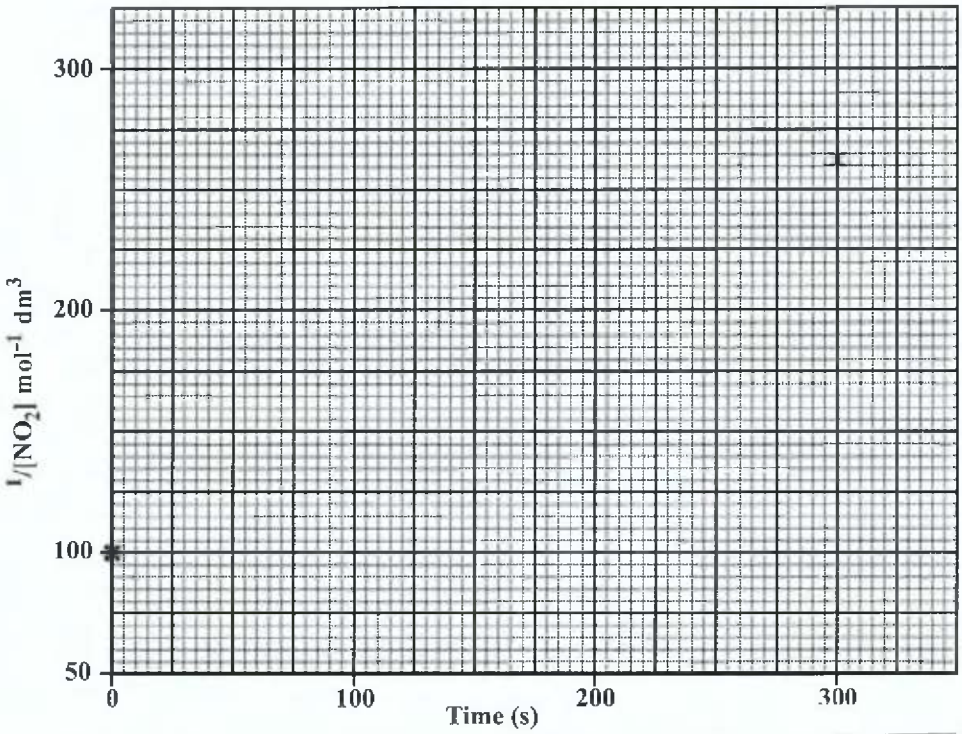
$$NO_2\,(g) \rightarrow NO\,(g) + \tfrac{1}{2}\,O_2\,(g)$$

TABLE 1 : DECOMPOSITION OF NITROGEN DIOXIDE

Time (s)	$[NO_2]$ mol dm^{-3}	$\frac{1}{[NO_2]}$ mol^{-1} dm^3
0.0	0.0100	100
50.0	0.00787	____
100.0	0.00649	154
200.0	0.00481	____
300.0	0.00380	263

(i) Complete Table 1 by writing the missing values for $\frac{1}{[NO_2]}$. **[2 marks]**

(ii) Plot a graph of $\frac{1}{[NO_2]}$ against time, on the grid below. The first and last points have been plotted on the grid.



[2 marks]

(iii) From your graph, determine the order of the reaction with respect to NO_2. Give a reason for your answer.

Order of reaction:

____

Reason:

____

[2 marks]

(iv) State the rate law for the reaction.

____

[1 mark]

(v) Use the slope of the graph to determine the value and units of the rate constant, k, for the reaction.

____

[2 marks]

(c) Several experimental methods, including titrimetry, can be used to determine reaction rates. Suggest TWO OTHER methods which can be used to determine reaction rates.

[2 marks]

(d) Outline TWO experimental steps in the determination of the reaction rate of an esterification reaction using titrimetry.

[2 marks]

Total 15 marks

MODULE 3

CHEMISTRY OF THE ELEMENTS

3. (a) Insert arrows in the relevant boxes in Figure 2 to show the electronic configuration of the species. **[5 marks]**

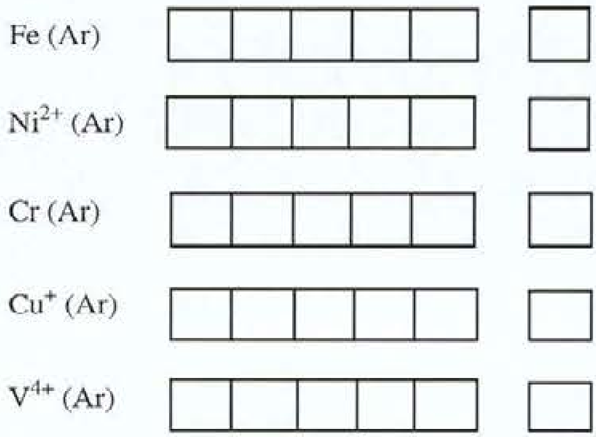


Figure 2. Electronic configuration of different species

(b) Use the distribution in the d-orbitals to account for colour in transition metal ions.

____

____

____

____

[2 marks]

(c) Account for the observation that Zn^{2+} compounds are normally colourless.

____

____

____

[2 marks]

(d) Figure 3 refers to the following reaction scheme.

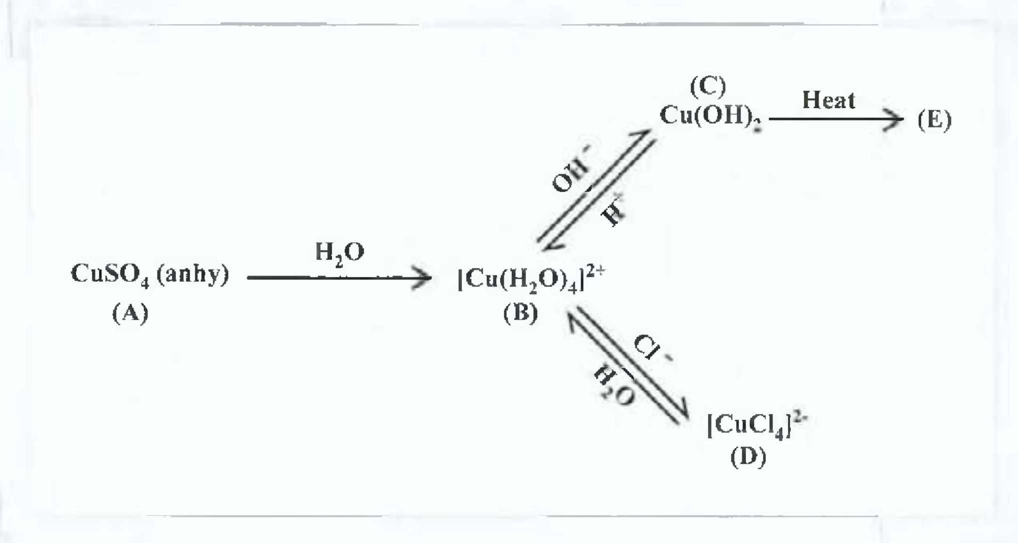


Figure 3. Reaction scheme

(i) Complete the table below by writing the colour of the species labelled A, B, C, D and E in Figure 3.

Species	A	B	C	D	E
Colour					

[5 marks]

(ii) Write the formula of Species E.

____

[1 mark]

Total 15 marks

GO ON TO THE NEXT PAGE

SECTION B

Answer ALL questions in this section.

Write your answers in the answer booklet provided.

MODULE 1

FUNDAMENTALS IN CHEMISTRY

4. Valence Shell Electron Pair Repulsion (VSEPR) theory is normally used to predict the shapes and bond angles of simple molecules and ions.

(a) State the basic principle behind the VSEPR theory. **[1 mark]**

(b) When hydrochloric acid reacts with water and ammonia the corresponding hydroxonium and ammonium ions are formed.

(i) Using the VSEPR theory, state the shapes of the hydroxonium (H_3O^+) and ammonium (NH_4^+) ions. **[2 marks]**

(ii) Using suitable diagrams, illustrate the shape of EACH ion in (b) (i). **[2 marks]**

(iii) Account for the shape of EACH of the species, H_3O^+ and NH_4^+. **[4 marks]**

(c) Suggest an explanation for EACH of the following observations:

(i) The experimental determination of the relative molecular mass of ethanoic acid (CH_3CO_2H) produces a value of 120 g. Your answer should include a suitable diagram. **[4 marks]**

(ii) The boiling point of propanone (acetone) is greater than the boiling point of butane. **[2 marks]**

Total 15 marks

MODULE 2

KINETICS AND EQUILIBRIA

5. The following equation represents a step in the Contact Process for the manufacture of sulphuric acid.

Equation 1: $2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$; $\Delta H = -196 \text{ kJ mol}^{-1}$

(a) State Le Chatelier's Principle. **[2 marks]**

(b) State the effect of EACH of the following on the equilibrium position of the reaction in Equation 1:

(i) An increase in pressure

(ii) An increase in temperature **[2 marks]**

(c) (i) When SO_2 and O_2 are mixed in a 2 : 1 ratio at 303 K the total equilibrium pressure of the system is 101.3 kPa.

Calculate K_p at 303 K for the reaction in Equation 1, if at equilibrium the number of moles of SO_2, O_2 and SO_3 are 1.2, 0.6 and 0.8 respectively. **[4 marks]**

(ii) Comment on the value for K_p at **695 K** for the reaction in Equation 1. **[1 mark]**

(d) Consider the following equation for a reversible reaction.

Equation 2: $H_2S + H_2O \rightleftharpoons H_3O^+ + HS^-$; $K_a = 8.9 \times 10^{-8}$

(i) Define the term 'Brönsted - Lowry base'. **[1 mark]**

(ii) Identify TWO bases in Equation 2. **[2 marks]**

(e) Calculate the pH of a 0.05 mol dm^{-3} solution of $Ba(OH)_2$. **[3 marks]**

Total 15 marks

MODULE 3

CHEMISTRY OF THE ELEMENTS

6. (a) Define the term 'electronegativity'. **[1 mark]**

(b) Consider the **chlorides** of the elements in Period 3 of the periodic table, and answer the following questions:

(i) Describe the structures of the chlorides. **[2 marks]**

(ii) Describe the differences in the pH of the solutions formed when the chlorides react with water. **[2 marks]**

(iii) Write the equation for the reaction of silicon(IV) chloride and water. **[2 marks]**

(c) Chlorine forms a colourless solution, P, when dissolved in cold sodium hydroxide. This reaction, which is represented by the reaction below, is referred to as a disproportionation.

$$Cl_2(g) + 2OH^-(aq) \underset{H^+}{\overset{OH^-}{\rightleftharpoons}} Cl^-(aq) + ClO^-(aq) + H_2O(l)$$

(i) What is meant by the term 'disproportionation'? **[1 mark]**

(ii) A suspension is formed when excess silver ions (Ag^+) are added to Solution P. On filtering the suspension and heating the filtrate a white precipitate is formed.

Given the fact that the filtrate contains both Ag^+ and ClO^- ions, account for the presence of the white precipitate on heating. **[2 marks]**

(d) A simple salt, S, when treated with concentrated sulphuric acid produces dense white fumes, T, and a red-brown gas, U.

T, on dissolving in water, produces a colourless solution which turns blue litmus paper red, and gives a cream precipitate, V, on addition of silver ions. V dissolves in aqueous ammonia.

(i) Identify the substances, T, U and V. **[3 marks]**

(ii) Write the formula for the ion present in S. **[1 mark]**

(iii) Write the equation for the formation of the cream precipitate, V. **[1 mark]**

Total 15 marks

END OF TEST

SECTION B

Answer ALL questions in this section.

Write your answers in the answer booklet provided.

MODULE 1

FUNDAMENTALS IN CHEMISTRY

4. Valence Shell Electron Pair Repulsion (VSEPR) theory is normally used to predict the shapes and bond angles of simple molecules and ions.

(a) State the basic principle behind the VSEPR theory. **[1 mark]**

(b) When hydrochloric acid reacts with water and ammonia the corresponding hydroxonium and ammonium ions are formed.

(i) Using the VSEPR theory, state the shapes of the hydroxonium (H_3O^+) and ammonium (NH_4^+) ions. **[2 marks]**

(ii) Using suitable diagrams, illustrate the shape of EACH ion in (b) (i). **[2 marks]**

(iii) Account for the shape of EACH of the species, H_3O^+ and NH_4^+. **[4 marks]**

(c) Suggest an explanation for EACH of the following observations:

(i) The experimental determination of the relative molecular mass of ethanoic acid (CH_3CO_2H) produces a value of 120 g. Your answer should include a suitable diagram. **[4 marks]**

(ii) The boiling point of propanone (acetone) is greater than the boiling point of butane. **[2 marks]**

Total 15 marks

FORM TP 2009157

TEST CODE **02112032**

MAY/JUNE 2009

CARIBBEAN EXAMINATIONS COUNCIL

ADVANCED PROFICIENCY EXAMINATION

CHEMISTRY

UNIT 1 – PAPER 03/2

2 hours

READ THE FOLLOWING INSTRUCTIONS CAREFULLY.

1. This paper consists of THREE questions. Answer ALL questions.
2. Write your answers in the spaces provided in this booklet.
3. ALL working MUST be shown.
4. The use of non-programmable calculators is permitted.
5. A data booklet is provided.

Answer ALL questions.

1. You are provided with a popular brand of vinegar. Carry out the following experiment to determine the percentage of acetic acid in your vinegar sample.

(a) Procedure

A. Pipette 10 cm^3 of vinegar into a 100 cm^3 volumetric flask and make up to the mark with distilled water.

B. Transfer (using a pipette) 20 cm^3 of the diluted vinegar solution into a 250 cm^3 conical flask and add two drops of phenolphthalein indicator.

C. Fill your burette with 0.10 mol dm^{-3} sodium hydroxide.

D. Titrate your vinegar solution against the NaOH in the burette.

E. Record both your initial burette reading and the reading at the end point in Table 1, to two decimal places.

F. Repeat steps B – E until consistent results are obtained.

TABLE 1: DATA FOR EXPERIMENTAL PROCEDURE

	1	2	3
Final burette reading (cm^3)			
Initial burette reading (cm^3)			
Volume of NaOH used (cm^3)			

[6 marks]

(b) Suggest a reason for using phenolphthalein as the indicator.

____

____

[1 mark]

GO ON TO THE NEXT PAGE

(c) Calculate the volume of NaOH used for the titration.

[**1 mark**]

(d) Write an equation for the reaction of sodium hydroxide and acetic acid.

[**1 mark**]

(e) Calculate the number of moles of sodium hydroxide used in the titration.

[**1 mark**]

(f) Calculate the number of moles of acetic acid present in your pipetted 20 cm^3 of vinegar solution (Step B).

[**2 marks**]

(g) Calculate the concentration of the 100 cm^3 vinegar solution (Step A).

[2 marks]

(h) Calculate the concentration of acetic acid in your original vinegar sample.

[1 mark]

(i) Calculate the percentage of acetic acid in your brand of vinegar if the density of the vinegar solution is 1.01 g cm^{-3}.

[3 marks]

Total 18 marks

GO ON TO THE NEXT PAGE

2. An experiment is carried out to investigate the rate of reaction between an excess of dolomite chips (magnesium carbonate) and 50 cm^3 of dilute hydrochloric acid. The volume of carbon dioxide is measured at regular intervals using a gas syringe. Figure 1 shows six readings of the volume of carbon dioxide as given by the gas syringe, and the corresponding time taken.

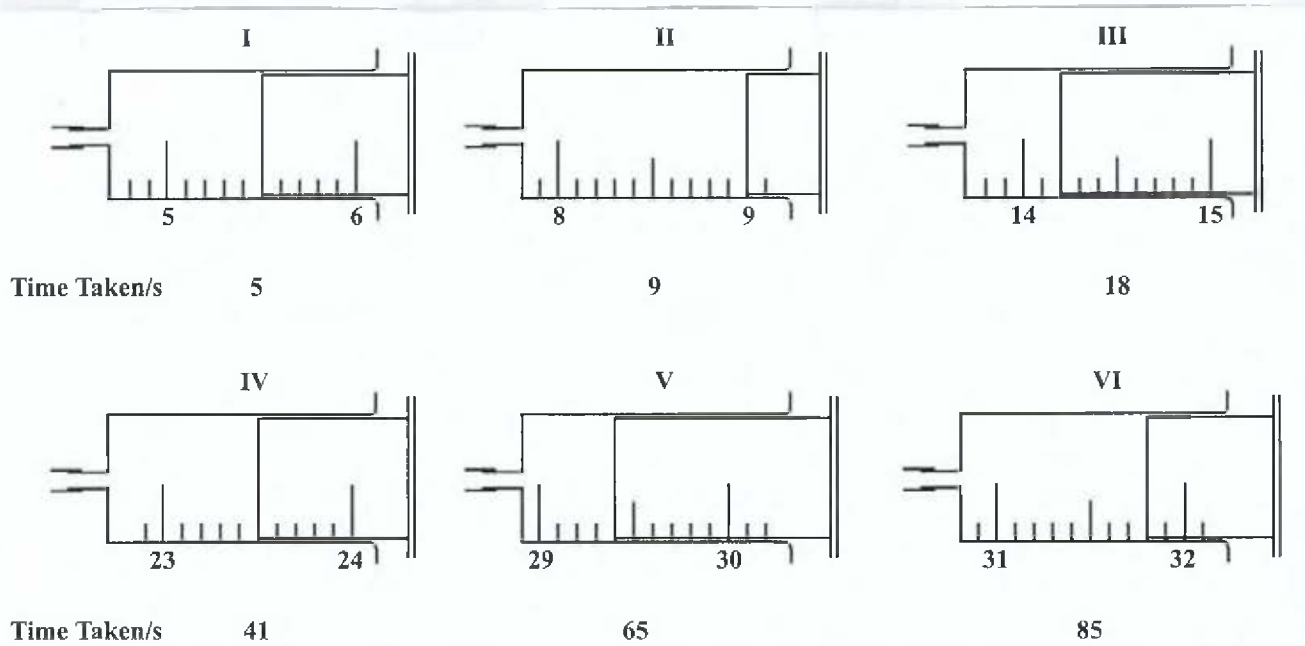


Figure 1. Volume of CO_2 measured by the gas syringe

(a) (i) From the results shown in Figure 1, construct a table to show number of readings, volume of CO_2 evolved, the time taken and the inverse of the time taken (l/t).

[5 marks]

GO ON TO THE NEXT PAGE

(ii) On the grid on page 7, plot a graph of volume of CO_2 evolved against time taken. **[4 marks]**

(iii) Explain the shape of the graph.

____

____

____

[2 marks]

(iv) From the graph, determine the rate of reaction at 20 and 40 seconds. Show all your working.

20 s ____

____

40 s ____

____

[4 marks]

(v) State what can be deduced about the rate of reaction from your answer in (a) (iv) above.

____

[1 mark]

(vi) Suggest the property of the reaction measured by the value, l/t (the inverse of the time).

____

[1 mark]

(vii) Suggest a reason for the use of excess dolomite (magnesium carbonate).

____

[1 mark]

Total 18 marks

GO ON TO THE NEXT PAGE

3. Dieticians refer to the energy content of foods consumed in terms of their calorie value, expressed as cal g^{-1} of food. The calorie and joule are both units of energy. Some persons believe that sweet potato contains more energy than yam.

Plan and design an experiment to test the truth of the claim above.

Your answer should include:

(a) Hypothesis

____

____

[1 mark]

(b) Aim

____

____

[1 mark]

(c) Apparatus and materials

____

____

____

____

[2 marks]

(d) Experimental procedure

____

____

____

____

[2 marks]

(e) Variables

(i) Manipulated

____

(ii) Responding

____

(iii) Controlled

____

[3 marks]

(f) Expected results

____

____

____

____

[1 mark]

(g) Treatment of results

____

____

____

____

[1 mark]

(h) State ONE source of error in the experiment.

____

[1 mark]

Total 12 marks

END OF TEST

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.

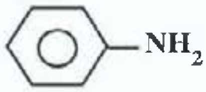
SECTION A

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.

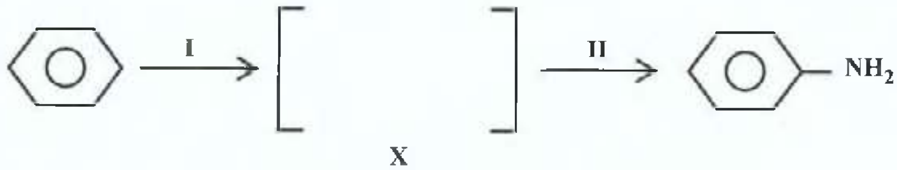


Figure 1. Reaction scheme for production of phenylamine

(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]

GO ON TO THE NEXT PAGE

(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.

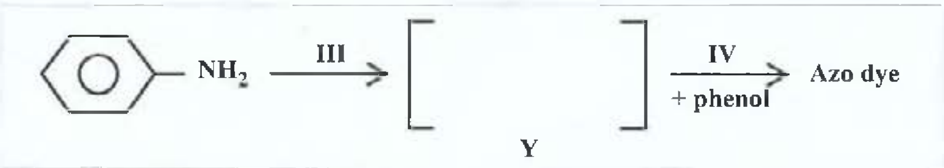


Figure 2. Reaction scheme for production of azo dye

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

[1 mark]

GO ON TO THE NEXT PAGE

(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]

GO ON TO THE NEXT PAGE

(c) 25 cm^3 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_2CO_3 remaining after filtration.

[2 marks]

(iii) Deduce the number of moles of $BaCl_2$ which reacted with the sodium carbonate solution.

[1 mark]

(iv) Calculate the concentration of barium ions in mol dm^{-3}.

[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

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'.

____

____

[2 marks]

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

____

____

[2 marks]

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

____

[2 marks]

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

____

____

[2 marks]

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

____

____

____

[2 marks]

(e) An exhibit at a Science Fair included a model of the process for the purification of aluminium oxide, Al_2O_3 from its bauxite ore. Figure 3 shows an outline of the process.

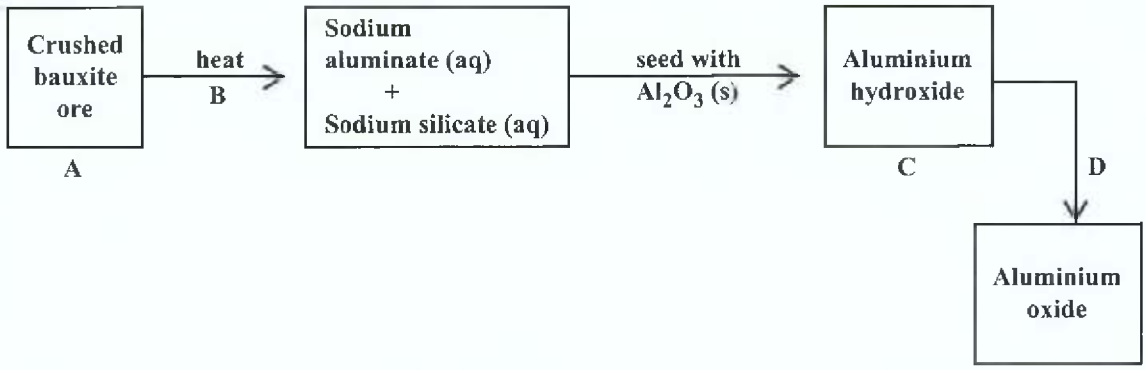


Figure 3. Outline of the process of the purification of Al_2O_3 from bauxite

(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

GO ON TO THE NEXT PAGE

SECTION B

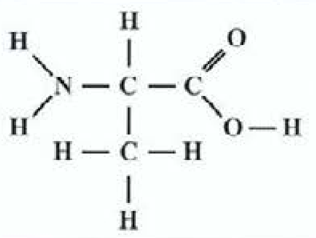
Answer ALL questions in this section.

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

GO ON TO THE NEXT PAGE

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.

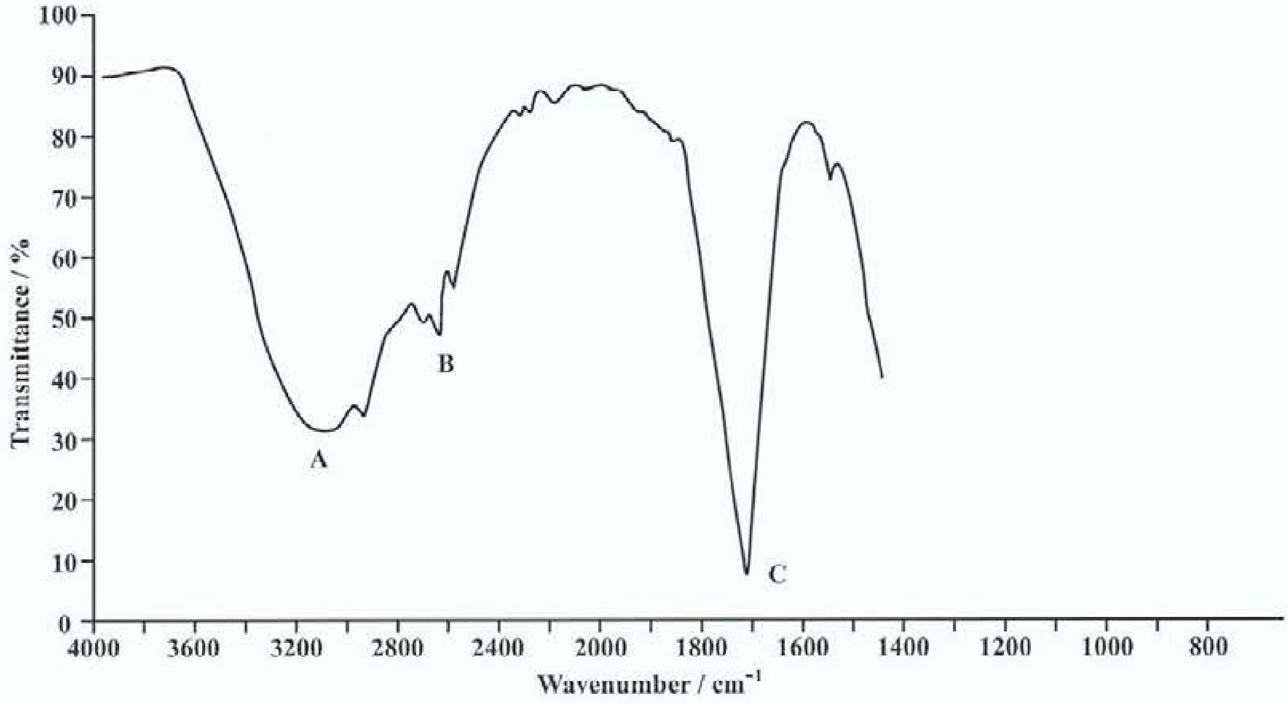


Figure 4. IR spectrum of Molecule Y

   (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]**

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

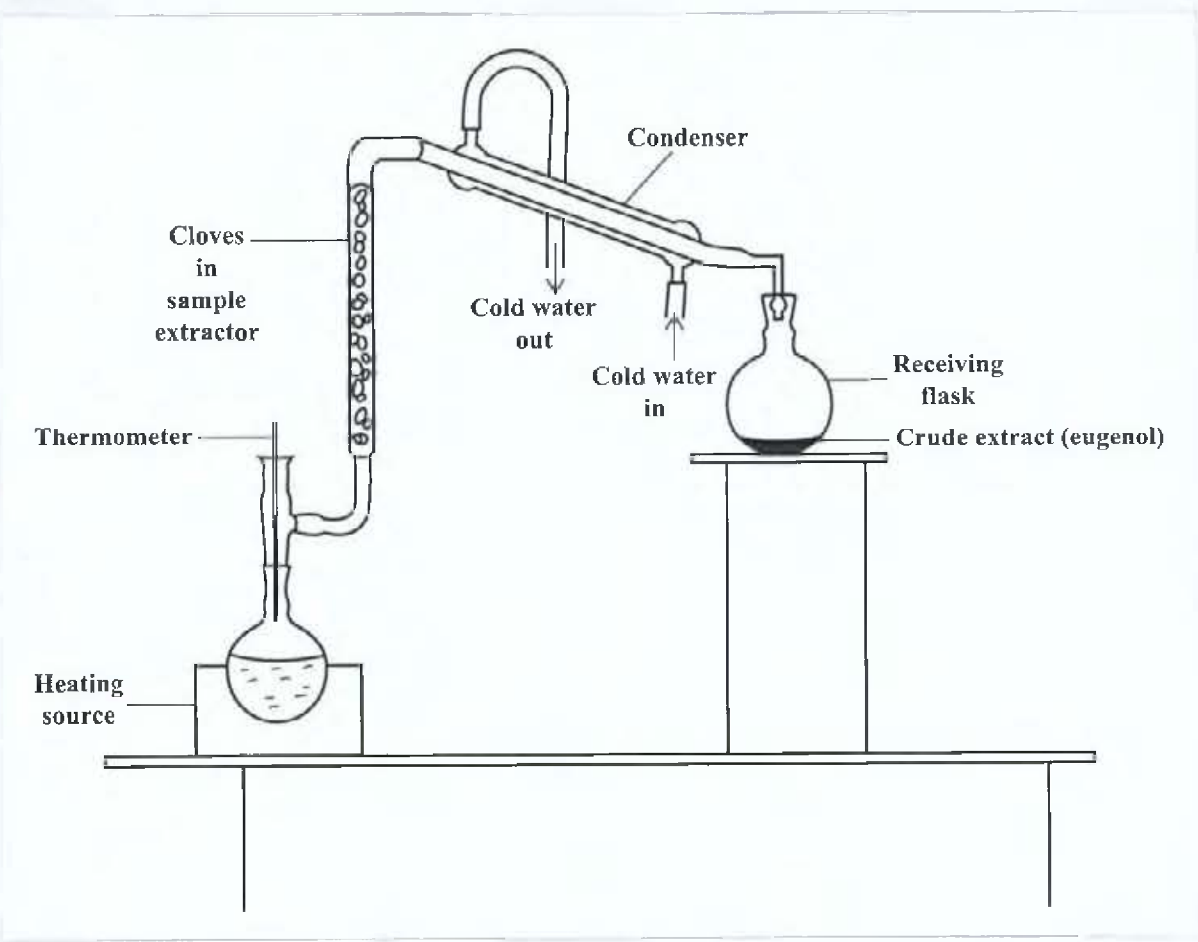


Figure 5. Steam distillation of clove

(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

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 diaphram cell. Describe the chemical processes involved in the production of TWO of the substances listed in (a) (i) above, when the diaphram 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 SO_2 in food preservation. Your answer must include ONE disadvantage. **[3 marks]**

Total 15 marks

END OF TEST

FORM TP 2009160

TEST CODE **02212032**

MAY/JUNE 2009

CARIBBEAN EXAMINATIONS COUNCIL

ADVANCED PROFICIENCY EXAMINATION

CHEMISTRY

UNIT 2 – PAPER 03/2

2 hours

READ THE FOLLOWING INSTRUCTIONS CAREFULLY.

1. This paper consists of THREE questions. Answer ALL questions.
2. Write your answers in the spaces provided in this booklet.
3. ALL working MUST be shown.
4. The use of non-programmable calculators is permitted.
5. A data booklet is provided.

Answer ALL questions.

1. You are provided with a sample, A, of the hydrated salt $Na_2CO_3 \cdot nH_2O$. You are required to determine the value of n and hence the formula of the hydrated salt.

(a) Weigh the empty crucible. Add between 4.50 g and 5.00 g of A and reweigh the crucible. Record your data in Table 1.

TABLE 1

Mass of empty crucible (g)	
Mass of crucible and A (g)	
Mass of A (g)	

[3 marks]

(b) Warm the crystals carefully to get rid of most of the water of crystallisation. Prevent loss of solid by gradually increasing the heat to a maximum, and then heat strongly for about 8 minutes.

Allow the crucible to cool.

Describe the appearance of the heated solid in the crucible.

____

[2 marks]

(c) Reweigh the crucible and its contents. Enter your results in Table 2.

Repeat steps (b) and (c) as many times so as to achieve constant mass. (At this point all the water of crystallisation would have been removed.)

TABLE 2

	1st weighing	**2nd weighing**	**3rd weighing**	
Mass of crucible and A after heating (g)				
Mass of A after heating (g)				

[2 marks]

GO ON TO THE NEXT PAGE

(d) Calculate the mass of water of crystallisation driven off during heating. Show all your working.

[1 mark]

(e) Calculate the mass of anhydrous salt, A, in the sample.

[1 mark]

(f) Calculate the number of moles of water driven off.

[2 marks]

(g) Calculate the number of moles of anhydrous salt, A.

[2 marks]

(h) Calculate the number of moles of water which combines with one mole of anhydrous salt, A.

[1 mark]

Deduce the value of n.

[1 mark]

(i) Write the equation to describe the heating of Salt A.

[2 marks]

Total 17 marks

2. A student is given the task of determining the concentration of a solution of oxalic acid (ethane-1,2,-dioic acid), $H_2C_2O_4$, by titrating 25 cm^3 portions of the acid with a standard solution of potassium manganate(VII) containing 0.02 mol dm^{-3}. Figure 1 shows the readings on the burette before and after each titration.

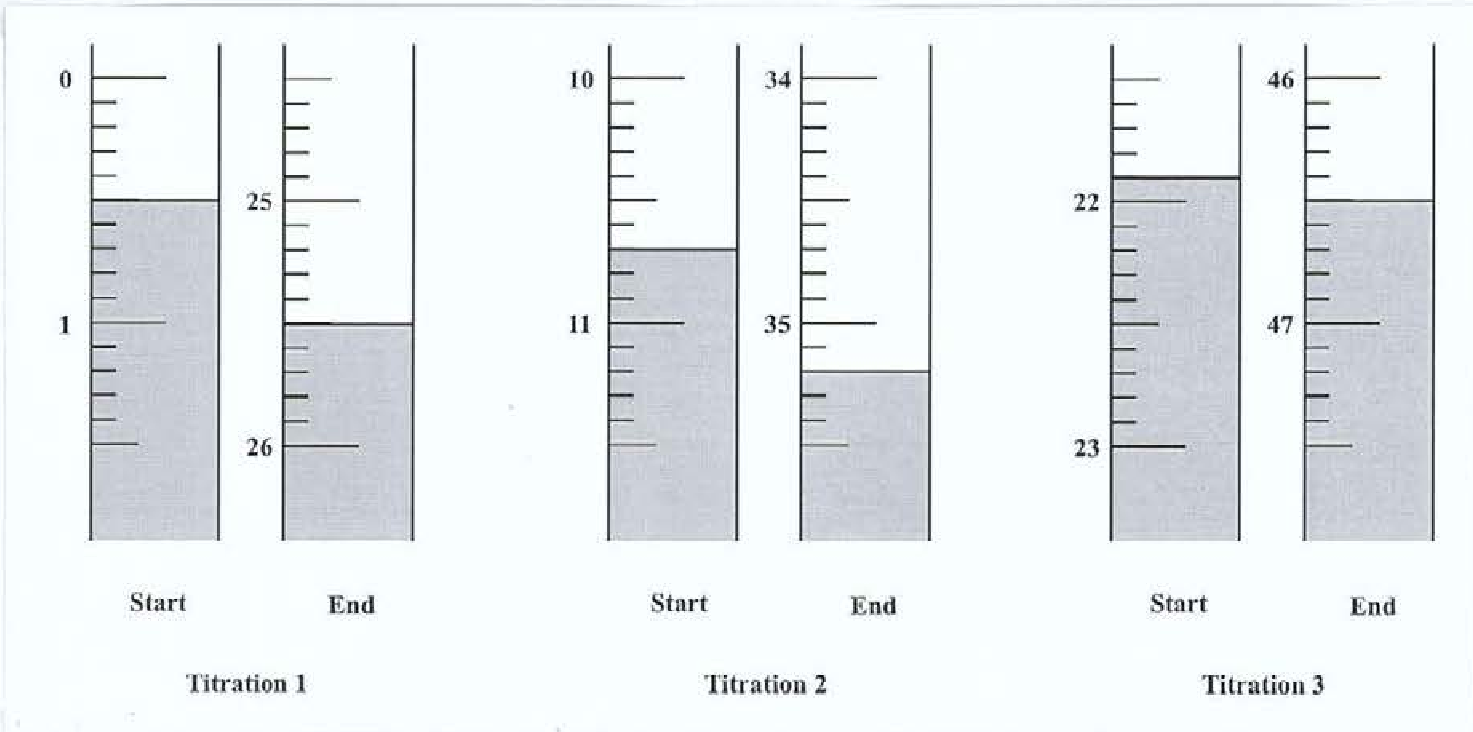


Figure 1. Burette reading

(a) (i) What substance in the titration is performing the role of the indicator?

____

[1 mark]

(ii) What colour change would be expected at the end of the reaction?

____

[1 mark]

GO ON TO THE NEXT PAGE

(iii) In the space below, construct Table 3 to record the titration results. Include the initial and final burette readings, and the volume of $KMnO_4$ used.

[5 marks]

(iv) State the volume of $KMnO_4$ (aq) to be used in the calculation.

____

[1 mark]

The redox nature of the reaction occurring in the titration can be represented by the two half-equations below.

$C_2O_4^{2-} \rightarrow 2CO_2\,(g) + 2e^-$

$5e^- + MnO_4^-\,(aq) + 8H^+\,(aq) \rightarrow Mn^{2+}(aq) + 4H_2O\,(l)$

(v) Write the ionic equation for the reaction occurring in the titration.

____

____

[2 marks]

GO ON TO THE NEXT PAGE

(vi) Calculate the concentration of the oxalic acid solution in mol dm^{-3}.

[4 marks]

(b) Outline the steps to be taken by the student in performing the titration.

[4 marks]

(c) In taking readings of liquids, the bottom of the meniscus is usually read. However, in the case of $KMnO_4$(aq), this procedure is not followed.

Give ONE reason for this deviation from the normal.

[1 mark]

Total 19 marks

GO ON TO THE NEXT PAGE

3. Two students were overheard discussing the alcoholic content of two brands of beer. One student was adamant in his claim that Brand A contained a greater percentage of alcohol than Brand B.

Plan and design an experiment to test the truth of his claim.

Your answer should include the following:

(a) Hypothesis

____

____

[1 mark]

(b) Aim

____

____

[1 mark]

(c) Apparatus and materials

____

____

[2 marks]

(d) Procedure

____

____

____

____

____

____

____

[3 marks]

(e) Variables

(i) Manipulated ______________________________

(ii) Responding ______________________________

[2 marks]

(f) Data to be collected

____

____

[1 mark]

(g) Discussion of expected results

____

____

[1 mark]

(h) ONE possible assumption or source of error.

____

[1 mark]

Total 12 marks

END OF TEST

TEST CODE **02112032 – IS**

FORM TP 2009157 – IS

MAY/JUNE 2009

CARIBBEAN EXAMINATIONS COUNCIL

ADVANCED PROFICIENCY EXAMINATION

CHEMISTRY

UNIT 1 – Paper 03/2

ALTERNATIVE TO INTERNAL ASSESSMENT

General Proficiency

27 MAY 2009 (a.m.)

INSTRUCTIONS FOR SETTING UP THE ALTERNATIVE TO INTERNAL ASSESSMENT EXAMINATION

The information contained in these instructions and the results of experiments carried out should NOT be communicated to candidates.

CONFIDENTIAL

In addition to equipment, chemicals and other materials normally present in the laboratory, the following equipment and materials must be provided.

Question 1.

For EACH candidate:

(a) 25 cm^3 of commercially available vinegar.

(b) 150 cm^3 of Solution B. This is an aqueous solution of a 0.10 mol dm^{-3} sodium hydroxide. This should be prepared as close as possible to the time of the examination.

(c) Phenolphthalein indicator.

(d) A pipette filler.

(e) A pipette (20 cm^3).

(f) A burette (50 cm^3).

(g) A wash bottle.

(h) A supply of distilled water.

(i) 3 conical flasks (250 cm^3 each).

(j) A volumetric flask (100 cm^3).

On the day of the examination, the person responsible for preparing the practical MUST carry out the experiment as described on the question paper and SEND in a report using the attached form entitled "Supervisor's Report on the Practical Examination". These persons are reminded that, if this is not done, candidates may be at a disadvantage.

The experiment must be carried out using similar apparatus to, and the same materials as, those supplied to the candidates. It should also be performed at the same time as the examination, or immediately before or after. This person's work should NOT be seen by, nor should his/her results be communicated to the candidates either directly or indirectly.

N.B. Supervisors are expected to report on the attached form entitled "Supervisor's Report on the Practical Examination", any special conditions which might have affected candidates' performances. Supervisors should specify whether all candidates were affected or if not, give the registration numbers of those candidates who were affected.

Candidates are allowed to have practical notebooks and/or any materials relevant to the practical examination.

Candidates may be given additional materials without penalty.

<u>If candidates lose time during the examination through no fault of their own, they must be awarded the equivalent time.</u>

END OF INSTRUCTIONS

TEST CODE **02112032 – SR**

FORM TP 2009157 – SR

MAY/JUNE 2009

SCHOOL/CENTRE NUMBER					

NAME OF SCHOOL/CENTRE

CARIBBEAN EXAMINATIONS COUNCIL

ADVANCED PROFICIENCY EXAMINATION

CHEMISTRY

UNIT 1 – Paper 03/2

ALTERNATIVE TO INTERNAL ASSESSMENT

General Proficiency

27 MAY 2009 (a.m)

SUPERVISOR'S REPORT ON THE ALTERNATIVE TO INTERNAL ASSESSMENT EXAMINATION

This report MUST be completed by the person(s) SETTING UP the Practical Examination. When completed, it MUST accompany candidates' answer booklets for the Practical Examination.

TEACHER'S NAME
(Please print)

____

SUPERVISOR'S NAME
(Please print)

____

TEACHER'S SIGNATURE

____

SUPERVISOR'S SIGNATURE

____

N.B. Please ensure that all the information above is provided before form is submitted.

REPORT ON QUESTION 1

Question 1

The person setting up this practical examination must carry out the exercise in Question 1 AT THE SAME TIME AS (OR VERY CLOSE TO) the examination. The results are to be entered into Table 1 below.

TABLE 1: TITRATION RESULTS

Burette Reading (cm^3)	**Titration Number**			
	1	2	3	4
Final burette reading				
Initial burette reading				
Volume of Solution B used				

Pipette volume used: .... cm^3

Average volume of Solution B used in titration = ... cm^3

Brand of Vinegar used ....

Reported acidity of brand used ....

Any special conditions that may have affected the performance of individual candidates. (Indicate registration numbers.)

TEST CODE **02212032 – IS**

FORM TP 2009160 – IS

MAY/JUNE 2009

CARIBBEAN EXAMINATIONS COUNCIL

ADVANCED PROFICIENCY EXAMINATION

CHEMISTRY

UNIT 2 – Paper 03/2

ALTERNATIVE TO INTERNAL ASSESSMENT

General Proficiency

09 JUNE 2009 (p.m.)

INSTRUCTIONS FOR SETTING UP THE ALTERNATIVE TO INTERNAL ASSESSMENT EXAMINATION

The information contained in these instructions and the results of experiments carried out should NOT be communicated to candidates.

CONFIDENTIAL

In addition to equipment, chemicals and other materials normally present in the laboratory, the following equipment and materials must be provided.

Question 1.

For EACH candidate:

(a) Sample A: 12 g $Na_2CO_3 \cdot 10\ H_2O$

(b) Crucible

(c) Weighing balance

(d) Bunsen burner

On the day of the examination, the person responsible for preparing the practical MUST carry out the experiment as described on the question paper and SEND in a report using the attached form entitled "Supervisor's Report on the Practical Examination". These persons are reminded that, if this is not done, candidates may be at a disadvantage.

The experiment must be carried out using similar apparatus to, and the same materials as, those supplied to the candidates. It should also be performed at the same time as the examination, or immediately before or after. This person's work should NOT be seen by, nor should his/her results be communicated to the candidates either directly or indirectly.

N.B. **Supervisors are expected to report on the attached form entitled "Supervisor's Report on the Practical Examination", any special conditions which might have affected candidates' performances. Supervisors should specify whether all candidates were affected or if not, give the registration numbers of those candidates who were affected.**

Candidates are allowed to have practical notebooks and/or any materials relevant to the practical examination.

Candidates may be given additional materials without penalty.

<u>If candidates lose time during the examination through no fault of their own, they must be awarded the equivalent time</u>.

END OF INSTRUCTIONS

FORM TP 2009160 – SR

TEST CODE **02212032 – SR**

MAY/JUNE 2009

SCHOOL/CENTRE NUMBER					

NAME OF SCHOOL/CENTRE

CARIBBEAN EXAMINATIONS COUNCIL

ADVANCED PROFICIENCY EXAMINATION

CHEMISTRY

UNIT 2 – Paper 03/2

ALTERNATIVE TO INTERNAL ASSESSMENT

General Proficiency

09 JUNE 2009 (p.m.)

SUPERVISOR'S REPORT ON THE ALTERNATIVE TO INTERNAL ASSESSMENT EXAMINATION

This report MUST be completed by the person(s) SETTING UP the Practical Examination. When completed, it MUST accompany candidates' answer booklets for the Practical Examination.

TEACHER'S NAME
(Please print)

____

SUPERVISOR'S NAME
(Please print)

____

TEACHER'S SIGNATURE

____

SUPERVISOR'S SIGNATURE

____

N.B. Please ensure that all the information above is provided before form is submitted.

REPORT ON QUESTION 1

Question 1

The person setting up this practical examination must carry out the exercise in Question 1 AT THE SAME TIME AS (OR VERY CLOSE TO) the examination. The results are to be entered into Table 1 below.

TABLE 1

Mass of empty crucible (g)	
Mass of crucible and A (g)	
Mass of A (g)	

TABLE 2

	1st weighing	**2nd weighing**	**3rd weighing**	
Mass of crucible and A after heating (g)				
Mass of A after heating (g)				

Any special conditions that may have affected the performance of individual candidates. (Indicate registration numbers.)

....

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TEST CODE **02112020**

FORM TP 2010149

MAY/JUNE 2010

C A R I B B E A N   E X A M I N A T I O N S   C O U N C I L

ADVANCED PROFICIENCY EXAMINATION

CHEMISTRY

UNIT 1 – 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 silent, 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

FUNDAMENTALS IN CHEMISTRY

1. (a) State the types of bonds (intra-molecular and inter-molecular) that exist in liquid ammonia.

____

____

[2 marks]

(b) Ammonia can be produced by heating calcium oxide with ammonium chloride. The two other products are calcium chloride and water.

(i) Write a balanced chemical equation for the reaction between calcium oxide and ammonium chloride.

____

____

[2 marks]

(ii) Calculate the mass of ammonium chloride needed to produce 1 dm^3 of ammonia at RTP (room temperature and pressure).
(Molar volume = 24 dm^3 at RTP)

[2 marks]

(c) (i) Ammonia gas deviates from ideal behaviour. Under which of the following sets of conditions, I, II or III, would the deviation be LEAST?

Conditions	**Temperature (°C)**	**Pressure (kPa)**
I	40	101
II	150	50
III	20	500

____

[1 mark]

(ii) State TWO assumptions of the kinetic theory as it pertains to ideal gases.

____

____

____

____

[2 marks]

(iii) Which assumption of the kinetic theory as it pertains to ideal gases would MOST likely account for your answer to (c) (i) above?

____

____

[1 mark]

(d) Some ammonia gas is dissolved in water. The exact concentration of the solution is unknown and has to be determined. Describe an experiment that would determine the concentration of the aqueous ammonia.

____

____

____

____

____

____

____

____

[5 marks]

Total 15 marks

GO ON TO THE NEXT PAGE

MODULE 2

KINETICS AND EQUILIBRIA

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

(i) Standard electrode potential of a half-cell

____

____

____

____

[2 marks]

(ii) Standard cell potential of an electrochemical cell

____

____

____

____

[2 marks]

(b) Figure 1 is a diagram of an electrochemical cell consisting of a standard copper electrode and a standard aluminium electrode, represented by the notation,
$Al(s) \mid Al^{3+}(aq) \parallel Cu^{2+}(aq) \mid Cu(s)$.

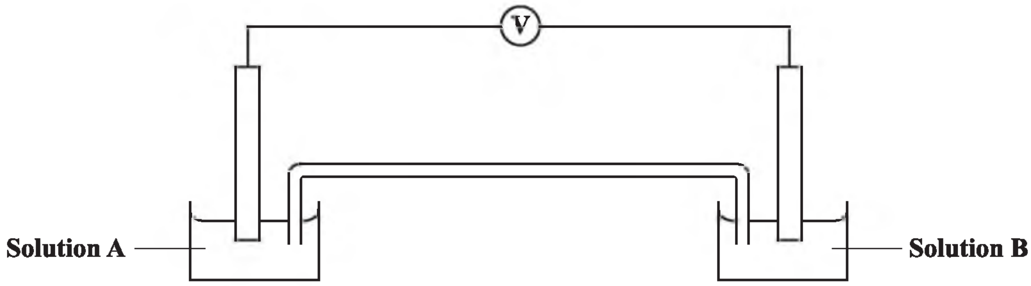


Figure 1. An electrochemical cell with standard copper and aluminium electrodes

(i) On the diagram in Figure 1, label

a) the ions in Solution A and Solution B

b) the salt bridge

c) the cathode and anode

d) the direction of electron flow. **[5 marks]**

(ii) State what would be observed at the cathode after the electrochemical cell in Figure 1 has been running for a few hours.

____

[1 mark]

(iii) State the experimental conditions used in the preparation of the cell in Figure 1.

Temperature ______________________________________

Concentration of Solutions A and B ______________________

____

[2 marks]

(iv) Use the information in your Data Booklet to calculate the standard cell potential, E_{cell}, for the electrochemical cell in Figure 1.

[3 marks]

Total 15 marks

MODULE 3

CHEMISTRY OF THE ELEMENTS

3. Ammonium vanadate(V), NH_4VO_3, is an orange solid. Tests are performed on NH_4VO_3 to show the variable oxidation states of vanadium.

(a) Record in Table 1 the observation expected for EACH of the tests below.

TABLE 1: TESTS ON AMMONIUM VANADATE(V)

Test	Observation	Inference
(i) A few cm^3 of bench NaOH is added to a small amount of solid NH_4VO_3, followed by a few cm^3 of dilute H_2SO_4 .	Colour: ____________________	VO_2^+ formed
(ii) A little granulated zinc is added to the solution in (i) above.	Colour changes to ________________________ , then to ________________________ , then to ________________________, and finally ________________________	VO_2^+ and VO^{2+} VO^{2+} V^{3+} V^{2+}

[5 marks]

(b) Calculate the oxidation number of vanadium in EACH of the following species:

(i) $VOSO_4$

____

(ii) VO_2^+

____

(iii) VO^{2+}

____

[3 marks]

GO ON TO THE NEXT PAGE

(c) When concentrated HCl is added to a pink solution of cobalt(II) chloride, the solution turns blue.

Give an explanation for the observation stated above in terms of the stability constant of the complex ion formed, and write a balanced equation for the reaction.

Explanation

____

____

____

____

____

Equation

____

[4 marks]

(d) Complete Table 2 to show the acid/base character of the oxides of Group IV elements in the +2 oxidation state.

TABLE 2: OXIDES OF GROUP IV ELEMENTS

Group IV Oxides	**Acid/Base Character**
CO	(i)
CO_2	(ii)
SnO	Amphoteric
PbO	(iii)

[3 marks]

Total 15 marks

GO ON TO THE NEXT PAGE

SECTION B

Answer ALL questions.

Write your answers in the separate answer booklet provided.

MODULE 1

FUNDAMENTALS IN CHEMISTRY

4. (a) Copy and complete Table 3, which provides information on the properties of the simple subatomic particles.

TABLE 3: PROPERTIES OF SIMPLE SUBATOMIC PARTICLES

Particle	Relative Mass	Relative Charge	Location
Electron	$\frac{1}{1840}$	–1	(i) ____________
Proton	(ii) ____________	+1	Nucleus
(iii) ____________	1	(iv) ____________	Nucleus

[4 marks]

(b) (i) Radioactive emissions are affected by an electric field. Name the type of radioactive particle that behaves in the same way as the electron. **[1 mark]**

(ii) $^{216}_{84}Po$ decays by emitting β particles. State the product formed from the decay of $^{216}_{84}Po$ by the emission of three β particles and calculate the n/p ratio of BOTH the reactant and product atoms. **[6 marks]**

(iii) Comment on the effect that the decay has on the stability of the nucleus of $^{216}_{84}Po$. **[1 mark]**

(c) (i) Draw the structures of the atomic orbitals of principal quantum number 2. Include x, y and z axes in the drawing. **[2 marks]**

(ii) Using s, p, d notation, write the electronic configuration of $_{24}Cr$. **[1 mark]**

Total 15 marks

MODULE 2

KINETICS AND EQUILIBRIA

5. A student prepares an ethanoic acid solution of pH 5. He uses this solution to make a buffer.

(a) Define EACH of the following terms:

(i) pH **[2 marks]**

(ii) Buffer solution **[2 marks]**

(b) The acid dissociation constant (K_a) of ethanoic acid at 25 °C has a numerical value of 1.7 x 10^{-5}. The equilibrium equation for the dissociation of ethanoic acid is

$$CH_3COOH(aq) \rightleftharpoons H^+(aq) + CH_3COO^-(aq).$$

(i) Write an expression for the acid dissociation constant (K_a) of ethanoic acid. **[1 mark]**

(ii) Calculate the equilibrium concentration of ethanoic acid in a solution that has a pH of 5. **[4 marks]**

(c) State the effect, on the equilibrium position of a buffer solution, of adding small amounts of

(i) H^+ (aq) **[1 mark]**

(ii) OH^- (aq). **[1 mark]**

(d) A buffer solution is made by adding 20.5 g of sodium ethanoate (CH_3COONa) to 500 cm^3 of 1.5 mol dm^{-3} ethanoic acid. (K_a = 1.7 x 10^{-5} at 25 °C for ethanoic acid).

Calculate the pH of this buffer solution. **[4 marks]**

(Relative atomic mass: H = 1, C = 12, O = 16, Na = 23)

Total 15 marks

MODULE 3

CHEMISTRY OF THE ELEMENTS

6. The elements in Period 3 of the periodic table are given below.

Na Mg Al Si P S Cl Ar

(a) Account for EACH of the following variations in properties across the period Na to Ar.

(i) Electronegativity increases across the period. **[2 marks]**

(ii) Melting point of the elements increases from Na to Si. **[2 marks]**

(b) Describe the trend in the acid/base character of the oxides of the elements in Period 3. **[3 marks]**

(c) When aluminium chloride dissolves in water, its solution is acidic. Account for the acidic nature of the aluminium chloride solution. **[2 marks]**

(d) Transition metals have higher melting points than metals such as calcium in the s-block of the periodic table. Suggest TWO reasons for this. **[2 marks]**

(e) P_4O_{10} and PCl_5 are the oxide and chloride of phosphorous in its highest oxidation state.

Write an equation to show how EACH of the following reacts with water.

(i) P_4O_{10} **[2 marks]**

(ii) PCl_5 **[2 marks]**

Total 15 marks

END OF TEST

TEST CODE **02112032**

FORM TP 2010150

MAY/JUNE 2010

C A R I B B E A N   E X A M I N A T I O N S   C O U N C I L

ADVANCED PROFICIENCY EXAMINATION

CHEMISTRY

UNIT 01 – Paper 03/2

ALTERNATIVE TO INTERNAL ASSESSMENT EXAMINATION

2 hours

You are advised to use the first 10 minutes for reading through this paper carefully.

READ THE FOLLOWING DIRECTIONS CAREFULLY.

1. **Answer ALL questions on this paper.**
2. **Use this answer booklet when responding to the questions. For EACH question, write your answer in the space indicated and return the answer booklet at the end of the examination.**
3. **The use of silent, non-programmable calculators is allowed.**
4. **A data booklet is provided.**

1. (a) Solid A is a mixture of two simple salts, one of which contains an alkali metal cation. You are required to carry out the following tests, being careful to add reagents gradually until no further change is observed, and gently shaking after each addition. Record your observations and relevant deductions in the table provided.

Include in your recordings

- details of colour changes and precipitates formed
- the names of gases evolved and details of the test used to identify EACH one.

Test	**Observations**	**Deductions**
(i) Heat a small quantity of A with dilute HCl. Test for gas evolved.	**[1 mark]**	**[2 marks]**
Shake A with distilled water for 2 mins, filte , keep residue and use filtrat to perform Test (ii) and Test (iii).		
(ii) Add $AgNO_3(aq)$ followed by dilute HNO_3.	**[1 mark]**	**[2 marks]**
(iii) Add $Cl_2(aq)$ followed by about 2 cm^3 of organic solvent B.	**[1 mark]**	**[1 mark]**
Wash residue with distilled water, pierce filte paper, wash residue into boiling tube with dilute H_2SO_4, warm to dissolve solid. Carry out Tests (iv) and (v) with portions of the solution.		

GO ON TO THE NEXT PAGE

(iv) Add NaOH(aq), let stand for about 2 mins, then add H_2O_2.	**[3 marks]**	**[2 marks]**
(v) Add a few grains of oxidizing agent C.	**[1 mark]**	**[2 marks]**

Total 12 marks

2. A student is given the task of investigating the relationship between the rate of reaction and temperature of the reaction between magnesium ribbon and dilute sulphuric acid, H_2SO_4.

The various pieces of apparatus are shown in Figure 1 below.

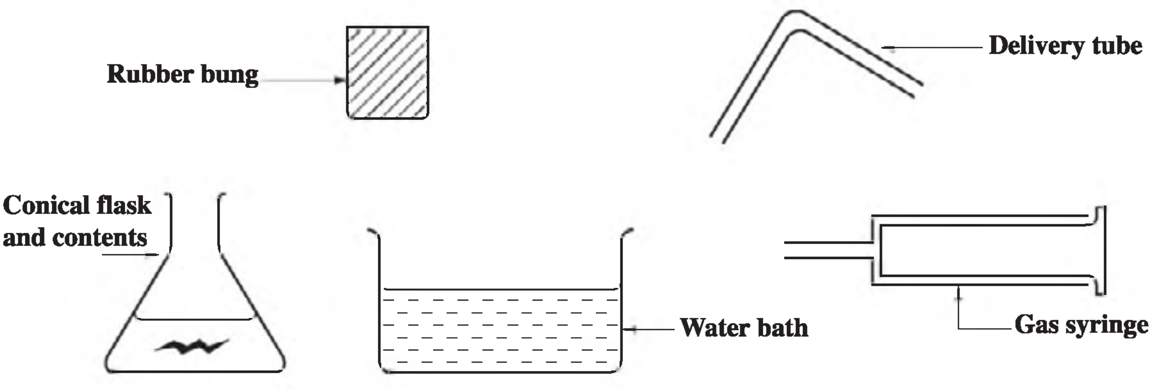


Figure 1. Apparatus for the investigation

The volume of hydrogen evolved from a known length of magnesium ribbon by a given volume of a 1 mol dm^{-3} solution of acid is measured at room temperature at various time intervals. The process is repeated at a temperature of 40 °C.

It is found that 52.5, 65, 78, 80, 85, 88 and 88 cm^3 of hydrogen evolve at intervals of 0.25, 0.50, 0.75, 1.0, 1.5, 2.0 and 2.5 minutes respectively, at a temperature of 40 °C.

(a) (i) Sketch the assembled apparatus that could be used to perform the experiment. **Label the sketch.**

[5 marks]

GO ON TO THE NEXT PAGE

(ii) Construct a table to record the observations on page 4 regarding volume of hydrogen and time, at 40 ˚C.

[4 marks]

(b) On the grid on page 6, which contains the plot of volume of hydrogen vs time at room temperature, plot the corresponding graph at the temperature of 40 ˚C. **[4 marks]**

(c) State the time taken for 50 cm^3 of hydrogen to be evolved at

(i) room temperature

____

(ii) 40 °C.

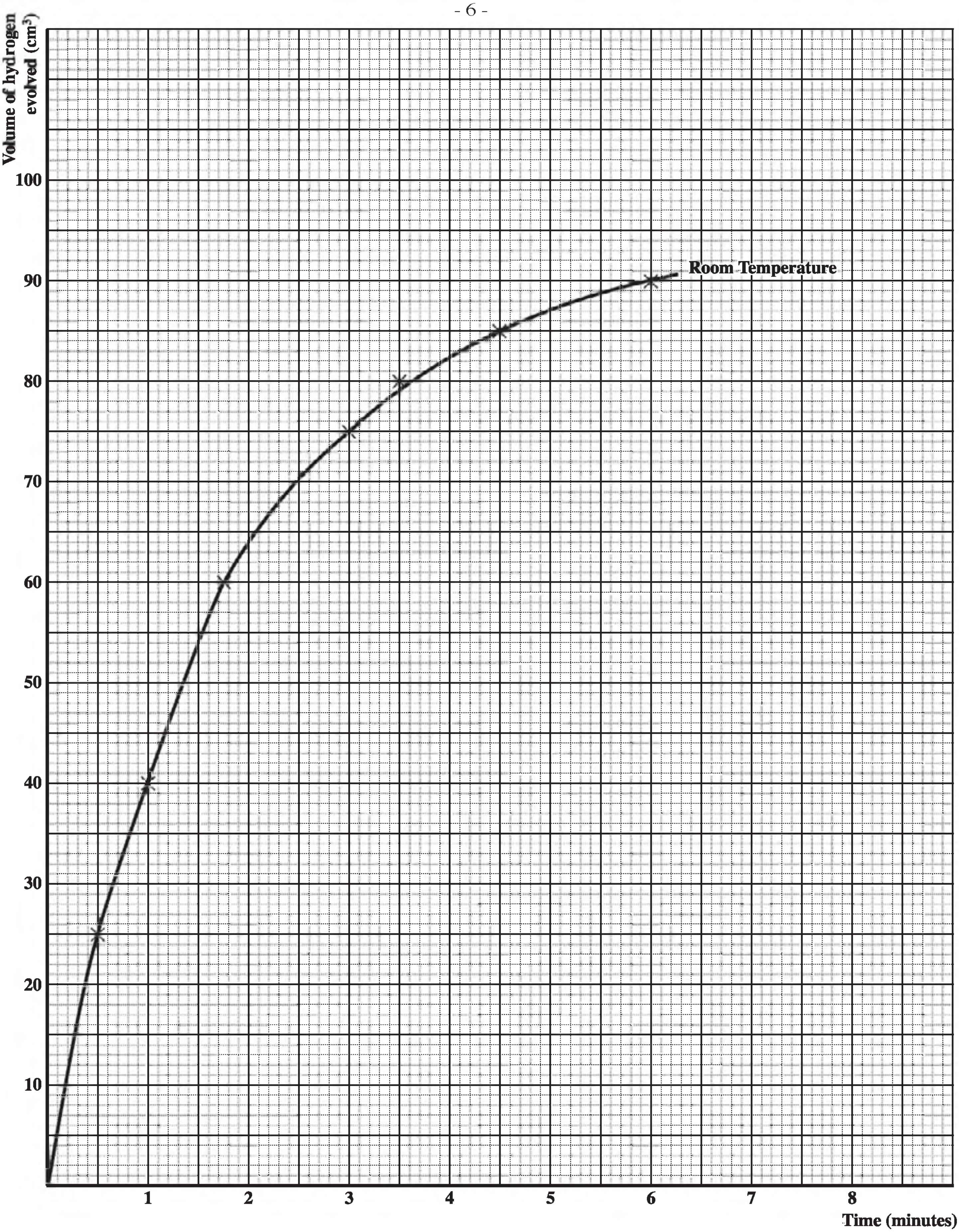
____

[2 marks]

(d) State the volume of hydrogen evolved in the reaction at 40 °C.

____

[1 mark]


Volume of hydrogen evolved (cm^3)
100
90
80
70
60
50
40
30
20
10
Room Temperature
1
2
3
4
5
6
7
8
Time (minutes)

(e) Compare the rates of reaction at room temperature and 40 °C.

____

____

[1 mark]

(f) Sketch on the same grid on page 6 the expected graph if the reaction were carried out at 20 °C. **[1 mark]**

Total 18 marks

3. A student is given the task of investigating the rate of reaction involving sulphuric acid and zinc metal. Having recently studied the properties of transition metals, it is suggested by a colleague that copper ions may be a suitable catalyst for this reaction. Plan and design an experiment to test the validity of this suggestion.

Your answer should include the following:

(i) Hypothesis

[1 mark]

(ii) Apparatus and materials

[2 marks]

(iii) Procedure

[3 marks]

(iv) Variables to be controlled

[1 mark]

(v) Variables to be manipulated and responding variables

[2 marks]

(vi) Data to be collected

[1 mark]

(vii) Discussion of expected results

[1 mark]

(viii) Sources of error/assumption

[1 mark]

Total 12 marks

END OF TEST

TEST CODE **02212020**

FORM TP 2010152

MAY/JUNE 2010

C A R I B B E A N   E X A M I N A T I O N S   C O U N C I L

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 silent, 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. Figure 1 shows a reaction scheme.

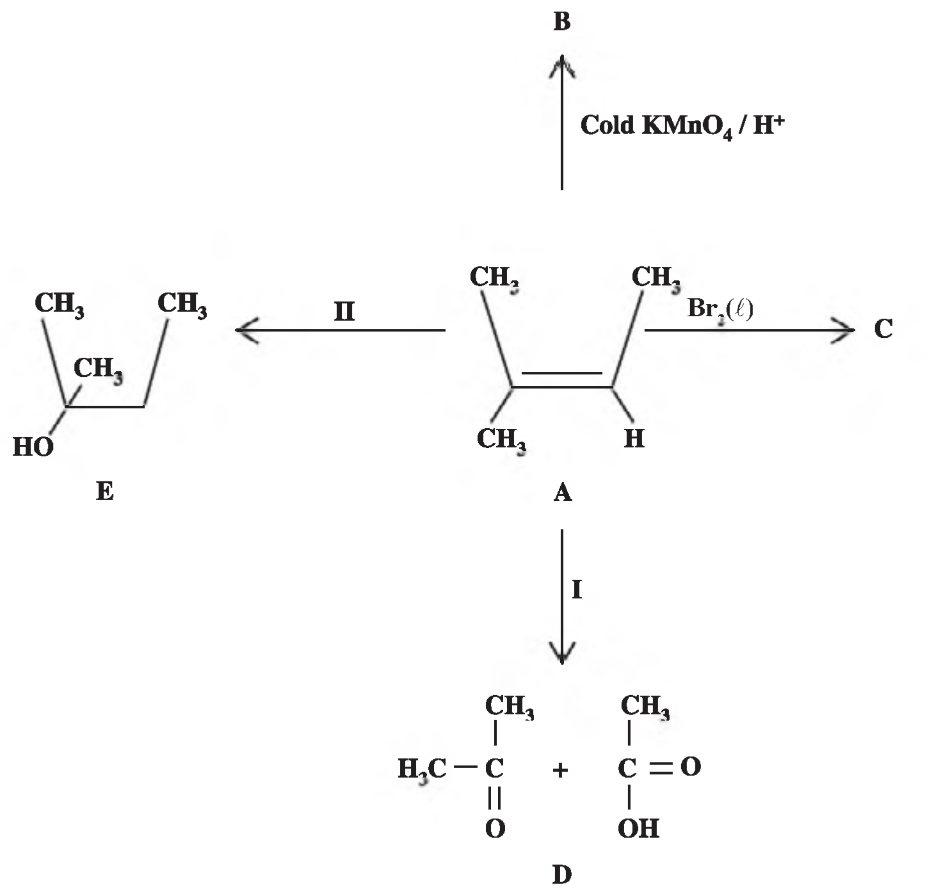


Figure 1. Reaction scheme

(a) State the reagents and/or conditions necessary for EACH of the following reactions:

(i) I (from **A** to **D**)

____

____

[2 marks]

(ii) II (from **A** to **E**)

____

____

[2 marks]

(b) Draw the structure for EACH of the following compounds:

(i) **B**

(ii) **C**

[2 marks]

(c) **A** can theoretically be used to make a polymer.

(i) What is meant by a 'polymer'?

____

____

[1 mark]

(ii) Identify the type of polymerisation **A** would MOST likely undergo.

____

[1 mark]

(iii) Name any ONE industrial polymer which could result from the polymerisation process named at (c) (ii) above.

____

[1 mark]

(iv) Suggest the repeat unit for a polymer made from **A**.

[1 mark]

(v) Can compounds such as those in **D** undergo addition polymerisation? Justify your answer.

____

____

[2 marks]

(d) Write the general structure of an amino acid.

[1 mark]

(e) Nylon 6.6 and proteins are macromolecules formed from the condensation of smaller molecules.

State the similarity and the difference between the structures of these macromolecules.

Similarity

Difference

[2 marks]

Total 15 marks

MODULE 2

ANALYTICAL METHODS AND SEPARATION TECHNIQUES

2. (a) State the meaning of EACH of the following terms:

(i) Electromagnetic radiation

____

____

____

(ii) Wavelength

____

____

(iii) Frequency

____

____

[3 marks]

(b) Using the formula, $\upsilon = c / \lambda$, calculate the missing frequencies and wavelengths in Table 1 and identify the corresponding type of electromagnetic radiation.
($c = 3.0 \times 10^8$ m s^{-1})

TABLE 1: PROPERTIES OF ELECTROMAGNETIC RADIATION

Wavelength (m)	**Frequency (Hz)**	**Type of Electromagnetic Radiation**
(i) ____________	3×10^{13}	(iii) ____________________
3.16	(ii) ____________	(iv) ____________________

[4 marks]

GO ON TO THE NEXT PAGE

(c) In the UV/VIS spectroscopic analysis of an organic compound, X, a beam of light of wavelength 200 nm is passed through the compound.

(i) State THREE steps that must be followed in preparing the sample of Compound X for UV/VIS spectroscopic analysis.

[3 marks]

(ii) Complexing reagents are sometimes used in the UV/VIS spectral analysis of compounds.

State TWO properties of complexing reagents which make them suitable for use in UV/VIS analysis.

[2 marks]

(d) Calculate EACH of the following:

(i) The amount of energy absorbed by one molecule of a compound where $\upsilon = 1.5 \times 10^{15}\ s^{-1}$

(Use $E = h\upsilon$, where $h = 6.63 \times 10^{-34}$ J s)

[1 mark]

(ii) The energy absorbed by one mole of the compound

[2 marks]

Total 15 marks

MODULE 3

INDUSTRY AND THE ENVIRONMENT

3. (a) Rain water in an unpolluted atmosphere has a pH of 5.6.

(i) Identify TWO gases in the atmosphere which contribute to this pH.

____

____

[2 marks]

(ii) Identify a natural source of EACH of the gases in (a) (i) above.

____

[2 marks]

(iii) Write a suitable equation to show the reaction of any ONE of the gases in (a) (i) with water.

____

[2 marks]

(b) Acid rain is a term used to describe rain water which has a pH less than 5. The occurrence of acid rain is more prevalent in industrialized, heavily populated areas.

(i) Briefly outline TWO factors that are responsible for acid rain in industrialized, heavily populated areas.

____

____

____

____

[2 marks]

(ii) Suggest TWO effects of acid rain on the environment.

____

____

____

____

[2 marks]

(c) 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.

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

____

____

[1 mark]

(ii) Name ONE reagent that you would use, to confirm the claim of contamination by EACH of the following:

Pb^{2+} ____

NO_3^- ____

[2 marks]

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

Pb^{2+} ____

NO_3^- ____

[2 marks]

Total 15 marks

SECTION B

Answer ALL questions in this section.

Write your answers in the separate answer booklet provided.

MODULE 1

THE CHEMISTRY OF CARBON COMPOUNDS

4. **A** and **B** are structural isomers.

$CH_2(OH)CH_2CH(CH_3)CH_2CH_2CH = CH(CH_3)$
A

$CH_3CH(CH_3)CH_2CH_2CH_2CH = CH(CH_2OH)$
B

(a) Explain why **A** and **B** are structural isomers. **[2 marks]**

(b) Name TWO functional groups present in BOTH molecules. **[2 marks]**

(c) **A** and **B** also show stereoisomerism.

(i) Draw the displayed formula of **A** and circle a chiral carbon atom on the molecule. **[2 marks]**

(ii) Draw geometrical isomers of **B**, AND suggest why **B** has NO optical isomers. **[3 marks]**

(d) (i) Explain what is meant by the term ‘cracking’. **[2 marks]**

(ii) The gaseous compound octane, C_8H_{18}, undergoes cracking to produce two hydrocarbon fragments, each containing the same number of carbon atoms.

a) Write the equation to represent the above process.

b) Describe a simple laboratory test to distinguish between these two hydrocarbon fragments. **[4 marks]**

Total 15 marks

MODULE 2

ANALYTICAL METHODS AND SEPARATION TECHNIQUES

5. (a) Mass spectrometry is used to measure particular characteristics of a given molecular sample. State THREE characteristics of a molecule that mass spectral data can be used to determine. **[3 marks]**

(b) Figure 2 shows the mass spectrum for a haloalkane containing chlorine.

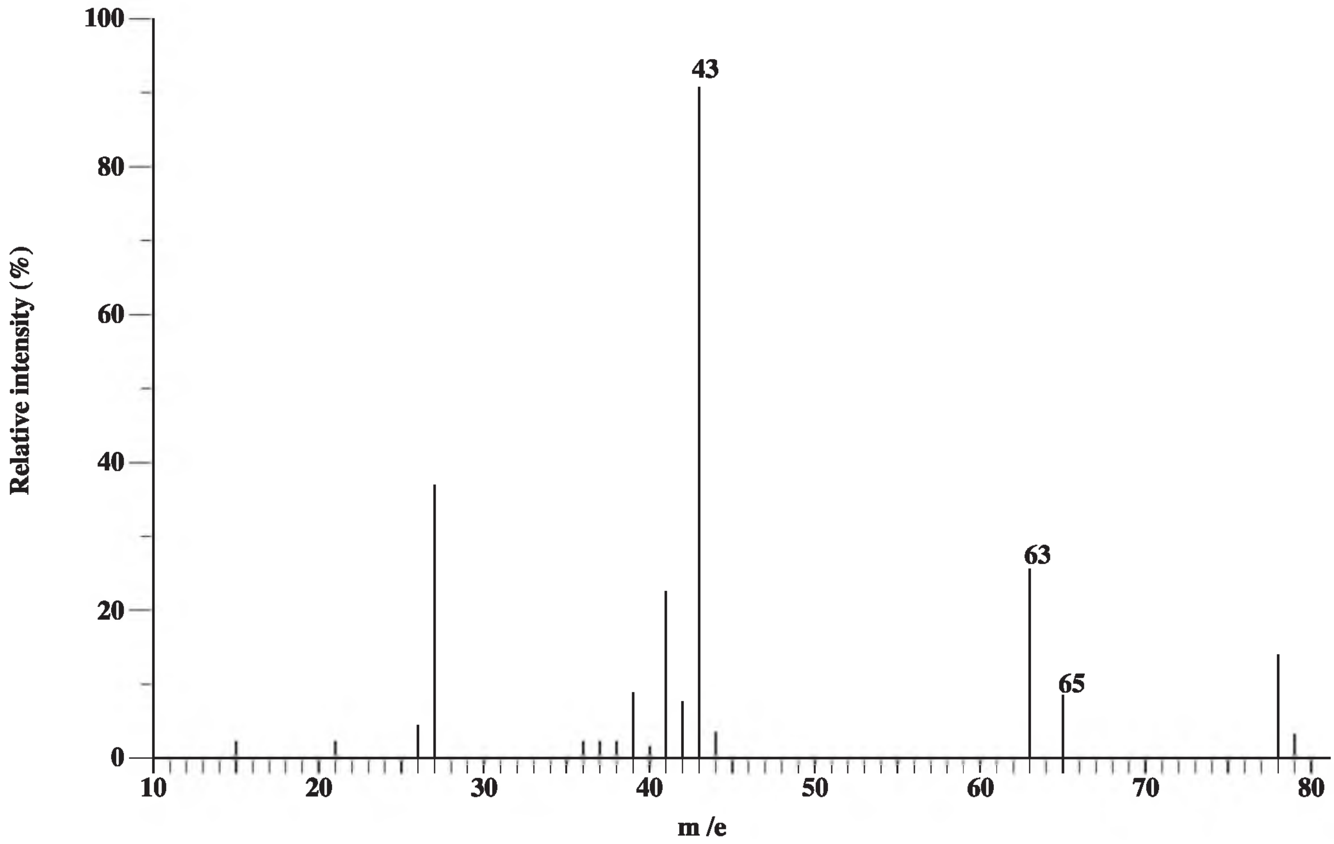


Figure 2. Mass spectrum for a haloalkane containing chlorine

(i) What is the m / e ratio of the M and M + 1 peak? **[2 marks]**

(ii) Deduce the formula of the fragments at m / e ratios: 43, 63 and 65. **[3 marks]**

(iii) Hence, deduce the formula of the M and M + 1 molecular ion species and name the compound. **[3 marks]**

(c) Chlorine has two isotopes with relative atomic masses of 34.97 and 36.96, and relative abundance of 75.77% and 24.23% respectively.

Deduce the average relative atomic mass of naturally occurring chlorine. **[2 marks]**

(d) Another separation technique used in industry is chromatography.

State TWO applications of chromatography. **[2 marks]**

Total 15 marks

MODULE 3

INDUSTRY AND ENVIRONMENT

6. Ammonia is manufactured from its elements by the Haber Process. The process taking place in the reaction chamber is represented by the equation

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g); \quad \Delta H^\theta = -92 \text{ kJ mol}^{-1}$$

(a) Identify the source and the process used to produce nitrogen. **[2 marks]**

(b) Hydrogen is obtained from natural gas by reaction with steam.

(i) State the name of the process. **[1 mark]**

(ii) Write the equation for its production. **[2 marks]**

(c) Using Le Chatelier's principle, describe the conditions under which optimal yields of ammonia can be obtained. **[2 marks]**

(d) Account for the differences between the conditions of (c) above with those used in the Haber Process. **[2 marks]**

(e) Water's ability to dissolve a wide range of substances accounts for it being easily polluted. The Showerdem River runs through the Niceness Valley. Drains from houses as well as crops enter the river directly. Three possible pollutants – nitrates, phosphates and lead – have been suggested by the Environmental Management Council (EMC) within the village.

Complete Table 2 to suggest ONE source for EACH pollutant and ONE effect of EACH pollutant.

TABLE 2: POLLUTANT, SOURCE AND EFFECT

Pollutant	Source	Polluting Effect
NO_3^-		
PO_4^{3-}		
Pb^{2+}		

[6 marks]

Total 15 marks

END OF TEST

FORM TP 2010153

TEST CODE **02212032**

MAY/JUNE 2010

C A R I B B E A N   E X A M I N A T I O N S   C O U N C I L

ADVANCED PROFICIENCY EXAMINATION

CHEMISTRY

UNIT 02 – Paper 03/2

ALTERNATIVE TO INTERNAL ASSESSMENT EXAMINATION

2 hours

You are advised to use the first 10 minutes for reading through this paper carefully.

READ THE FOLLOWING DIRECTIONS CAREFULLY.

1. **Answer ALL questions on this paper.**
2. **Use this answer booklet when responding to the questions. For EACH question, write your answer in the space indicated and return the answer booklet at the end of the examination.**
3. **The use of silent, non-programmable calculators is allowed.**
4. **A data booklet is provided.**

1. (a) You have been provided with five samples – three alcohols (A, B and C) and two carbonyl compounds (D and E). Carry out the following tests, being careful to add reagents gradually until no further change is observed, and shaking gently after each addition. Record your observations in Table 1 and Table 2 where relevant. Your recordings should include details of colour changes and precipitates formed.

TABLE 1: TESTS ON ALCOHOLS A, B AND C

Test	**Observations**		
	A	**B**	**C**
Carry out the following tests on approximately 2 cm^3 of each alcohol.			
(i) Add K_2CrO_7(aq) followed by a few drops of dilute H_2SO_4 and warm gently.			
(ii) Add approximately 2 cm^3 of NaOH(aq) followed by I_2 dropwise, until I_2 is no longer decolourized. Warm gently.			

GO ON TO THE NEXT PAGE

TABLE 2. TESTS ON CARBONYL COMPOUNDS D AND E

Test	Observations: D	Observations: E
Carry out the following tests on approximately 2 cm^3 of each carbonyl compound.		
(i) Add approximately 2 cm^3 of NaOH followed by I_2 dropwise, until I_2 is no longer decolourized.		
(ii) Add a few drops of 2, 4 – DNPH.		
(iii) To approximately 2 cm^3 of $AgNO_3$ add a few drops of NaOH(aq) followed by NH_3(aq) until the precipitate dissolves. Add the carbonyl compound and warm the mixture.		

[12 marks]

(b) Alcohols A, B and C may be 1-butanol, 2-methyl -2 - propanol or 2-butanol. Based on your observations in Table 1, identify EACH alcohol, A, B and C.

Sample	Alcohol
A	______________________
B	______________________
C	______________________

[3 marks]

(c) (i) Based on your observations in Table 2, identify the class of carbonyl compounds in the samples, D and E.

Sample	Carbonyl Compound
D	______________________
E	______________________

[2 marks]

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

____

____

[1 mark]

Total 18 marks

2. A student was required to determine the solubility of ammonium chloride using a back titration technique described by the following equations:

(i) NH_4Cl + NaOH → NaCl + NH_3 + H_2O + unreacted NaOH

(ii) NaOH + HCl → NaCl + H_2O

The procedure followed by the student is as follows:

(i) Pipette 5.0 cm^3 of saturated NH_4Cl solution into a 250.0 cm^3 volumetric flask and make up to the mark with distilled water. Label this solution A.

(ii) Pipette 20.0 cm^3 portions of Solution A into each of three 250 cm^3 conical flasks, adding 20 cm^3 of 0.200 ml dm^{-3} NaOH solution to each flask.

(iii) Heat the contents of each conical flask to boiling to remove all traces of ammonia.

(iv) Cool the flasks and contents, and titrate each against 0.100 mol dm^{-3} HCl solution using an appropriate indicator.

N.B.: For each titration the initial titre volume was taken as 0.50 cm^3.

Burette readings of the titre (volume) for each experiment are given in Figure 1.

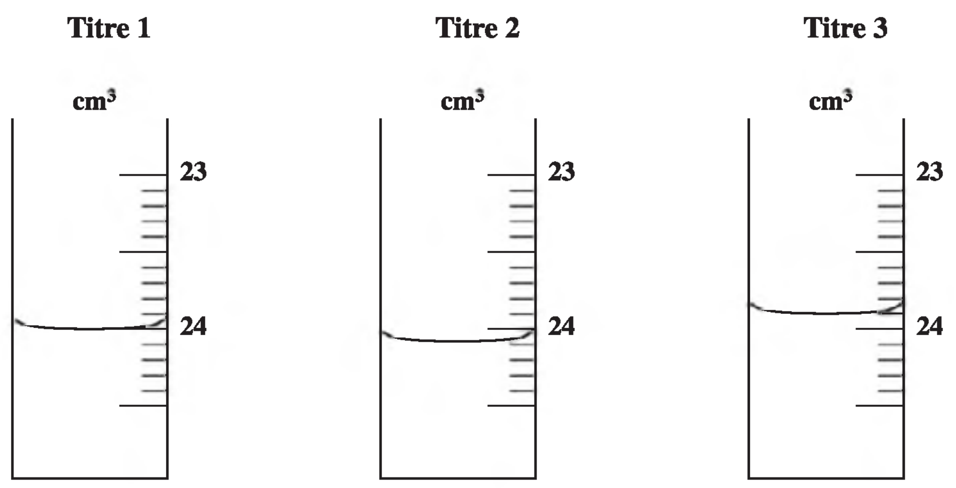


Figure 1. Burette readings for each experiment

(a) Using the readings in Figure 1, record the titre volumes of the experiments in Table 3.

TABLE 3: VOLUME OF TITRE

	Expt 1	Expt 2	Expt 3	
Final volume of HCl (cm^3)				
Initial volume of HCl (cm^3)	0.50	0.50	0.50	Avg. Volume
Volume of HCl used (cm^3)				

[4 marks]

(b) Calculate the number of moles of sodium hydroxide present in 20.0 cm^3 of NaOH solution.

____

____

____

____

[2 marks]

(c) Calculate the number of moles of HCl used in the titration.

____

____

____

____

[2 marks]

(d) Determine the number of moles of NaOH which remained after boiling with NH_4Cl solution.

____

____

____

____

[1 mark]

(e) Determine the number of moles of NH_4Cl present in 20.0 cm^3 of Solution A.

[2 marks]

(f) Calculate the number of moles of NH_4Cl present in 5.0 cm^3 of the saturated solution.

[2 marks]

(g) Calculate the solubility of NH_4Cl in water at room temperature in mol dm^{-3} and g dm^{-3} of solution.

Solubility of NH_4Cl in mol dm^{-3}:

Solubility of NH_4Cl in g dm^{-3}:

[3 marks]

(h) Suggest ONE way the student could determine that all the ammonia had been boiled off in Step (iii) of the experimental procedure (page 5).

[1 mark]

(i) Suggest a suitable indicator for the titration carried out in Step (iv) of the experimental procedure (page 5).

[1 mark]

Total 18 marks

3. You are told by your neighbour that the drinking water in the community contains traces of lead due to the lead pipes used in the community water system.

Use the following guidelines to plan and design an experiment to establish the truth of your neighbour's claim.

(i) Hypothesis:

[1 mark]

(ii) Reagents and equipment:

[3 marks]

(iii) Procedure:

____

____

____

____

[3 marks]

(iv) Variables

Controlled:

____

Manipulating:

____

Responding:

____

[3 marks]

(v) One precaution to be taken:

____

____

____

____

[1 mark]

(vi) Expected results:

____

____

____

____

[1 mark]

Total 12 marks

END OF TEST

TEST CODE **02112032 – IS**

FORM TP 2010150 – IS

MAY/JUNE 2010

C A R I B B E A N   E X A M I N A T I O N S   C O U N C I L

ADVANCED PROFICIENCY EXAMINATION

CHEMISTRY

UNIT 01 – Paper 03/2

ALTERNATIVE TO INTERNAL ASSESSMENT

07 MAY 2010 (a.m.)

INSTRUCTIONS FOR SETTING UP THE ALTERNATIVE TO INTERNAL ASSESSMENT EXAMINATION

The information contained in these instructions and the results obtained should NOT be communicated to candidates.

In addition to equipment, chemicals and other materials normally present in the laboratory, the following equipment and materials must be provided.

Question 1.

For EACH candidate:

(a) Solid A: mixture in equal proportions KBr and $MnCO_3$ (5g per candidate)

(b) Organic solvent, B, 1, 1, 2, 2–tetrachloroethane or chloroform or carbon tetrachloride

(c) Oxidising agent, C – sodium bismuthate or peroxodisulphate (sodium)

(d) Aqueous solution of chlorine, Cl_2 (aq), (bubble chlorine through distilled water for 1 minute)

On the day of the examination, the person responsible for preparing the practical MUST carry out the experiment as described on the question paper and SEND in a report using the attached form entitled "Supervisor's Report on the Practical Examination". These persons are reminded that, if this is not done, candidates may be at a disadvantage.

The experiment must be carried out using similar apparatus to, and the same materials as, those supplied to the candidates. It should also be performed at the same time as the examination, or immediately before or after. This person's work should NOT be seen by, nor should his/her results be communicated to the candidates either directly or indirectly.

N.B. **Supervisors are expected to report on the attached form, entitled "Supervisor's Report on the Practical Examination", on any special conditions which might have affected candidates' performances. Supervisors should specify whether all candidates were affected or if not, give the registration numbers of those candidates who were affected.**

Candidates are allowed to have practical notebooks and/or any materials relevant to the practical examination.

Candidates may be given additional materials without penalty.

If candidates lose time during the examination through no fault of their own, they must be awarded the equivalent time.

END OF INSTRUCTIONS

TEST CODE **02112032 – SR**

FORM TP 2010150 – SR

MAY/JUNE 2010

SCHOOL/CENTRE NUMBER							

NAME OF SCHOOL/CENTRE

C A R I B B E A N   E X A M I N A T I O N S   C O U N C I L

ADVANCED PROFICIENCY EXAMINATION

CHEMISTRY

UNIT 01 – Paper 03/2

ALTERNATIVE TO INTERNAL ASSESSMENT EXAMINATION

07 MAY 2010 (a.m.)

SUPERVISOR'S REPORT ON THE ALTERNATIVE TO INTERNAL ASSESSMENT EXAMINATION

This report MUST be completed by the person(s) SETTING UP the Practical Examination. When completed, it MUST accompany candidates' answer booklets for the Practical Examination.

TEACHER'S NAME
(Please print)

____

SUPERVISOR'S NAME
(Please print)

____

TEACHER'S SIGNATURE

____

SUPERVISOR'S SIGNATURE

____

N.B. Please ensure that all the information above is provided before this form is submitted.

Question 1

The person setting up this practical examination must carry out the exercise in Question 1 AT THE SAME TIME AS (OR VERY CLOSE TO) the examination. The results are to be entered into Table 1 below.

Test	Observations	Deductions
(i) Heat a small quantity of A with dilute HCl. Test for gas evolved.		
Shake A with distilled water for 2 mins, filte , keep residue and use filtrat to perform Tests (ii) and (iii).		
(ii) Add $AgNO_3$(aq) followed by dilute HNO_3.		
(iii) Add Cl_2(aq) followed by about 2 cm^3 of organic solvent B.		
Wash residue with distilled water, pierce filte paper, wash residue into boiling tube with dilute H_2SO_4, warm to dissolve solid. Carry out Tests (iv) and (v) with portions of the solution.		

(iv) Add NaOH(aq), let stand for about 2 mins, then add H_2O_2.		
(v) Add a few grains of oxidizing agent C.		

Any special conditions that may have affected the performance of individual candidates. (Indicate registration numbers.)

TEST CODE **02212032 – IS**

FORM TP 2010153 – IS

MAY/JUNE 2010

CARIBBEAN EXAMINATIONS COUNCIL

ADVANCED PROFICIENCY EXAMINATION

CHEMISTRY

UNIT 02 – Paper 03/2

ALTERNATIVE TO INTERNAL ASSESSMENT

19 MAY 2010 (a.m.)

INSTRUCTIONS FOR SETTING UP THE ALTERNATIVE TO INTERNAL ASSESSMENT EXAMINATION

The information contained in these instructions and the results obtained should NOT be communicated to candidates.

In addition to equipment, chemicals and other materials normally present in the laboratory, the following equipment and materials must be provided.

Question 1.

For EACH candidate:

(a) Sample A – 2-butanol

(b) Sample B – 2-methyl-2-propanol

(c) Sample C – 1-butanol

(d) Sample D – acetone / propanone

(e) Sample E – methanal / formaldehyde

<u>Reagents</u>

(a) 2, 4-dinitrophenylhydrazine (2, 4 -DNPH)

(b) Tollen's reagent

(c) Iodine solution

On the day of the examination, the person responsible for preparing the practical MUST carry out the experiment as described on the question paper and SEND in a report using the attached form entitled "Supervisor's Report on the Practical Examination". These persons are reminded that, if this is not done, candidates may be at a disadvantage.

The experiment must be carried out using similar apparatus to, and the same materials as, those supplied to the candidates. It should also be performed at the same time as the examination, or immediately before or after. This person's work should NOT be seen by, nor should his/her results be communicated to the candidates either directly or indirectly.

N.B. **Supervisors are expected to report on the attached form, entitled "Supervisor's Report on the Practical Examination", on any special conditions which might have affected candidates' performances. Supervisors should specify whether all candidates were affected or if not, give the registration numbers of those candidates who were affected.**

Candidates are allowed to have practical notebooks and/or any materials relevant to the practical examination.

Candidates may be given additional materials without penalty.

<u>If candidates lose time during the examination through no fault of their own, they must be awarded the equivalent time.</u>

END OF INSTRUCTIONS

TEST CODE **02212032 – SR**

FORM TP 2010153 – SR

MAY/JUNE 2010

SCHOOL/CENTRE NUMBER							

NAME OF SCHOOL/CENTRE

C A R I B B E A N   E X A M I N A T I O N S   C O U N C I L

ADVANCED PROFICIENCY EXAMINATION

CHEMISTRY

UNIT 02 – Paper 03/2

ALTERNATIVE TO INTERNAL ASSESSMENT EXAMINATION

19 MAY 2010 (a.m.)

SUPERVISOR'S REPORT ON THE ALTERNATIVE TO INTERNAL ASSESSMENT EXAMINATION

This report MUST be completed by the person(s) SETTING UP the Practical Examination. When completed, it MUST accompany candidates' answer booklets for the Practical Examination.

TEACHER'S NAME
(Please print)

____

SUPERVISOR'S NAME
(Please print)

____

TEACHER'S SIGNATURE

____

SUPERVISOR'S SIGNATURE

____

N.B. Please ensure that all the information above is provided before this form is submitted.

Question 1

The person setting up this practical examination must carry out the exercise in Question 1 AT THE SAME TIME AS (OR VERY CLOSE TO) the examination. The results are to be entered into Table 1 and Table 2 where appropriate.

TABLE 1: TEST ON ALCOHOLS A, B AND C

Test	**Observations**		
	A	**B**	**C**
Carry out the following tests on approximately 2 cm^3 of each alcohol.			
(i) Add K_2CrO_7(aq) followed by a few drops of dilute H_2SO_4 and warm gently.			
(ii) Add approximately 2 cm^3 of NaOH(aq) followed by I_2 dropwise, until I_2 is no longer decolourized. Warm gently.			

TABLE 2. TESTS ON CARBONYL COMPOUNDS

Test	Observations	
	D	**E**
Carry out the following tests on approximately 2 cm^3 of each carbonyl compound.		
(i) Add approximately 2 cm^3 of NaOH followed by I_2 dropwise, until I_2 is no longer decolourized.		
(ii) Add a few drops of 2, 4 – DNPH.		
(iii) To approximately 2 cm^3 of $AgNO_3$ add a few drops of NaOH(aq) followed by NH_3(aq) until the precipitate dissolves. Add the carbonyl compound and warm the mixture.		

GO ON TO THE NEXT PAGE

Any special conditions that may have affected the performance of individual candidates. (Indicate registration numbers.)

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TEST CODE **02112020**

FORM TP 2011153

MAY/JUNE 2011

C A R I B B E A N   E X A M I N A T I O N S   C O U N C I L

ADVANCED PROFICIENCY EXAMINATION

CHEMISTRY

UNIT 1 – 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 silent 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

FUNDAMENTALS IN CHEMISTRY

1. (a) In 1803, John Dalton came up with a series of postulates concerning the atom which later became known as Dalton's atomic theory.

(i) List FOUR postulates of Dalton's atomic theory.

[4 marks]

(ii) Identify TWO of Dalton's postulates which were proven invalid by modern atomic theory.

[2 marks]

(b) A student was asked to investigate the relative reducing abilities of the elements zinc and copper.

(i) List TWO chemicals and ONE piece of apparatus that the student may use to carry out the investigation.

Chemicals: ______________________________

Apparatus: ______________________________

[3 marks]

(ii) Describe ONE physical change that the student may have observed.

____

[1 mark]

(iii) Identify the reducing agent in the experiment.

____

[1 mark]

(iv) Write relevant half equations to illustrate the chemical changes that occur with EACH element.

____

____

[2 marks]

(v) From the half equations in (iv), deduce a **balanced** equation for the redox reaction.

____

____

[2 marks]

Total 15 marks

MODULE 2

KINETICS AND EQUILIBRIA

2. (a) List

(i) the factor which affects the solubility product constant, K_{sp}

____

____

[1 mark]

(ii) ONE factor (except that in (i) above) which influence the solubility of a salt.

____

[1 mark]

(b) Describe the 'common ion effect' as it relates to the solubility of salts.

____

____

[2 marks]

(c) One type of kidney stones is formed by the precipitation of calcium phosphate ($Ca_3(PO_4)_2$), which has a K_{sp} of 1.3×10^{-32} at 25 °C. A patient submitted a urine sample which contained concentrations of 1.2×10^{-4} mol dm^{-3} calcium ions and 1.1×10^{-8} mol dm^{-3} phosphate ions.

(i) Write a **balanced** equation for the formation of calcium and phosphate ions from calcium phosphate.

____

[2 marks]

(ii) Write the expression for the solubility product constant for calcium phosphate.

____

[2 marks]

(iii) Calculate the ionic product of calcium phosphate in the patient's urine.

____

____

[1 mark]

GO ON TO THE NEXT PAGE

(iv) State why kidney stones are likely to form in the patient's urine.

[1 mark]

(d) Outline an experimental procedure for the determination of the solubility product constant of barium hydroxide $Ba(OH)_2$.

[5 marks]

Total 15 marks

GO ON TO THE NEXT PAGE

MODULE 3

CHEMISTRY OF THE ELEMENTS

3. (a) Group II elements exhibit an oxidation number of +2 in their compounds.

Write the ionic equation of such an element, M, to show the formation of the ion present.

____

[1 mark]

(b) The second ionisation energy for some members of Group II are provided in Table 1.

TABLE 1: DATA FOR SOME GROUP II ELEMENTS

Elements	**Mg**	**Ca**	**Sr**	**Ba**
Second Ionisation Energy (kJ mol^{-1})	1450	1150	1060	970

Use the information in Table 1 to account for the differences in reactivity of the elements shown.

____

____

____

[3 marks]

(c) Radium, Ra, is the last member of the Group II elements. Using a knowledge of Group II chemistry,

(i) comment on the solubility of the sulphate of radium in water

____

(ii) write the **balanced** equation for the thermal decomposition of the nitrate of radium, $Ra(NO_3)_2$.

____

[3 marks]

(d) (i) State the steps that should be taken in the investigation of the differences in solubility of the sulphates of magnesium, calcium and barium.

[3 marks]

(ii) List the names of the reagents that may be used in the investigation.

[2 marks]

(e) List THREE uses of calcium carbonate.

[3 marks]

Total 15 marks

SECTION B

Answer ALL questions.

Write your answers in the separate answer booklet provided.

MODULE 1

FUNDAMENTALS IN CHEMISTRY

4. (a) State the FOUR basic assumptions of the kinetic theory with reference to an ideal gas. **[4 marks]**

(b) 0.785 g of an organic compound, Z, was vapourized at 100 °C and 101.325 kPa. The vapour occupied a volume of 0.40 dm^3. Calculate the relative molecular mass of Z ($R = 8.314$ J K^{-1} mol^{-1}). **[3 marks]**

(c) (i) State Hess's Law. **[2 marks]**

(ii) Construct a diagram of a well-labelled Born-Haber cycle showing the formation of magnesium oxide (MgO) from magnesium metal and oxygen gas. On your diagram, show **clearly ALL** the enthalpy changes and species involved in the process. **[6 marks]**

Total 15 marks

MODULE 2

KINETICS AND EQUILIBRIA

5. (a) (i) Why is chemical equilibrium referred to as dynamic? **[1 mark]**

(ii) State THREE characteristics of a chemical system at equilibrium. **[3 marks]**

(b) Defin the equilibrium constant, K_c, and describe its significance to a system in dynamic equilibrium. In your response make reference to the importance of its magnitude. **[3 marks]**

(c) At a certain temperature, $K_c = 4.66 \times 10^{-3}$ for the reaction
$N_2O_4\ (g) \rightleftharpoons 2NO_2\ (g)$, $\Delta H^{\theta} = +58$ kJ mol^{-1}.

(i) Calculate the equilibrium concentration of EACH gas, at the same temperature, if 0.800 moles of N_2O_4 were injected into a closed container of volume 1 dm^3. **[6 marks]**

(ii) Using Le Chatelier's principle, describe the effect, on the equilibrium position, of decreasing the volume of the container. **[1 mark]**

(iii) Describe the effect on the equilibrium constant, K_c, of increasing the temperature of the reaction. **[1 mark]**

Total 15 marks

MODULE 3

CHEMISTRY OF THE ELEMENTS

6. (a) Copy and complete the information in Table 2 regarding some physical properties of elements in Group IV of the Periodic Table.

TABLE 2: SOME PHYSICAL PROPERTIES OF ELEMENTS IN GROUP IV

Element	**C (Diamond)**	**Si**	**Sn**	**Pb**
Electrical Conductivity	__________	Semi-conductor	__________	Conductor
Structure	Giant molecular	__________	Giant metallic	____________

[4 marks]

(b) Both melting and boiling points of Group IV elements decrease from carbon to lead while there is an increase in their densities.

Use a knowledge of structure and bonding to explain these trends. **[4 marks]**

(c) Account for the following observations, using the bonding present in the compounds.

(i) Silicon tetrachloride is a volatile liquid at room temperature. **[1 mark]**

(ii) When exposed to the atmosphere, $SiCl_4$ produces white fumes while no such fumes are produced with CCl_4. **[3 marks]**

(d) With reference to (c) (ii) above,

(i) name the type of reaction taking place

(ii) state the name and the formula of the substance responsible for the presence of the white fumes. **[2 marks]**

(e) State ONE use of a ceramic material based on silicon (IV) oxide. **[1 mark]**

Total 15 marks

END OF TEST

TEST CODE **02112032**

FORM TP 2011154

MAY/JUNE 2011

C A R I B B E A N   E X A M I N A T I O N S   C O U N C I L

ADVANCED PROFICIENCY EXAMINATION

CHEMISTRY

UNIT 1 – Paper 03/2

ALTERNATIVE TO INTERNAL ASSESSMENT EXAMINATION

2 hours

You are advised to use the first 10 minutes for reading through the paper carefully.

READ THE FOLLOWING INSTRUCTIONS CAREFULLY.

1. Answer ALL questions on this paper.
2. Use this answer booklet when responding to the questions. For EACH question, write your answer in the space indicated and return the answer booklet at the end of the examination.
3. The use of silent non-programmable calculators is allowed.
4. A data booklet is provided.

NOTHING HAS BEEN OMITTED.

1. You are provided with a saturated solution of calcium hydroxide, $Ca(OH)_2$. Carry out the following experiment to determine the solubility product constant at room temperature for $Ca(OH)_2$.

(a) Procedure:

(i) Filter 100 cm^3 of a saturated solution of calcium hydroxide, $Ca(OH)_2$.

(ii) Transfer (using a pipette) 20 cm^3 of the filtered $Ca(OH)_2$ solution into a 250 cm^3 conical flask and add TWO drops of screened methyl orange indicator.

(iii) Fill your burette with 0.0500 mol dm^{-3} HCl.

(iv) Titrate your calcium hydroxide solution against the HCl in the burette.

(v) Record in Table 1, to two decimal places, both your initial burette reading and the reading at the end point.

(vi) Repeat steps (ii) - (iv) until consistent results are obtained.

TABLE 1: DATA FOR EXPERIMENTAL PROCEDURE

Titration	**1**	**2**	**3**
Final burette reading (cm^3)			
Initial burette reading (cm^3)			
Volume of HCl used (cm^3)			

[6 marks]

(b) Calculate the volume of HCl used for the titration.

[1 mark]

(c) Write a **balanced** equation for the reaction between $Ca(OH)_2$ and HCl.

____

[2 marks]

(d) Calculate the number of moles of HCl used in the titration.

[1 mark]

(e) Calculate the number of moles of $Ca(OH)_2$ used in the titration.

[1 mark]

(f) Write an equation for the dissociation of $Ca(OH)_2$.

____

[1 mark]

(g) Calculate the number of moles of Ca^{2+} ions used in the titration.

[1 mark]

(h) Calculate the number of moles of OH^- ions used in the titration.

[1 mark]

(i) Calculate the concentration in mol dm^{-3} of Ca^{2+} and OH^{-} ions present in the $Ca(OH)_2$ solution.

[2 marks]

(j) Write the K_{sp} expression for $Ca(OH)_2$.

____

[1 mark]

(k) Calculate K_{sp} at room temperature for $Ca(OH)_2$.

[1 mark]

Total 18 marks

2. A student was asked to find the heat of neutralization for the reaction between 50 cm^3 of 2.0 mol dm^{-3} HCl and 50 cm^3 of an equimolar solution of NaOH. The student recorded the initial temperatures of the HCl and NaOH solutions and found them both to be 23.26 °C. After mixing the solutions, the student recorded the temperature of the mixture every 20 seconds for 3 minutes. The recorded temperatures were 28.50, 28.55, 28.48, 28.38, 28.27, 28.16, 28.05, 27.95 and 27.84 °C.

(a) Construct a table to record the observations of the student.

[3 marks]

(b) On the axes provided in Figure 1 on page 7, and using a scale of 1 cm to represent 10 seconds on the horizontal axis and 2 cm to represent 0.1 °C on the vertical axis (beginning at 27.6 °C), plot a graph of temperature vs time for the reaction.

[6 marks]

(c) Explain the shape of the curve obtained from your graph.

____

____

____

[2 marks]

(d) Write the equation for the neutralization reaction.

____

[1 mark]

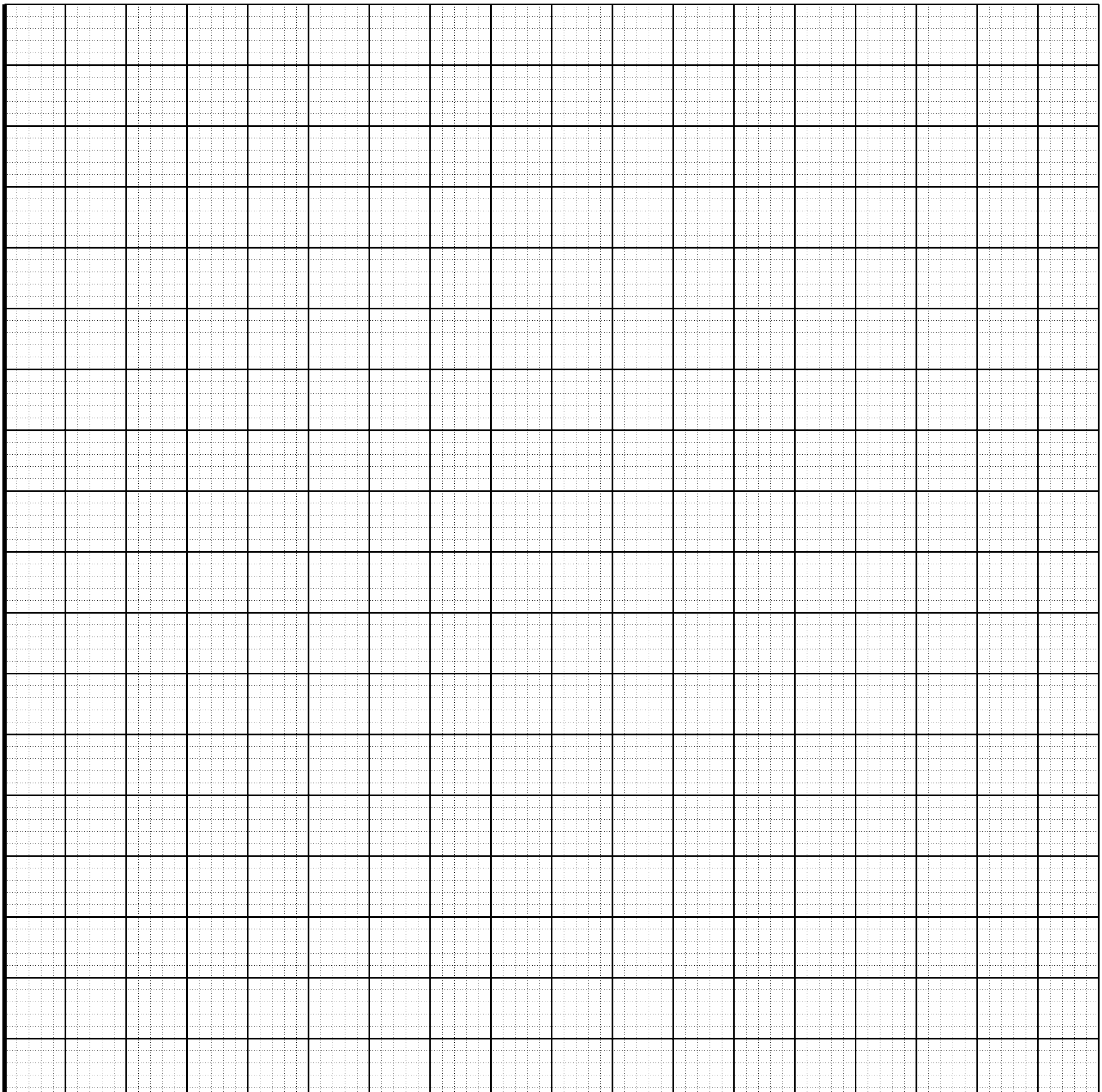


Figure 1

(e) Assuming the heat capacity of the calorimeter is negligible and can therefore be ignored, calculate the heat of the reaction in Joules.

(Density and heat capacity of all solutions are assumed to be 1.01 g cm^{-3} and 4.18 Jg^{-1} °C^{-1} respectively).

[4 marks]

(f) Calculate the enthalpy change of the reaction in kJ mol^{-1}.

[2 marks]

Total 18 marks

3. A chemistry student was taught that groups of elements in the Periodic Table exhibit variations in their chemical properties. The student was encouraged to investigate the variation in reactivities of the Group VII elements.

Plan and design an experiment that could be used by the student in his or her investigation.

Your answer should include:

(a) Aim

[1 mark]

(b) Hypothesis

[1 mark]

GO ON TO THE NEXT PAGE

(c) Apparatus and materials

____

____

____

____

[3 marks]

(d) Experimental procedure

____

____

____

____

____

[3 marks]

(e) Variables

(i) Manipulated

____

(ii) Responding

____

(iii) Controlled

____

[3 marks]

(f) Treatment of results

____

____

[1 mark]

Total 12 marks

END OF TEST

TEST CODE **02212020**

FORM TP 2011156

MAY/JUNE 2011

C A R I B B E A N   E X A M I N A T I O N S   C O U N C I L

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 silent non-programmable calculators is permitted.
6. A data booklet is provided.

SECTION A

Answer ALL questions in this section.

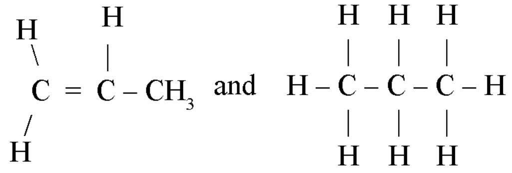
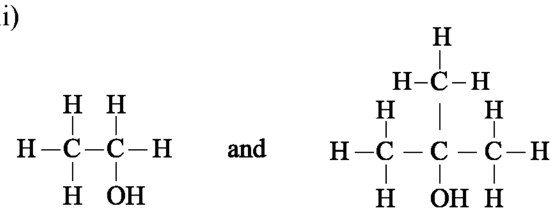
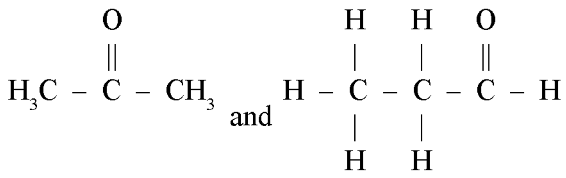
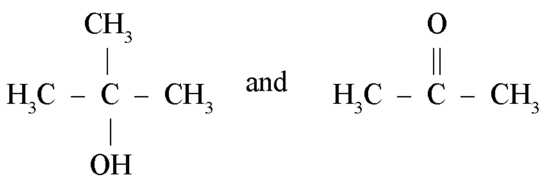
Write your answers in the spaces provided in this booklet.

MODULE 1

THE CHEMISTRY OF CARBON COMPOUNDS

1. (a) Complete Table 1 by indicating simple test tube reactions used to distinguish between the pairs of compounds indicated. Record your expected observations in the spaces provided.

TABLE 1: TEST TUBE REACTIONS FOR DISTINGUISHING PAIRS OF CARBON COMPOUNDS

Compounds	Test	Observation
(i)  **A** **B**	Addition of Br_2(aq) to both A and B	Compound A decolourized Br_2(aq); colour changes from brown to colourless
(ii)  A B		
(iii)  **A** **B**	Addition of Tollen's reagent to both A and B	
(iv)  **A** **B**		

[5 marks]

(b) The structural formula of A (2-bromo-2-methylpropane) is given below.

$$
\begin{array}{c}
CH_3 \\
| \\
H_3C - C - CH_3 \\
| \\
Br
\end{array}
$$

A

(i) Show the steps involved in the mechanism of the reaction between A and sodium hydroxide. Use curved arrows and fish hook notation to show the movement of electrons.

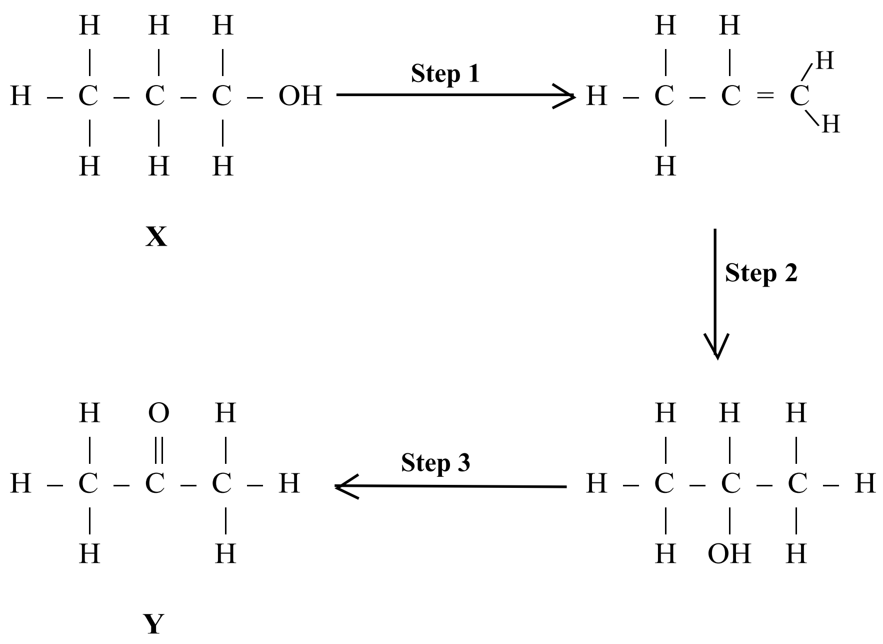
[4 marks]

(ii) State the name of the reaction mechanism outlined in (b) (i) above.

____

[1 mark]

(c) The reaction scheme below shows the conversion of Compound X to Compound Y in three steps.



(i) State the reagent(s) used for the conversion at EACH step.

Step 1 ______________________________

Step 2 ______________________________

Step 3 ______________________________

[4 marks]

(ii) Name the process which occurs in Step 3 of the reaction.

____

[1 mark]

Total 15 marks

MODULE 2

ANALYTICAL METHODS AND SEPARATION TECHNIQUES

2. (a) Distinguish between the terms 'precision' and 'accuracy'.

[3 marks]

(b) A student was asked to measure 50 cm^3 of a liquid in order to carry out an experiment.

List THREE pieces of apparatus that could be used to accurately measure the required volume.

[2 marks]

(c) Each of four students carried out an experiment to determine the percentage of acetic acid in a vinegar sample. The procedure was repeated four times by each student and the results recorded in Table 2.

(i) Complete Table 2 by calculating the standard deviation (SD) of EACH of the four sets of results, using the formula

$$SD = \sqrt{\frac{\sum(x - \overline{x})^2}{n - 1}} .$$

TABLE 2: RESULTS OF EXPERIMENT

Student	Volume 1 (cm^3)	Volume 2 (cm^3)	Volume 3 (cm^3)	Volume 4 (cm^3)	Mean, $\overline{x}$ (cm^3)	SD
1	24.15	24.20	24.10	24.05	24.13	
2	26.00	24.00	24.00	26.00	25.00	
3	29.15	24.95	33.25	27.75	28.78	
4	25.10	24.90	25.00	25.00	25.00	

[2 marks]

(ii) Evaluate the results obtained by EACH student by commenting on the accuracy and precision of EACH set of titre volumes.

Student 1: ______________________________

Student 2: ______________________________

Student 3: ______________________________

Student 4: ______________________________

[4 marks]

(d) A student was asked to calibrate a 10 cm^3 pipette. Outline the experimental steps that should be taken by the student to complete this exercise.

____

____

____

____

____

____

____

____

[4 marks]

Total 15 marks

MODULE 3

INDUSTRY AND THE ENVIRONMENT

3. (a) Outline the THREE principles of the primary distillation of crude oil.

[3 marks]

(b) To meet the requirements of modern industry, secondary refining processes such as 'cracking' and 'reforming' are used.

Define the terms

(i) Cracking

(ii) Reforming

[2 marks]

(c) Octane undergoes cracking to produce two hydrocarbons, one of which is butane.

Write the **balanced** equation which represents this process.

[2 marks]

(d) The products of cracking are widely used as raw materials in the manufacture of petrochemicals.

State THREE uses of these products.

[3 marks]

(e) Figure 1 shows the materials used to illustrate the process of fermentation.

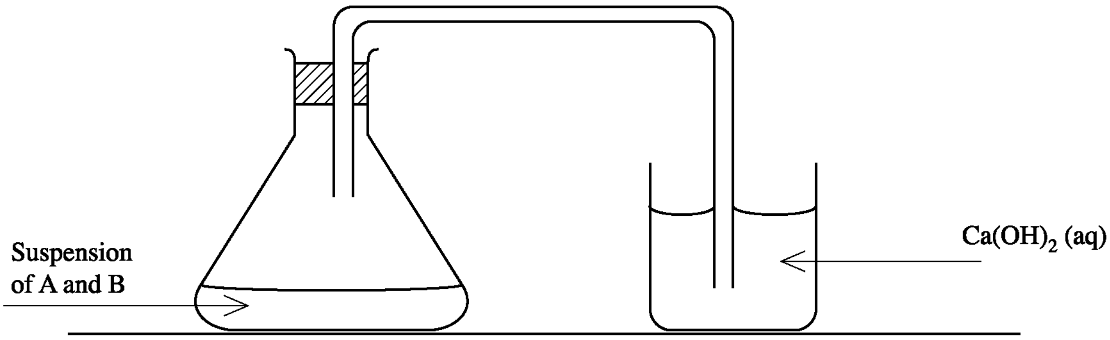


Figure 1. Fermentation process

(i) State the names of the substances A and B in the suspension.

A. ______________________________

B. ______________________________

[2 marks]

(ii) State what would be observed after a period of time in the

– conical flask

____

– beaker.

____

[2 marks]

(iii) The fermentation process is carried out in surroundings where the temperature is controlled. Very high temperatures must be avoided. Give a reason for this condition.

____

[1 mark]

Total 15 marks

SECTION B

Answer ALL questions in this section.

Write your answers in the separate answer booklet provided.

MODULE 1

THE CHEMISTRY OF CARBON COMPOUNDS

4. (a) (i) Define the term ‘structural isomerism’ **[2 marks]**

(ii) Identify TWO types of structural isomers, giving an example of EACH. **[4 marks]**

(b) 10 cm^3 of a gaseous hydrocarbon were mixed with 45 cm^3 of oxygen and exploded in a reaction chamber. After cooling to room temperature, the residual gases occupied 30 cm^3. By absorption with NaOH solution, a decrease in volume of 20 cm^3 was produced. The remaining gas was shown to be oxygen. Determine the molecular formula of the hydrocarbon. (Pressure remained constant at 1 atm.) **[4 marks]**

(c) Explain the difference in acidity of alcohols, phenols and carboxylic acids. In your response, make reference to acid strength, inductive and conjugative effects. **[5 marks]**

Total 15 marks

MODULE 2

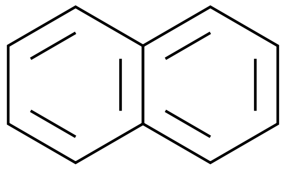
ANALYTICAL METHODS AND SEPARATION TECHNIQUES

5. (a) (i) State the source of absorption in UV/VIS spectroscopy. **[1 mark]**

(ii) Use an energy level diagram to show the electronic transitions that can occur in UV/VIS spectroscopy. **[3 marks]**

(b) (i) Define the term 'chromophore' **[1 mark]**

Naphthalene, P, the formula for which is given below, is a constituent of coal tar, a crude oil residue.



(ii) Suggest the chromophore in P that is responsible for the absorption of UV radiation. **[1 mark]**

A sample of coal tar was subjected to solvent extraction using ethanol. The volume of extract was reduced and a solution of P was obtained by separation techniques.

A sample of the solution in a cell of path 1 cm gave an absorbance of 1.2 at a wavelength of 312 nm and an extinction coefficient (molar absorptivity) of 288 $dm^3\ mol^{-1}\ cm^{-1}$.

(iii) Calculate the concentration of P in the solution. **[3 marks]**

(c) Explain the use of calibration curves and standard solutions in UV/VIS analysis. **[4 marks]**

(d) List TWO uses of UV/VIS spectroscopy in chemical analysis. **[2 marks]**

Total 15 marks

MODULE 3

INDUSTRY AND ENVIRONMENT

6. Figure 2 presents a simplified version of the nitrogen cycle with some components, A, B, C and D, unlabelled.

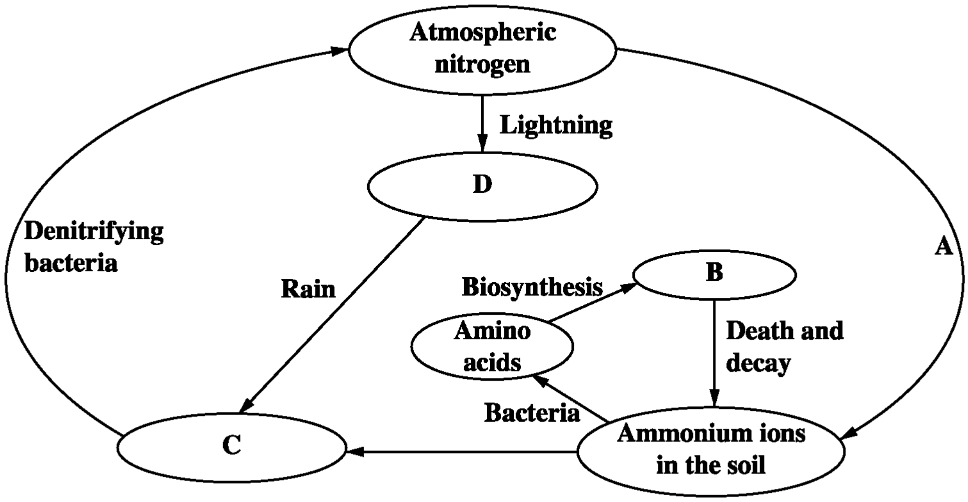


Figure 2. The nitrogen cycle

(a) Identify the unlabelled components, A, B, C and D, in Figure 2. **[4 marks]**

(b) The nitrogen and carbon cycles have natural sources which enable the maintenance of balance. However, the input of additional gases due to human activity has led to the disturbance of the existing balance.

State TWO human activities that have led to the disturbance of the balance of these cycles. **[2 marks]**

(c) Explain, with the use of relevant equations, the processes which allow for the maintenance of the concentration of ozone in the stratosphere.

In your answer, discuss the process of oxygen formation and decomposition.
[9 marks]

Total 15 marks

END OF TEST

TEST CODE **02212032**

FORM TP 2011157

MAY/JUNE 2011

C A R I B B E A N   E X A M I N A T I O N S   C O U N C I L

ADVANCED PROFICIENCY EXAMINATION

CHEMISTRY

UNIT 2 – Paper 03/2

ALTERNATIVE TO INTERNAL ASSESSMENT EXAMINATION

2 hours

You are advised to use the first 10 minutes for reading through the paper carefully.

READ THE FOLLOWING DIRECTIONS CAREFULLY.

1. Answer ALL questions on this paper.
2. Use this answer booklet when responding to the questions. For EACH question, write your answer in the space indicated and return the answer booklet at the end of the examination.
3. The use of silent non-programmable calculators is allowed.
4. A data booklet is provided.

1. You are provided with two organic liquids, P and Q. Carry out the following experiments on the two organic liquids, P and Q. Record your observations and deductions in the spaces provided in Table 1.

Your answer should include

– colour changes

– names of gases evolved and details of the tests used to identify EACH.

TABLE 1: DATA FOR EXPERIMENTAL PROCEDURES

Tests	Observations	Deductions
(a) Tests with liquid P (i) Place about 3 cm^3 of P in a test tube, add dil H_2SO_4 and about 1 cm^3 of $KMnO_4(aq)$, warm gently.	**[1 mark]**	**[1 mark]**
(ii) Repeat test (i) using $K_2Cr_2O_7(aq)$ in place of $KMnO_4(aq)$.	**[2 marks]**	**[1 mark]**
(iii) Place about 3 cm^3 of P in a boiling tube, add equal volume of conc. H_2SO_4. Carefully heat mixture and pass gas evolved through $Br_2(aq)$.	**[2 marks]**	**[1 mark]**

GO ON TO THE NEXT PAGE

Tests	Observations	Deductions
(b) Tests with liquid Q. (i) Add a piece of Mg ribbon to about 3 cm^3 of Q in a test tube. Warm gently.	**[2 marks]**	**[1 mark]**
(ii) Add some solid sodium hydrogen carbonate to about 3 cm^3 of Q in a test tube.	**[1 mark]**	**[1 mark]**
(iii) a) In a boiling tube place about 3 cm^3 of Q and an equal volume of P. Add carefully about 1 cm^3 of conc. H_2SO_4 and boil for about 1 minute.		
b) Transfer contents of boiling tube into a small beaker and carefully dilute with equal volume of water and allow to stand.	**[2 marks]**	**[1 mark]**

Identify the functional group in P ______________________________

[1 mark]

Identify the functional group in Q ______________________________

[1 mark]

Total 18 marks

2. (a) An experiment was carried out to investigate the changes in pH during the titration of 20 cm^3 of a 0.1 mol dm^{-3} solution of HCl with a solution of a base X.

The graph shown in Figure 1 on page 5 was obtained by observing the volume of X added to the acid which produced values of pH 1.2, 1.4, 1.8, 2.3, 3.6, 5.5, 7.1, 8.2, 8.7, 8.8.

(i) Using the graph provided in Figure 1, construct a table to record observations of volume of X added in dm^3 and values of pH.

[5 marks]

(ii) Account for the shape of the graph.

____

____

[3 marks]

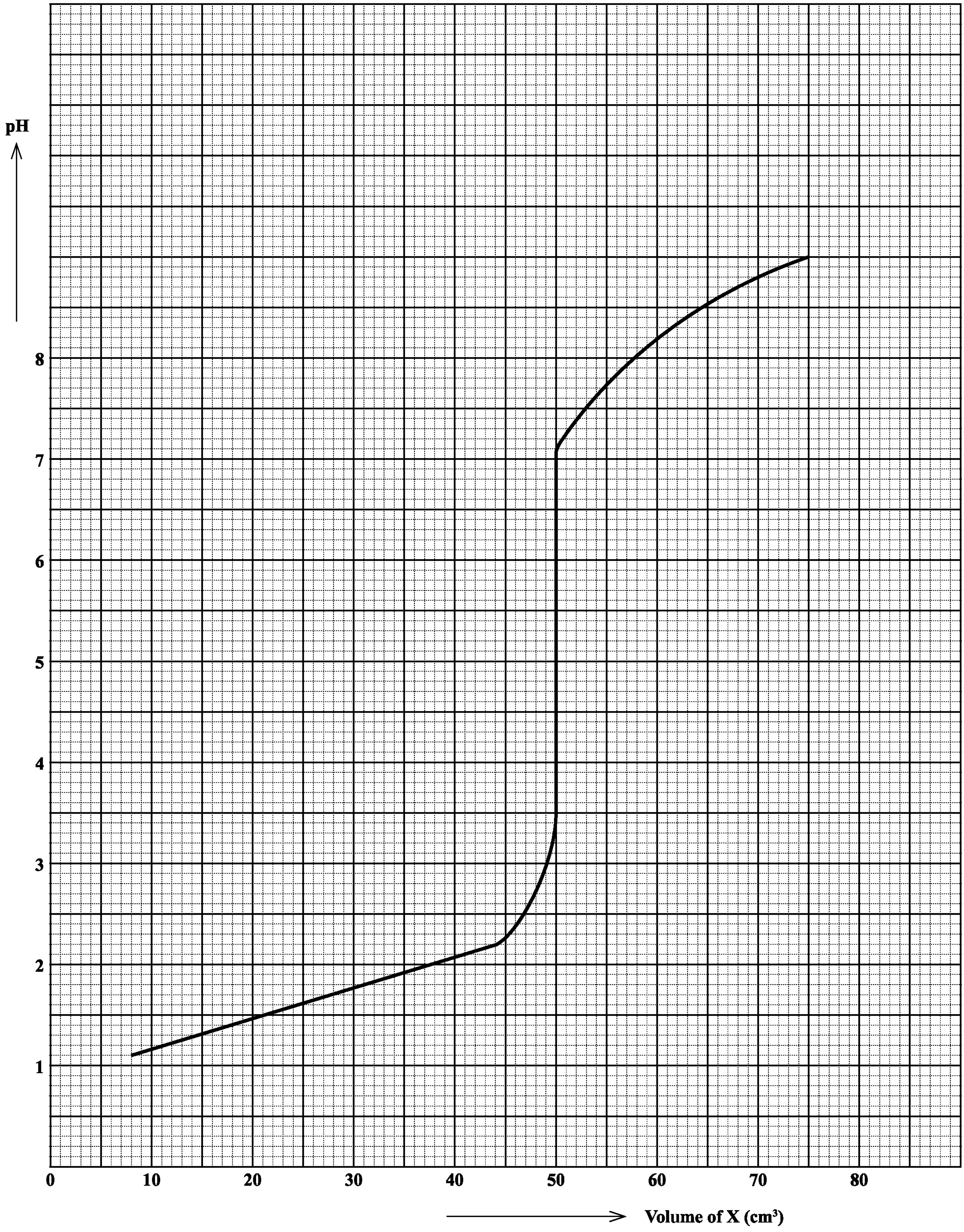


Figure 1. Changes in pH during a titration

(b) (i) Defin the term 'equivalence point' as it applies to titrations.

____

____

[1 mark]

(ii) State the pH at the equivalence point during the titration of HCl and X.

____

[1 mark]

(c) (i) Suggest the strength of X in terms of 'strong' or 'weak' and give a reason for your choice.

Strength

____

Reason

____

____

[2 marks]

(ii) Identify X.

____

[1 mark]

(d) Given the reacting mole ratio of acid to base as 1:1, calculate the concentration of the solution of X.

____

____

____

____

[3 marks]

Total 16 marks

3. A young chemist was challenged to test his assertion that fats become saturated after they undergo hydrogenation.

Plan and design an experiment that would allow the young chemist to positively test his claim. Your answer should include:

(a) Aim

[1 mark]

(b) Hypothesis

[1 mark]

(c) Apparatus and materials

[2 marks]

(d) Method

[3 marks]

(e) Variables

(i) Controlled

[1 mark]

(ii) Manipulated

[1 mark]

(iii) Responding

[1 mark]

(f) Data to be collected

[1 mark]

(g) Discussion of expected results

[2 marks]

(h) Precautions

[1 mark]

Total 14 marks

END OF TEST

TEST CODE **02112032 – IS**

FORM TP 2011154 – IS

MAY/JUNE 2011

C A R I B B E A N   E X A M I N A T I O N S   C O U N C I L

ADVANCED PROFICIENCY EXAMINATION

CHEMISTRY

UNIT 1 – Paper 03/2

ALTERNATIVE TO INTERNAL ASSESSMENT EXAMINATION

06 MAY 2011 (a.m.)

INSTRUCTIONS FOR SETTING UP THE ALTERNATIVE TO INTERNAL ASSESSMENT EXAMINATION

The information contained in these instructions and the results carried out should NOT be communicated to candidates.

In addition to equipment, chemicals and other materials normally present in the laboratory for use in volumetric analysis, the following equipment and materials MUST be provided.

Question 1.

For EACH candidate:

(a) 100 cm^3 of saturated $Ca(OH)_2$ solution

(b) 300 cm^3 of 0.0500 mol dm^{-3} HCl

Reagents:

(a) Screened methyl orange or methyl orange indicator

On the day of the examination, the person responsible for preparing the practical MUST carry out the experiment as described on the question paper and SEND in a report using the attached form entitled "Supervisor's Report on the Practical Examination". These persons are reminded that, if this is not done, candidates may be at a disadvantage.

The experiment must be carried out using similar apparatus to, and the same materials as those supplied to the candidates. It should also be performed at the same time as the examination, or immediately before or after. This person's work should NOT be seen by any candidate, nor should his/her results be communicated to any candidate either directly or indirectly.

N.B. **Supervisors are expected to report on the attached form, entitled "Supervisor's Report on the Practical Examination", on any special conditions which might have affected candidates' performances. Supervisors should specify whether all candidates were affected or if not, give the registration numbers of those candidates who were affected.**

Candidates are allowed to have practical notebooks and/or any materials relevant to the practical examination.

Candidates may be given additional materials without penalty.

If candidates lose time during the examination through no fault of their own, they must be awarded the equivalent time.

END OF INSTRUCTIONS

FORM TP 2011157 – IS

MAY/JUNE 2011

C A R I B B E A N   E X A M I N A T I O N S   C O U N C I L

ADVANCED PROFICIENCY EXAMINATION

CHEMISTRY

UNIT 2 – Paper 03/2

ALTERNATIVE TO INTERNAL ASSESSMENT EXAMINATION

19 MAY 2011 (a.m.)

INSTRUCTIONS FOR SETTING UP THE ALTERNATIVE TO INTERNAL ASSESSMENT EXAMINATION

The information contained in these instructions and the results carried out should NOT be communicated to candidates.

In addition to equipment, chemicals and other materials normally present in the laboratory, the following equipment and materials MUST be provided.

Question 1.

For EACH candidate:

(a) P: Propan-1-ol – 20 cm^3 (in a stopped container)

(b) Q: Propanoic acid – 20 cm^3 (in a stopped container)

(c) Solid sodium hydrogen carbonate – 3g

(d) Magnesium ribbon – about 2 cm

(e) Bromine water

On the day of the examination, the person responsible for preparing the practical MUST carry out the experiment as described on the question paper and SEND in a report using the attached form entitled "Supervisor's Report on the Practical Examination". These persons are reminded that, if this is not done, candidates may be at a disadvantage.

The experiment must be carried out using similar apparatus to, and the same materials as those supplied to the candidates. It should also be performed at the same time as the examination, or immediately before or after. This person's work should NOT be seen by any candidate, nor should his/her results be communicated to any candidate either directly or indirectly.

N.B. **Supervisors are expected to report on the attached form, entitled "Supervisor's Report on the Practical Examination", on any special conditions which might have affected candidates' performances. Supervisors should specify whether all candidates were affected or if not, give the registration numbers of those candidates who were affected.**

Candidates are allowed to have practical notebooks and/or any materials relevant to the practical examination.

Candidates may be given additional materials without penalty.

<u>If candidates lose time during the examination through no fault of their own, they MUST be awarded the equivalent time</u>.

END OF INSTRUCTIONS

TEST CODE **02112020**

FORM TP 2012153

MAY/JUNE 2012

C A R I B B E A N   E X A M I N A T I O N S   C O U N C I L

ADVANCED PROFICIENCY EXAMINATION

CHEMISTRY

UNIT 1 – 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.

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO.

SECTION A

Answer ALL questions in this section.

Write your answers in the spaces provided in this booklet.

MODULE 1

FUNDAMENTALS IN CHEMISTRY

1. (a) With the aid of an example, defin the term ‘dative (co-ordinate) covalent bond’.

____

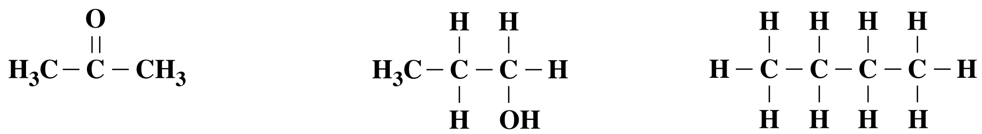
____

____

[2 marks]

(b) Intermolecular forces of attraction influenc the physical properties of substances, such as, their melting points, boiling points, and solubility in polar and non-polar solvents.

Consider the structure of the following substances and answer the questions which follow.



(A) propanone (B) 1-propanol (C) butane

(i) Place substances A, B and C in order of **increasing** boiling point (lowest boiling point first)

____

[1 mark]

(ii) Identify the intermolecular attractive forces found in EACH of the substances in (b) (i) above.

____

____

____

[3 marks]

GO ON TO THE NEXT PAGE

(iii) Describe the origin of TWO of the intermolecular attractive forces named in (b) (ii).

____

____

____

____

____

____

____

[4 marks]

(c) Complete Table 1 by indicating whether EACH of the substances, potassium bromide, acetone and solid iodine are soluble or insoluble in the two solvents, water (polar solvent) and toluene (non-polar solvent).

TABLE 1: SOLUBILITY IN POLAR AND NON-POLAR SOLVENTS

Substance	Water (Polar)	Toluene (Non-polar)
Potassium bromide		
Acetone		Soluble
Solid iodine		

[5 marks]

Total 15 marks

MODULE 2

KINETICS AND EQUILIBRIA

2. (a) Describe, using FIVE essential steps, an experiment which can be used to determine the solubility product of $Ca(OH)_2$ at room temperature.

[5 marks]

(b) The solubility product, K_{sp}, at 25 °C for calcium carbonate ($CaCO_3$) was found to be 5.0×10^{-9} mol^2 dm^{-6}.

(i) Defin the term 'solubility product'.

[1 mark]

(ii) Write the equation for the dissociation of calcium carbonate.

[1 mark]

(iii) Write the solubility constant expression for calcium carbonate.

[2 marks]

GO ON TO THE NEXT PAGE

(c) Calculate the solubility of calcium carbonate ($K_{sp} = 5.0 \times 10^{-9}$ mol^2 dm^{-6} at 25°C) in

(i) pure water

[2 marks]

(ii) 0.1 mol dm^{-3} Na_2CO_3 solution.

[3 marks]

(d) What is responsible for the difference between the solubilities in (c) (i) and (c) (ii) above?

____

____

[1 mark]

Total 15 marks

MODULE 3

CHEMISTRY OF THE ELEMENTS

3. (a) Describe the reaction of EACH of the following halogens with hydrogen.

(i) Fluorine

____

(ii) Chlorine

____

(iii) Bromine

____

[3 marks]

(b) A student was provided with three test tubes, EACH containing one hydrogen halide. A red hot wire (exceeding 300 °C) was quickly placed into each test tube in turn. The observations were recorded in Table 2.

TABLE 2: OBSERVATIONS FOR HYDROGEN HALIDES

Test Tube	Hydrogen Halide	Observation
I	Hydrogen chloride	No change
II	Hydrogen bromide	Slight brown colouration seen
III	Hydrogen iodide	Copious violet fumes seen

(i) Identify the gases observed in

Test Tube II ____

Test Tube III ____

[2 marks]

(ii) Write a **balanced** equation to represent the reaction occurring in Test Tube II.

____

[2 marks]

(iii) Using the relevant information provided in the data booklet, explain the trend in the observations recorded in Table 2.

____

____

[2 marks]

(iv) What would you observe if hydrogen fluorid was used in the experiment?

____

[1 mark]

(c) Concentrated sulphuric acid was carefully added to test tubes containing sodium chloride and sodium bromide respectively.

State what would be observed in the case of

(i) sodium chloride

____

[1 mark]

(ii) sodium bromide.

____

[2 marks]

(d) The products of the reaction in (c) (i) above were passed into water and the resultant solution treated with $AgNO_3$(aq) followed by aqueous ammonia.

State what would be observed.

____

____

[2 marks]

Total 15 marks

SECTION B

Answer ALL questions.

Write your answers in the separate answer booklet provided.

MODULE 1

FUNDAMENTALS IN CHEMISTRY

4. (a) State THREE factors which affect the firs ionisation energy of the elements. **[3 marks]**

(b) Write the s, p and d electronic configuratio of the following species:

(i) Cu

(ii) O^{2-}

(iii) Mn^{2+}

(iv) Fe^{3+}

(v) Ca **[5 marks]**

(c) Explain how ionization energy data provide evidence for shells and subshells. **[3 marks]**

(d) Study Figure 1 which shows the logarithm to the base ten of the successive ionisation energies of an element and answer the questions which follow.

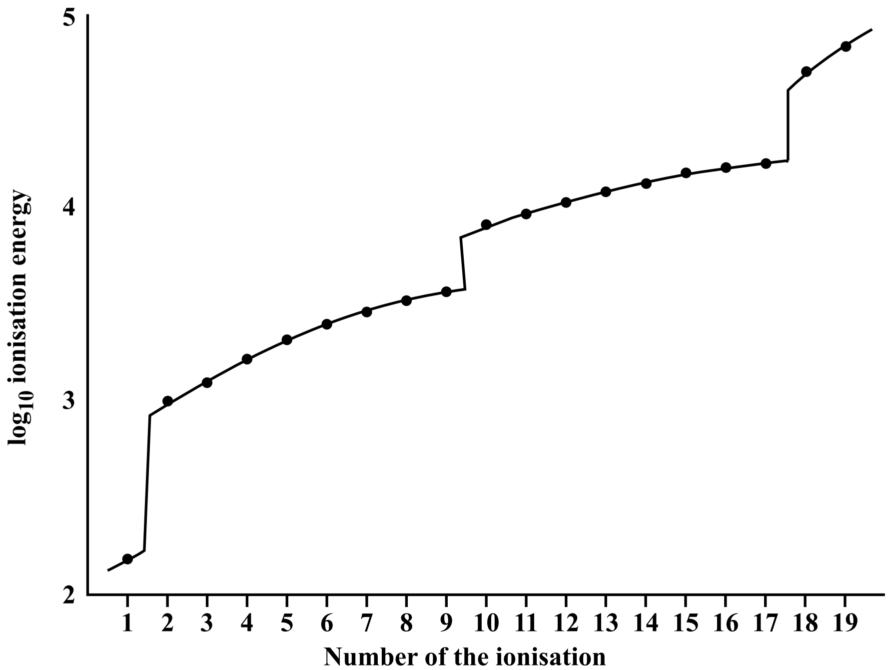


Figure 1. Log_{10} of ionisation energies of an element

(i) Write the electronic configuratio of the element represented in Figure 1. **[1 mark]**

(ii) Suggest an identity for the element. **[1 mark]**

(iii) Write a **balanced** equation to illustrate the firs ionisation of the element. **[2 marks]**

Total 15 marks

MODULE 2

KINETICS AND EQUILIBRIA

5. (a) (i) Copy and complete Table 3 to show the type of equilibrium for the selected equilibrium systems.

TABLE 3: SELECTED EQUILIBRIUM SYSTEMS

System Number	Equilibrium System	Type of Equilibrium
1	Saturated solution of a salt at room temperature	
2	The vertical balancing of a ruler on a fla surface	
3	Heating of limestone at 800 °C	

[3 marks]

(ii) State TWO characteristics of the equilibrium represented by System 1 in Table 3. **[2 marks]**

(b) Substances A, B, X and Y form an equilibrium mixture represented by the equation below.

$$aA + bB \rightleftharpoons xX + yY$$

(i) Write the expression for the equilibrium constant. **[1 mark]**

(ii) What deduction can be made when the equilibrium constant is much greater than 1? **[1 mark]**

GO ON TO THE NEXT PAGE

(c) When solid bismuth (III) chloride, $BiCl_3$ is added to water, a white precipitate BiOCl is produced. These compounds form an equilibrium mixture represented by the equation

$$BiCl_3(aq) + H_2O(l) \rightleftharpoons BiOCl(s) + 2HCl(aq).$$

(i) Explain why the white precipitate, BiOCl, disappears on the addition of aqueous HCl to the equilibrium mixture. **[2 marks]**

(ii) Explain what would be observed if a large volume of water was added to the equilibrium mixture. **[3 marks]**

(d) Phosphorus(V) chloride, PCl_5, decomposes at 250 °C and forms an equilibrium mixture represented by the equation

$$PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g).$$

One equilibrium mixture at this temperature contains PCl_5 and PCl_3 at concentrations of 0.20 mol dm^{-3} and 0.010 mol dm^{-3} respectively.

Given K_c at 250 °C = 0.19 mol dm^{-3}, calculate the concentration of Cl_2 in the mixture. **[3 marks]**

Total 15 marks

MODULE 3

CHEMISTRY OF THE ELEMENTS

6. (a) The elements sodium to argon (Period 3) are often used to illustrate periodic trends.

(i) State the general trend in atomic radii in moving from left to right across Period 3 (from sodium to argon). **[1 mark]**

(ii) Give a reason for the trend stated in (i) above. **[1 mark]**

(b) Each element in Period 3 exhibits one of three structures: **simple molecular**, **giant metallic** or **giant molecular**.

Which structure is exhibited by EACH of the following elements in Period 3?

(i) Magnesium

(ii) Silicon

(iii) Sulphur **[3 marks]**

(c) Study Figure 2 which shows **the variation in melting points across the elements in Period 3** and answer the question that follows.

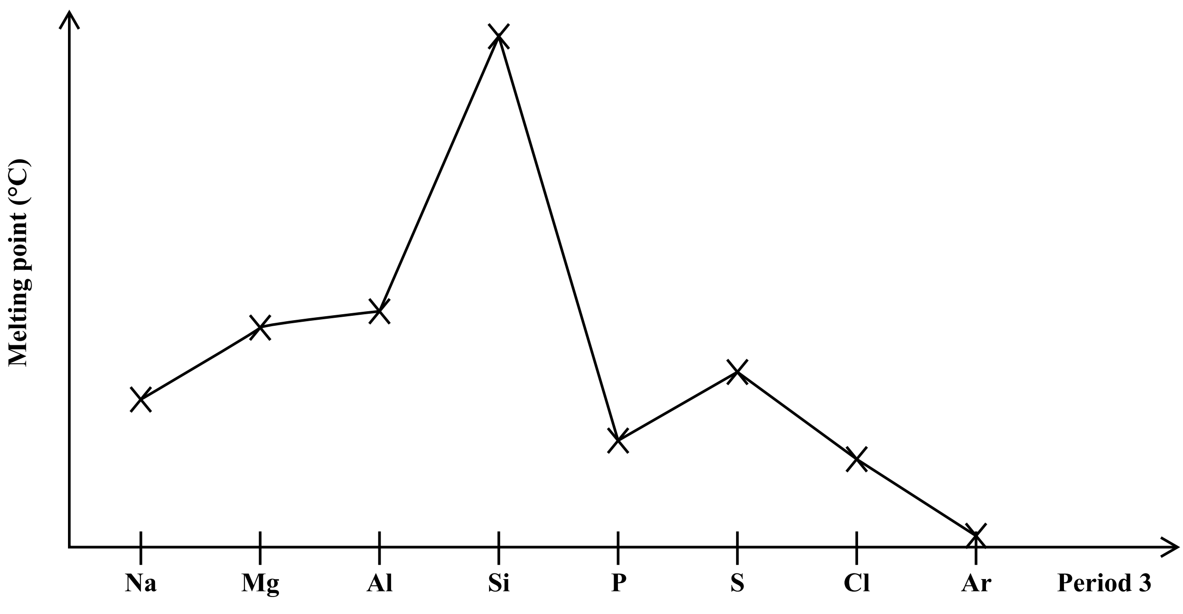


Figure 2. Variation in melting points across Period 3

With reference to structure and bonding, account for the variation in melting points shown in the figure. **[3 marks]**

(d) (i) Sketch a similar diagram to Figure 2 given in 6 (c) to illustrate the variation in the electrical conductivity of the elements in Period 3. **[2 marks]**

(ii) With reference to structure, explain the variations shown on your sketch in (d) (i) above. **[3 marks]**

(e) (i) Describe the reaction which occurs when magnesium is heated in dry chlorine gas. **[1 mark]**

(ii) Write an equation to represent the reaction in (e)(i) above. **[1 mark]**

Total 15 marks

END OF TEST

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

TEST CODE **02112032**

FORM TP 2012154

MAY/JUNE 2012

C A R I B B E A N   E X A M I N A T I O N S   C O U N C I L

ADVANCED PROFICIENCY EXAMINATION

CHEMISTRY

UNIT 1 – Paper 032

ALTERNATIVE TO INTERNAL ASSESSMENT EXAMINATION

2 hours

READ THE FOLLOWING INSTRUCTIONS CAREFULLY.

1. Answer ALL questions on this paper.
2. Use this answer booklet when responding to the questions. For EACH question, write your answer in the space indicated and return the answer booklet at the end of the examination.
3. The use of non-programmable calculators is allowed.
4. A data booklet is provided.

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO.

NOTHING HAS BEEN OMITTED.

Answer ALL questions.

1. You are are provided with

- T, a solution of sodium thiosulphate
- S, sulphuric (VI) acid solution
- A piece of white paper; 6 cm square on which a bold black cross, +, has been printed.

When acid is added to a solution of sodium thiosulphate, $Na_2S_2O_3$, a fine colloidal suspension of sulphur is formed along with sulphur dioxide as the only sulphur containing products.

(a) Procedure

Experiment 1

(i) Place a 200 cm^3 beaker on the square piece of white paper with the bold black cross.

(ii) Using a measuring cylinder, put 50 cm^3 of S into the beaker.

(iii) Using a different measuring cylinder, add 50 cm^3 of T to the beaker and IMMEDIATELY start the stop clock.

(iv) Stop the clock IMMEDIATELY as the cross disappears when viewed directly from above.

(v) Record the time taken for the cross to disappear.

(vi) Discard the mixture and carefully wash the beaker.

Experiment 2

(vii) Place the 200 cm^3 beaker on the square piece of white paper with the bold black cross.

(viii) Using the measuring cylinder, place 50 cm^3 of S into the beaker.

(ix) Using a different measuring cylinder, prepare a mixture of sodium thiosulphate (T) and water by using 40 cm^3 of the sodium thiosulphate (T) and 10 cm^3 of the water.

(x) Add the mixture to the beaker and IMMEDIATELY start the stop clock.

(xi) Stop the clock IMMEDIATELY as the cross disappears when viewed directly from above.

(xii) Record the time taken for the cross to disappear.

(xiii) Discard the mixture and carefully wash the beaker.

Experiments 3 - 5

(xiv) Repeat Steps (vii) to (xiii) using **the volumes of sodium thiosulphate and water specified in Table 1.**

TABLE 1: DATA

Expt. Number	**Volume of Acid (cm^3)**	**Volume of Thiosulphate (cm^3)**	**Volume of Water (cm^3)**	**Time, t (s)**	**$\frac{1}{\text{Time}}$; $\frac{1}{t}$ (3 decimal places)**
1	50	50	0		
2	50	40	10		
3	50	30	20		
4	50	25	25		
5	50	20	30		

[8 marks]

(b) Write the ionic equation for the reaction of thiosulphate with acid.

____

[2 marks]

(c) Plot a graph of volume of thiosulphate against $\frac{1}{t}$ using the axes provided in Figure 1 on page 5. **[4 marks]**

(d) What is measured by $\frac{1}{t}$?

____

[1 mark]

(e) From your graph deduce the relationship between your answer in (d) and the concentration of thiosulphate.

____

____

[2 marks]

(f) Use the shape of the graph to deduce the order of the reaction with respect to thiosulphate ions.

____

[1 mark]

Total 18 marks

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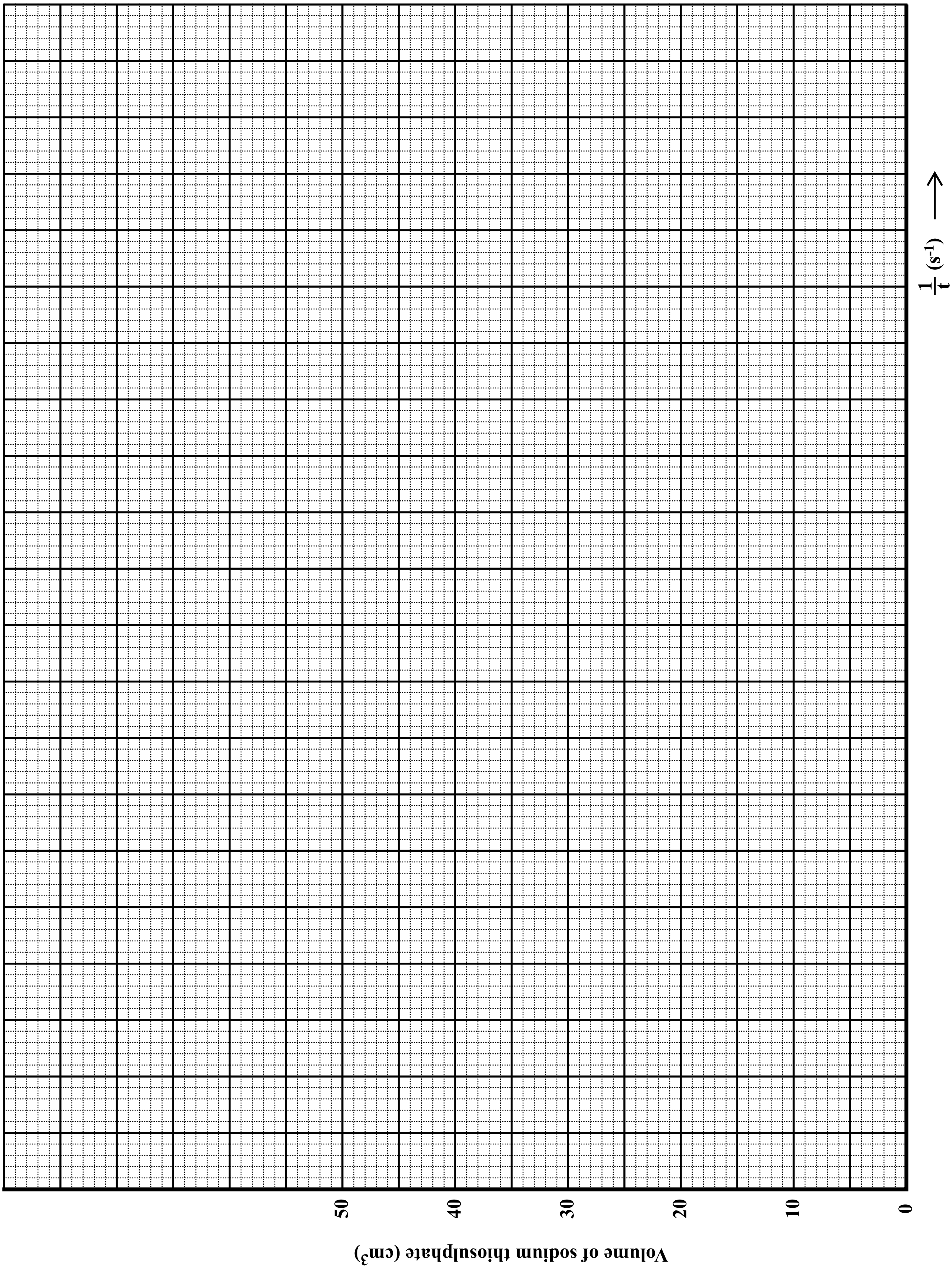


Figure 1. Volume of sodium thiosulphate against $\frac{1}{t}$

2. The label of a hydrogen carbonate of a Group I metal, $XHCO_3$, was accidently removed from its container.

A student used the following procedure to determine the identity of the metal, X.

3.65 g of the hydrogen carbonate, $XHCO_3$, was dissolved in 250 cm^3 of water. 20 cm^3 of this solution was placed in a conical flask and titrated with 0.05 mol d^{-3} H_2SO_4(aq).

Three titrations were needed to obtain consistent values.

Figure 2 shows the burette readings before and after each titration.

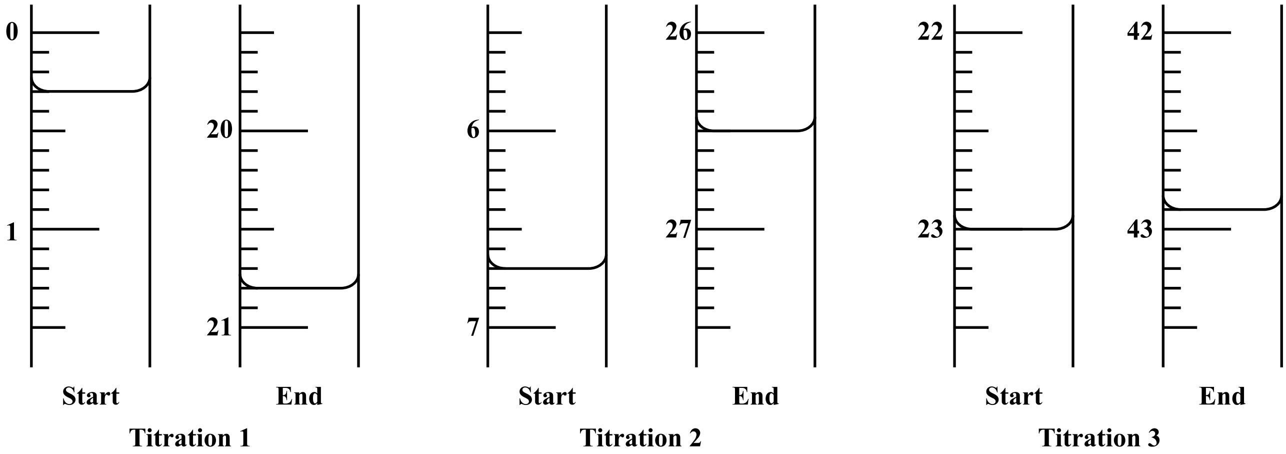


Figure 2. Readings on the burette

(a) Suggest an indicator that can be used in the above titration.

____

[1 mark]

(b) In the space below, construct Table 2 to record the titration results. You should include the initial and final burette readings and the volumes of $_2SO_4$(aq) used.

[6 marks]

GO ON TO THE NEXT PAGE

(c) Write the ionic equation for the reaction that occurs during the titration.

____

[2 marks]

(d) Calculate the number of moles of acid used in the titration.

[2 marks]

(e) Deduce the number of moles of $XHCO_3$ that reacted with the acid.

____

[1 mark]

(f) Calculate the concentration of the hydrogen carbonate solution in mol dm^{-3}.

[1 mark]

(g) Calculate the molar mass of $XHCO_3$.

[3 marks]

(h) Determine the relative atomic mass of the metal, X.

____

[1 mark]

(i) Suggest the formula of the hydrogen carbonate.

____

[1 mark]

Total 18 marks

3. The pharmacist at your local drugstore insists on the effectiveness of Brand A antacid over Brand B.

Plan and design an experiment to determine the truth of the pharmacist's claim.

(a) Hypothesis:

____

____

[1 mark]

(b) Aim:

____

____

[1 mark]

(c) Apparatus and materials:

[3 marks]

(d) Experimental procedure:

[3 marks]

(e) Variables:

(i) Manipulated

(ii) Responding

(iii) Controlled

[3 marks]

(f) Expected results:

[1 mark]

Total 12 marks

END OF TEST

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

TEST CODE **02212020**

FORM TP 2012156

MAY/JUNE 2012

C A R I B B E A N   E X A M I N A T I O N S   C O U N C I L

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.

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO.

SECTION A

Answer ALL questions.

Write your answers in the spaces provided in this booklet.

MODULE 1

THE CHEMISTRY OF CARBON COMPOUNDS

1. (a) Draw and state the name of FOUR isomeric alcohols with formula $C_4H_{10}O$.

(i)

(ii)

Name______________________________ Name______________________________

(iii)

(iv)

Name______________________________ Name______________________________

[8 marks]

(b) Identify the type of isomerism illustrated in (a) above.

____

[1 mark]

(c) State ONE other **type** of isomerism that can be displayed by alcohols.

____

[1 mark]

(d) EACH isomer in 1. (a) on page 2 was treated with acidifie potassium permanganate. Describe the expected observation in EACH case.

Alcohol	Observation
(i)	
(ii)	
(iii)	
(iv)	

[4 marks]

(e) $K_2Cr_2O_7/H^+_{(aq)}$ would also react with the alcohols in a way similar to $KMnO_4/H^+_{(aq)}$.

State the colour change with $K_2Cr_2O_7/H^+_{(aq)}$ which would indicate a positive result.

____

[1 mark]

Total 15 marks

MODULE 2

ANALYTICAL METHODS AND SEPARATION TECHNIQUES

2. (a) State ONE use of chromatography in criminal investigations.

[1 mark]

(b) Outline FOUR essential experimental steps in the separation of the components of a dye using thin-layer chromatography (TLC).

[4 marks]

(c) Defin the terms 'stationary phase' and 'mobile phase' in relation to thin-layer chromatography (TLC).

Stationary phase

Mobile phase

[2 marks]

(d) Name TWO materials commonly used as the stationary phase in TLC.

____

____

[2 marks]

(e) Figure 1 shows the separation of the components of a dye on a TLC plate.

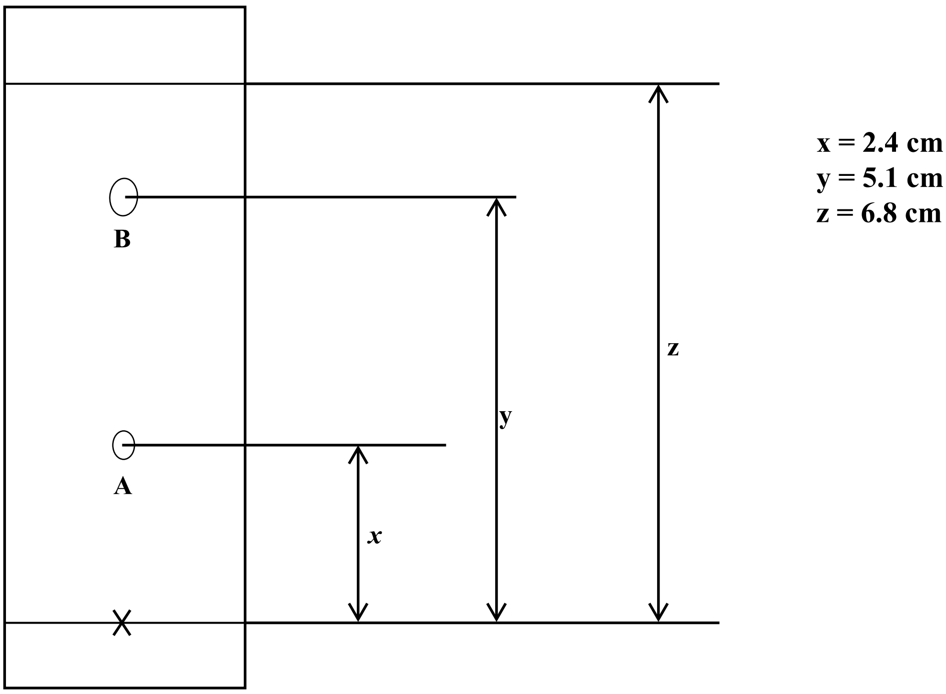


Figure 1. The separation of the components of a dye using TLC

(i) Calculate the R_f values of components A and B.

R_f values of component A ________________________ **[1 mark]**

R_f values of component B ________________________ **[1 mark]**

(ii) Suggest TWO reasons for the difference in the R_f values of A and B.

[2 marks]

(iii) State TWO factors, other than the distance travelled by the solvent, which influenc the R_f value of a solute.

[2 marks]

Total 15 marks

MODULE 3

CHEMISTRY AND THE ENVIRONMENT

3. (a) Describe how the concepts of reuse, recycle and reduce can be applied to paper as a solid waste.

Paper

Reuse

____

____

[1 mark]

Recycle

____

____

[1 mark]

Reduce

____

____

[1 mark]

(b) Suggest TWO ways in which the presence of nuclear waste can affect the terrestrial environment.

____

____

____

[2 marks]

(c) In landfills chemical and microbial reactions can lead to the formation of gaseous pollutants. State the names OR chemical formulae of TWO landfil gases.

____

____

[2 marks]

(d) (i) Describe, **with the aid of equations**, the steps involved in the fermentation of sucrose.

____

____

____

____

____

[5 marks]

(ii) When beer is exposed to air for some time, it produces a sharp smell and is described as becoming “sour”.

Identify TWO possible compounds responsible for the sharp smell and state the type of reaction responsible.

Compound 1: ____

Compound 2: ____

Type of Reaction ____

____

[3 marks]

Total 15 marks

SECTION B

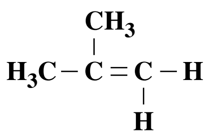
Answer ALL questions in this section.

Write your answers in the answer booklet provided.

MODULE 1

THE CHEMISTRY OF CARBON COMPOUNDS

4. Compound A is an alkene. Study its structural formula given below and answer the questions which follow.



Compound A

(a) Give the structural formula for the reaction of Compound A with

(i) aqueous bromine

(ii) liquid bromine

(iii) cold $KMnO_4/H^+$

(iv) hot $KMnO_4/H^+$. **[6 marks]**

(b) State whether Compound A exhibits geometric (cis/trans) isomerism. **[1 mark]**

(c) Give TWO reasons for your answer in (b). **[2 marks]**

(d) Outline the mechanism for the reaction between Compound A and HBr, using curved arrows to show the movement of electrons. **[5 marks]**

(e) State the type of reaction mechanism outlined in (d) above. **[1 mark]**

Total 15 marks

MODULE 2

ANALYTICAL METHODS AND SEPARATION TECHNIQUES

5. (a) Two pieces of apparatus used in the filtratio process are shown in Figure 2 and Figure 3 respectively.

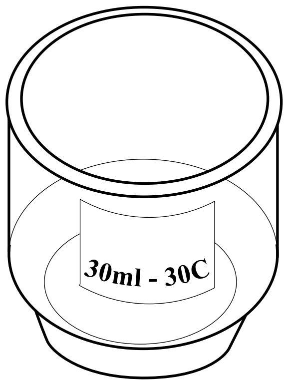


Figure 2

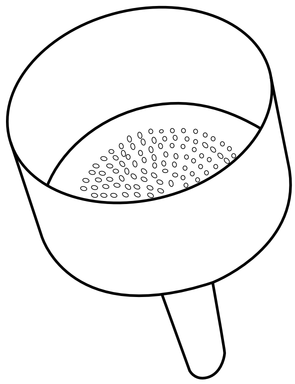


Figure 3

State the names and functions of these pieces of apparatus. **[5 marks]**

(b) When a solute is shaken in a mixture of two immiscible solvents and allowed to stand, a dynamic equilibrium is established in which the solute is partitioned or distributed between the two solvents.

(i) Write an equation to explain the term 'partition coefficient or 'distribution coefficient using the example of an ester dissolved in a mixture of water and toluene. **[1 mark]**

(ii) State TWO factors which affect the value of the partition coefficient. **[2 marks]**

(iii) Explain the principles of solvent extraction with respect to the recovery of an organic compound from an aqueous solution. **[4 marks]**

(iv) A solution of 10.0 g of an ester, Y, in 100 cm^3 of water was shaken with 200 cm^3 of ether. After separation, the aqueous solution was found to contain 1.6 g of Y.

Calculate the partition coefficien of Y between ether and water. **[3 marks]**

Total 15 marks

MODULE 3

INDUSTRY AND THE ENVIRONMENT

6. (a) List FOUR factors which would influenc the location of an industrial plant. **[4 marks]**

(b) State TWO safety concerns associated with the locating of an ammonia plant and for EACH concern suggest a measure that can be taken to reduce its effect. **[4 marks]**

(c) The reduction in harmful gaseous emission from vehicles has been achieved by fittin vehicles with catalytic converters. These allow for the conversion of carbon monoxide and nitrogen monoxide to carbon dioxide and nitrogen, respectively.

Write TWO equations for these conversions. **[4 marks]**

(d) The burning of fossil fuels in industrialised countries emits sulphur dioxide as one of the combustion products.

(i) ONE reason why sulphur dioxide is considered to be a pollutant is that it produces acid rain.

Write an equation to support this reason. **[2 marks]**

(ii) Give ONE reason (other than the production of acid rain) why sulphur dioxide is considered to be a pollutant. **[1 mark]**

Total 15 marks

END OF TEST

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

TEST CODE **02212032**

FORM TP 2012157

MAY/JUNE 2012

C A R I B B E A N   E X A M I N A T I O N S   C O U N C I L

ADVANCED PROFICIENCY EXAMINATION

CHEMISTRY

UNIT 2 – Paper 032

ALTERNATIVE TO INTERNAL ASSESSMENT EXAMINATION

2 hours

READ THE FOLLOWING INSTRUCTIONS CAREFULLY.

1. Answer ALL questions on this paper.
2. Use this answer booklet when responding to the questions. For EACH question, write your answer in the space indicated and return the answer booklet at the end of the examination.
3. The use of non-programmable calculators is allowed.
4. A data booklet is provided.

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO.

Answer ALL questions.

1. A is a solution containing barium ions.

B is a solution of sodium carbonate containing 0.1 moles in 1 dm^3.

C is a solution containing 0.1 moles of hydrochloric acid in 1 dm^3 of solution.

You are required to determine the concentration of barium ions in A.

(a) Procedure

(i) Pipette 25 cm^3 of A into the beaker provided and boil gently.

(ii) Using a pipette, add 50 cm^3 of B to the beaker.

(iii) Stir the contents of the beaker and filte into a conical flask wash the beaker and precipitate with water several times and collect the washings with the filtrat in the flask

(iv) Titrate the total filtrat with C in the burette, using the indicator provided.

(v) In Table 1, record **to two decimal places**, both your initial burette reading and the reading at the end point.

(vi) Repeat steps (ii) - (v).

TABLE 1: BURETTE READINGS

	Burette Readings	
	1	**2**
Final Volume (cm^3)		
Initial Volume (cm^3)		
Volume of HCl used (cm^3)		

[5 marks]

(b) Determine the volume of HCl to be used in your calculations. **[1 mark]**

(c) Calculate the number of moles of Na_2CO_3 in 50 cm^3 of B.

[1 mark]

GO ON TO THE NEXT PAGE

(d) Write an equation for the reaction of sodium carbonate and hydrochloric acid.

____

[2 marks]

(e) Calculate the number of moles of hydrochloric acid used to neutralise the excess sodium carbonate.

[1 mark]

(f) Calculate the number of moles of excess sodium carbonate used.

[1 mark]

(g) Deduce the number of moles of sodium carbonate used to precipitate the barium ions in A.

[1 mark]

(h) Write an equation for the precipitation of barium ions by sodium carbonate.

____

[2 marks]

(i) Deduce the number of moles of barium ions in 25 cm^3 of A.

[1 mark]

(j) Calculate the concentration, in moles per dm^3, of barium ions in A.

[1 mark]

(k) State a reason why the concentration of barium ions in A could not be determined by direct titration with hydrochloric acid.

____

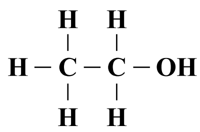
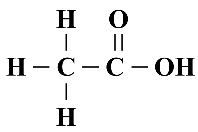
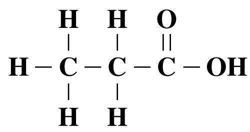
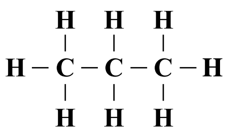
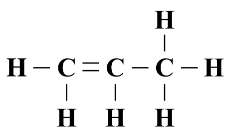
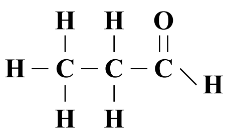
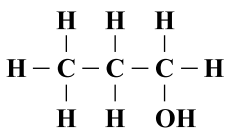
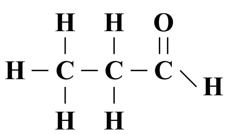
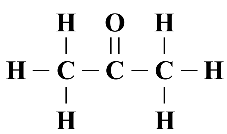
____

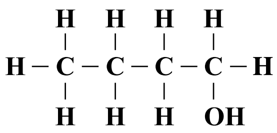
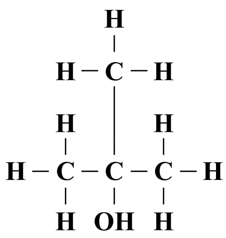
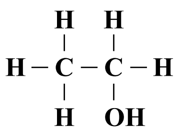
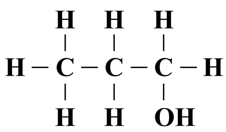
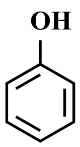
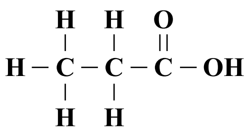
[1 mark]

Total 17 marks

2. Complete Table 2, using simple, common test-tube reactions, with the associated observations to distinguish between EACH pair of Compounds P and Q. Suggest (by drawing the structure) ONE other compound, with **no more than four carbon atoms**, which would also give a positive result with the test you have chosen. The firs one (a) is done for you.

TABLE 2: DISTINGUISHING BETWEEN COMPOUNDS A AND B

Compounds	**Test**	**Observation**	**Suggested Compound**
(a)  P  Q	(i) Add $NaHCO_3$ to both P and Q	(ii) No reaction with P; effervescense occurs with Q.	(iii) 
(b)  P  Q	(i) **1 mark**	(ii) **1 mark**	(iii) **1 mark**
(c)  P  Q	(i) **1 mark**	(ii) **1 mark**	(iii) **1 mark**
(d)  P  Q	(i) **1 mark**	(ii) **1 mark**	(iii) **1 mark**

Compounds	Test	Observation	Suggested compound
(e)  P  Q	(i) 1 mark	(ii) 1 mark	(iii) 1 mark
(f)  P  Q	(i) 1 mark	(ii) 1 mark	(iii) 1 mark
(g)  P  Q	(i) 1 mark	(ii) 1 mark	

Total 17 marks

3. A student has been advised to include an iron supplement in her diet to combat possible deficienc . Two brands of the supplement in tablet form have been identified

Plan and design an experiment to allow the student to decide which is the better brand based on the amount of available iron.

(a) Hypothesis:

____

____

[1 mark]

(b) Aim:

____

____

[1 mark]

(c) Apparatus and materials:

____

____

____

____

[3 marks]

(d) Experimental procedure:

____

____

____

____

____

[3 marks]

(e) Variables:

(i) Manipulated

____

(ii) Responding

____

(iii) Controlled

____

[3 marks]

(f) Expected results:

____

____

____

[1 mark]

(g) Treatment of results:

____

____

____

____

[1 mark]

(h) Chemical principle used in (g):

____

____

____

[1 mark]

Total 14 marks

END OF TEST

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

TEST CODE **02112032 – IS**

FORM TP 2012154 – IS

MAY/JUNE 2012

C A R I B B E A N   E X A M I N A T I O N S   C O U N C I L

ADVANCED PROFICIENCY EXAMINATION

CHEMISTRY

UNIT 1 – Paper 032

ALTERNATIVE TO SCHOOL-BASED ASSESSMENT

08 MAY 2012 (a.m.)

INSTRUCTIONS FOR SETTING UP THE ALTERNATIVE TO SCHOOL-BASED ASSESSMENT EXAMINATION

The information contained in these instructions and the results obtained should NOT be communicated to candidates.

In addition to equipment, chemicals and other materials normally present in the laboratory, the following equipment and materials must be provided.

Question 1.

EACH candidate should be provided with the following:

2 Measuring cylinders - 100 cm^3 ; ± 1 cm^3

1 Stirring rod

1 White paper 8 cm × 8 cm; with bold black cross, +, printed in centre

1 Wash bottle with distilled water

1 Stop clock (or stop watch)

1 Beaker 200 cm^3

2 Beakers 300 cm^3

T: $Na_2 S_2 O_3$ (aq) 0.1 M; 300 cm^3

S: H_2SO_4 (aq) 1.0 M; 400 cm^3.

N.B. All containers **MUST** be rinsed with distilled water prior to use in each experiment.

On the day of the examination, the person responsible for preparing the practical MUST carry out the experiment as described on the question paper and SEND in a report using the attached form entitled "Supervisor's Report on the Practical Examination". These persons are reminded that, if this is not done, candidates may be at a disadvantage.

The experiment must be carried out using similar apparatus to, and the same materials as those supplied to the candidates. It should also be performed at the same time as the examination, or immediately before or after. This person's work should NOT be seen by any candidate, nor should his/her results be communicated to any candidate either directly or indirectly.

N.B. Supervisors are expected to report on the attached form, entitled "Supervisor's Report on the Practical Examination, on any special conditions which might have affected candidates' performances. Supervisors should specify whether all candidates were affected or if not, give the registration numbers of those candidates who were affected.

Candidates are allowed to have practical notebooks and/or any materials relevant to the practical examination.

Candidates may be given additional materials without penalty.

<u>If candidates lose time during the examination through no fault of their own, they MUST be awarded the equivalent time</u>.

END OF INSTRUCTIONS

TEST CODE **02212032 – IS**

FORM TP 2012157 – IS

MAY/JUNE 2012

C A R I B B E A N   E X A M I N A T I O N S   C O U N C I L

ADVANCED PROFICIENCY EXAMINATION

CHEMISTRY

UNIT 2 – Paper 032

ALTERNATIVE TO SCHOOL-BASED ASSESSMENT

21 MAY 2012 (a.m.)

INSTRUCTIONS FOR SETTING UP THE ALTERNATIVE TO SCHOOL-BASED ASSESSMENT EXAMINATION

The information contained in these instructions and the results obtained should NOT be communicated to candidates.

In addition to equipment, chemicals and other materials normally present in the laboratory, the following equipment and materials must be provided.

Question 1.

EACH candidate should be provided with the following:

2 Conical flasks (250 c ^{3})

1 50 cm^3 burette

1 50 cm^3 pipette

1 25 cm^3 pipette

3 250 cm^3 beakers

2 150 cm^3 beakers

1 Stirring rod

1 Filter funnel

filter paper (3 circles) ≥ 9 cm diamete

1 Bunsen burner

1 Tripod and guaze

Screened methyl orange/methyl orange or any other appropriate indicator

Other relevant apparatus for volumetric analysis

100 cm^3 $BaCl_2$; A, 0.1 mol dm^{-3}

200 cm^3 Na_2CO_3; B, 0.1 mol dm^{-3}

150 cm^3 HCl(aq); 0.1 mol dm^{-3}

On the day of the examination, the person responsible for preparing the practical MUST carry out the experiment as described on the question paper and SEND in a report using the attached form entitled "Supervisor's Report on the Practical Examination". These persons are reminded that, if this is not done, candidates may be at a disadvantage.

The experiment must be carried out using similar apparatus to, and the same materials as those supplied to the candidates. It should also be performed at the same time as the examination, or immediately before or after. This person's work should NOT be seen by any candidate, nor should his/her results be communicated to any candidate either directly or indirectly.

N.B. **Supervisors are expected to report on the attached form, entitled "Supervisor's Report on the Practical Examination, on any special conditions which might have affected candidates' performances. Supervisors should specify whether all candidates were affected or if not, give the registration numbers of those candidates who were affected.**

Candidates are allowed to have practical notebooks and/or any materials relevant to the practical examination.

Candidates may be given additional materials without penalty.

<u>If candidates lose time during the examination through no fault of their own, they MUST be awarded the equivalent time</u>.

END OF INSTRUCTIONS

TEST CODE **02212032 – SR**

FORM TP 2012157 – SR

MAY/JUNE 2012

SCHOOL/CENTRE NUMBER							

NAME OF SCHOOL/CENTRE

C A R I B B E A N E X A M I N A T I O N S C O U N C I L

ADVANCED PROFICIENCY EXAMINATION

CHEMISTRY

UNIT 02 – Paper 032

ALTERNATIVE TO SCHOOL-BASED ASSESSMENT

21 MAY 2012 (a.m.)

SUPERVISOR'S REPORT ON THE ALTERNATIVE TO SCHOOL-BASED ASSESSMENT EXAMINATION

This report MUST be completed by the person(s) SETTING UP the Practical Examination. When completed, it MUST accompany candidates' answer booklets for the Practical Examination.

TEACHER'S NAME
(Please print)

____

SUPERVISOR'S NAME
(Please print)

____

TEACHER'S SIGNATURE

____

SUPERVISOR'S SIGNATURE

____

N.B. Please ensure that all the information above is provided before this form is submitted.

Question 1

The person setting up this practical examination MUST carry out the exercise in Question 1 AT THE SAME TIME AS (OR VERY CLOSE TO) the examination. The results are to be entered into Table 1 appropriately.

A is a solution containing barium ions.

B is a solution of sodium carbonate containing 0.1 moles in 1 dm^3.

C is a solution containing 0.1 moles of hydrochloric acid in 1 dm^3 of solution.

You are required to determine the concentration of barium ions in A.

(a) Procedure

(i) Pipette 25^3 cm of A into the beaker provided and boil gently.

(ii) Using a pipette, add 50 cm^3 of B to the beaker.

(iii) Stir the contents of the beaker and filte into a conical flask wash the beaker and precipitate with water several times and collect the washings with the filtrat in the flask

(iv) Titrate the total filtrat with C in the burette, using the indicator provided.

(v) In Table 1, record **to two decimal places**, both your initial burette reading and the reading at the end point.

(vi) Repeat steps (ii) - (v).

TABLE 1: BURETTE READINGS

	Burette Readings	
	1	**2**
Final Volume (cm^3)		
Initial Volume (cm^3)		
Volume of HCl used (cm^3)		

GO ON TO THE NEXT PAGE

Record in the space below any special conditions that may have affected the performance of individual candidates. (Indicate candidates'registration numbers.)

TEST CODE **02112020**

FORM TP 2013153

MAY/JUNE 2013

C A R I B B E A N   E X A M I N A T I O N S   C O U N C I L

CARIBBEAN ADVANCED PROFICIENCY EXAMINATION®

CHEMISTRY

UNIT 1 – 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. 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.

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO.

SECTION A

Answer ALL questions in this section.

Write your answers in the spaces provided in this booklet.

MODULE 1

FUNDAMENTALS IN CHEMISTRY

1. (a) Defin the terms

(i) oxidation ____

____

(ii) reduction . ____

____

[2 marks]

(b) When an acidifie solution of potassium manganate(VII) is added to hydrogen peroxide a redox reaction occurs and the observations include effervescence and a colour change.

(i) State the colour change observed.

____

[1 mark]

(ii) Write the TWO half equations for the reaction, indicating the changes in oxidation number.

____

____

____

____

[6 marks]

(iii) State the roles of the two reagents, potassium manganate(VII) and hydrogen peroxide.

____

____

[2 marks]

(c) Describe an experiment, **including observations**, that can be used to compare the oxidizing ability of the elements chlorine, bromine and iodine.

[4 marks]

Total 15 marks

MODULE 2

KINETICS AND EQUILIBRIA

2. (a) Defin the term ‘buffer solution’.

[2 marks]

(b) Explain, using relevant equations, how a buffer solution containing ammonia and ammonium chloride reacts in the following circumstances:

(i) Contamination of the buffer with a small quantity of base

[2 marks]

(ii) Contamination of the buffer with a small quantity of acid

[2 marks]

(c) Calculate the pH of a buffer solution made from 20.00 cm^3 of 0.10 mol dm^{-3} propanoic acid (CH_3CH_2COOH) and 40.00 cm^3 of 0.050 mol dm^{-3} sodium propanoate (CH_3CH_2COONa).

(The acid dissociation constant, K_a, for propanoic acid is 1.22×10^{-5}.)

[5 marks]

(d) The experimental determination of the pH of the buffer solution in 2 (c) was carried out by a group of students.

(i) List TWO relevant pieces of apparatus and/or materials that may have been used to carry out the experiment.

____

____

____

[2 marks]

(ii) Describe TWO relevant steps taken by the students to determine the pH of the buffer.

____

____

____

____

____

____

[2 marks]

Total 15 marks

GO ON TO THE NEXT PAGE

MODULE 3

CHEMISTRY OF THE ELEMENTS

3. (a) (i) Outline TWO reasons why aqueous hydroxide ions, OH^- (aq), are used in the identificatio of cations.

____

____

____

____

[2 marks]

(ii) Table 1 shows an incomplete list of a number of cations with the expected results of their respective flam tests.

Complete the table.

TABLE 1: FLAME TEST RESULTS

Element	**Na^+**	**K^+**	**Ca^{2+}**	**Ba^{2+}**	**Cu^{2+}**
Colour of Flame					Green

[2 marks]

(b) M is a mixture of a soluble and an insoluble salt. Table 2 is an incomplete laboratory report of tests carried out on M.

Complete Table 2 by writing the relevant observations.

TABLE 2: LABORATORY REPORT

No.	Tests	Observations	Inferences
(i)	Add dil. HCl to M and warm.	• •	SO_2 evolved
(ii)	Shake M with water and then filte . To the colourless filtrate, add acidifie $Cr_2O_7^{2-}$ (aq).	•	SO_3^{2-} (aq) present
(iii)	Dissolve residue from (ii) in dil. HNO_3. Add a) KI (aq) and b) boil for 1 minute.	• •	Pb^{2+} present PbI_2 formed

[5 marks]

(c) (i) Write half equations to explain the observation in test (b) (ii).

____

____

____

[4 marks]

(ii) Identify the salts in mixture M.

____

____

[2 marks]

Total 15 marks

GO ON TO THE NEXT PAGE

SECTION B

Answer ALL questions.

Write your answers in the spaces provided at the end of each question.

MODULE 1

FUNDAMENTALS IN CHEMISTRY

4. Calcium oxide, quicklime, is produced by roasting limestone. Quicklime is used to neutralize the acidity of soils.

(a) Defin the term 'standard enthalpy of formation'. **[2 marks]**

(b) Write a balanced equation for formation of CaO(s). **[1 mark]**

(c) Construct a Born-Haber cycle for the formation of CaO(s) showing clearly, **using equations**, the steps of the enthalpy changes involved. **[6 marks]**

(d) Distinguish between 'exothermic enthalpy change' and 'endothermic enthalpy change', citing enthalpy changes from your Born-Haber cycle in (c) to support your answer. **[4 marks]**

(e) Explain, by writing an equation, how the data from the Born-Haber cycle can be used to calculate the lattice energy of CaO(s). **[2 marks]**

Total 15 marks

Write the answer to Question 4 here.

Write the answer to Question 4 here.

Write the answer to Question 4 here.

MODULE 2

KINETICS AND EQUILIBRIA

5. (a) With the aid of appropriate Boltzmann distribution curves, **(using the axes provided on page 12)** describe the effect of EACH of the following on reaction rates:

(i) Temperature **[4 marks]**

(ii) Catalyst **[3 marks]**

(b) The values of initial rates measured for the reaction below are recorded in Table 3.

$$S_2O_8^{2-} + 2I^- \longrightarrow 2SO_4^{2-} + I_2$$

TABLE 3: INITIAL RATES DATA

Experiment	**$[S_2O_8^{2-}]$ (mol dm^{-3})**	**$[I^-]$ (mol dm^{-3})**	**Initial Rate (mol dm^{-3} min^{-1})**
1	0.15	0.25	1.4×10^{-5}
2	0.15	0.50	5.6×10^{-5}
3	0.075	0.50	2.8×10^{-5}
4	0.075	0.25	7.0×10^{-6}

(i) Use the information from the table to deduce the rate equation and calculate the overall order of the reaction. **[5 marks]**

(ii) Calculate the

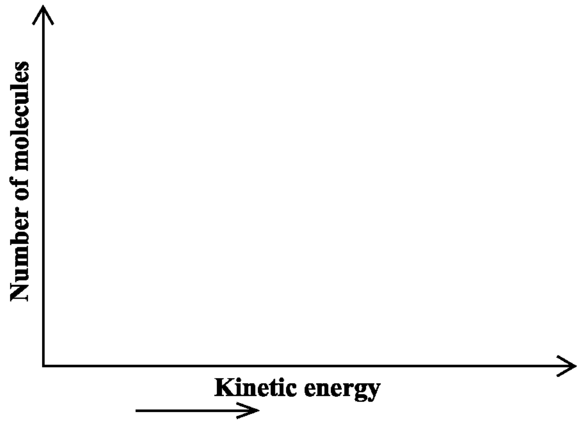
a) rate constant **[2 marks]**

b) initial rate of the reaction when $[S_2O_8^{2-}]_0 = 0.13$ mol dm^{-3} and $[I^-]_0 = 0.32$ mol dm^{-3}. **[1 mark]**

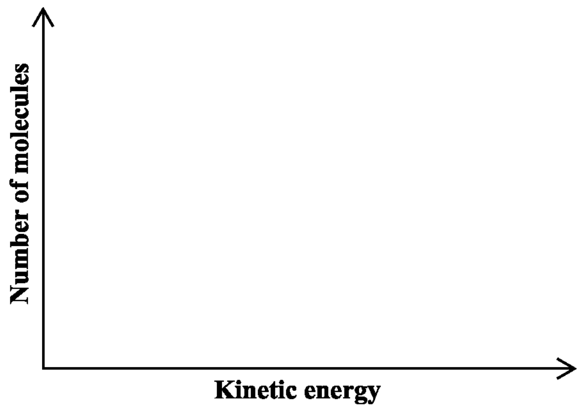
Total 15 marks

Write the answer to Question 5 here.

(a) (i) Temperature



(ii) Catalyst



Write the answer to Question 5 here.

Write the answer to Question 5 here.

MODULE 3

CHEMISTRY OF THE ELEMENTS

6. (a) The atomic radii across the firs row of transition elements show a gradual decrease.

Outline the reasons for this trend. **[2 marks]**

(b) (i) State the FULL electronic configuratio for the ions, Ti^{3+}; Fe^{2+}; Cr^{3+}. **[3 marks]**

(ii) Explain, in terms of electronic configuration why iron(II) is readily converted to iron(III). **[2 marks]**

(c) When aqueous copper ions are treated separately with aqueous ammonia and concentrated hydrochloric acid, the complex ions $[Cu(NH_3)_4(H_2O)_2]^{2+}$ and $[CuCl_4]^{2-}$ are formed.

State the name of the shape for

(i) EACH of the complex ions **[2 marks]**

(ii) a complex ion of the formula $[ML_4]^{n-}$ where M is the central metal and L represents the ligand. **[1 mark]**

(d) When titanium(III) chloride is dissolved in water, a purple solution is formed.

Explain carefully how the colour is produced. **[5 marks]**

Total 15 marks

Write the answer to Question 6 here.

Write the answer to Question 6 here.

Write the answer to Question 6 here.

END OF TEST

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

TEST CODE **02112032**

FORM TP 2013154

MAY/JUNE 2013

C A R I B B E A N   E X A M I N A T I O N S   C O U N C I L

CARIBBEAN ADVANCED PROFICIENCY EXAMINATION®

CHEMISTRY

UNIT 1 – Paper 032

ALTERNATIVE TO SCHOOL-BASED ASSESSMENT

2 hours

READ THE FOLLOWING INSTRUCTIONS CAREFULLY.

1. This paper consists of THREE questions. Answer ALL questions.
2. Write your answers in the spaces provided in this booklet.
3. ALL working MUST be shown.
4. You may use a silent, non-programmable calculator to answer questions.
5. A data booklet is provided.

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO.

Answer ALL questions.

1. Solid **P** is a mixture of two simple salts of an alkali metal. You are required to carry out the following tests, being careful to add reagents gradually until no further change is observed, and gently shaking after each addition.

Record your observations and relevant deductions in the table provided.

Include in your recordings

- details of colour changes and precipitates formed
- the names of gases evolved and details of the tests used to identify EACH.

Test	Observations	Deductions
Using small quantities of **P**: (a) Add dilute HCl. Test for gas evolved.	• **[1 mark]**	• **[1 mark]**
(b) Add with care approximately 1 cm^3 conc. H_2SO_4 and warm gently. Test for gases evolved.	• • **[2 marks]**	• • • **[3 marks]**
(c) Shake **P** with distilled water and carry out the following tests on three separate portions.		
(d) To firs portion add $AgNO_3$(aq) and allow to stand for 1 minute; then add NH_3(aq).	• **[1 mark]** • **[1 mark]**	• **[1 mark]** • **[1 mark]**

Test	Observations	Deductions
(e) To second portion add $Pb(NO_3)_2$ (aq); allow to stand for 1 minute.	• **[1 mark]**	• **[1 mark]**
(f) To third portion add $BaCl_2$(aq) slowly, followed by dil HCl(aq).	• • • **[3 marks]**	• • **[2 marks]**

Total 18 marks

NOTHING HAS BEEN OMITTED

2. An experiment is carried out to investigate the rate of reaction between an excess of dolomite chips (magnesium carbonate) and 50 cm^3 of dilute hydrochloric acid. The volume (cm^3) of carbon dioxide is measured at regular intervals using a gas syringe. Figure 1 shows six readings of the volume of carbon dioxide as given by the gas syringe, and the corresponding time(s) taken.

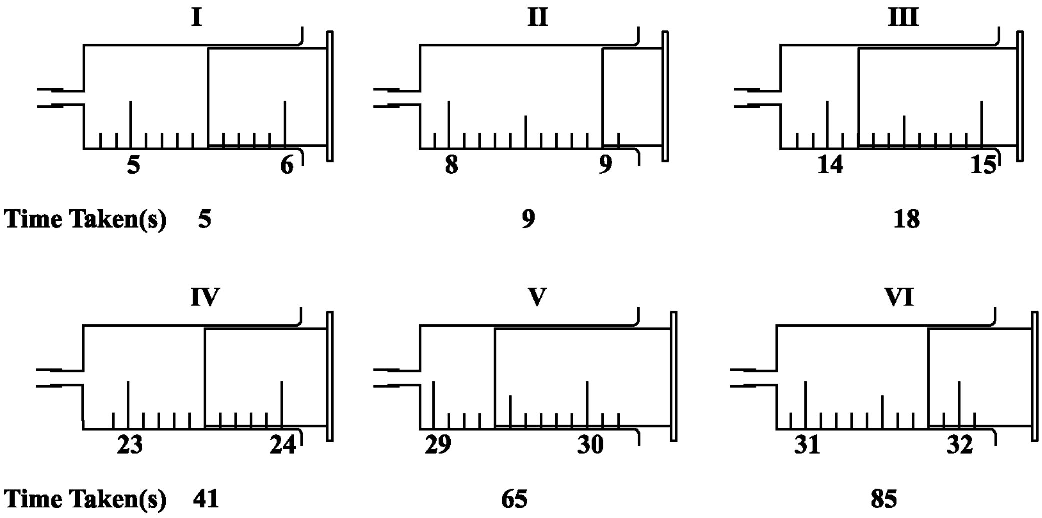


Figure 1. Volume of CO_2 measured by the gas syringe

(a) From the results shown in Figure 1, construct a table to show number of readings, volume of CO_2 evolved, the time taken and the inverse of the time taken (1/t).

[5 marks]

GO ON TO THE NEXT PAGE

(b) **On the grid on page 7**, plot a graph of volume CO_2 evolved against time taken.

[5 marks]

(c) State a reason for the shape of the graph.

____

____

____

[1 mark]

(d) From your graph, determine the rate of reaction at 30 seconds and 60 seconds respectively. Show ALL your working.

30 s ____

____

60 s ____

____

[4 marks]

(e) State what can be deduced about the rate of reaction from your answer in (d) above.

____

[1 mark]

(f) Suggest the property of the reaction measured by the value, 1/t (the inverse of the time).

____

[1 mark]

(g) Suggest a reason for the use of excess dolomite (magnesium carbonate).

____

[1 mark]

Total 18 marks

3. A student was taught that transition metals possessed catalytic properties.

Plan and design an experiment that would allow the student to test the truth of this principle.

Your answer should include:

(a) Hypothesis

[1 mark]

(b) Aim

[1 mark]

(c) Apparatus/Materials

[2 marks]

(d) Experimental procedure

[2 marks]

(e) Variables

(i) Manipulated

____

[1 mark]

(ii) Responding

____

[1 mark]

(iii) Controlled

____

[1 mark]

(f) Data to be collected

____

____

[1 mark]

(g) Discussion of expected results

____

____

____

____

____

[2 marks]

Total 12 marks

END OF TEST

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

TEST CODE **02212020**

FORM TP 2013156

MAY/JUNE 2013

C A R I B B E A N   E X A M I N A T I O N S   C O U N C I L

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. 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.

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO.

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) Figure 1 shows two reactions of Compound X, a vegetable oil.

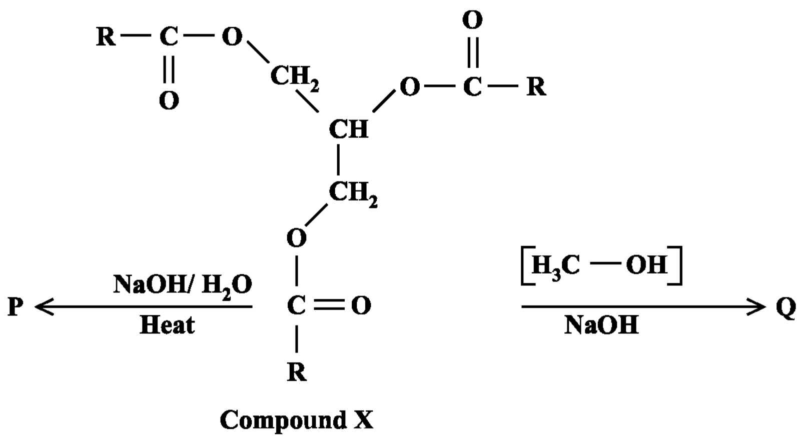


Figure 1. Reaction of Compound X

(i) Draw the products formed at P.

[2 marks]

(ii) Draw the products formed at Q.

[2 marks]

(iii) Identify the process which leads to the formation of the products at

a) P ____

b) Q ____

[2 marks]

(iv) State a use of the non-alcoholic product formed at

a) P ____

b) Q ____

[2 marks]

(b) (i) A student was asked to identify the organic compound, Z. Table 1 shows the student's incomplete record of tests conducted on Z. Complete the student's record by writing the correct observation or inference in the appropriate space.

TABLE 1: RECORD OF TESTS ON COMPOUND Z

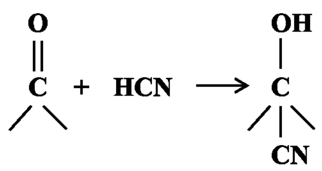
Test	**Observation**	**Inference**
To 1.0 cm^3 Z in a test tube add 2,4 – DNPH.	a)	Z is a carbonyl compound.
To 1.0 cm^3 of Z in a test tube add acidifie $KMnO_4$ and heat.	b)	Z reduces $KMnO_4$.
To 1.0 cm^3 of Z in a test tube add Tollen's reagent.	A silver mirror appears.	c)
To 1.0 cm^3 of Z in a test tube add Fehling's solution.	No reaction	d)

[4 marks]

(ii) Draw the LIKELY structure for Compound Z.

[1 mark]

(c) The reaction between carbonyl compounds and HCN occurs via nucleophilic addition.



Outline the mechanism for the reaction, using curved arrows to show the movement of electrons.

[2 marks]

Total 15 marks

MODULE 2

ANALYTICAL METHODS AND SEPARATION TECHNIQUES

2. (a) State TWO characteristics of a molecule which make it suitable for analysis by infrared spectroscopy (IR).

[2 marks]

(b) Give TWO examples of the use of IR spectroscopy.

[2 marks]

(c) The IR spectra in Figures 2, 3 and 4 belong to the compounds 2-propanol ($CH_3CH(OH)CH_3$), butanoic acid ($CH_3CH_2CH_2COOH$) and acetone (CH_3COCH_3). Identify EACH of the compounds A, B and C in Figures 2, 3 and 4 respectively from the IR spectra provided. Justify your choice by indicating which band on the spectra was used to verify the identity of the compounds and indicate the functional group responsible for the band in EACH case.

(i)

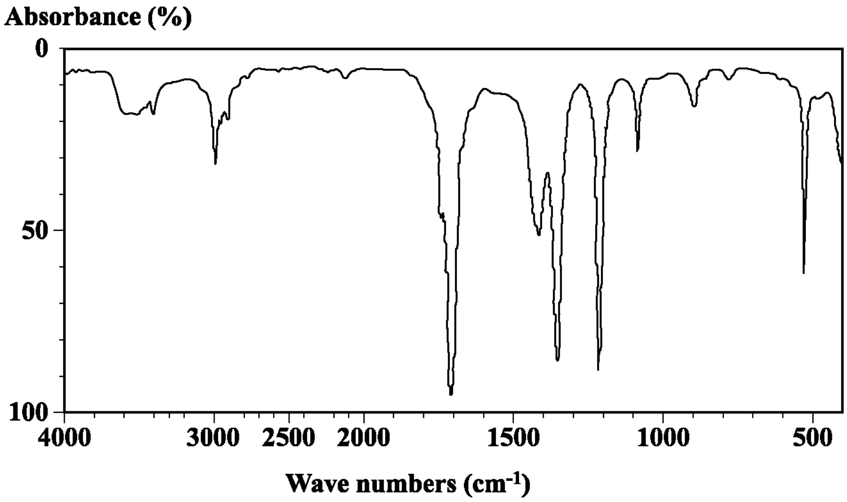


Figure 2. Compound A

a) Identity of Compound A ________________________________

b) Band used for identification and functional group

____

____

[2 marks]

(ii)

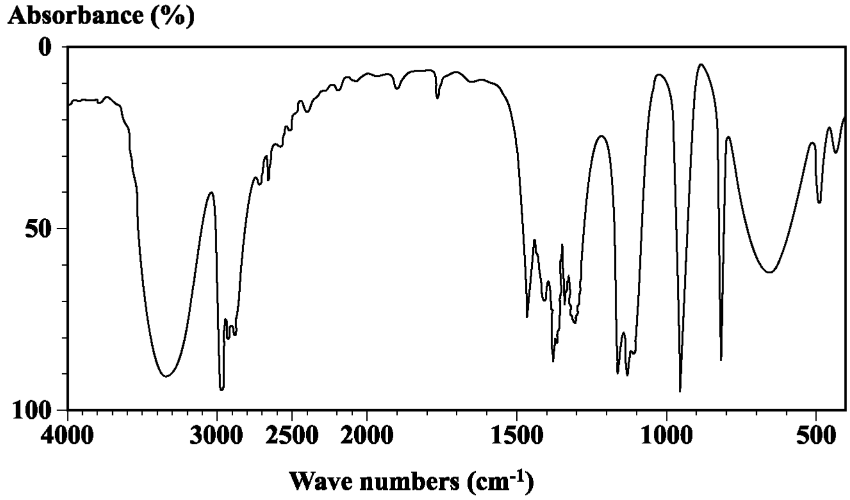


Figure 3. Compound B

a) Identity of Compound B ____________________________________

b) Band used for identification and functional group

____

____

[2 marks]

(iii)

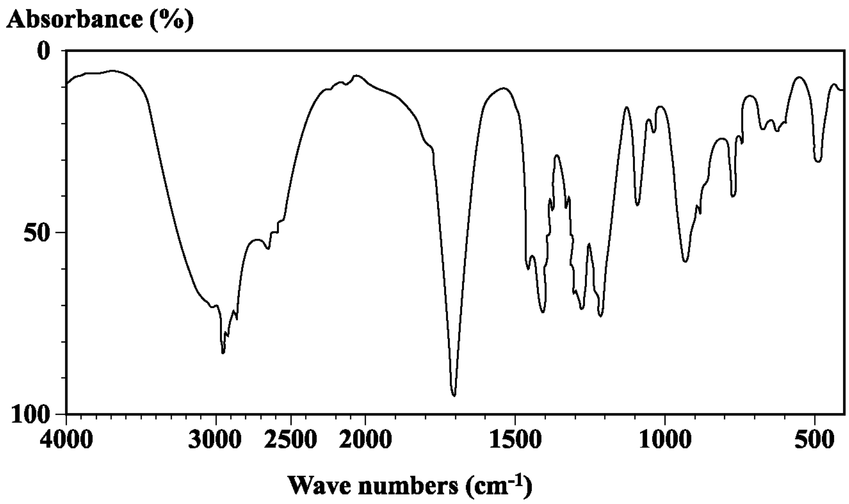


Figure 4. Compound C

a) Identity of Compound C ____________________

b) Band used for identification and functional group

____

____

[2 marks]

(d) A student is asked to prepare a solid sample for analysis using IR spectroscopy.

(i) Describe FOUR steps to be taken by the student in preparing the sample and analysing it.

____

____

____

____

____

____

[4 marks]

(ii) Why are the plates used for IR spectroscopy made from NaCl?

____

____

____

____

____

[1 mark]

Total 15 marks

MODULE 3

INDUSTRY AND THE ENVIRONMENT

3. (a) A stream which fl ws through an agricultural community is also used for domestic washing. Samples taken from a site downstream after a heavy rainfall were found to contain a number of pollutants.

(i) State the process that may have resulted in pollutants being present in the stream.

____

[1 mark]

(ii) Identify TWO sources of the pollutants (other than fertilizers) that are MOST likely to be present in the stream.

____

____

[2 marks]

(b) Analysis of the samples revealed excessive quantities of nitrates and phosphates.

Describe how the presence of these pollutants can be identifie in a laboratory.

(i) <u>Nitrates</u>

Reagents:

____

Observations:

____

____

[2 marks]

(ii) <u>Phosphates</u>

Reagents:

____

Observations:

____

____

[2 marks]

(c) (i) State TWO ways by which oxygen enters waterways.

[2 marks]

(ii) Dissolved oxygen is essential for maintaining good water quality and the preservation of aquatic life.

Explain why the process of eutrophication leads to poor water quality.

[2 marks]

(iii) Explain why dissolved oxygen must be removed from water before it is used in industrial processes.

[2 marks]

(d) State TWO steps involved in the treatment of water in order to make it potable.

[2 marks]

Total 15 marks

SECTION B

Answer ALL questions.

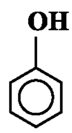
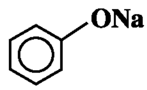
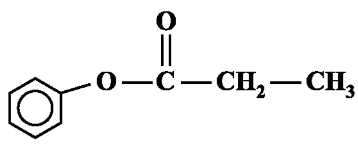
Write your answers in the spaces provided at the end of each question.

MODULE 1

THE CHEMISTRY OF CARBON COMPOUNDS

4. (a) Table 2 shows some reactions of phenol. Identify the reagents and structures needed to complete the table correctly. **(Write your answers in the space provided on page 14.)**

TABLE 2: REACTIONS OF PHENOL

Phenol	**Reagents**	**Structure of Organic Product Formed**
	(i)	
	$Br_2(aq)$	(ii)
	(iii)	

[3 marks]

(b) Figure 5 shows the formation of 3-bromoaniline from benzene in three steps labelled I, II and III.

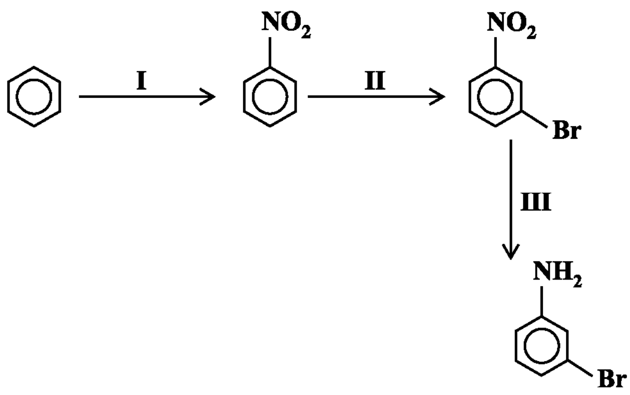


Figure 5. Formation of 3-bromoaniline from benzene

(i) State the reagents and conditions to be used in EACH of the reactions at Steps I, II and III. **[3 marks]**

(ii) Outline the reaction mechanism for the reaction in Step I, using curved arrows to show the movement of electrons. **[3 marks]**

(iii) State the reaction mechanism outlined in (b) (ii) above. **[1 mark]**

(iv) For Step II, explain why the bromo substituent occupies its position on the molecule. **[1 mark]**

(c) Benzene, nitrobenzene and methylbenzene will react with chlorine, in the presence of a catalyst, to form aromatic substituted compounds. The three reactions take place at different rates.

(i) Arrange the reagents benzene, nitrobenzene and methylbenzene in order of INCREASING ease of reactivity with chlorine. **[1 mark]**

(ii) For EACH reaction, draw the MAJOR mono-substituted aromatic product that is formed. **[3 marks]**

Total 15 marks

Write the answer to Question 4 here.

(a) (i) Reagent: ____________________

(ii) Structure:

(iii) Reagent ____________________

Write the answer to Question 4 here.

MODULE 2

ANALYTICAL METHODS AND SEPARATION TECHNIQUES

5. (a) Define the term 'partition coefficient'. **[2 marks]**

(b) When butanedioic acid was shaken with a mixture of water and ether, 10 cm^3 of water was found to contain 0.854 g of the acid while a similar volume of ether contained 0.159 g.

In a separate experiment, 10 cm^3 of water and 20 cm^3 of ether were shaken together with 1 g of the acid.

Calculate the mass of the acid found in the aqueous layer. **[4 marks]**

(c) Suggest an appropriate method for separating the components of EACH of the following:

(i) Eucalyptus oil from an aqueous suspension of its leaves

(ii) Penicillin (organic solid) from an aqueous solution

(iii) Components of a coal tar residue

(iv) Ethoxyethane from an impure source **[4 marks]**

(d)

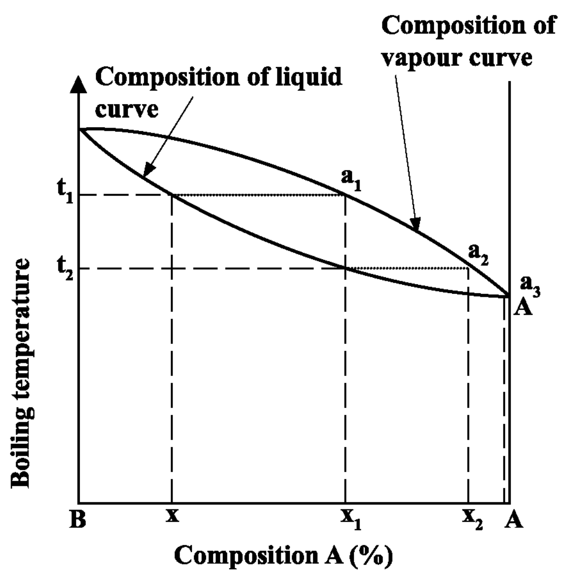


Figure 6. Boiling point – composition curve for ideal mixture of liquids

Use the boiling point – composition curve in Figure 6 to explain the principles of fractional distillation, starting with a liquid of composition *x*. **[5 marks]**

Total 15 marks

Write the answer to Question 5 here.

Write the answer to Question 5 here.

MODULE 3

INDUSTRY AND ENVIRONMENT

6. (a) Describe the process of extracting aluminium oxide from its ore. Include TWO relevant equations in your answer. **[7 marks]**

(b) (i) Name a pollutant formed as a by-product of the process in (a).

(ii) Describe TWO environmental consequences resulting from the named pollutant in (b) (i). **[3 marks]**

(c) Aluminium is extracted by electrolysis of its oxide.

(i) Write equations to show the reactions occurring at the electrodes. **[2 marks]**

(ii) a) Outline ONE reason for the high cost associated with this method of extraction.

b) Suggest TWO reasons why the recycling of aluminium is important. **[3 marks]**

Total 15 marks

Write the answer to Question 6 here.

Write the answer to Question 6 here.

Write the answer to Question 6 here.

END OF TEST

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

TEST CODE **02212032**

FORM TP 2013157

MAY/JUNE 2013

C A R I B B E A N   E X A M I N A T I O N S   C O U N C I L

CARIBBEAN ADVANCED PROFICIENCY EXAMINATION®

CHEMISTRY

UNIT 2 – Paper 032

ALTERNATIVE TO SCHOOL-BASED ASSESSMENT

2 hours

READ THE FOLLOWING INSTRUCTIONS CAREFULLY.

1. This paper consists of THREE questions. Answer ALL questions.
2. Write your answers in the spaces provided in this booklet.
3. ALL working MUST be shown.
4. You may use a silent, non-programmable calculator to answer questions.
5. A data booklet is provided.

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO.

Answer ALL questions.

1. (a) You are provided with a solution of an oxalate salt. Carry out the following redox titration with standardized potassium manganate(VII) ($KMnO_4$) to determine the molarity of the oxalate solution.

Procedure

A. Pipette 25 cm^3 of oxalate solution into a 250 cm^3 conical flask

B. To the conical flask add 30 c ^{3} of 2M H_2SO_4, with stirring.

C. Fill your burette with standardized 0.020 mol dm^{-3} potassium manganate(VII) solution.

D. Heat the contents of the conical fl sk to 70–80°C. DO NOT BOIL THE SOLUTION.

E. Titrate the oxalate solution against the $KMnO_4$ in the burette.

F. Record both the initial burette reading and the final reading (at the end point), in Table 1.

G. Repeat Steps A–F until consistent results are obtained.

TABLE 1: DATA FOR EXPERIMENTAL PROCEDURE

	1	**2**	**3**
Final burette reading (cm^3)			
Initial burette reading (cm^3)			
Volume of $KMnO_4$ used (cm^3)			

[6 marks]

(b) State the name of the solution which was used as the indicator in the titration.

[1 mark]

(c) What colour change did you observe at the end point of the reaction?

[1 mark]

(d) State the reason why the mixture was heated in Step D of the experiment.

____

[1 mark]

(e) When taking burette readings of liquids, the bottom of the meniscus is usually read. Give ONE reason why this could not be done in the above titration.

____

[1 mark]

(f) Calculate the volume of $KMnO_4$ used in the titration.

[1 mark]

(g) Write the ionic equation for the reaction occurring in the titration.

[2 marks]

(h) Calculate the number of moles of $KMnO_4$ used in the titration.

[1 mark]

(i) Calculate the number of moles of oxalate present in your pipetted 25 cm^3 of oxalate solution.

[2 marks]

(j) Calculate the molarity of the oxalate solution.

[2 marks]

Total 18 marks

2. An experiment was carried out to determine the value of n in the hydrated salt, $Na_2CO_3 \cdot n\, H_2O$.

In a crucible, 4.58 g of the salt was gradually heated, increasing the heat to a maximum and then heated strongly for 10 minutes.

The crucible and its contents were allowed to cool and then weighed. The heating, cooling and weighing of the sample were repeated until a constant mass was achieved.

The results after each heating were as follows:

10 minutes – 1.73 g, 15 minutes – 1.71 g, 20 minutes – 1.70 g,
25 minutes – 1.69 g, 30 minutes – 1.69 g.

(a) Construct a table to show the mass of the sample after EACH heating.

[5 marks]

(b) What was the purpose of heating the sample?

____

[1 mark]

(c) Why was the sample heated gradually at first before being heated strongly at a maximum?

____

[1 mark]

(d) Why was it important to cool the sample before weighing?

____

[1 mark]

(e) State the mass of anhydrous salt in the sample.

[1 mark]

(f) Calculate the mass of water present in the hydrated salt.

[1 mark]

(g) Calculate the number of moles of water in the sample.

[2 marks]

(h) Calculate the number of moles of anhydrous salt in the sample.

[2 marks]

(i) Calculate the number of moles of water which combines with one mole of anhydrous salt.

[1 mark]

(j) Deduce the value of *n* in the formula for the hydrated salt.

____

[1 mark]

(k) Write the equation to describe the heating of the hydrated salt.

____

____

[2 marks]

Total 18 marks

3. You suspect that the drinking water in your community contains high levels of nitrates due to leaching of fertilizers that are used by local farmers.

Use the following guidelines to plan and design an experiment to confirm your suspicions

(a) Hypothesis

[1 mark]

(b) Aim

[1 mark]

(c) Reagents and equipment

[3 marks]

(d) Procedure

[2 marks]

(e) Variables

(i) Manipulated

[1 mark]

(ii) Controlled

[1 mark]

(f) One precaution to be taken

[1 mark]

(g) Expected results

[2 marks]

Total 12 marks

END OF TEST

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

TEST CODE **02112020**

FORM TP 2014150

MAY/JUNE 2014

C A R I B B E A N   E X A M I N A T I O N S   C O U N C I L

CARIBBEAN ADVANCED PROFICIENCY EXAMINATION®

CHEMISTRY

UNIT 1 – 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. 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.

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO.

SECTION A

Answer ALL questions.

Write your answers in the spaces provided in this booklet.

MODULE 1

FUNDAMENTALS IN CHEMISTRY

1. (a) Defin the terms

(i) mole

____

____

[2 marks]

(ii) molar mass (include the units).

____

____

[2 marks]

(b) A carbonate of a metal, M, has the formula M_2CO_3. The equation for the reaction of M_2CO_3 with hydrochloric acid is given below.

$$M_2CO_3(aq) + 2HCl(aq) \rightarrow 2MCl(aq) + CO_2(g) + H_2O(l)$$

6.125 g of M_2CO_3 was used to prepare 1 dm^3 of solution. 40 cm^3 of the solution was required to neutralize exactly 23.6 cm^3 of 0.150 mol dm^{-3} hydrochloric acid.

(i) Calculate

a) the number of moles of M_2CO_3

____

____

____

____

[2 marks]

b) the relative molecular mass of M_2CO_3.

[2 marks]

(ii) Deduce the identity of M.

[2 marks]

(c) Outline the experimental steps required to carry out the reaction described in (b) on page 2.

[5 marks]

Total 15 marks

MODULE 2

KINETICS AND EQUILIBRIA

2. (a) (i) State the Bronsted–Lowry theory of acids and bases.

[1 mark]

(ii) Distinguish between a ‘strong acid’ and a ‘weak acid’.

[2 marks]

(b) 25 cm^3 of 0.1 mol dm^{-3} hydrochloric acid is titrated with 0.1 mol dm^{-3} of aqueous ammonia.

(i) In the space below, sketch the curve which is expected to illustrate the changes that take place during titration.

[2 marks]

(ii) Suggest an indicator, **giving a reason** for your choice.

____

____

____

[2 marks]

(c) A solution of a halic acid, HOX, readily decomposes at room temperature with oxygen as the only gaseous product. The data in the table below applies to the decomposition of aqueous HOX at room temperature.

Experiment	**Initial Concentration of HOX ($mol\ dm^{-3}$)**	**Initial Rate ($mol\ dm^{-3}\ s^{-1}$)**
I	1.6×10^{-3}	0.12
II	2.4×10^{-3}	0.18
III	3.2×10^{-3}	0.24

(i) Deduce the order of the reaction.

[1 mark]

(ii) Calculate the rate constant for the decomposition.

[2 marks]

(d) (i) Magnesium filings were added to the remaining solution at 2 (c). What observation is expected?

____

[1 mark]

(ii) Outline an alternative experimental method to determine the rate of decomposition of HOX at room temperature.

____

____

____

____

____

____

____

[4 marks]

Total 15 marks

MODULE 3

CHEMISTRY OF THE ELEMENTS

3. (a) Defin the term ‘transition element’.

____

____

[2 marks]

(b) Cisplatin, $[Pt(NH_3)_2Cl_2]$, is a drug used in cancer treatment.

(i) Deduce the oxidation number of the platinum atom.

____

[1 mark]

(ii) Suggest the shape of the cisplatin molecule.

____

[1 mark]

(c) (i) Complete the diagrams below by inserting arrows to show the electronic configuratio of EACH ion.

	3d						4s
a) Fe^{2+} : [Ar]							
b) Mn^{2+} : [Ar]							

[2 marks]

(ii) Use the information in (c) (i) b) to explain why Mn^{2+} ions resist oxidation to Mn^{3+} ions.

____

____

____

____

[2 marks]

(d) A sequence of reactions involving compounds of cobalt, with ions labelled A, B, C and D, is shown below.

$$\underset{\text{Blue}}{\overset{\textbf{A}}{[Co(OH)_4]^{2-}(aq)}} \overset{H_2O}{\rightleftharpoons} \overset{\textbf{B}}{[Co(H_2O)_6]^{2+}(aq)} \overset{NH_3}{\rightleftharpoons} \overset{\textbf{C}}{[Co(NH_3)_6]^{2+}(aq)} \overset{Cl^-}{\rightleftharpoons} \overset{\textbf{D}}{[Co(Cl_4)]^{2-}(aq)}$$

(i) List the colour of the following ions:

B: ______________________________

C: ______________________________

D: ______________________________

[3 marks]

(ii) Sketch the arrangement of bonds in the ion labelled C.

[2 marks]

(e) State the changes that would be observed when a solution of copper(II) ions is treated with concentrated hydrochloric acid followed by concentrated ammonia.

____

____

[2 marks]

Total 15 marks

SECTION B

Answer ALL questions.

Write your answers in the spaces provided at the end of each question.

MODULE 1

FUNDAMENTALS IN CHEMISTRY

4. (a) Carbon combines with hydrogen covalently to form a gas, ethane.

(i) State the electronic configuratio of carbon in its ground state using sp notation. **[1 mark]**

(ii) Account for the number and type of orbitals around EACH carbon atom in a molecule of ethane. **[3 marks]**

(iii) Use the VSEPR theory to deduce the arrangement of the orbitals and the bond angles around EACH carbon atom in a molecule of dichloroethane, CH_2ClCH_2Cl. **[3 marks]**

(b) (i) State THREE assumptions of the kinetic theory as it pertains to ideal gases. **[3 marks]**

(ii) Under what conditions of temperature and pressure will a real gas deviate from ideal gas behaviour? **[1 mark]**

(c) A gas with a mass of 0.299 g was collected in a 400 cm^3 container at a pressure of 4.2×10^4 Pa and a temperature of 25 °C.

Calculate the relative molecular mass (M_r) of the gas.

$[R = 8.31 \text{ J K}^{-1} \text{ mol}^{-1}]$ **[4 marks]**

Total 15 marks

Write the answer to Question 4 here.

(a) (i) ____

(ii) ____

____

____

____

Write the answer to Question 4 here.

(a) (iii)

(b) (i)

Write the answer to Question 4 here.

(b) (ii)

(c)

MODULE 2

KINETICS AND EQUILIBRIA

5. (a) Defin the terms

(i) solubility **[2 marks]**

(ii) solubility product. **[2 marks]**

(b) At 25 °C, a saturated solution of lead(II) azide, $Pb(N_3)_2$, is prepared by dissolving 0.025 g in water to make 100.0 cm^3 of solution.

(i) Calculate the solubility, in mol dm^{-3}, of the lead(II) azide. **[2 marks]**

(ii) Lead(II) azide dissociates in a saturated solution according to the following equation:

$$Pb(N_3)_2(s) \rightleftharpoons Pb^{2+}(aq) + 2N_3^-(aq)$$

Write the expression for the solubility product of lead(II) azide. **[2 marks]**

(iii) Calculate the solubility product of lead(II) azide. **[2 marks]**

(c) (i) Sketch a diagram showing the distribution of energies in a gas at a given temperature, T_1. **[2 marks]**

(ii) On the same diagram as in 5 (c) (i), insert **another** curve showing the distribution of energies of the molecules at a higher temperature, T_2. **[1 mark]**

(iii) Using your sketch, explain the difference in the rates of reaction at temperatures T_1 and T_2. **[2 marks]**

Total 15 marks

Write the answer to Question 5 here.

(a) (i) ______________________________

____

____

____

____

____

Write the answer to Question 5 here.

(a) (ii)

(b) (i)

(ii)

(iii)

Write the answer to Question 5 here.

(c) (i) – (ii)

(iii)

MODULE 3

CHEMISTRY OF THE ELEMENTS

6. (a) Defin the term ‘polarization’. **[2 marks]**

(b) (i) State the trend in ionic size of the elements from Na to Al. **[1 mark]**

(ii) Explain the following observation. (Include relevant equations to support your answer.)

The pH of an aqueous solution of sodium chloride is 7, while the corresponding value for aluminium chloride is 3. **[7 marks]**

(c) When a stream of chlorine gas is passed through an aqueous solution of a metal halide, A, of molecular mass 212.5, a reddish-brown solution, B, is formed. Shaking B with tetrachloromethane in a separatory funnel produces C, a purple organic layer, and D, a colourless aqueous layer.

(i) State the name of the halide ion in A. **[1 mark]**

(ii) Write the formula equation for the reaction of A with chlorine. **[2 marks]**

(iii) Describe an additional simple test to confir the identity of the halide ion in A. **[2 marks]**

Total 15 marks

Write the answer to Question 6 here.

(a)

Write the answer to Question 6 here.

(b) (i)

(ii)

Write the answer to Question 6 here.

(c) (i)

(ii)

(iii)

END OF TEST

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

TEST CODE **02112032**

FORM TP 2014151

MAY/JUNE 2014

C A R I B B E A N   E X A M I N A T I O N S   C O U N C I L

CARIBBEAN ADVANCED PROFICIENCY EXAMINATION®

CHEMISTRY

UNIT 1 – Paper 032

ALTERNATIVE TO SCHOOL-BASED ASSESSMENT

2 hours

READ THE FOLLOWING INSTRUCTIONS CAREFULLY.

1. This paper consists of THREE questions. Answer ALL questions.
2. Write your answers in the spaces provided in this booklet.
3. ALL working MUST be shown.
4. You may use a silent, non-programmable calculator to answer questions.
5. A data booklet is provided.
6. You are advised to take some time to read through the paper and plan your answers.

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO.

Answer ALL questions.

1. You are provided with the following reagents:

- A standard 0.10 M solution of sodium thiosulfate, $Na_2S_2O_3$, labelled R
- A solution of potassium iodate, KIO_3, containing 3.00 g dm^{-3}, labelled S
- A solution of potassium iodide, KI, of approximately 15 g dm^{-3}
- 1 M sulfuric acid
- Starch solution

Carry out the following experiment to determine the ratio of iodate to iodide ions in the acid solution.

(a) Procedure

(i) Pipette 20.0 cm^3 of the solution, S, into a conical flask

(ii) Add approximately 20 cm^3 of potassium iodide solution into the same conical flask

(iii) Add approximately 10 cm^3 of 1 M sulfuric acid to the conical flas in (ii) above.

(iv) Fill your burette with the standard, Solution R.

(v) Titrate the iodine produced in the conical flas with Solution R, swirling after each addition of R, then add 5 drops of starch solution when the colour in the titration flas becomes yellow. Continue titrating with Solution R, while swirling, until the mixture becomes colourless.

(vi) Record both your initial burette reading and the reading at the end point in Table 1 to TWO decimal places.

(vii) Repeat Steps (i)–(vi) until consistent results are obtained.

TABLE 1: DATA FOR EXPERIMENTAL PROCEDURE

	1	2	3
Final burette reading (cm^3)			
Initial burette reading (cm^3)			
Volume of R used (cm^3)			

[6 marks]

(b) Calculate the volume of Solution R used for the titration.

____

[1 mark]

(c) Suggest a reason for using starch as the indicator.

____

____

[1 mark]

(d) The thiosulfate ions are oxidized by the iodine according to the following half-equation:

$$2S_2O_3^{2-} \rightleftharpoons S_4O_6^{2-} + 2e^-$$

Write the half-equation for the reduction of iodine.

____

[2 marks]

(e) Write the **balanced** equation for the reaction between the thiosulfate ions and iodine.

____

[2 marks]

(f) Calculate

(i) the number of moles of thiosulfate ions used in the titration

[1 mark]

(ii) the number of moles of iodine produced by the 20.0 cm^3 of the potassium iodate solution

[1 mark]

(iii) the number of moles of iodine formed when one mole of iodate ions reacts with the excess iodide ions.

[2 marks]

(g) Write a **balanced** equation for the reaction between iodate and iodide ions in acid solution.

____

____

[2 marks]

Total 18 marks

2. An experiment is carried out to investigate the catalytic decomposition of hydrogen peroxide using finel divided manganese(IV) oxide as catalyst, at room temperature. The volume of oxygen evolved is measured at regular intervals using a gas syringe. Figure 1 shows six readings of the volume of oxygen as indicated by the appropriate section of the gas syringe, and the corresponding time taken.

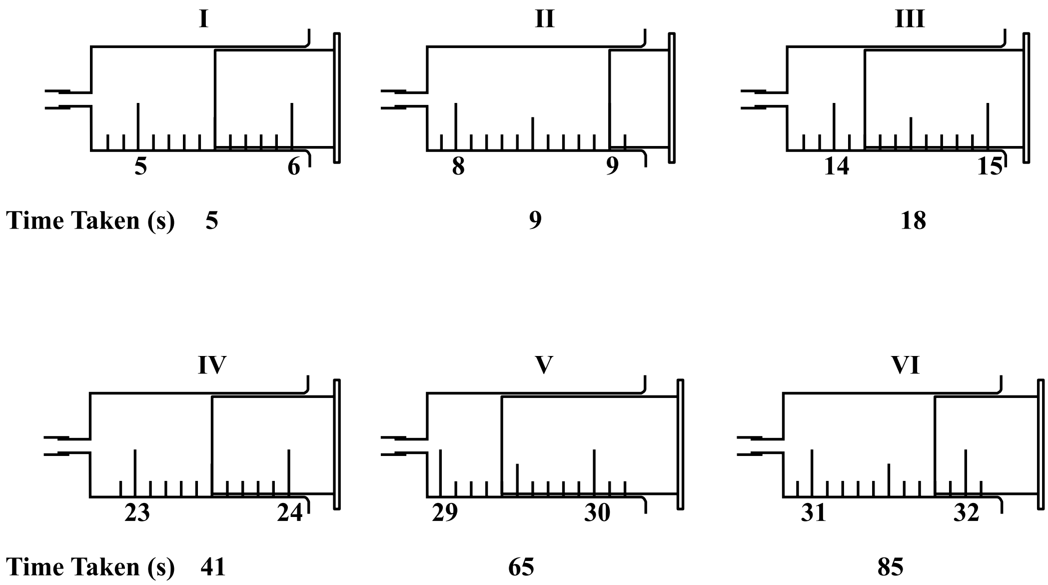


Figure 1. Volume of O_2 measured by the gas syringe

(a) From the results shown in Figure 1, construct a table to show the number of syringe readings, volume of O_2 evolved and the time taken.

[5 marks]

GO ON TO THE NEXT PAGE

(b) **On the grid on page 7**, plot a graph of volume O_2 evolved against time taken.

[4 marks]

(c) Explain the shape of the graph.

____

____

____

[2 marks]

(d) From your graph, determine the rate of reaction at 15 and 30 seconds respectively. **Show ALL your working.**

15 seconds____

____

30 seconds____

____

[4 marks]

(e) Suggest a likely effect on the rate of the reaction if the catalyst was NOT in a finel divided state.

____

____

[1 mark]

(f) If the temperature of the reaction is increased, suggest a possible effect on

(i) the rate of reaction

____

____

[1 mark]

(ii) the catalyst in the reaction.

____

____

[1 mark]

Total 18 marks

3. A researcher suspects that there is a difference in the hardness of tap water from an urban and a rural parish. It is known that dissolved ions such as calcium and magnesium contribute to the hardness of water.

Plan and design an experiment to determine the relative hardness of tap water in an urban parish and a rural parish.

Your answer should include:

(a) Hypothesis

____

____

[1 mark]

(b) Aim

____

____

[1 mark]

(c) Apparatus and materials

____

____

____

____

[2 marks]

(d) Experimental procedure

____

____

____

____

____

____

____

____

[2 marks]

(e) Variables

(i) Manipulated

____

[1 mark]

(ii) Responding

____

[1 mark]

(iii) Controlled

____

[1 mark]

(f) Expected results

____

____

____

____

[1 mark]

(g) Treatment of results

____

____

____

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[1 mark]

(h) A source of error in the experiment

____

[1 mark]

Total 12 marks

END OF TEST

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

TEST CODE **02212020**

FORM TP 2014153

MAY/JUNE 2014

C A R I B B E A N   E X A M I N A T I O N S   C O U N C I L

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. 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.

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO.

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 RNH_2, 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_b values in (b) (ii).

[2 marks]

(c) (i) Suggest a value for K_b for ethanamide, CH_3CONH_2.

[1 mark]

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

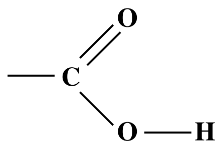
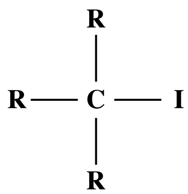
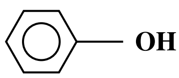
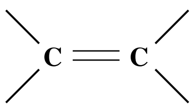
[1 mark]

(d) 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

	Test	**Functional Group**	**Observation**
(i)	Add $SOCl_2$ very cautiously.		• • **[2 marks]**
(ii)	Add $AgNO_3$(aq) and boil gently.		• **[1 mark]**
(iii)	Add Br_2(aq).		• **[1 mark]**
(iv)	Add Br_2(aq).		• **[1 mark]**

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 (λ) and frequency (v).

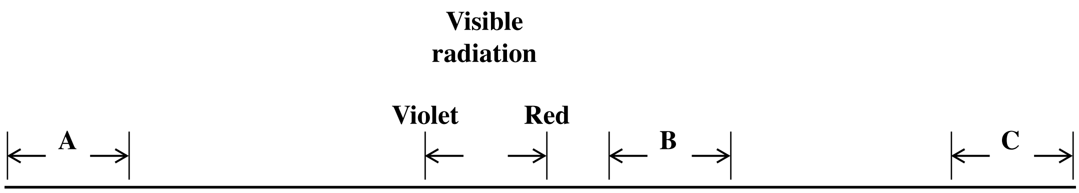


Figure 1. Electromagnetic spectrum

(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 4.5×10^{15} Hz. (Velocity of light = 3.0×10^{8} m s^{-1})

[2 marks]

GO ON TO THE NEXT PAGE

(c) State ONE example of the use of gravimetric analysis in quality control.

[1 mark]

(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-cm^3 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:

[2 marks]

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

[2 marks]

(iii) State the apparatus that should be used in Step 3.

[1 mark]

(e) Washing soda is hydrated sodium sulfate, $Na_2SO_4.x\ H_2O$.

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 $Na_2SO_4.x\ H_2O$.

(RAM: Na = 23; S = 32; O = 16; H = 1)

[4 marks]

Total 15 marks

MODULE 3

INDUSTRY AND THE ENVIRONMENT

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

(i) raising the temperature

[2 marks]

(ii) raising the pressure.

[2 marks]

GO ON TO THE NEXT PAGE

(c) Figure 2 is a flow diagram showing the manufacture of ammonia which involves a number of experimental processes including A, B, C and D.

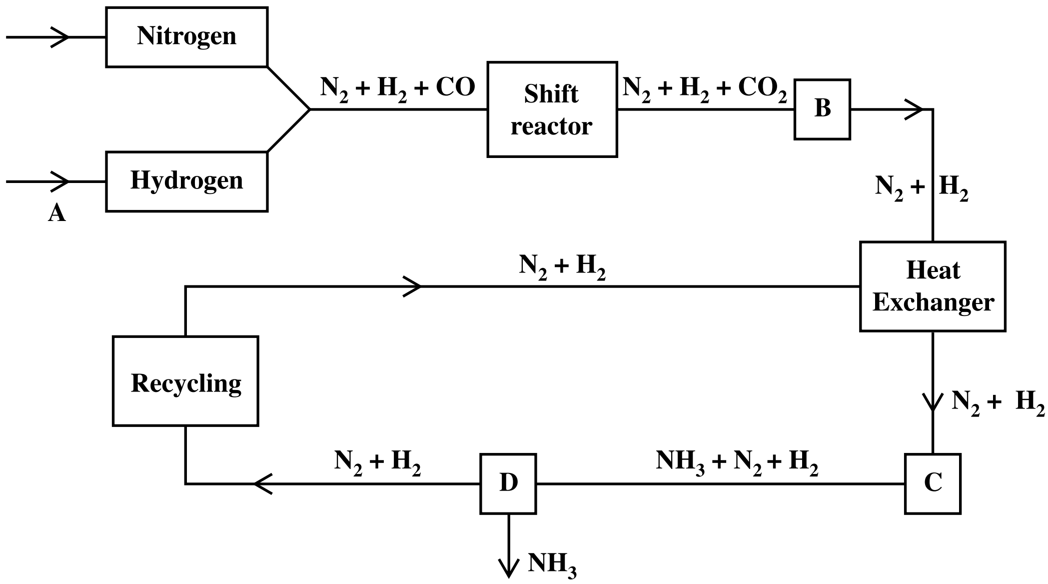


Figure 2. Flow diagram showing the manufacture of ammonia

(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) ______________________________

MODULE 2

ANALYTICAL METHODS AND SEPARATION TECHNIQUES

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 fiel **[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.

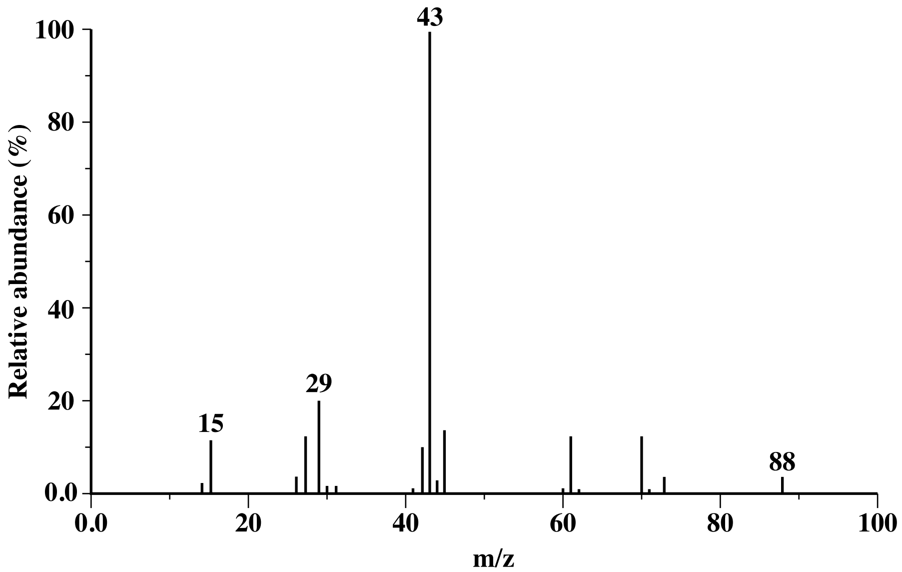


Figure 3. Mass spectrum of Compound X

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)

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]**

Total 15 marks

Write the answer to Question 6 here.

(a) (i) ______________________________

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Write the answer to Question 6 here.

(a) (ii)

(iii)

(b) (i)

(ii)

Write the answer to Question 6 here.

(c)

END OF TEST

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

TEST CODE **02212032**

FORM TP 2014154

MAY/JUNE 2014

C A R I B B E A N   E X A M I N A T I O N S   C O U N C I L

CARIBBEAN ADVANCED PROFICIENCY EXAMINATION®

CHEMISTRY

UNIT 2 – Paper 032

ALTERNATIVE TO SCHOOL-BASED ASSESSMENT

2 hours

READ THE FOLLOWING INSTRUCTIONS CAREFULLY.

1. This paper consists of THREE questions. Answer ALL questions.
2. Write your answers in the spaces provided in this booklet.
3. ALL working MUST be shown.
4. You may use a silent, non-programmable calculator to answer questions.
5. A data booklet is provided.
6. You are advised to take some time to read through the paper and plan your answers.

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO.

Answer ALL questions.

1. You have been provided with the following reagents:

- A solution of sodium hydroxide containing 1 mole in 1000 cm^3, labelled P
- A solution of ethanoic acid, labelled Q

Carry out the following experiment to determine the concentration of ethanoic acid.

(a) Procedure:

(i) Record your observations in Table 1.

(ii) Using a pipette, transfer 50 cm^3 of P to a polystyrene cup.

(iii) Allow to stand for a few minutes and record the temperature of the solution.

(iv) Fill the burette with Q.

(v) Add 5.0 cm^3 of Q from the burette to the cup.

(vi) Immediately stir the mixture with the thermometer and record its temperature.

(vii) Continue to add 5.0 cm^3 portions until a total of 50 cm^3 of Q is transferred, recording the temperature after each addition.

TABLE 1: TABLE OF OBSERVATIONS

Volume of Q (cm^3)										
Temperature (°C)										
Initial Temperature of P (°C)										

[5 marks]

(b) **On the grid provided on page 3**, plot a graph of temperature (°C) vs volume (cm^3) of Q added by drawing straight lines of best fi and extending the lines until they intersect.
[6 marks]

(c) What information is provided by the maximum temperature displayed by the graph?

____

____

[2 marks]

(d) Calculate the number of moles of P used in the reaction.

[1 mark]

(e) Write the equation for the reaction of sodium hydroxide and ethanoic acid.

____

[1 mark]

(f) Deduce the number of moles of ethanoic acid needed to neutralize the sodium hydroxide.

[1 mark]

(g) Use the information provided by the graph to determine the concentration of the ethanoic acid in mol dm^{-3}.

____

____

[1 mark]

(h) Suggest a source of error.

____

____

[1 mark]

Total 18 marks

2. After being opened and used, a bottle of AR iron(II) sulfate was left on the laboratory shelf for some time. 10 g of the sample were then dissolved in some dilute sulfuric acid and 1 dm^3 of solution was prepared. 20 cm^3 of this solution was placed in a conical flas and titrated with 0.02 mol dm^{-3} $KMnO_4(aq)/H^+(aq)$.

Figure 1 shows the readings on the burette at the start and end of each titration.

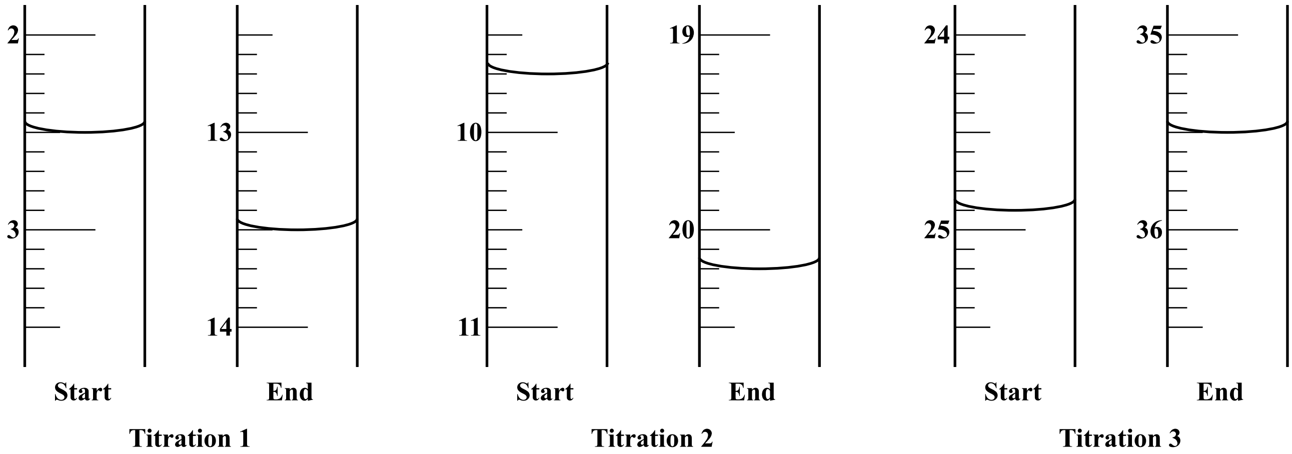

Figure 1. Reading on the burette

(a) (i) What colour change would you expect at the end point of the reaction?

____

[1 mark]

(ii) In the space below, construct Table 2 to record the titration results. You should include the initial and fina burette readings and the volumes of $KMnO_4(aq)/H^+(aq)$ used.

TABLE 2: TITRATION RESULTS

[5 marks]

GO ON TO THE NEXT PAGE

(iii) What is the volume of $KMnO_4(aq)/H^+(aq)$ to be used for calculation?

[1 mark]

(iv) Write the ionic equation for the reaction that occurs during the titration.

[1 mark]

(v) Calculate the concentration of the Fe^{2+} ions in the given solution in g dm^{-3}.

[3 marks]

(vi) Calculate the percentage purity of the sample.

[1 mark]

GO ON TO THE NEXT PAGE

(b) Outline the steps that you would take to prepare 1 dm^3 of the iron(II) sulfate solution.

[4 marks]

Total 16 marks

3. As part of an advertising strategy, a manufacturer of margarine, G, claims that his product is healthier than those of his two competitors. He bases this claim on the quantity of unsaturated oils present in his product.

Plan and design an experiment to test the accuracy of this claim.

Your answer should include the following:

(a) Hypothesis

____

____

[1 mark]

(b) Aim

____

____

[1 mark]

(c) Apparatus and materials

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[2 marks]

(d) Method

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[3 marks]

(e) Variables

(i) Controlled

[1 mark]

(ii) Manipulated

[1 mark]

(iii) Responding

[1 mark]

(f) Data to be collected

[1 mark]

(g) Expected results

[2 marks]

(h) Precaution

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[1 mark]

Total 14 marks

END OF TEST

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

TEST CODE **02112020**

FORM TP 2015156

MAY/JUNE 2015

C A R I B B E A N   E X A M I N A T I O N S   C O U N C I L

CARIBBEAN ADVANCED PROFICIENCY EXAMINATION®

CHEMISTRY

UNIT 1 – 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

FUNDAMENTALS IN CHEMISTRY

1. (a) (i) Defin the term 'bond energy'.

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[1 mark]

(ii) The bond lengths and bond energies of carbon-carbon single, double and triple bonds are listed below.

	C—C	C═C	C≡C
Bond Lengths	1.54Å	1.34Å	1.20Å
Bond Energy	348 kJ mol^{-1}	614 kJ mol^{-1}	839 kJ mol^{-1}

State the relationship between the strength of a covalent bond and its length.

....

....

[1 mark]

(b) Bond energies can be used to estimate the enthalpies of reactions in which bonds are broken and new bonds are formed. Consider the gas-phase reaction between methane (CH_4) and chlorine to produce methyl chloride (CH_3Cl) and hydrogen chloride.

(i) Write a balanced equation to represent the reaction above.

....

[2 marks]

GO ON TO THE NEXT PAGE

(ii) Using bond energy values from Table 1, calculate the enthalpy change of reaction, ΔH_{rxn}, for the equation required in (b) (i).

TABLE 1: BOND ENERGY VALUES

Bond	Energy ($kJ\ mol^{-1}$)
H—H	436
F—F	158
Cl—Cl	244
H—F	562
H—Cl	431
C—C	350
C—H	410
C—Cl	340
C—O	360
S—H	347

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[3 marks]

(iii) Is the reaction in (b) (i) exothermic or endothermic?

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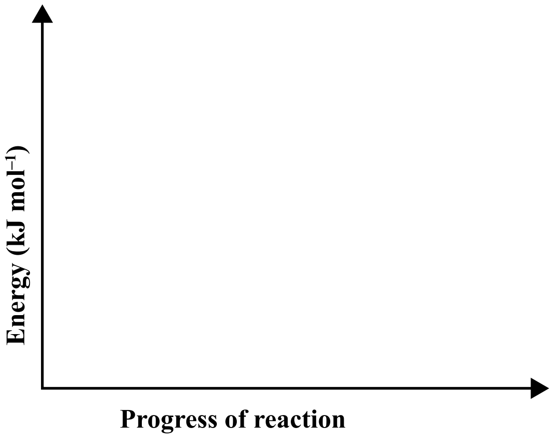
[1 mark]

GO ON TO THE NEXT PAGE

(iv) On the axes provided below, draw the energy-profil diagram for the reaction in (b) (i).



[2 marks]

(c) A student is asked to determine the enthalpy of the neutralization reaction between 75 cm^3 of 1.00 M hydrochloric acid and 75 cm^3 of 1.00 M potassium hydroxide solution. Outline the experimental steps (including calculations) required to obtain an accurate value.

[Assume that the densities of the solutions of acid and base and their heat capacities are equal to the density (1 g cm^{-3}) and heat capacity (4.18 J g^{-1} $°C^{-1}$) of water.]

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[5 marks]

Total 15 marks

MODULE 2

KINETICS AND EQUILIBRIA

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

(i) Standard electrode potential of a half-cell

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[2 marks]

(ii) Standard cell potential of an electrochemical cell

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[2 marks]

(b) Consider the following (unbalanced) equation which describes the process that is taking place in an electrochemical cell under standard conditions.

$$Al(s) + Sn^{2+}(aq) \rightarrow Al^{3+}(aq) + Sn(s)$$

(i) Write the ionic half-equation for the reaction taking place at EACH of the electrodes.

ANODE: ....

CATHODE: ....

[2 marks]

(ii) Write the cell diagram.

[1 mark]

GO ON TO THE NEXT PAGE

(iii) Draw a well-labelled diagram of the electrochemical cell. Indicate the direction of electron flo .

[6 marks]

(iv) For EACH electrode shown in Table 2, select the $E^{\ominus}$ value to determine the $E^{\ominus}_{cell}$.

TABLE 2: ELECTRODE POTENTIALS

Electrode Reaction	**E° at 298 K (25 °C) (volts)**
$Ag^{+} + e^{-} \rightleftharpoons Ag$	+0.80
$Al^{3+} + 3e^{-} \rightleftharpoons Al$	–1.66
$Ba^{2+} + 2e^{-} \rightleftharpoons Ba$	–2.90
$Sn^{2+} + 2e^{-} \rightleftharpoons Sn$	–0.14
$Sn^{4+} + 2e^{-} \rightleftharpoons Sn^{2+}$	+0.15

[2 marks]

Total 15 marks

GO ON TO THE NEXT PAGE

MODULE 3

CHEMISTRY OF THE ELEMENTS

3. The Group IV elements exhibit oxidation states of +2 and +4 in their compounds.

(a) Complete Table 3 for the oxides of carbon and lead.

TABLE 3: OXIDES OF GROUP IV ELEMENTS

	CO	**CO_2**	**PbO**	**PbO_2**
Acid/base nature	Neutral			Amphoteric
Thermal stability		Stable		
Oxidation state of Group IV element			+2	

[4 marks]

(b) (i) Explain the relative stabilities of the +2 oxidation states of the oxides of carbon and lead.

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[4 marks]

GO ON TO THE NEXT PAGE

(ii) Use the electrode potential value in the electrode reaction for lead ions, to explain the relative stabilities of the +2 and +4 oxidation states of lead:

$$Pb^{4+} + 2e^{-} \longrightarrow Pb^{2+}, \quad E^{\ominus} = +\ 1.80 \text{ volts}$$

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[2 marks]

(c) Describe what should be observed when

(i) concentrated sodium hydroxide is added to solid lead(IV) oxide

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[1 mark]

(ii) concentrated hydrochloric acid is added to solid lead(IV) oxide.

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[2 marks]

(d) Describe a test to identify Pb^{2+} ions in solution.

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[2 marks]

Total 15 marks

SECTION B

Answer ALL questions.

MODULE 1

FUNDAMENTALS IN CHEMISTRY

4. (a) The atoms of certain elements contain nuclei in which the ratio of neutrons to protons is greater than 1. These nuclei tend to emit radiation in order to bring the ratio closer to 1.

(i) Describe the THREE types of radiation that an unstable atom may emit. Include in your answer the symbols and penetrating power of EACH type of radiation.

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[6 marks]

(ii) Americium-241 (Am-241) decays via alpha particle emission. Write the nuclear equations to show the new element that forms when an atom of $^{241}_{95}$Am decays via the emission of 2 alpha particles.

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[2 marks]

(b) (i) Draw the diagrams of the atomic orbitals of principal quantum number 2. Include *x*, *y* and *z* axes in your drawing.

[2 marks]

(ii) Comment on the similarity and difference in the electronic configuration of K, Sc and Zn^{2+} given below.

K : $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^1$

Sc : $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^1\ 4s^2$

Zn^{2+} : $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}$

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[5 marks]

Total 15 marks

GO ON TO THE NEXT PAGE

MODULE 2

KINETICS AND EQUILIBRIA

5. A buffer consisting of $H_2PO_4^-$ and HPO_4^{2-} helps control the pH of physiological fluids Many carbonated soft drinks also use this buffer system.

(a) Using the buffer system mentioned above, describe how the solution maintains an almost constant pH even when small amounts of acid or alkali are added to the solution.

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[6 marks]

GO ON TO THE NEXT PAGE

(b) Calculate the pH of a soft drink in which the major buffer ingredients are 6.5 g of NaH_2PO_4 and 8.0 g of Na_2HPO_4 per 355 cm^3 of solution.

[K_a ($H_2PO_4^-$) = 6.4×10^{-8} mol dm^{-3}]

[Relative atomic mass: H = 1, Na = 23, O = 16, P = 31]

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[5 marks]

(c) Many chemical reactions occur in living systems such as the human body. Discuss the importance of biological buffers to the maintenance of a healthy body. (Include an example of a chemical reaction of a blood buffer.)

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[4 marks]

Total 15 marks

MODULE 3

CHEMISTRY OF THE ELEMENTS

6. (a) The atomic and ionic radii of the Group II elements gradually increase down the group. Outline the reasons for this trend.

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[3 marks]

(b) Account for the variation in the melting points of the Group II elements from magnesium to barium.

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[4 marks]

(c) Table 4 shows the observations when 0.1 mol dm^{-3} solutions of the metal ions are treated with 1 mol dm^{-3} Na_2SO_4.

TABLE 4: OBSERVATIONS OF REACTIONS

Solution of Group II Cations 0.1 mol dm^{-3}	**Observations with 1 mol dm^{-3} Na_2SO_4**
Mg^{2+}	No precipitate
Ca^{2+}	Thin, white precipitate
Sr^{2+}	White precipitate
Ba^{2+}	Thick, white precipitate

Account for the trend indicated in Table 4.

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[5 marks]

GO ON TO THE NEXT PAGE

(d) Explain the variation in the thermal decomposition of the nitrates of the Group II elements.

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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.

TEST CODE **02112032**

FORM TP 2015157

MAY/JUNE 2015

C A R I B B E A N   E X A M I N A T I O N S   C O U N C I L

CARIBBEAN ADVANCED PROFICIENCY EXAMINATION®

CHEMISTRY

UNIT 1 – Paper 032

ALTERNATIVE TO SCHOOL-BASED ASSESSMENT

2 hours

READ THE FOLLOWING INSTRUCTIONS CAREFULLY.

1. This paper consists of THREE questions. Answer ALL questions.
2. Write your answers in the spaces provided in this booklet.
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Answer ALL questions.

1. (a) You are provided with a calorimeter (two polystyrene cups nested together with a plastic cover) and a quantity of potassium nitrate.

Carry out the following procedure (Trial 1) to determine the molar heat of solution for potassium nitrate. The procedure is to be repeated (Trial 2).

The results are to be entered into Table 1.

Procedure

A. Construct a calorimeter – place two polystyrene cups together with a plastic cover on top.

B. Weigh and record the mass of the clean, dry calorimeter.

C. Place about 50 cm^3 of water in the calorimeter and weigh.

D. Place the calorimeter into a 500-cm^3 beaker for stability during the experiment.

E. Measure the temperature of the water to 0.01 °C.

F. Weigh out about 5 grams of potassium nitrate.

G. Add ALL the solid to the calorimeter as quickly as possible.

H. Swirl the calorimeter and determine the minimum or maximum temperature reached to 0.01 °C as the solid dissolves.

I. Ensure that the solid is completely dissolved.

J. After the fina temperature is determined, weigh the calorimeter with the dissolved solid.

K. **Repeat the procedure.** Use the same calorimeter containing a new sample of 50 cm^3 of water. Assume the same mass for the dry calorimeter.

TABLE 1: DATA FOR EXPERIMENTAL PROCEDURE

	Trial 1	**Trial 2**
Mass of empty calorimeter (g)		
Mass of calorimeter and water (g)		
Mass of potassium nitrate (g)		
Mass of solution (g)		
Original temperature, T_1 (°C)		
Final temperature, T_2 (°C)		
$\Delta T = [T_1 - T_2]$ (°C)		

[7 marks]

(b) Is the reaction exothermic or endothermic?

....

[1 mark]

(c) Calculate the heat, Q, lost or gained by the solution in the calorimeter. Assume that the solution has the same specifi heat capacity and density as pure water.

$[Q = mc\Delta T]$ $(c = 4.18\ \text{J g}^{-1}\ °\text{C}^{-1})$

[2 marks]

(d) Calculate the heat of the reaction, ΔH_{rxn}, in J g^{-1} KNO_3.

[2 marks]

(e) Calculate the number of moles of potassium nitrate used.

[RAM: K = 39.10; N = 14.01; O = 16.00]

[1 mark]

(f) Calculate the molar heat of solution for potassium nitrate in kJ mol^{-1} KNO_3.

[2 marks]

(g) List THREE experimental steps/changes that you would introduce to improve the accuracy of your value obtained for the heat of solution of potassium nitrate.

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[3 marks]

Total 18 marks

2. The rate of decomposition of azomethane, $C_2H_6N_2$, as represented by the equation below, was monitored by measuring the partial pressure, *P*, of azomethane as a function against time.

$$C_2H_6N_2\,(g) \longrightarrow C_2H_6\,(g) + N_2\,(g)$$

A student recorded his calculations in his notebook as follows:

0 seconds – 284 mmHg, 100 seconds – 220 mmHg, 150 seconds – 193 mmHg,

200 seconds – 170 mmHg, 250 seconds – 150 mmHg

(a) Construct a table to represent the information above, as well as values of $\ln P$ for EACH measurement.

[6 marks]

(b) **On the grid provided on page 7**, plot a graph of $\ln P$ vs time. **[5 marks]**

(c) From your graph, deduce the order of reaction with respect to azomethane.

....

[1 mark]

GO ON TO THE NEXT PAGE

(d) Calculate the rate constant, *k*, for the reaction.

[4 marks]

(e) Suggest ONE alternative method that could have been used to determine the rate of this reaction.

....

....

[1 mark]

(f) State ONE safety precaution that one should take when carrying out gas-phase reactions such as the decomposition of azomethane.

....

....

[1 mark]

Total 18 marks

3. A student claims that the acid/base nature of oxides of the Period 3 elements, changes from acidic to basic on moving left to right across the periodic table. Plan an experiment that will test this hypothesis.

Your answer should include:

(a) Hypothesis

....

....

....

[1 mark]

(b) Aim

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[1 mark]

(c) Reagents and apparatus

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[3 marks]

(d) Experimental procedure

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[3 marks]

(e) Manipulated variables

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[1 mark]

(f) Expected results

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[3 marks]

Total 12 marks

END OF TEST

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

FORM TP 2015159

TEST CODE **02212020**

MAY/JUNE 2015

C A R I B B E A N   E X A M I N A T I O N S   C O U N C I L

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.
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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. Propane is one of the major components of liquefie petroleum gas (LPG). The petroleum industry uses a process to produce another alkane and two alkenes from propane according to the equation below.

$$2\,CH_3CH_2CH_3\,(g) \xrightarrow{A} B\,(g) + C\,(g) + CH_2{=}CH_2(g) + H_2\,(g)$$

(a) (i) Identify the process represented by the equation.

....

[1 mark]

(ii) State the conditions at A.

....

[1 mark]

(iii) Write the condensed structural formulae of

B ....

C ....

[2 marks]

(b) (i) Account for the tetravalency of the carbon atom.

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....

....

[2 marks]

GO ON TO THE NEXT PAGE

(ii) Aqueous bromine will only react with propane in sunlight but aqueous bromine reacts quickly with propene without sunlight.

Using appropriate notation and equations, explain the steps involved in the mechanism of the chemical reaction of aqueous bromine with propane (in sunlight) **OR** aqueous bromine with propene (without sunlight).

[4 marks]

(iii) Name the mechanism of the reaction selected in (b) (ii).

....

[1 mark]

(c) Describe the observations expected when

(i) aqueous bromine is added to liquid heptane (in sunlight)

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[2 marks]

(ii) acidifie potassium permanganate solution is added to liquid heptene (without sunlight.

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[2 marks]

Total 15 marks

MODULE 2

ANALYTICAL METHODS AND SEPARATION TECHNIQUES

2. (a) In a titrimetric analysis, state ONE operation which can affect

(i) accuracy

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[1 mark]

(ii) precision.

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[1 mark]

(b) List TWO requirements which a primary standard reagent that is to be used in a titrimetric analysis must satisfy.

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[2 marks]

(c) In a thermometric titration, 25 cm^3 of 2 mol dm^{-3} NaOH were used to determine the concentration of hydrochloric acid.

(i) Using the results in Table 1, plot a graph of temperature against volume of acid on the axes provided on **page 7**.

TABLE 1: RESULTS OF TITRATION

Volume of Acid (cm^3)	**Temperature (°C)**
5.00	30.0
10.00	32.0
15.00	32.5
20.00	33.0
25.00	34.0
30.00	33.5
35.00	33.0
40.00	33.0
45.00	33.0

[4 marks]

(ii) Hence, determine the end-point volume of the acid.

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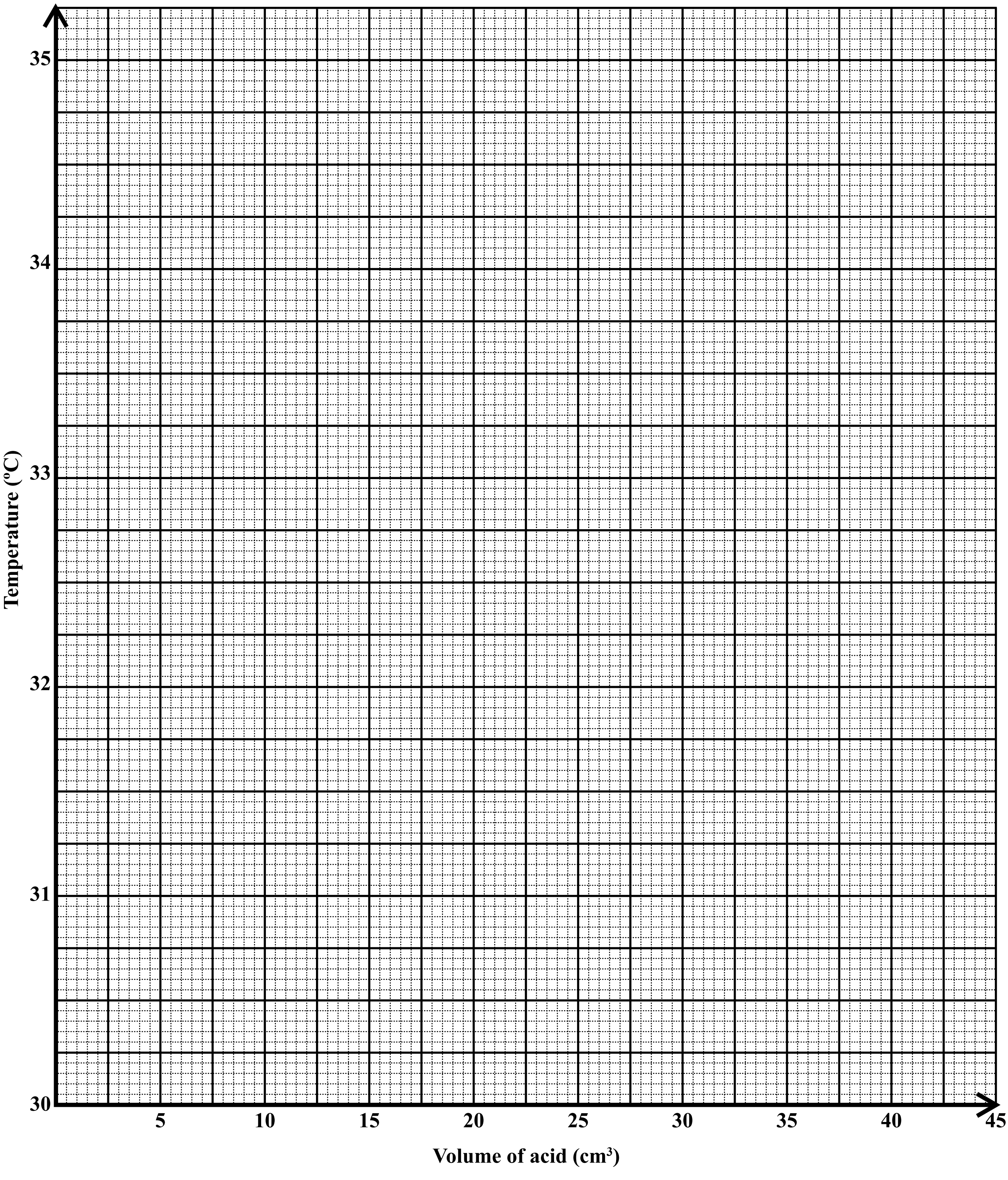
[1 mark]

(iii) Calculate the concentration of the acid.

[2 marks]

GO ON TO THE NEXT PAGE


Temperature (°C)
35
34
33
32
31
30
5
10
15
20
25
30
35
40
45
Volume of acid (cm³)

(d) Outline the experimental steps for this type of titration.

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[4 marks]

Total 15 marks

MODULE 3

INDUSTRY AND THE ENVIRONMENT

3. (a) Sulfuric acid is manufactured in industry by a process known as the Contact Process. The slowest step during the process is the conversion of SO_2 to SO_3 which can be represented by the equation:

$$2\ SO_2\ (g) + O_2\ (g) \rightleftharpoons 2\ SO_3\ (g), \quad \Delta H = -197\ kJ\ mol^{-1}$$

List the THREE ways in which the rate of SO_3 production can be improved.

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[3 marks]

(b) The manufacturing conditions utilized during the Contact Process can be optimized by considering Le Chatelier's principle.

(i) State Le Chatelier's principle.

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[1 mark]

(ii) What general conditions of temperature and pressure are predicted by Le Chatelier's principle in order for the MAXIMUM yield of SO_3 to be obtained?

Temperature ....

Pressure ....

[2 marks]

GO ON TO THE NEXT PAGE

(iii) Describe how the sulfur trioxide produced is converted to concentrated sulfuric acid.

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[2 marks]

(iv) Write TWO equations to represent the process that you described in (b) (iii).

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[4 marks]

(v) Outline the safety considerations that guide the process in (b) (iii).

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[3 marks]

Total 15 marks

SECTION B

Answer ALL questions.

MODULE 1

THE CHEMISTRY OF CARBON COMPOUNDS

4. (a) Distinguish between ‘addition polymerization’ and ‘condensation polymerization’.

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[4 marks]

(b) List TWO classes of naturally occurring polymers, giving an example of ONE.

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[3 marks]

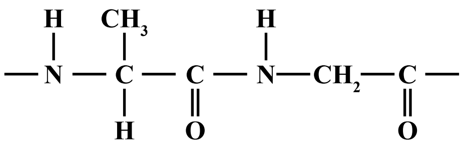
(c) Terylene is a co-polymer formed from the monomers ethane-1, 2-diol and benzene-1, 4-dicarboxylic acid.

Using a chemical equation, show how terylene can be formed from the two monomers.

[4 marks]

GO ON TO THE NEXT PAGE

(d) The structure, A, shown below represents the repeating unit of a polymeric substance.

A: 

Deduce the structural formulae of the monomers used to form the polymer.

[4 marks]

Total 15 marks

MODULE 2

ANALYTICAL METHODS AND SEPARATION TECHNIQUES

5. (a) Explain how chromatography can be used to separate a mixture of dyes.

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[4 marks]

(b) Figure 1 shows the separation of a mixture of amino acids, obtained in the hydrolysis of a dipeptide, on a thin layer chromatography (TLC) plate.

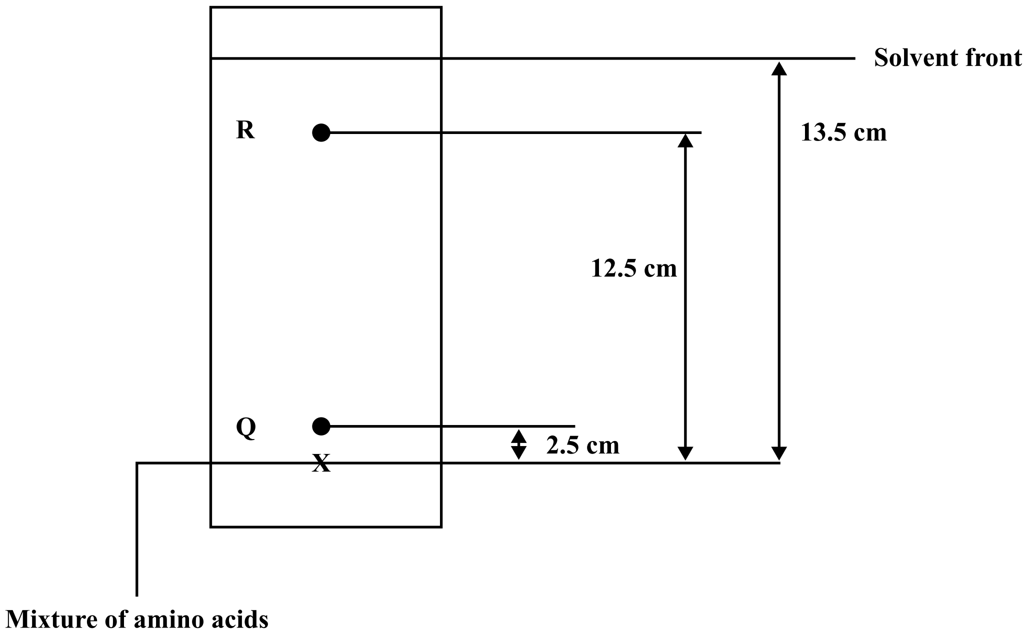

Figure 1. The separation of a mixture of amino acids

(i) Explain how the presence of the components can be detected.

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[2 marks]

(ii) Calculate the R_f (retention factor) values of Q and R.

[3 marks]

(iii) Suggest TWO reasons for the difference in the R_f values of R and Q.

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[2 marks]

GO ON TO THE NEXT PAGE

(c) The methods of thin layer chromatography and column chromatography are both similar and different. Assess the methods of these two types of chromatography in relation to their uses.

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[4 marks]

Total 15 marks

MODULE 3

INDUSTRY AND THE ENVIRONMENT

6. (a) Chlorine is considered to be the most important halogen. Using an appropriate annotated diagram, describe how chlorine can be produced through use of a diaphragm cell. Include the equations occurring at EACH electrode.

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[6 marks]

GO ON TO THE NEXT PAGE

(b) Explain why there are health concerns associated with the use and disposal of the diaphragm cell.

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[3 marks]

(c) One of the major uses of chlorine is in the production of organic compounds known as chlorofluorocarbon (CFCs).

(i) Assess the impact of CFCs on the environment.

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[3 marks]

(ii) "Like CFCs, the products of the combustion of fossil fuels also have a negative effect on the environment."

Suggest THREE reasons to support this statement.

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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.

TEST CODE **02212032**

FORM TP 2015160

MAY/JUNE 2015

C A R I B B E A N   E X A M I N A T I O N S   C O U N C I L

CARIBBEAN ADVANCED PROFICIENCY EXAMINATION®

CHEMISTRY

UNIT 2 – Paper 032

ALTERNATIVE TO SCHOOL-BASED ASSESSMENT

2 hours

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Answer ALL questions.

1. (a) You are provided with three samples of organic compounds labelled **A**, **B** and **C**.

Carry out the tests indicated in Table 1 being careful to add reagents gradually until no further change is observed and shake gently after each addition.

The results are to be entered into Table 1 on **page 3**.

Your recordings should include details of colour changes and precipitates formed.

[12 marks]

(b) Based on your observations in Table 1, identify the class of compound to which EACH sample belongs.

A ....

B ....

C ....

[3 marks]

(c) State reasons for your answers in (b) above.

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[3 marks]

Total 18 marks

GO ON TO THE NEXT PAGE

TABLE 1: TESTS ON ORGANIC COMPOUNDS, A, B AND C

Test	Observation		
	A	**B**	**C**
Carry out the following tests on approximately 2 cm^3 of each sample of **A**, **B** and **C**.			
(i) Add approximately 2 cm^3 of 2, 4-DNPH.			
(ii) Add approximately 2 cm^3 of acidifie potassium permanganate or potassium dichromate.			
(iii) To approximately 2 cm^3 of $AgNO_3$ solution, add 2 drops of NaOH (aq) followed by 2 drops of NH_3 (aq) until the precipitate dissolves. Add the sample compound and warm the mixture.			
(iv) Add 1 cm^3 of I_2/KI (aq) followed by NaOH (aq) dropwise until the iodine colour is removed. Warm the mixture.			

2. Sodium oxalate, $Na_2C_2O_4$, was selected as a primary standard for the standardization of potassium permanganate solution. The sodium oxalate was accurately weighed based on the data in Table 2, and 25 cm^3 portions of the oxalate solution was titrated against the permanganate solution.

TABLE 2: MASS OF SODIUM OXALATE

	Mass (g)
Mass of bottle and oxalate	43.3920
Mass of bottle	41.7420

(a) (i) Determine the mass of sodium oxalate used.

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[1 mark]

(ii) Suggest a reason for the use of sodium oxalate as a primary standard.

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[1 mark]

(b) Figure 1 shows the reading on the burette **before** and **after** each titration.

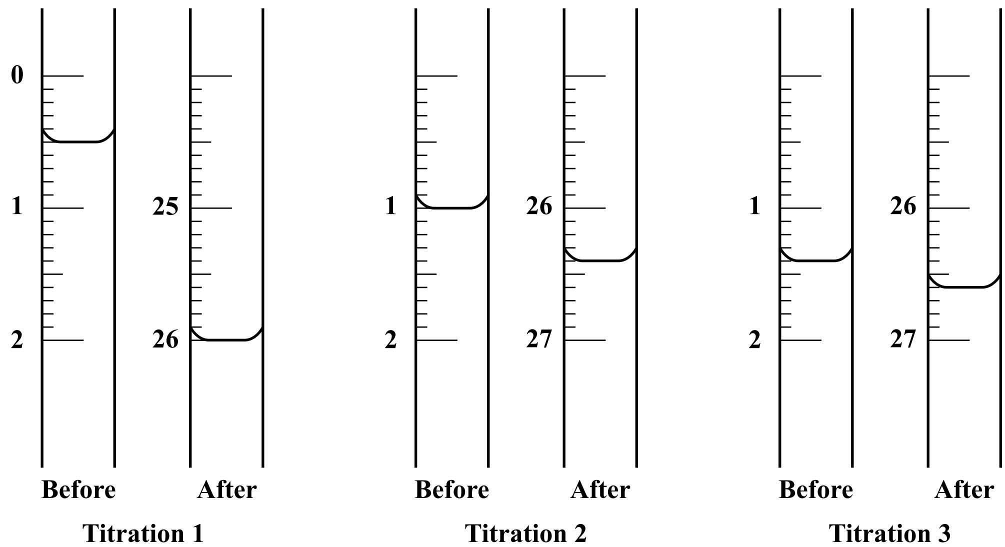

Figure 1. Burette readings

GO ON TO THE NEXT PAGE

(i) What colour change should be expected at the end point of EACH titration?

....

[1 mark]

(ii) Using the readings in Figure 1, record the titre volumes of the experiment in Table 3.

TABLE 3: TITRE VOLUMES

	Experiment 1	**Experiment 2**	**Experiment 3**	
Final volume of $KMnO_4$ (cm^3)				
Initial volume of $KMnO_4$ (cm^3)				Average Volume to be used (cm^3)
Volume of $KMnO_4$ used (cm^3)				

[5 marks]

(c) Outline the steps that were taken in performing the titration.

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[3 marks]

(d) Determine the concentration of the sodium oxalate solution made in mol dm^{-3}.

[2 marks]

(e) The two half-equations below represent the changes in the oxalate and permanganate substances in the redox reaction.

$$C_2O_4^{2-}(aq) \longrightarrow 2CO_2\,(g) + 2e^-$$

$$5e^- + MnO_4^-(aq) + 8H^+(aq) \longrightarrow Mn^{2+}(aq) + 4H_2O(l)$$

Write the ionic equation for the reaction occurring in the titration.

....

[2 marks]

(f) Calculate the concentration of the potassium permanganate solution in mol dm^{-3}.

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....

[3 marks]

Total 18 marks

3. Two bottles of the same brand of wine were found in a chemistry laboratory. One bottle was opened and the other unopened. A student suggested that the ethanol in the opened bottle of wine had been oxidized to ethanoic acid (vinegar). Plan and design an experiment to test the validity of this suggestion using the following guidelines.

Your answer should include:

(a) Hypothesis

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[1 mark]

(b) Aim

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[1 mark]

(c) Reagents and apparatus

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[2 marks]

(d) Experimental procedure

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[3 marks]

(e) Variables

(i) Manipulated

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[1 mark]

(ii) Controlled

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[1 mark]

(iii) Responding

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[1 mark]

(f) Expected results

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[2 marks]

Total 12 marks

END OF TEST

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

TEST CODE **02112020**

FORM TP 2016166

MAY/JUNE 2016

C A R I B B E A N E X A M I N A T I O N S C O U N C I L

CARIBBEAN ADVANCED PROFICIENCY EXAMINATION®

CHEMISTRY

UNIT 1 – 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.
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DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO.

“*”Barcode Area”*”
Sequential Bar Code

SECTION A

Answer ALL questions.

MODULE 1

FUNDAMENTALS IN CHEMISTRY

1. (a) John Dalton proposed the atomic theory in 1803.

(i) State THREE postulates of Dalton's atomic theory.

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[2 marks]

GO ON TO THE NEXT PAGE

(ii) Later developments in science led to the modification of the atomic theory. Explain the modification of ONE of the postulates.

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[2 marks]

(b) The dichromate(VI) ion reacts in an acidic medium according to the following half-equation:

$$Cr_2O_7^{2-}(aq) + 14\,H^+(aq) + 6e^- \longrightarrow 2\,Cr^{3+}(aq) + 7\,H_2O(l)$$

(i) Identify the ion responsible for the green colour.

....

[1 mark]

(ii) Given that the sulfate(IV) ion, SO_3^{2-}, is converted to the sulfate(VI) ion, SO_4^{2-}, in the presence of water, deduce the balanced equation for the redox reaction between $Cr_2O_7^{2-}(aq)$ and SO_3^{2-}.

[4 marks]

(iii) Identify the oxidizing agent in (b) (ii).

....

[1 mark]

GO ON TO THE NEXT PAGE

(c) The results of two tests are to be recorded in Table 1. Complete the table by inserting the missing observations or inferences.

TABLE 1: RESULTS OF TESTS

Test	Observation	Inference
(i) Chlorine water is added to potassium bromide solution followed by aqueous silver nitrate.	• • White precipitate formed	• Br^- oxidized to Br_2 •
(ii) Bromine water is added to potassium chloride solution followed by aqueous silver nitrate.	• • White precipitate formed on addition of $AgNO_3(aq)$	• •

[5 marks]

Total 15 marks

GO ON TO THE NEXT PAGE

MODULE 2

KINETICS AND EQUILIBRIA

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

(i) Weak acid

....

....

....

....

[1 mark]

(ii) K_a

....

....

....

....

[2 marks]

(b) In aqueous solution, carbonic acid forms a weak acidic solution containing the hydrogen carbonate ion.

(i) Write an equation to represent the dissociation of carbonic acid in aqueous solution.

[2 marks]

(ii) Write the K_a expression for the reaction in (b) (i).

[1 mark]

(iii) Calculate the pH of a 0.100 mol dm^{-3} aqueous solution of carbonic acid.
($K_a = 4.5 \times 10^{-7}$ mol dm^{-3} at 25 ^{o}C.)

[4 marks]

GO ON TO THE NEXT PAGE

(c) A student was given a particular brand of club soda (carbonated beverage) to determine the carbonic acid content. Outline the experimental steps required for the investigation if the student is given 200 cm^3 of 0.100 mol dm^{-3} sodium hydroxide solution.

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[5 marks]

Total 15 marks

MODULE 3

CHEMISTRY OF THE ELEMENTS

3. Figure 1 shows the melting points of the elements in Period 3.

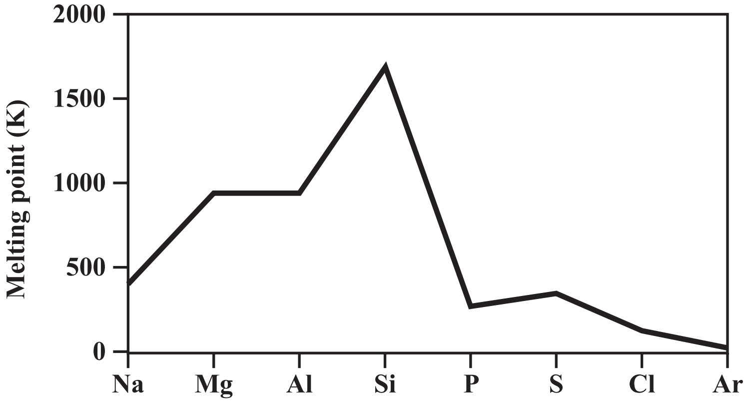

Figure 1. Melting points of elements in Period 3

(a) Explain, in terms of structure and bonding, why

(i) aluminium has a higher melting point than sodium

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[2 marks]

GO ON TO THE NEXT PAGE

“*”Barcode Area”*”
Sequential Bar Code

(ii) silicon has the highest melting point in the period

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[2 marks]

(iii) sulfur melts at a higher temperature than phosphorous.

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[3 marks]

(b) The reactions of the oxides of magnesium and phosphorous with water are to be summarized in Table 2.

TABLE 2: REACTION OF OXIDES WITH WATER

Oxide	Reaction with Water	pH of Resulting Liquid
MgO		
P_4O_{10}		

(i) Complete Table 2 by describing the reaction of EACH oxide with water and suggesting a pH value for the resulting liquid. **[2 marks]**

(ii) Write the equation which represents the reaction of water with P_4O_{10}.

[2 marks]

GO ON TO THE NEXT PAGE

“*”Barcode Area”*”
Sequential Bar Code

(c) Write equations to show what happens when EACH of the following chlorides reacts with water.

(i) $SiCl_4$

[2 marks]

(ii) $AlCl_3$

[2 marks]

Total 15 marks

SECTION B

Answer ALL questions.

MODULE 1

FUNDAMENTALS IN CHEMISTRY

4. (a) (i) Describe how the bonds are formed in EACH of the solids, potassium chloride and iodine.

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[4 marks]

(ii) Complete Table 3 by comparing the physical properties of potassium chloride (KCl) and iodine (I_2).

TABLE 3: SOME PHYSICAL PROPERTIES OF KCl AND I_2

Properties	**KCl**	**I_2**
Melting/Boiling point	High	Low
Electrolytic conductivity	•	•
Solubility in water	•	•

[2 marks]

(b) Account for EACH of the following statements:

(i) The boiling point of H_2O is higher than that of H_2S.

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[3 marks]

(ii) The molecules of aluminium fluoride in the presence of ammonia forms a white solid of formula NH_3AlF_3. (Include an appropriate equation in your account.)

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[3 marks]

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(c) Explain the difference between the shapes of NH_3 and NH_4^+.

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[3 marks]

Total 15 marks

MODULE 2

KINETICS AND EQUILIBRIA

5. The following equation represents the reaction between hydrogen and iodine.

$$H_2(g) + I_2(g) \rightleftharpoons 2\,HI(g), \quad \Delta H = -10 \text{ kJ mol}^{-1}$$

The reaction is said to be in a state of equilibrium at a particular temperature and pressure.

(a) (i) State FOUR characteristics of a reaction in 'dynamic equilibrium'.

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[4 marks]

(ii) Write the expression for the equilibrium constant in terms of partial pressures, K_p, for the reaction shown by the equation above.

[2 marks]

(iii) State TWO factors which would NOT affect the equilibrium of the reaction shown by the equation above.

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[2 marks]

GO ON TO THE NEXT PAGE

(b) Describe the effect of decreasing the temperature on

(i) the equilibrium of the reaction

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[2 marks]

(ii) the value of K_p.

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[2 marks]

(c) When 0.5 mol of hydrogen and 0.5 mol of iodine are allowed to reach equilibrium in a $1.00\ dm^3$ flask at 500 ^oC and $1.01 \times 10^5\ N\ m^{-2}$, the amount of hydrogen iodide at equilibrium is 0.78 mol. Calculate K_p at 500 ^oC if the total pressure is 1 Pa.

[3 marks]

Total 15 marks

MODULE 3

CHEMISTRY OF THE ELEMENTS

6. (a) List FOUR properties of transition metals.

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[4 marks]

(b) Titanium(III) chloride forms a violet solution when dissolved in water.

(i) Write the electronic configuration using the s, p and d orbitals of the titanium ion.

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[1 mark]

(ii) Explain the colour of the aqueous solution.

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[4 marks]

(c) (i) Describe what would be observed when concentrated hydrochloric acid is slowly added to an aqueous solution of Co^{2+}.

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[1 mark]

(ii) Write an ionic equation to represent the observation in (c) (i).

[2 marks]

(iii) Using the concept of stability constant, explain the changes observed in (c) (ii).

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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.

TEST CODE **02112032**

FORM TP 2016167

MAY/JUNE 2016

C A R I B B E A N   E X A M I N A T I O N S   C O U N C I L

CARIBBEAN ADVANCED PROFICIENCY EXAMINATION®

CHEMISTRY

UNIT 1 – Paper 032

ALTERNATIVE TO SCHOOL-BASED ASSESSMENT

2 hours

READ THE FOLLOWING INSTRUCTIONS CAREFULLY.

1. This paper consists of THREE questions. 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. You are advised to take some time to read through the paper and plan your answers.
8. 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.**
9. **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.

“*”Barcode Area”*”
Sequential Bar Code

Answer ALL questions.

1. You are provided with the following chemicals:

R – standard potassium manganate(VII) solution containing 3.2 g $KMnO_4$ in 1 dm^3 of solution

S – 2.0 mol dm^{-3} sulfuric acid

T – 10 grams of iron(II) sulfate crystals ($FeSO_4$. $7H_2O$).

(a) Carry out the following practical activity to determine the concentration and the percentage purity of a solution of iron(II) sulfate heptahydrate.

Procedure:

1. Weigh between 7.50 g and 7.70 g of the crystals, **T**. Record your results (to 2 decimal places) in Table 1.
2. Dissolve the crystals in a minimum volume of distilled water and transfer the solution to a 250 cm^3 volumetric flask. Make up to the mark with distilled water.
3. Pipette 25.0 cm^3 of this solution into a conical flask and add an equal volume of the 2 mol dm^{-3} sulfuric acid.
4. Titrate the mixture with the standard potassium manganate(VII) solution. Record your results (to 2 decimal places) in Table 2 **on page 5**.
5. Repeat Steps 3–4 until consistent readings are obtained.

(i) TABLE 1: DATA FOR WEIGHING

Item	**Mass (g)**
Weighing bottle and crystals	
Weighing bottle	
Crystals	

[3 marks]

(ii) TABLE 2: DATA FOR TITRATION

Volume of Manganate(VII)	**Reading (cm^3)**		
	1	**2**	**3**
Final burette reading			
Initial burette reading			
Volume of manganate(VII)			

[5 marks]

(b) Determine the volume of manganate(VII) to be used in the calculations.

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[1 mark]

(c) State the colour of the solution at the end point.

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[1 mark]

(d) Calculate the number of moles of the manganate(VII) solution used in the titration.

[2 marks]

(e) Write a balanced ionic equation for the reaction between the manganate(VII) and iron(II) solutions.

[2 marks]

(f) Calculate the concentration of the iron(II) solution in g dm^{-3}.

[2 marks]

(g) Determine the percentage purity of the iron(II) solution.

[2 marks]

Total 18 marks

2. The disintegration of a photogenerated complex, A, was investigated using UV–VIS spectroscopy.

Measurements of concentration (in mol dm^{-3}) were taken every half-minute for the first 3.5 minutes with the first taken at zero minutes. The values of the concentration of A at these times were 1.5, 1.15, 0.82, 0.62, 0.46, 0.26, 0.20 and 0.14 respectively.

(a) Construct a table (in the space provided below) to record the information above regarding concentration of the complex, A, and time.

[4 marks]

(b) **On the grid in Figure 1 provided on page 9**, plot a graph of concentration vs time. **[5 marks]**

(c) From your graph in (b), determine the time taken for the concentration of A to reach

(i) 0.75 mol dm^{-3} ....

(ii) 0.38 mol dm^{-3} ....

(iii) 0.19 mol dm^{-3} .... **[3 marks]**

(d) Comment on the significance of these times.

....

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

(e) Deduce the order of this reaction.

.... **[1 mark]**

(f) Write an expression for the rate law for the disentegration of A.

.... **[1 mark]**

(g) Deduce the units for the rate constant.

.... **[1 mark]**

(h) Give an example of a class of reactions which follows the kinetics in (d) above.

.... **[1 mark]**

Total 18 marks

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“*”Barcode Area”*”
Sequential Bar Code

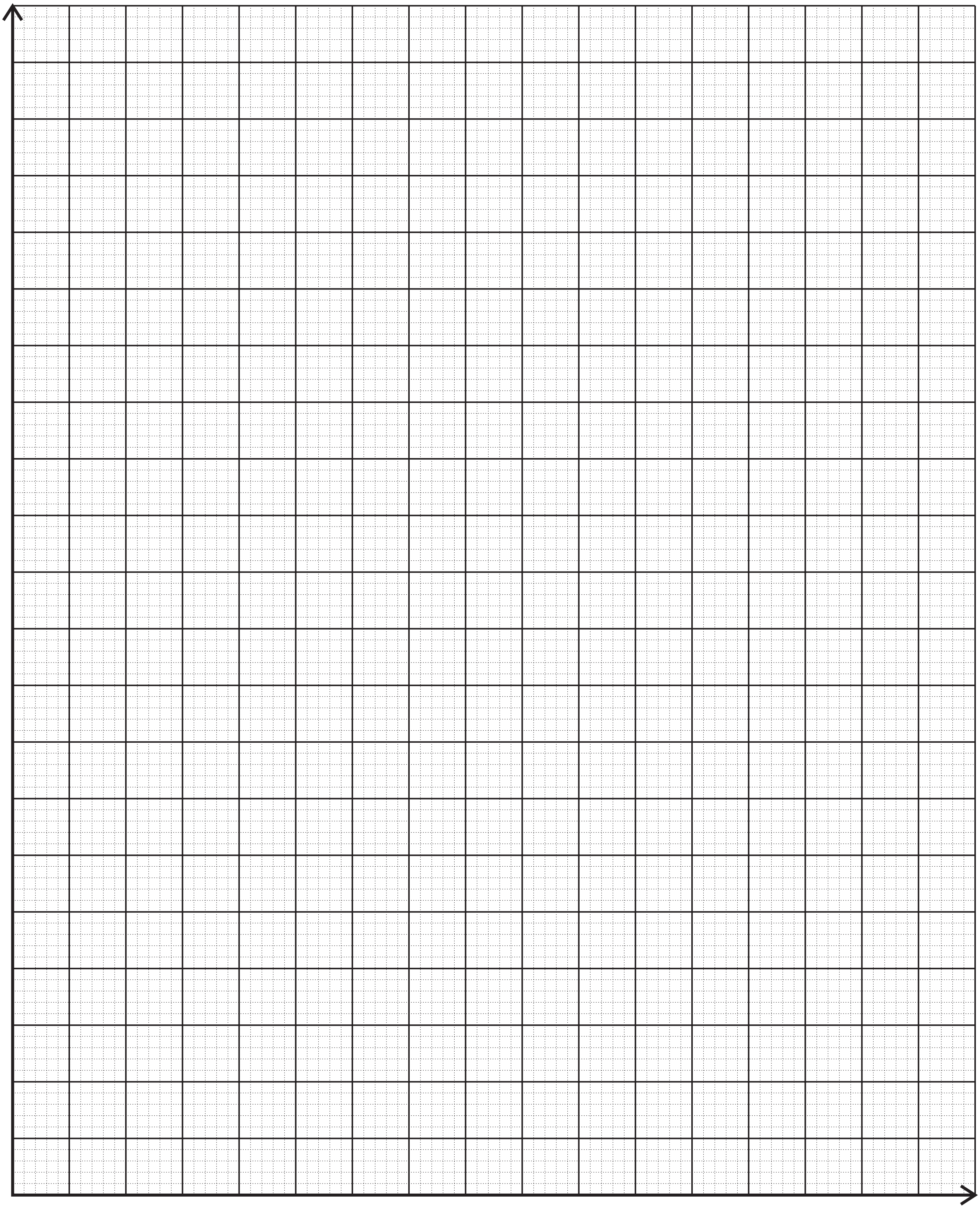

Figure 1. Concentration versus time

3. A student is assigned the practical activity to use manganese(IV) oxide as the catalyst for the decomposition of hydrogen peroxide, but suggests that copper(II) oxide is a more effective catalyst.

Plan and design an experiment to establish the validity of this suggestion.

Your answer should include the following:

(a) Hypothesis

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[1 mark]

(b) Aim

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[1 mark]

(c) Apparatus and materials

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[3 marks]

(d) Procedure

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[3 marks]

(e) Variables

(i) Controlled

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[1 mark]

(ii) Manipulated

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[1 mark]

(iii) Responding

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[1 mark]

(f) Expected results

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[1 mark]

Total 12 marks

END OF TEST

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

TEST CODE **02212020**

FORM TP 2016169

MAY/JUNE 2016

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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.

“*”Barcode Area”*”
Sequential Bar Code

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.

....

[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

GO ON TO THE NEXT PAGE

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]

GO ON TO THE NEXT PAGE

(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.

....

[2 marks]

Total 15 marks

GO ON TO THE NEXT PAGE

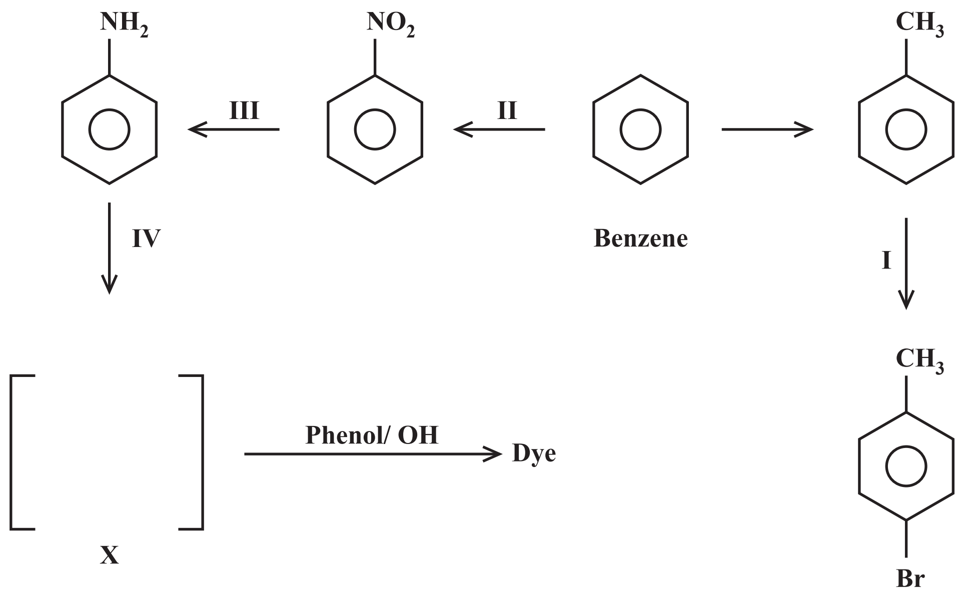
SECTION B

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]

GO ON TO THE NEXT PAGE

(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

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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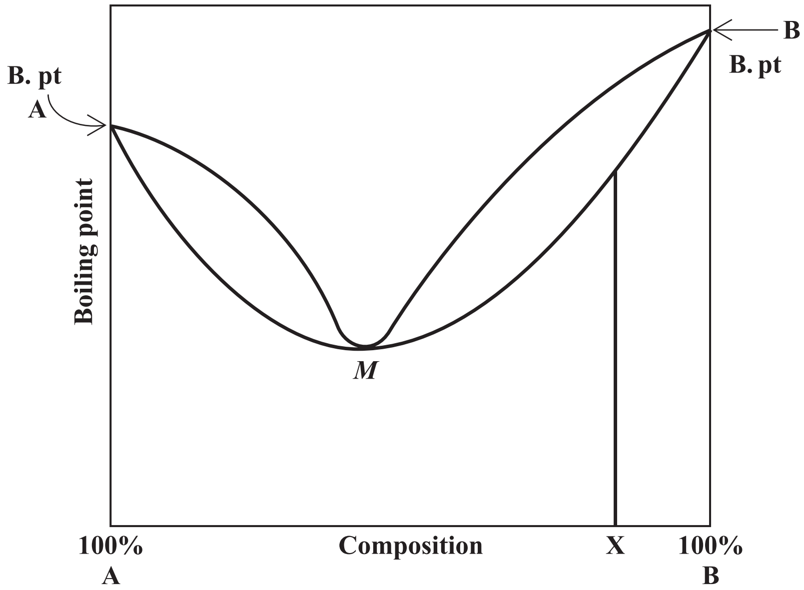
[1 mark]

GO ON TO THE NEXT PAGE

(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]

GO ON TO THE NEXT PAGE

(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.

TEST CODE **02212032**

FORM TP 2016170

MAY/JUNE 2016

C A R I B B E A N   E X A M I N A T I O N S   C O U N C I L

CARIBBEAN ADVANCED PROFICIENCY EXAMINATION®

CHEMISTRY

UNIT 2 – Paper 032

ALTERNATIVE TO SCHOOL-BASED ASSESSMENT

2 hours

READ THE FOLLOWING INSTRUCTIONS CAREFULLY.

1. This paper consists of THREE questions. Answer ALL questions.
2. Write your answers in the spaces provided in this booklet.
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DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO.

“*”Barcode Area”*”
Sequential Bar Code

Answer ALL questions.

1. (a) **R** and **S** are two fragrant organic liquids. You are required to carry out the tests indicated in Table 1, gently shaking after EACH addition. Record your observations and relevant deductions in the table provided.

Include in your recordings:

- Details of colour changes
- The names of gases evolved and details of the tests used to identify EACH

TABLE 1: TESTS

Test	Observation	Inference
Using 2 cm^3 portions of **R**: (i) Add carefully 1 cm^3 conc. H_2SO_4, heat and pass gas through $Br_2(aq)$.	**[2 marks]**	**[1 mark]**
(ii) Add $H_2SO_4(aq)$ followed by aqueous potassium dichromate (VI) and heat.	**[2 marks]**	**[1 mark]**
Using 2 cm^3 portions of **S**: (iii) Add $Na_2CO_3(s)$.	**[2 marks]**	**[2 marks]**
(iv) Add PCl_5.	**[2 marks]**	**[1 mark]**
(v) Add 3 cm^3 of **R** followed by conc. H_2SO_4 and boil for 1 minute. Pour mixture into 100 cm^3 beaker half-filled with water.	**[2 marks]**	**[1 mark]**

[16 marks]

GO ON TO THE NEXT PAGE

(b) Write the equation representing the reaction in Test (v) of (a) using the structural formulae of the functional groups contained in **R** and **S** respectively.

[2 marks]

Total 18 marks

2. An experiment is carried out to determine the solubility of ammonium chloride by back titration, 5.0 cm^3 of a saturated ammonium chloride solution are added to a 250.0 cm^3 volumetric flask and made up with distilled water. After shaking, 20.0 cm^3 portions are added separately to a conical flask to which is added 20.0 cm^3 of 0.2 mol dm^{-3} sodium hydroxide solution. The mixture is heated strongly, then gently until no more ammonia evolves. The flasks are cooled and the contents titrated with 0.1 mol dm^{-3} HCl. Figure 1 shows the burette readings.

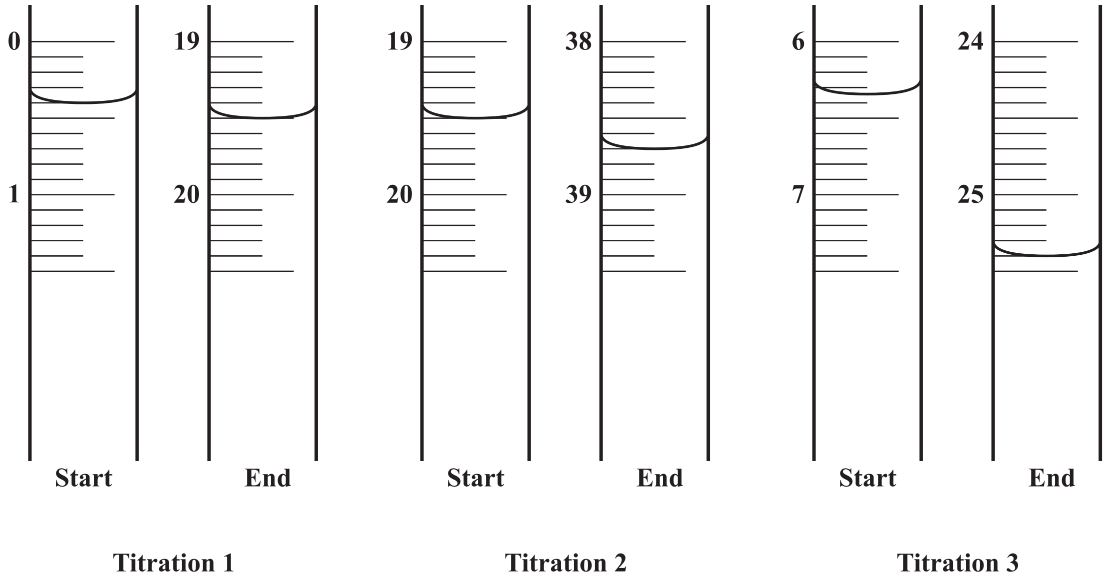

Figure 1. Burette readings

(a) Suggest an indicator and its colour change at the end point, that can be used in the titration above.

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[2 marks]

(b) In the space provided below, construct a suitable table to record the titration results. Include the initial and final burette readings (to 2 decimal places), and the volumes of hydrochloric acid used.

[6 marks]

GO ON TO THE NEXT PAGE

“*”Barcode Area”*”
Sequential Bar Code

(c) State TWO reasons why back titration is used to determine the solubility of ammonium chloride.

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[2 marks]

(d) Describe a simple chemical test to determine when the evolution of ammonia gas has ceased.

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[1 mark]

(e) Calculate the number of moles of sodium hydroxide present in 20.0 cm^3 of 0.2 mol dm^{-3} NaOH.

[1 mark]

(f) Determine the number of moles of HCl added in the titration.

[1 mark]

(g) Calculate the number of moles of NaOH remaining after boiling with the ammonium chloride solution.

[1 mark]

(h) Calculate the number of moles of NaOH which reacted with 20.0 cm^3 of ammonium chloride solution.

[1 mark]

(i) Calculate the number of moles of ammonium chloride present in 20.0 cm^3 of the diluted solution.

[1 mark]

(j) Calculate the number of moles of ammonium chloride present in 5.0 cm^3 of the saturated solution.

[1 mark]

(k) Calculate the solubility of ammonium chloride in water at room temperature in g dm^{-3}.

[1 mark]

Total 18 marks

GO ON TO THE NEXT PAGE

3. It was observed by members of a village downstream from an agricultural plot that after washing their clothing a few times, the fabric started to disintegrate.

A science student suggested that the acid leached from the fertilizers applied to the plot had, overtime, resulted in increased acidity of the river and hence damage to the villagers' clothing.

Plan and design an experiment to establish the validity of this suggestion.

Your answer should include the following:

(a) Hypothesis

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[1 mark]

(b) Aim

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[1 mark]

(c) Apparatus and materials

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[2 marks]

(d) Procedure

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[3 marks]

(e) Variables

(i) Controlled

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[1 mark]

(ii) Manipulated

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[1 mark]

(iii) Responding

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[1 mark]

(f) Data to be collected

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[1 mark]

(g) Expected results

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[1 mark]

Total 12 marks

END OF TEST

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