TEST CODE **02112020**

FORM TP 2012153

MAY/JUNE 2012

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.

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'.

_____

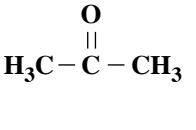
_____

_____

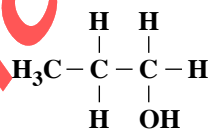
[2 marks]

(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.

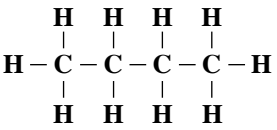
Consider the structure of the following substances and answer the questions which follow.



(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]

(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.

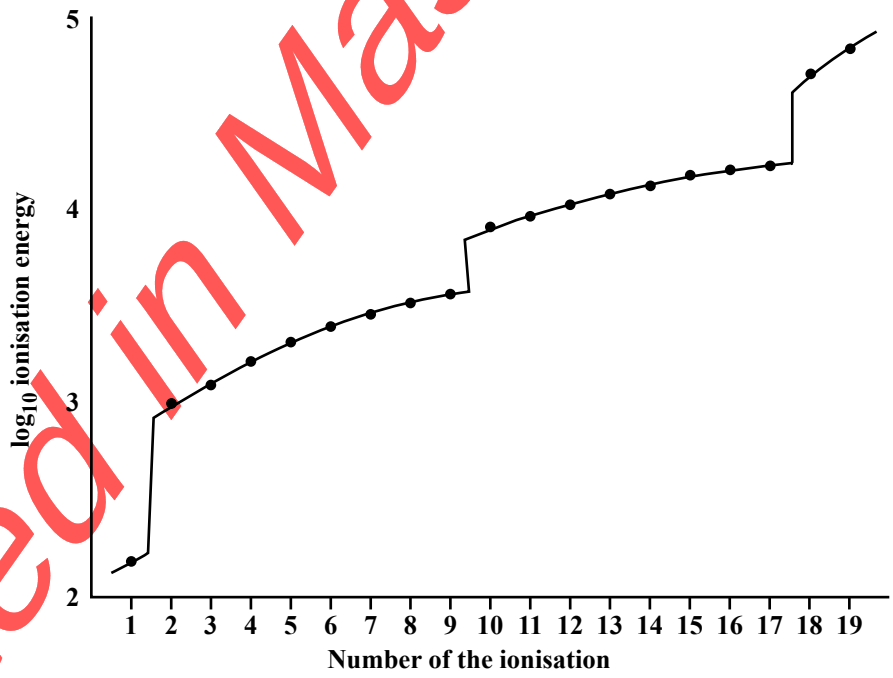


Figure 1. Log_{10} of ionisation energies of an element

(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]**

(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.

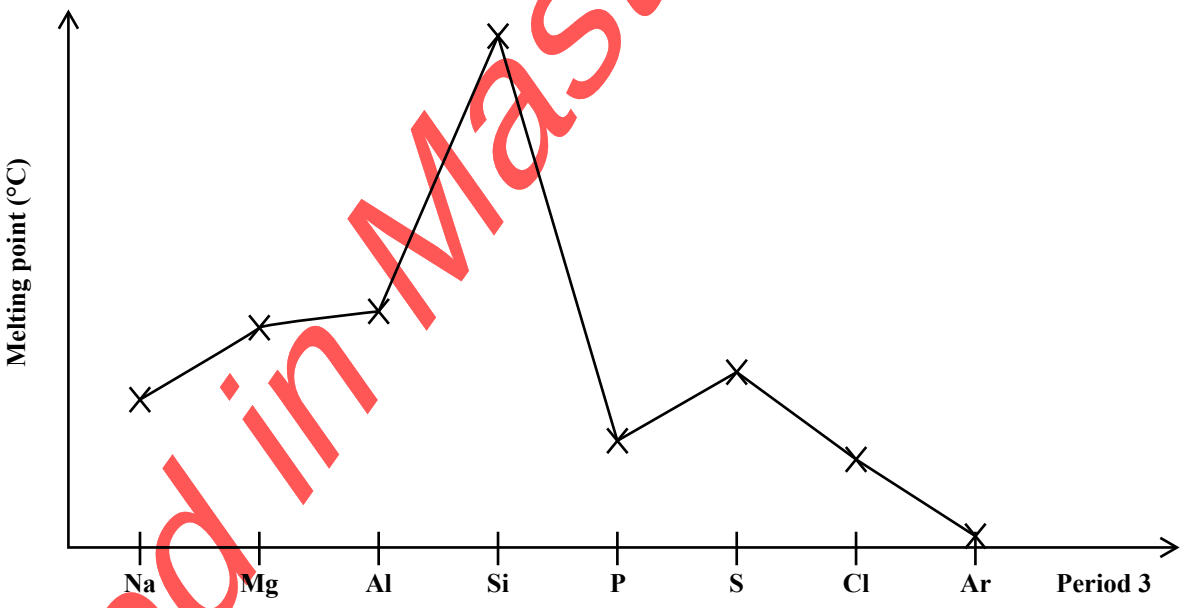


Figure 2. Variation in melting points across Period 3

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.