TEST CODE **02112020**

FORM TP 2011153

MAY/JUNE 2011

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 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]

(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

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

GO ON TO THE NEXT PAGE

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