TEST CODE 02112
SPECIMEN

CARIBBEAN EXAMINATIONS COUNCIL

CARIBBEAN ADVANCED PROFICIENCY EXAMINATION

CHEMISTRY

Unit 1 - Paper 02

2 hours 30 minutes

Specimen

READ THE FOLLOWING INSTRUCTIONS CAREFULLY

1. **This paper consists of SIX COMPULSORY questions in two sections.**
2. **Section A consists of THREE compulsory questions, one from each Module. Write your answers in the spaces provided in this booklet. Each question is worth 15 marks**
3. **Section B consists of THREE compulsory questions, one from each Module. Write your answers in the answer booklet provided. Each question is worth 15 marks.**
4. **Attach your answer booklet to the question booklet and return them to the supervisor.**
5. **The use of non-programmable calculators is allowed.**
6. **A data booklet is provided.**

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO

SECTION A

Answer ALL questions.

MODULE 1

FUNDAMENTALS IN CHEMISTRY

1. (a) Define the terms

(i) mole

_____

_____

[2 marks]

(ii) molar mass.

_____

_____

[1 mark]

(iii) State the units of molar mass.

_____

[1mark]

(b) 20 cm^3 of a solution of phosphorous (V) acid containing 1.96g dm^{-3} reacted with 25 cm^3 of a solution containing 1.28 g dm^{-3} sodium hydroxide to give a solution of sodium hydrogen phosphate (Na_2HPO_4).

Relative atomic masses: P = 31.0, H = 1.0, Na = 23.0, O = 16.0

Calculate the number of moles of

(i) phosphorous (V) acid that reacted

[2marks]

(ii) sodium hydroxide that reacted

[1 mark]

(iii) sodium hydroxide that reacted with 1 mole of the acid.

[1mark]

(c) Derive the equation for the reaction that occurred in Part (b) above.

_____

[1mark]

(d) (i) State Avogadro's Law.

_____

_____

[1 mark]

(e) Outline the experimented steps involved in carrying out the reaction described in (b) on page 2.

_____

_____

_____

_____

_____

_____

[5 marks]

Total 15 marks

MODULE 2

KINETICS AND EQUILIBRIA

2. A student is attempting to find the cell potential of a Daniell (Zn/Cu) cell.

(a) (i) Outline the experimented steps he has to follow to obtain a reading of approximately 1.10 V on his voltmeter.

_____

_____

_____

_____

_____

_____

_____

_____

_____

[5 marks]

(ii) Write the ionic half equation for the reaction occurring at EACH of the electrodes.

_____

_____

[2 marks]

(iii) Identify the anode and the cathode.

Anode: _____

Cathode: _____

[1 mark]

(iv) Explain the direction of electron flow.

_____

_____

[1 mark]

(v) Write the cell diagram.

_____

_____

[1 mark]

(vi) Write the equation to represent the cell reaction.

_____

_____

[1 mark]

(b) Use the $E^{\ominus}$ value for each electrode (in the data booklet) to determine the $E^{\ominus}_{cell}$.

[2 marks]

(c) Suggest TWO changes which could be made to the cell in (a) to cause the cell potential to be greater than 1.10V.

_____

_____

_____

_____

_____

[2 marks]

Total 15 marks

MODULE 3

CHEMISTRY OF THE ELEMENTS

3. (a) Transition elements form coloured compounds.

State THREE OTHER characteristic properties of transition elements.

_____

_____

_____

[3 marks]

(b) What are the colours of aqueous

(i) Co^{2+} ? _____

(ii) Mn^{2+} ? _____

[2 marks]

(c) If aqueous Co^{2+} is heated to dryness, what colour is observed?

_____

[1 mark]

(d) Explain what is meant by the term 'ligand'.

_____

_____

[1 mark]

(e) Write the formula of the species formed, and describe what occurs when

(i) ammonia solution is added to aqueous copper (II) sulphate (IV)

_____

Formula: _____

[2 marks]

(ii) an excess of ammonia solution is added to (e) (i) on page 6.

(ii) an excess of ammonia solution is added to (e) (i) on page 6.

_____

Formula: _____

[2 marks]

(f) The presence of carbon monoxide in the blood can prevent oxygen from reaching the tissues.

Use the ligand exchange theory to account for this occurrence.

_____

_____

_____

_____

[4 marks]

Total 15 marks

SECTION B

Answer ALL questions

MODULE 1

FUNDAMENTALS IN CHEMISTRY

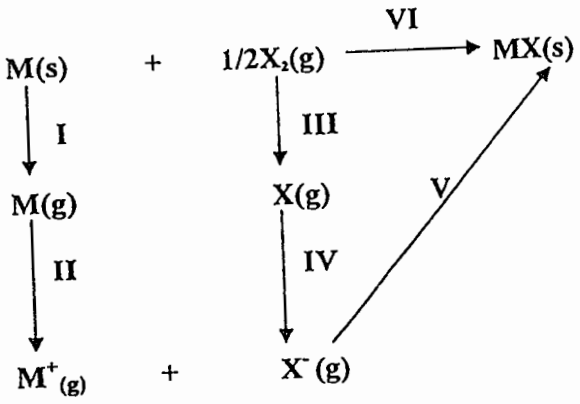
4. (a) State Hess's Law. **[1 mark]**

(b) Define

(i) standard enthalpy change of formation

(ii) lattice energy. **[2 marks]**

(c) The following diagram represents the Born Haber cycle for the formation of compound MX(s).



The associated enthalpy changes in kJ mol^{-1} for the cycle above are as follows:

ΔH^{θ}_{A} M(s) = +86; ΔH^{θ}_{I} M(g) = + 408; ΔH^{θ}_{F} (MX(s)) = -431; ΔH^{θ}_{D} X_2 = + 122; ΔH^{θ}_{E} X(g) = -372

(i) Which enthalpy values correspond to EACH of the stages I, III and IV in the cycle above?

(ii) Calculate the lattice energy of MX(s). **[6 marks]**

(d) Account for the difference in the lattice energy for $MgCl_2$(s) and NaCl(s). **[4 marks]**

(e) Explain why the molar enthalpy changes for the following reactions have identical values.

$HCl\ (aq) + NaOH\ (aq) \rightarrow NaCl\ (aq) + H_2O(l)$
$H_2SO_4\ (aq) + 2KOH\ (aq) \rightarrow K_2SO_4\ (aq) + 2H_2O(l)$

[2 marks]

Total 15 marks

MODULE 2

KINETICS AND EQUILIBRIA

5. (a) Account for the observations in the statement below.

Pure water is a poor conductor of electricity whereas water in the presence of a trace of $H^+(aq)$ is a good conductor.

[3 marks]

(b) (i) Derive the relationship for the ionic product of water, K_w.

(ii) State how the value of K_w varies with temperature.

[3 marks]

(c) (i) Calculate the pH of EACH of the solutions A, B and C, given that their concentrations are as shown in the table below.

Solution	Concentration of $H^+(aq)$ mol dm^{-3}
A	2×10^{-5}
B	1×10^{-2}
C	1×10^{-14}

(ii) Place the solutions A, B and C in 5 (c) (i) on a pH scale relative to the pH of pure water.

[4 marks]

(d) A student is asked to prepare a buffer solution using an aqueous solution of sodium hydroxide and one of the aqueous solutions, X(aq) or Y(aq). The dissociation constants for X is $K_a = 1.8 \times 10^{-5}$, and for Y is $K_b = 1.8 \times 10^{-5}$

(i) Define the term 'buffer solution'.

(ii) Which of the solutions, X or Y, would you use with the sodium hydroxide to prepare a buffer solution? Justify your answer.

(iii) Explain how small additions of H^+ and OH^- ions are accommodated in the buffer solution prepared in 5 (d) (ii).

[5 marks]

Total 15 marks

MODULE 3

CHEMISTRY OF THE ELEMENTS

6 (a) (i) Calculate the oxidation number of the first mentioned element in EACH of the following compounds, and explain the variation in these oxidation numbers:

$MgCl_2$ $[Al(OH)_4]^-$ SiF_6^{2-} PO_3^{3-}

[5 marks]

(b) (i) Explain the terms 'atomic radius' and 'ionic radius'

(ii) Account for the variation in atomic and ionic radii of the elements in Group II.

(iii) Account for the variation in the solubility of the sulphate (VI) of the Group II elements.

[5 marks]

(c) Explain the variation in the acid/base character of the oxides of oxidation state +2 of the elements of Group IV.

[5 marks]

Total 15 marks

END OF TEST