EASTERN UNIVERSITY, SRI LANKA
FIRST EXAMINATION IN SCIENCE
EXTERNAL DEGREE
EXCH 101 PEREODICITY & BONDING, THERMODYNAMICS AND INTRODUCTION TO ELECTROCHEMISTRY
(RE-REPEAT –2004)

ANSWER FOUR QUESTIONS ONLY **Time : 02 Hours**

1.(a) State Pauli's exclusion principle and Aufbau's principle. (2X11)

(b) Usng x, y, z axes system, draw

(i) d_{xy} orbital
(ii) d_{z^2} orbital
(iii) d_{x2-y2} orbital (3X10)

(c) Predict the shape of the following molecules using Valence Shell Electron Pair Repulsion (VSEPR) theory.

BCl_3, XeF_4, NH_3, CH_4 (4X12)

2. (a) (i)Write down the Nernst equation for the redox reaction

$$[ox] + n\,e \rightleftharpoons [red]$$

and define each term in it. (10+24)

(ii) Given that, at 298 K

$$MnO_4^-{}_{(aq)} + 8\,H^+_{(aq)} + 5\,e \longrightarrow Mn^{2+}_{(aq)} + 4\,H_2O: E^\varphi = 1.51\ V$$

$$MnO_{2(aq)} + 4\,H^+_{(aq)} + 2\,e \longrightarrow Mn^{2+}_{(aq)} + 2\,H_2O: E^\varphi = 1.239\ V$$

Deduce the value of E^φ for the following system

$$MnO_4^- + 4\,H^+ + 3\,e \longrightarrow MnO_2 + 2\,H_2O \quad (30)$$

(b) Represent the cell with the cell reaction

$$Cd + 2\,Ag^+ \longrightarrow Cd^{2+} + 2\,Ag$$

Writing down the half cell reaction calculate the value of E^φ of the cell.

Given:

$$E^\varphi_{Cd^{2+}/Cd} = -0.40V$$
$$E^\varphi_{Ag^+/Ag} = 0.080V \text{ at } 298\ K \quad (36)$$

Contd.....

3 (a) (i) Write down the Einstein's equation and Planck's equation and identify all the terms in them. (22)

(ii) In two second a certain lamp gives out 50J of energy in the form of yellow light of wavelength 580nm. How many photons of yellow light are generated in one second?
(Velocity of light = 3×10^8 ms^{-1}, Planck's const.= 6.63×10^{-34} Js) (28)

(b) Describe, using examples, the following
(i) Photoelectric effect
(ii) Hydrogen bonding
(iii) Resonance (3X10)

(c) Give the differences between the ionic and covalent compounds. (30)

4. (a) Write down the mathematical expressions for the following
(i) First law of thermodynamics (2X10)
(ii) Second law of thermodynamics and identify all the terms in it.

(b) From the fundamental equations of Thermodynamics derive the following.
1. $dU = TdS - PdV$
2. $dA = -PdV - SdT$
3. $dG = VdP - SdT$ (3X15)

(c) (i) Derive an expression for the work done during an isothermal reversible expansion of an ideal gas from a volume V_1 to V_2. (20)

(ii) Calculate the maximum work done when liquid Nitrogen gas (20 l) is isothermally allowed to expand from 10^6 Pa to 10^5 Pa. (15)

5 (a) Derive the Maxwell relation $(\partial V/\partial T)_P = -(\partial S/\partial P)_T$. (25)

(b) i. Define the term molar heat capacity
ii. From the first law of thermodynamics derive the relationship (30)
$C_P = (\partial H/\partial T)_P$

(c) By using Euler's theorem prove the following.
1. $(\partial T/\partial P)_S = -(\partial V/\partial S)_P$
2. $(\partial S/\partial V)_T = (\partial P/\partial T)_V$
3. $-(\partial P/\partial S)_V = (\partial T/\partial V)_S$ (3X15)

6. (a) What is meant by electrode potential of an electrochemical redox system? Calculate the $E^{\varnothing}$ of Ni^{2+}/Ni electrode from the cell $Ni_{(s)}/Ni^{2+}_{(aq)}//Cu^{2+}_{(aq)}/Cu_{(s)}$. The $E^{\varnothing}$ of the cell is 0.59 V ($E^{\varnothing}$ Cu^{2+}/Cu = 0.34 V). (60)

(b) Calculate the electrode potential of a Zn^{2+}/Zn electrode in which the concentration of Zn^{2+} ions is 0.01 M ($E^{\Phi}_{Zn^{2+}/Zn} = -0.76$ V) (40)

XXXXXXXXXXXXXXXXXXXXXXXX