EASTERN UNIVERSITY, SRI LANKA

FIRST YEAR FIRST SEMESTER EXAMINATION IN SCIENCE-2010/2011

(NOVEMBER 2012)

CH 102 INTRODUCTION TO ELECTROCHEMISTRY AND THERMODYNAMICS

Answer all questions — Time: 01 hour

$R = 8.314\ J\ mol^{-1}\ K^{-1}$, $2.303\ RT/F = 0.5091\ V$

1) (a) What do you mean by extensive and intensive properties and give three examples for each.

[10 marks]

(b) (i) Write the mathematical expression for the first and second laws of thermodynamics.

[10 marks]

(ii) A piston filled with 0.04 mole of an ideal gas expand reversibly from 50.0 ml to 375.0 ml at a constant temperature of 37.0 ^{0}C. During the process it absorbs 208 J of heat. Calculate q, W, ΔU and ΔH.

[30 marks]

(c) (i) Using the combination of first and second laws of thermodynamics show that the entropy change (ΔS) on heating of the 'n' moles of substance reversibly from temperature T_1 to T_2 at constant volume is

$$\Delta S = C_v \ln\left(\frac{T_2}{T_1}\right)$$

(Assume C_v is independent of temperature)

[15 marks]

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CH 102 - 2012 (2)

(ii)The heat capacity of oxygen at constant volume is given by the empirical equation

$$C_v = \alpha + \beta T + \gamma T^2$$

Where α, β and γ are constants. Show that the entropy change (ΔS) of oxygen is heated from T_1 to T_2 is

$$\Delta S = \alpha ln\frac{T_2}{T_1} + \beta(T_2 - T_1) + \frac{\gamma}{2}(T_2^2 - T_1^2)$$

[20 marks]

(iii) Determine entropy change (ΔS) -when the oxygen is heated from 300 K to 500 K. Where α = 25.503 J K^{-1} mol^{-1}, β =13.612x10^{-3} J K^{-2} mol^{-1} and γ =-42.553x10^{-7} J K^{-3} mol^{-1}.

[15 marks]

2) (a) (i) Show that the Maxwell relation as $\left(\frac{\partial S}{\partial V}\right)_T = \left(\frac{\partial P}{\partial T}\right)_V$

[15 marks]

(ii) For a gas follows a van der Waals equation of state show that

$$\left(\frac{\partial S}{\partial V}\right)_T = \frac{nR}{V-nb}$$

[15 marks]

(b) Assume the following reaction occurs in an electrochemical cell

$$Cd\ (s) + Cu^{2+} \longrightarrow Cd^{2+} + Cu\ (s)$$

(i) What is the cell representation for the cell

(ii) What is standard electrode potential (E^{θ}_{cell}) of the cell at 25 ^{0}C

(iii) Determine standard change in Gibb's free energy(ΔG^{θ}) and equilibrium constant K of the cell at 25 ^{0}C

[40 marks]

(c) Calculate the electrode potential (E_{cell}) of the following cell by using the Nernst equation

Zn(s) / Zn^{2+}**(0.004 M)** // Cu^{2+}**(0.033 M)**/ Cu (s)

[30 marks]

$$[E^{\theta}_{Cu^{2+},Cu} = 0.3394\ V, E^{\theta}_{Cd^{2+},Cd} = -0.40224\ V,\ E^{\theta}_{Zn^{2+},Zn} = -0.7618\ V]$$

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