EASETRN UNIVERSITY, SRI LANKA

FIRST EXAMINATION IN SCIENCE – PROPER

EXTERNAL DEGREE

FIRST SEMESTER 2003-2004 (OCTOBER 2006)

EXTCH 102 THERMODYNAMICS & INTRODUCTION TO ELECTRO CHEMISTRY

Time allowed: **ONE Hour**

Candidate must NOT start writing their answers until told to do so

You may find the following data useful

Avagadro constant (N_A): 6.023×10^{23} mol^{-1}

Electron charge (e): 1.602×10^{-19} C

Faraday constant (F): 9.648×10^{4} $Cmol^{-1}$

Gas constant (R): 8.314 $JK^{-1}mol^{-1}$

Planck's constant (h): 6.626×10^{-34} Js

Rest mass of electron (m_e): 9.1×10^{-31} kg

Velocity of light (c): 3×10^{8} ms^{-1}

The use of a non –programmable calculator is permitted

1. a) (i) Write the mathematical form of total work done by a gas.

(05 marks)

(ii) Given that the equation of state of gas is $P(V - nb) = nRT$, where 'b' is a constant. Show that the work done (W) by the gas in a reversible isothermal expansion when the volume is changed from V_1 to V_2 is,

$$W = nRT \ln\left(\frac{V_1 - nb}{V_2 - nb}\right)$$

(25 marks)

(iii) If the above gas behaves ideally then deduce that $W = nRT \ln\left(\frac{V_1}{V_2}\right)$

(10 marks)

(iv) 2 moles of ideal gas at 300 K and 6 atm pressure undergo expansion isothermally to half the initial pressure. Calculate the work done by the gas on the surroundings. ($R = 8.314$ $Jmol^{-1}K^{-1}$)

(30 marks)

b) (i) Define the term 'molar heat capacity'.

(05 marks)

(ii) The molar isobaric heat capacity C_p for $NH_3(g)$ is given by $C_p = a + bT + \frac{c}{T}$, where T is the temperature and 'a', 'b' and 'c' are constants. Show that the change in enthalpy (ΔH) when the temperature of **one mol** of $NH_3(g)$ is increased from T_1 to T_2 is

$$C_p = a(T_2 - T_1) + \frac{b}{2}(T_2^2 - T_1^2) + c \ln\left(\frac{T_2}{T_1}\right)$$

(25 marks)

[Hint: $C_p = \left(\frac{\partial H}{\partial T}\right)_p$]

2. a) Derive the following auxiliary relations for a reversible process

(i) $dH = TdS + VdP$ (ii) $dG = VdP - SdT$

[Hint: $dU = TdS - PdV$]

(20 marks)

b) (i) Assuming $G = G(T, P)$, derive the Maxwell relation

$$\left(\frac{\partial V}{\partial T}\right)_P = -\left(\frac{\partial S}{\partial P}\right)_T$$

(20 marks)

(ii) 3 moles of $O_2(g)$ at 300 K is compressed isothermally from 10 to 20 atm. Calculate the change in entropy, assuming that $O_2(g)$ obeys the ideal gas equation

(25 marks)

c) (i) Write the Nernst equation and identify all the terms involved in it.

(10 marks)

(ii) If the electrode potential E for the Fe^{3+}/Fe^{2+} system is 0.889 V calculate $\frac{[Fe^{3+}]}{[Fe^{2+}]}$. ($E^{\theta}_{Fe^{3+}/Fe^{2+}} = 0.771$ V; 2.303 RT/F = 0.059)

(25 marks)

End