EASTERN UNIVERSITY, SRI LANKA
FIRST SEMESTER FIRST EXAMINATION IN SCIENCE 2004/2005
EXTERNAL DEGREE
MAY/JUNE 2008
EXTCH 102: INTRODUCTION TO ELECTROCHEMISTRY AND THERMODYNAMICS - Repeat -

TIME: 01 HOUR

R = 8.314 J mol^{-1} K^{-1} $\qquad$ **$2.303\,\frac{RT}{F} = 0.0591$**

---

1. (a) Define the following terms

   (i) Closed system (ii) Adiabatic wall (iii) Reversible process

   (12 marks)

   (b) Calculate the work done for an isothermal reversible expansion of 3 moles of hydrogen gas from volume 2 dm^3 to 100 dm^3 at 273 K, which obeys to the equation of state $P(V-\gamma) = nRT$, where $\gamma = 0.015$ dm^3.

   (25 marks)

   (c) (i) Derive the following equation;

$$C_P - C_V = \left[P + \left(\frac{\partial U}{\partial V}\right)_T\right]\left(\frac{\partial V}{\partial T}\right)_P$$

   (20 marks)

   (ii) Hence show that for an ideal gas

   (08 marks)

$$C_P - C_V = nR$$

   (d) (i) Show that the entropy change (ΔS) on heating or cooling of a substance from temperature T_1 to T_2 is,

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

   (10 marks)

   Assume C_V is independent of temperature.

   (ii) Calculate the entropy change (ΔS) of 2 moles of an ideal gas ($C_V = 2.5\,R$) at 27° C K is heated to 127° C.

   (25 marks)

2. (a) Show that the following auxiliary and the Maxwell relations for a reversible process.

(i) $dA = -SdT - PdV$ (Hint: $dU = TdS - PdV$) (10 marks)

(ii) $\left(\frac{\partial S}{\partial V}\right)_T = \left(\frac{\partial P}{\partial T}\right)_V$ (10 marks)

(iii) Hence, for a gas which obeys to the equation of state $P(V - nb) = nRT$ undergoing an isothermal expansion from volume V_1 to V_2

I. Show that $\Delta A = nRT \ln\left(\frac{V_1 - nb}{V_2 - nb}\right)$ (15 marks)

II. Determine $\left(\frac{\partial P}{\partial T}\right)_V$ (05 marks)

III. Show that $\Delta S = nR \ln\left(\left(\frac{V_2 - nb}{V_1 - nb}\right)\right)$ (10 marks)

(b) A cell is prepared with a copper rod in 1 M $CuSO_4$ solution and a nickel rod in 1 M $NiSO_4$ solution. The standard reduction potential of copper electrode and nickel electrode are 0.34 V and -0.25 V respectively.

i. Write the cell reaction.
ii. What is the standard EMF of the cell?
iii. How will this cell be represented?

(20 marks)

(c) Represent schematically the cell made up the following half cell reactions:

$Mg \rightarrow Mg^{2+}(0.01\ M) + 2e,\ E^{\theta} = 2.34$ V

$Sn^{2+}(0.1\ M) + 2e \rightarrow Sn,\quad E^{\theta} = -0.136$ V.

Calculate the E^{θ}_{cell} and E_{cell} of the above cell at 25 °C by using Nernst equation.

(30 marks)