EASTERN UNIVERSITY, SRI LANKA

FIRST SEMESTER FIRST EXAMINATION IN SCIENCE

2008/2009 (July/ August 2010)

External degree (2005/2006)

EXTCH 102 Introduction to Electrochemistry and Thermodynamics

Answer all questions — Time: one Hour

$R = 8.314\ J\ mol^{-1}\ K^{-1}$, $2.303\ RT/F = 0.0591\ V$

1]

(a) Explain graphically the work done by the system in a reversible expansion of an ideal gas is greater than that of irreversible process. **[20 marks]**

(b) One mole of a gas is allowed to expand isothermally and reversibly from a volume of 1 dm^3 to 50 dm^3 at 273 K. Calculate w, q and ΔU assuming Van der Waals behaviour. Van der Waals constants are a = 6.5 atm $dm^6\ mol^{-2}$; b = 0.056 $dm^3\ mol^{-1}$ and R = 0.082 atm $dm^3\ K^{-1}\ mol^{-1}$.

[40 marks]

(c) i. Derive an expression for the entropy change $\Delta S = C_V \ln\left(\frac{T_2}{T_1}\right) + R \ln\left(\frac{V_2}{V_1}\right)$

[20 marks]

ii. Calculate the entropy changed experienced by 2 mol of an ideal gas which is allowed to expand from an initial state of 100 dm^3 at 323 K to a final state of 150 dm^3 at 423 K. [$C_{V,m} = 4R$]

20 marks

2]

(a) i. Derive the Maxwell relation $\left(\frac{\partial S}{\partial V}\right)_T = \left(\frac{\partial P}{\partial T}\right)_V$ **[15 marks]**

ii. 0.5 moles of methane expands isothermally from 1.00 l t 1.50 l. Find $\left(\frac{\partial P}{\partial T}\right)_V$ and calculate the entropy change (ΔS), assuming that methane obeys the Van der Waals equation of state. [Van der Waals constants are a = 6.5 atm $dm^6\ mol^{-2}$; b = 0.056 $dm^3\ mol^{-1}$ and R = 0.082 atm $dm^3\ K^{-1}\ mol^{-1}$]

[25 marks]

Cont..

(b) The following redox reaction occurs in a cell:

$$2Au^{3+}(aq) + 3Ni\ (s) \rightarrow 3Ni^{2+}(aq) + 2Au(s)$$

(i) Identify the oxidizing agent in the reaction

(ii) How many electrons are transferred in the redox reaction

(iii) Represent the electrochemical cell for the cell reaction

(iv) Calculate the standard cell potential (E^{θ}_{cell}) for the cell.

$[E^{\theta}_{Au^{3+}/Au} = 1.38V, E^{\theta}_{Ni^{2+}/Ni} = -0.23V]$

(v) Calculate the cell potential (E_{cell}) for the cell when [Au^{3+}] =1.2 x 10^{-6} M and [Ni^{2+}] = 1.10 M

[60 marks]

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