Eastern University, Sri Lanka

First Year First Semester Examination in Science

2011/2012 (January 2013)

CH 102 Introduction to Electrochemistry and Thermodynamics
(Proper& Repeat)

Answer all questions Time: 01 hour

Gas constant (R) = 8.314 J K^{-1} mol^{-1} 2.303 RT/F = 0.0591V

1.

a) i. Write the mathematical expression for first law of thermodynamics

(05 marks)

ii. A sample of 0.175 mol of an ideal gas is allowed to expand under adiabatic and reversible conditions from a volume of 5.0 dm^3 at a pressure of 303975 Nm^{-2} and 298 K until the volume becomes 10.0 dm^3. Calculate the final pressure and final temperature of the gas and the values of $q, w, \Delta U$ and, ΔH.

(45 marks)

b) i. Define 'Joule – Thomson coefficient', and show that $\mu_{J-T} = -1/C_p\left(\frac{\partial H}{\partial P}\right)_T$

(15 marks)

ii. The μ_{J-T} for CO_2 gas at pressure up to 20 atm pressure can be taken as constant and equal to 1.054 K atm^{-1}. Calculate the change in enthalpy (ΔH) when 5 moles of CO_2 at 25 ^{o} C and 1 atm pressure is compressed isothermally to 20 atm pressure. (The isobaric thermal heat capacity (C_p) of CO_2 is 36 J K^{-1} mol^{-1})

(35 marks)

Cont..

2.

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

(10 marks)

ii. One mole of gas which obeys to the equation of state $P = \frac{RT}{V-b} - \frac{a}{TV^2}$ expands from V_1 to V_2. Determine $\left(\frac{\partial P}{\partial T}\right)_V$ and hence show that $\Delta S = Rln\left[\frac{V_2-b}{V_1-b}\right] + \frac{a}{T^2}\left[\frac{1}{V_1} - \frac{1}{V_2}\right]$

(25 marks)

b) Consider the galvanic cell
$Cu(s)/Cu^{2+}(aq, 0.25\ M)//\ Fe^{3+}(aq, 0.0001\ M)\ /Fe^{2+}(aq, 0.20\ M)$.

i. Write the cell reaction

ii. Calculate the standard electrode potential and electrode potential of the cell.

Given that $E^{\theta}_{Cu^{2+}/Cu.} = 0.34$ V and $E^{\theta}_{Fe^{3+}/Fe^{2+}} = 0.77$ V

(40 marks)

c) Calculate the change in standard free energy (ΔG^{θ}) at 298 K for the reaction

$$Sn\ (s) + Pb^{2+}\ (aq) \longrightarrow Sn^{2+}\ (aq) + Pb(s)$$

Given that $E^{\theta}_{Sn^{2+}/Sn} = -0.14$ V and $E^{\theta}_{Pb^{2+}/Pb} = -0.126$ V

(25 marks)

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