



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) = $8.314 \text{ J K}^{-1} \text{ mol}^{-1}$

$2.303 RT/F = 0.0591V$

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 , ΔU 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°C and 1 atm pressure is compressed isothermally to 20 atm pressure. (The isobaric thermal heat capacity (C_p) of CO_2 is $36 \text{ J K}^{-1} \text{ mol}^{-1}$)

(35 marks)

Cont..

2.

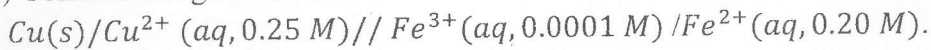
a) i. Derive the Maxwell relation $\left(\frac{\partial S}{\partial V}\right)_T = \left(\frac{\partial P}{\partial T}\right)_V$

(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 $\Delta S = R \ln \left[\frac{V_2-b}{V_1-b}\right] + \frac{a}{T^2} \left[\frac{1}{V_1} - \frac{1}{V_2}\right]$

(25 marks)

b) Consider the galvanic cell



i. Write the cell reaction

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

$$\text{Given that } E_{\text{Cu}^{2+}/\text{Cu}}^{\theta} = 0.34 \text{ V and } E_{\text{Fe}^{3+}/\text{Fe}^{2+}}^{\theta} = 0.77 \text{ V}$$

(40 marks)

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



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

(25 marks)