



Eastern University, Sri Lanka

First Year First Semester Examination in Science

2013/2014 (October 2015)

CH 102 Introduction to Electrochemistry and Thermodynamics

Answer all questions

Time: 01 hour

Gas constant (R) =  $8.314 \text{ J K}^{-1} \text{ mol}^{-1}$

$2.303 \text{ RT/F} = 0.0591 \text{ V}$

1.

- a) i) Write the mathematical expression for total work done of a gas (05 marks)
- ii) Derive the equation for the work of reversible isothermal expansion of a Vander der Waals gas from  $V_1$  to  $V_2$  (25 marks)
- iii) One mole of  $\text{CH}_4$  expands reversibly from 1 to 50 liter at  $25^\circ\text{C}$ . Calculate the work in joules assuming the gas obeys the Vander der Waals equation. For  $\text{CH}_4$   $a = 1.36 \text{ l}^2 \text{ atm mol}^{-2}$  and  $b = 0$ . (20 marks)
- b) i) Using the combination of first and second laws of thermodynamics, show that the entropy change ( $\Delta S$ ) on heating of 'n' moles of substance reversibly from temperature  $T_1$  to  $T_2$  at constant volume is

$$\Delta S = C_v \ln \frac{T_2}{T_1}, \text{ assume } C_v \text{ is independent of temperature.}$$

(20 marks)

- ii) The heat capacity of oxygen at constant volume is given by the empirical equation

$$C_v = \alpha(T^2 - 2) + \beta T + \gamma$$

Where  $\alpha$ ,  $\beta$  and  $\gamma$  are constants. Show that the entropy change ( $\Delta S$ ) of oxygen when it is heated from  $T_1$  to  $T_2$  is

$$\Delta S = \frac{\alpha}{2}(T_2^2 - T_1^2) + \beta(T_2 - T_1) + (\gamma - 2\alpha) \ln \frac{T_2}{T_1}$$

(30 marks)

Contd.....

2)

- a) i) Write the Clausius – Clapeyron equation and hence show that the integrated form of the equation is

$$\ln\left(\frac{P_1}{P_2}\right) = \frac{\Delta H_{vap}}{R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right)$$

(15 marks)

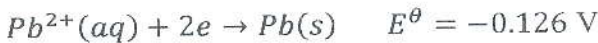
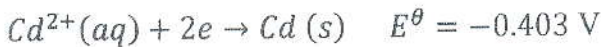
- ii) Naphthalene ( $C_{10}H_8$ ) melts at  $80.2^\circ C$ . If the vapour pressure of the liquid is 10 Torr at  $85.8^\circ C$  and 40 Torr at  $119.3^\circ C$ , use this equation to calculate the enthalpy of vaporization ( $\Delta H_{vap}$ )

(20 marks)

- b) Write the Nernst equation and explain the terms involved in it.

(05 marks)

- c) Reduction half-reactions at  $25^\circ C$ , are given below



- i) Write the cell reaction  
ii) Represent the electrochemical cell  
iii) Calculate the standard cell potential  
iv) Calculate the cell potential of the cell, where  $[Cd^{2+}(aq)] = 0.02$  and  $[Pb^{2+}(aq)] = 0.2 M$ .

(45 marks)

- d) Predict whether Zinc and Silver react with  $1M H_2SO_4$  to give out hydrogen gas or not. Given that the standard reduction potentials of Zinc and Silver are  $-0.76 V$  and  $0.80 V$  respectively.

(15 marks)

\*\*\*\*\*