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 J K^{-1} mol^{-1} 2.303 RT/F = 0.0591V

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 CH_4 expands reversibly from 1 to 50 liter at 25 ^{0}C. Calculate the work in joules assuming the gas obeys the Vander der Waals equation. For CH_4 $a = 1.36$ l^2 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 (ΔS) 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 α, β and γ are constants. Show that the entropy change (ΔS) 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 Clasius – Clapeyron equation and hence show that the integrated form 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° C. If the vapour pressure of the liquid is 10 T at 85.8 ° C and 40 Torr at 119.3 ° C, use this equation to calculate the enthalpy vaporization (ΔH_{Vap})

(20 marks

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

(05 marks

c) Reduction half-reactions at 25 °C, are given below

$$Cd^{2+}(aq) + 2e \rightarrow Cd\ (s) \quad E^{\theta} = -0.403\ \text{V}$$

$$Pb^{2+}(aq) + 2e \rightarrow Pb(s) \quad E^{\theta} = -0.126\ \text{V}$$

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 Given that the standard reduction potentials of Zinc and Silver are -0.76 V and 0.8 respectively.

(15 marks

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