Eastern University, Sri Lanka

First Year First Semester Examination in Science

2015/2016 (July/August 2017)

CH 102 Introduction to Electrochemistry and Thermodynamics

(Repeat)

all questions Time: 01 hour

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

1.

(a) State the first law of thermodynamics

Consider 2 moles of an ideal gas at an initial pressure of 1 atm and initial temperature of 273.15 K. Assume it expands adiabatically against a pressure of 0.435 atm until its volume doubles. Calculate the work, the final temperature, and the ΔU of the process.

(40 marks)

(b) Derive the expression for heat capacity at constant volume (C_V) from the first principle.

The temperature of 1.00 mol of $O_2(g)$, changes from -20.0 ° C to 37.0 ° C at constant volume. Evaluate change in internal energy, ΔU in the following cases.

i) It is an ideal gas with $C_V = 20.78$ J mol^{-1} K^{-1}

ii) It is a real gas with $C_V = 21.6 + 4.18X10^{-3}T - (1.67X10^5)/T^2$

(60 marks)

2. (a) i) Derive the integrated form of Clausius – Clapeyron equation from Clapeyron equation between two sets of conditions, (p_1, T_1) and (p_2, T_2).

ii) All liquids have characteristic vapour pressures that vary with temperature. The characteristic vapour pressure for pure water at 22 ° C is 19.827 mmHg and at 30 ° C is 31.824 mmHg. Use these data to calculate the change in enthalpy per mole for the vaporization process

(35 marks)

(c) For the following cell,

$$Cd(s)/\ Cd^{2+}(aq, x\ M)//\ Ni^{2+}(aq, 1\ M)/Ni(s)$$

i) Write the half-cell and cell reactions

ii) Calculate standard electrode potential (E^{θ}_{cell})

iii) If the electrode potential of the cell (E_{cell}) is 2.4 V, determine the value

$$[E^{\theta}_{Ni^{2+},Ni} = -0.23\ V, E^{\theta}_{Cd^{2+},Cd} = -0.40\ V]$$

(40 m

(d) Calculate the standard electrode potential (E^{θ}_{cell}), standard Gibb's energy(ΔG^{θ}) and equilibrium constant K at 25°C for the following ele reaction

$$Cu(s) + Fe^{3+}(aq) \rightarrow Cu^{2+}(aq) + F^{2+}(aq)$$

(25 m

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