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MAIN EXAMINATION

AUGUST - DECEMBER 2016 TRIMESTER

FACULTY OF SCIENCE

DEPARTMENT OF CHEMISTRY

REGULAR PROGRAMME

CHEM 201: PHYSICAL CHEMISTRY II

Date: DECEMBER 2016	**Duration: 2 Hours**
INSTRUCTIONS: Answer Question ONE and ANY OTHER TWO Questions	

Useful Information **Useful Constants**

R = 8.314 $Jmol^{-1}K^{-1}$ = 0.08206 $L.atm\ mol^{-1}\ K^{-1}$

1 atm = 760 mmHg = 101325 Pa or $1atm = 101325N/m^2$

Q1. a) Using the 1st and 2nd laws of thermodynamics, show that:

$\Delta s = CvInT + RInV$ **(7 marks)**

b) One mol of an ideal gas at 25^0c was allowed to expand isothermally and reversibly from 1050.25 KPa to 10.5025kPa against a pressure that was gradually reduced. Calculate

(i) the work done. **(3 marks)**

(ii) ΔE, ΔH and Q **(6 marks)**

(iii) Δs and ΔG **(6 marks)**

c) Briefly define the following terms as used in thermodynamics.
(i) state variables
(ii) extensive properties
(iii) entropy
(iv) reversible process

(8 marks)

Q2. a) Given the equation $C_{12}H_{22}O_{11} + H_2O \rightarrow 2C_6H_{12}O_6 \quad \Delta Hr$

Show that: $\Delta Hr = 2\Delta H_{f,c_6H_{12}O_6} - \left(\Delta H_{f,c_{12}H_{22}O_{11}} + \Delta H_{f,H_2O}\right)$

(10 marks)

b) Using a carnot cycle show that entropy is a state function. **(10 marks)**

Q3. a) Briefly discuss how the change in temperature affects the spontaneity of a given reaction. **(8 marks)**

b) Calculate the temperature at which it is thermodynamically possible for carbon to reduce iron (iii) oxide to iron under standard conditions by the endothermic reaction. $2Fe_2O_{3(S)} + 3C_{(s)} \rightarrow 4Fe_{(s)} + 3CO_{2(G)}$

Component	$\Delta H_f / Kjmol^{-1}$	**S^o/Jmol^{-1}k**
$Fe_2O_{3(s)}$	-824.2	89.4
$C_{(S)}$	0	5.7
$Fe_{(s)}$	0	27.3
$CO_{2(G)}$	-393.5	213.7

(8 marks)

c) Calculate the work done when 1 mol of a gas expands from 10dm^3 to 15dm^3 against a constant pressure of 1 atmosphere.

Q4. a) (i) Plot on the some graph the variation of absolute entropy versus temperature for H_2 and CH_3Cl in the range 0k to 300k. **(6 marks)**

(ii) Explain the variation for the graph in (i). **(4 marks)**

b) Liquid water at 373k is in equilibrium with water vapour at 1 atm pressure if ΔH_{vap} at 373k is 40.60kj mol^{-1}. Calculate

(i) ΔG and ΔS

(ii) Suppose the water vapour pressure is 0.900 atm. What are the values of ΔG and ΔS for the vapourization process? **(6 marks)**

Q5. a) Consider the system $M_{(g)} \rightleftharpoons N_{(g)}$ at 25^0c. Given that

$G^0_M = 8996 Jmol^{-1}$ and $G^0_N = 11718 Jmol^{-1}$, Calculate the value of the equilibrium constant for this reaction. **(6 marks)**

b) Calculate the equilibrium pressure that results if 1.00mol $M_{(g)}$ at 1.00 atm and 1.00 mol $N_{(g)}$ at 1.00 atm are mixed together at 25^0c. **(8 marks)**

c) Given that G= H-TS, E = Q + W and H = E+PV. Show that for 1 mol of an ideal gas dG = Vdp-SdT. **(6 marks)**

END