EMBU UNIVERSITY COLLEGE

(A Constituent College of the University of Nairobi)

2015/2016 ACADEMIC YEAR

SECOND SEMESTER EXAMINATION

THIRD YEAR EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE

SCH 303: THERMODYNAMICS II AND PHASE EQUILIBRIA

DATE: APRIL 7, 2016 **TIME: 08:30-10:30AM**

INSTRUCTIONS:

Answer Question ONE and ANY other two Questions

QUESTION ONE

a) Define the following concepts as used in chemistry

i) Entropy

ii) Enthalphy

iii) Chemical activity

iv) Chemical potential

v) Work (5 Marks)

b) Two mole of an ideal gas at STP are heated at constant volume to a temperature of 350K.

i) Determine the new pressure attained by the gas on heating. (2 Marks)

ii) Determine the increase in entropy on heating the gas. (3 Marks)

c) The molar heat capacity at constant pressure of ammonia gas is expressed by;

$Cp = (25.87 + 3.3x\ 10^{-2}T - 3.04 \times 10^{-6}T^2)\ JK^{-1}Mole^{-1}$. 1 mole of ammonia is heated from 298K to 398 K. Calculate the increase in entropy. (5 Marks)

d) The boiling point of water at a pressure of 50 atmospheres is 265 °C and at 1 atmosphere it is 100°C. Assuming the temperature of the sink is 40 °C, determine the theoretical efficiencies of a steam engine operating between the boiling point of water and that of the sink at 1atmosphere. (5 Marks)

e) Given the following information

SUBSTANCE	S^O(Jmol-1 K-1)
$H_{2(g)}$	130.59
$C_{(c, graphite)}$	5.69
$CH_{4(g)}$	186.19
$C_2H_{2\,(g)}$	200.82
$C_2H_{4(g)}$	219.45
$C_2H_{6(g)}$	229.49

Determine the changes in entropy for the following reaction (5 Marks)

$$C_2H_{2(g)} + H_{2(g)} \rightarrow C_2H_{4(g)}$$

f) For the reversible reaction

$$N_{2(g)} + 3H_{2(g)} = 2NH_{3(g)}$$

at 773K, the value of K^P, with partial pressures in atmospheres, is 1.44 x 10-5 at low pressures where the gases behave ideally. Determine the corresponding value of K_C with concentrations in mole litre^{-1}. (5 Marks)

QUESTION TWO

a) For an ideal gas

$$\delta q^{rev} = CvdT + PdV$$

where only pressure - volume work is involved and all symbols used have their usual meaning, show that:

i) $\Delta S = C_V Ln\left(\frac{T_2}{T_1}\right) + RLn\left(\frac{V_2}{V_1}\right)$ (8 Marks)

ii) $\Delta S_T = RLn\left(\frac{V_2}{V_1}\right)$ (7 Marks)

b) Two mole of a gas at RTP are heated at constant volume to a temperature of 350K. Determine the increase in entropy for the system. (Cv = 12.47 J/Mol/K) (5 Marks)

QUESTION THREE

a) Given that $\int_{G_1}^{G_2} dG = \int_{P_1}^{P_2} VdP$

Show that $\Delta G = nRT \ln \frac{P_2}{P_1}$ (8 Marks)

b) Calculate the change in free energy when 11.21 dm^3 of a perfect gas at 0^oC and 760 mmHg pressure expands isothermally until its pressure is 190 mmHg. (5 Marks)

c) You are given the following entropies and enthalpies of combustion at 25^oC;

Substance	S (JK^{-1})	ΔH (kJ)
$C_{(graphite)}$	5.9	-396
$H_{2(g)}$	131.0	-287
$C_2H_{6(g)}$	231.0	-1567

State whether the following reaction is thermodynamically possible.

$2\ C_{(graphite)} + 3\ H_{2(g)} \longrightarrow C_2H_{6(g)}$ (7 Marks)

QUESTION FOUR

Given the equation

$$G_A \Leftrightarrow G_B$$

For two phases, A and B, of the same substance in equilibrium with one another at a temperature T and pressure P. Deduce the Clapeyron-Clausius equation

$$\frac{dP}{dT} = \frac{\Delta H}{T(V_B - V_A)}$$ (20 Marks)

QUESTION FIVE

Consider a binary solution that has component 1 as the solvent and component 2 as the solute

a) Give the general expression for the Gibb's Duhelm equation in terms of mole fractions and chemical potential for a solution with only two components. Explain the general applications of the equation. (12 Marks)

b) From $nM = \sum dn_i \overline{M}_i$ for partial molar properties where i = 1 and 2 only, show that the Gibb's Duhelm equation (a above) holds. (8 Marks)

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