



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

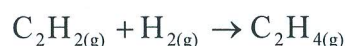
- a) Define the following concepts as used in chemistry
- i) Entropy
 - ii) Enthalpy
 - iii) Chemical activity
 - iv) Chemical potential
 - v) Work (5 Marks)
- b) Two mole of an ideal gas at STP are heated at constant volume to a temperature of 350K.
- i) Determine the new pressure attained by the gas 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;
- $$C_p = (25.87 + 3.3 \times 10^{-2}T - 3.04 \times 10^{-6}T^2) \text{ JK}^{-1}\text{Mole}^{-1}$$
- 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)

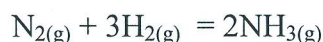
e) Given the following information

SUBSTANCE	$S^{\circ}(\text{Jmol}^{-1} \text{K}^{-1})$
$\text{H}_{2(\text{g})}$	130.59
$\text{C}_{(\text{c, graphite})}$	5.69
$\text{CH}_{4(\text{g})}$	186.19
$\text{C}_2\text{H}_2(\text{g})$	200.82
$\text{C}_2\text{H}_4(\text{g})$	219.45
$\text{C}_2\text{H}_6(\text{g})$	229.49

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



f) For the reversible reaction



at 773K, the value of K^P , with partial pressures in atmospheres, is 1.44×10^{-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

$$\delta q^{\text{rev}} = C_v dT + PdV$$

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

$$\text{i) } \Delta S = C_v \ln\left(\frac{T_2}{T_1}\right) + R \ln\left(\frac{V_2}{V_1}\right) \quad (8 \text{ Marks})$$

$$\text{ii) } \Delta S_T = R \ln\left(\frac{V_2}{V_1}\right) \quad (7 \text{ Marks})$$

- 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. ($C_v = 12.47 \text{ J/Mol/K}$) (5 Marks)

QUESTION THREE

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

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°C 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°C ;

Substance	S (JK^{-1})	ΔH (kJ)
$\text{C}_{(\text{graphite})}$	5.9	-396
$\text{H}_{2(\text{g})}$	131.0	-287
$\text{C}_2\text{H}_{6(\text{g})}$	231.0	-1567

State whether the following reaction is thermodynamically possible.



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

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

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 $nM = \sum dn_i \bar{M}_i$ 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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