NATIONAL OPEN UNVERSITY OF NIGERIA
PLOT 91, CADASTRAL ZONE, NNAMDI AZIKIWE EXPRESSWAY, JABI - ABUJA
FACULTY OF SCIENCES
DEPARTMENT OF PURE & APPLIED SCIENCES
2021_2 EXAMINATION 45678

COURSE CODE: CHM 301 **CREDIT: 3 Units**
COURSE TITLE: PHYSICAL CHEMISTRY III **TIME ALLOWED: 3 Hours**
INSTRUCTION: Answer Question ONE (1) and any other Four (4) Questions

Q1a) Derive Kirchhoff's equation. (6Marks)

b) Explain bond enthalpy and state its application (3Marks)

c) State the three applications of Clausius-Clapeyron equation (6Marks)

d) Explain phase diagram of water system (7Marks)

2a) 1.00 Mol. of a monoatomic gas initially at 3.00×10^2 K and occupying 2.00×10^{-3} m^3 is heated to 3.25×10^2 K and the final volume is 4.00×10^{-3} m^3. Assuming ideal behaviour, calculate the entropy change for the process. (4Marks)

b) Derive an equation for entropy of mixing for mole fraction of gases (8Marks)

3a) What is the total volume of the solution, when 3.80 mol of water is mixed with 0.500 Mol. of ethanol? The partial molar volumes of water and ethanol at this composition are $1.80 \times 105M^3$ mol^{-1} and $5.34 \times 10^{-5}M^3Mol^{-1}$, respectively. (5Marks)

b) Derive an expression for determining the fugacity of a gas at any pressure. (4Marks)

c) The γ factor in the above derivation is known as what. Give the general ideal gas equation. (3Marks)

4a) The equilibrium constant for the reaction

$H_2(g) + S(s) \rightarrow H_2S(g)$

is 18.5 at 925 K and 925 at 1000 K, respectively. Calculate the standard enthalpy of the reaction. Also calculate $\Delta_rG°$ and $\Delta_rS°$ at 925 K. (4Marks)

b) Discuss osmotic pressure as one of the colligative properties (6Marks)

c) What are two allotropic form of sulphur and which one exist at low temperature. (2Marks)

5a) Derive an expression for isothermal reversible process and state the conditions of W (3Marks)

b) An ideal gas initially at 3.00×10^2 K and 3.00×10^5 Pa pressure occupies 0.831 m^3 space. What is the minimum amount of work required to compress the gas isothermally and reversibly so that the final pressure is 6.00×10^6 Pa?

$p_1 = 3.00 \times 10^5$ Pa; $p_2 = 6.00 \times 10^6$ Pa

$R = 8.314$ J mol k^{-1}; $T = 3.00 \times 10^2$ K (5Marks)

c) Briefly discuss the entropy change of a system undergoing isothermal Irreversible Expansion and Reversible Compression (5Marks)

6a) Derive a Helmholtz equation to show that the change in Helmholtz; free energy is equal to the amount of reversible work done on the system. (5Marks)

b) For the reaction,

$2NO\ (g) + O_2\ (g) \rightarrow 2NO_2\ (g)$

Calculate ΔG at 7.00×10^2 K. The entropy and enthalpy changes at 7.00×10^2 K are respectively, -1.45×10^2 J Mol^{-1} K^{-1} and -1.13×10^2 kJ Mol^{-1}. (4Marks)

c) Derive this relation: $\left(\frac{\partial A}{\partial T}\right)_V = -S$ at constant volume (3Marks)