NATIONAL OPEN UNIVERSITY OF NIGERIA

DEPARTMENT OF PURE AND APPLIED SCIENCES

2021_1 EXAMINATION 1234

COURSE CODE: CHM 405   **CREDIT UNIT:** 2
COURSE TITLE: CHEMICAL THERMODYNAMICS   **TIME:** 2 HRS
INSTRUCTION: *Answer question 1 and any other 3 questions*

QUESTION ONE

(a)   if a state function y = f(x,z). derive an expression for exact differential of the function. Hence explain the principle of reciprocity with reference to state function   **(6 marks)**

(b)   Explain the three classes thermodynamic processes can be grouped into (based on variables). Hence explain one example of each of the variables   **(6 marks)**

(c)   What is a cyclic process? Give one example of a cycle process that consist of four stages   **(2 marks)**

(d)   Differentiate between thermodynamics process and kinetic reversible process in equilibrium   **(3 marks)**

(e)   (i)   Given that force is equal to the product of pressure and surface area, show that thermodynamic work done can be expressed as follow, $dW = -P(V_2 - V_1)$ **(6 marks)**

(ii) calculate the pressure that would be needed to be exerted in a system such that the gas expand from 10 to 20 m^3 and the work done is 40 J   **(2 marks)**

QUESTION TWO

(a)   What is a spontaneous reaction. Hence how would you use the value of free energy change to differentiate between spontaneous, non spontaneous and reaction at equilibrium

(4 marks)

(b)   Equation for the decomposition of nitrogen (IV) oxide is give as $N_2O_{4(g)} \rightarrow 2NO_{2(g)}$

The standard changes in entropy and enthalpy are 176 J/K and 58220 J respectively. Calculate the standard change in free energy of the reaction? Is the reaction spontaneous? Give reason for your answer.   **(4.5 marks)**

(c)   Calculate the equilibrium constant of the reaction at 300 K   **(3.5 marks)**

(d)   At what temperature will the standard change in free energy be equal to zero?. **(3 marks)**

QUESTION THREE

(a)   State the third law of thermodynamics and state three limitations of the law **(4 marks)**

(b)   A system contains 1 cm^3 matter with a mass of 1g, equivalent to 20 g/mol. The number of identical atoms in the system is 3 x 10^{23} at 0 K and one atom absorb a photon of wavelength of 1 cm. Calculate

        (i)   The entropy change for the system   **(4 marks)**

        (ii)   The energy change of the system due to absorption of one mole   **(3 mark)**

        (ii)   The expected rise in the temperature of the system   **(4 marks)**

QUESTION FOUR

(a)   What is thermodynamic potential ?   **(1 mark)**

(b)   Given that the internal energy change is expressed as $dU = dq + dw$, derive the total differentiation equations for internal energy   **(9 marks)**

(c)   Given the following total differentiation,

    i. $dU = TdS - PdV$

    ii. $dH = TdS + VdP$

    iii. $dA = -PdV - SdT$

    iv. $dG = VdP - SdT$

Apply the principle of reciprocity to derive the four basic equations according to Maxwell
                                                                            (4 marks)

QUESTION FIVE

 (a)   (i) Show that at constant temperature, the change in the Gibbs free energy is a function of pressure.   **(4 marks)**

(ii)   Calculate the change in Gibbs free energy for a reaction, whose pressure changes from 101325 Pa to 202650 Pa at 298 K   **(3 marks)**

(b)   show that at constant pressure, is $\frac{1}{T}\frac{d}{dT}(\Delta G) - \frac{\Delta G}{T^2}$ **(8 marks)**