

**NATIONAL OPEN UNVERSITY OF NIGERIA**

**PLOT 91, CADASTRAL ZONE, NNAMDI AZIKIWE EXPRESSWAY, JABI - ABUJA**

**FACULTY OF SCIENCES**

**DEPARTMENT OF PURE & APPLIED SCIENCES**

 **APRIL/MAY, 2019 EXAMINATIONS**

**CHM 301-PHYSICAL CHEMISTRY III (3 UNITS)**

**INSTRUCTION: Answer question 1 and any other 4 questions.**

**Time allowed 2 ½ Hours**

*R= 0.0821 L atmmol-1K-1=8.314JK-1mol-1=62.396mmHgLK-1mol-1 =1.987calK-1mol-1; k= 1.38066 x 10-23;* $π$*= 3.142; F= 96,500 coulombs*

**QUESTION 1**

1. Define the following terms as applied to chemical thermodynamics
2. Internal energy (ii) heat (iii) work *(6 marks)*

 (b) Methane gas, CH4 originally at $800℃$, undergoes a reversible adiabatic expansion that

 doubles its volume. Assuming the gas is ideal calculate the following

(i) The final temperature. *(4 marks)*

(ii) The maximum work done for 0.5 moles of the gas *(2 marks)*

 (c) The vapour pressure of propanol (C3H8O) is 375 torr at 38.8 oC, but droped to 372.1 torr when 8.69 g of an involatile organic compound Y is dissolved in 50 g of the propanol. Calculate

1. The mole fraction of solute and solvent *(4 marks)*
2. The molar mass of compound Y *(2 marks)*

(d) Calculate the change in the chemical potential of a perfect gas when it expands isothermally at a temperature of 20.0°C so that its volume doubles. *(4 marks)*

**QUESTION 2**

(a)Differentiate between a state and path function. *(2 marks)*

(b) A diatomic gas assumed ideal, initially at 23.7 L 0.9 bar and 308K expands to 38.2 L. calculate:

* 1. Number of moles present *(2 marks)*
	2. work done
		1. Isothermally and reversibly *(2 marks)*
		2. Under isobaric conditions *(2 marks)*
		3. Adiabatically *(4 marks)*

**QUESTION 3**

(a) What are the features used by Carnot to analyze the functioning of an engine *(5 marks)*

 (b) Define the term entropy *(3 marks)*

(c) Calculate the change of entropy when $3.6×10^{4} J$ of heat is transferred reversibly and isothermally to a system at 600 K. *(4 marks)*

**QUESTION 4**

(a) The equilibrium constant for the reaction

$$H\_{2} \left(g\right)+S \left(s\right) ⇌H\_{2}S (g)$$

 is 18.5 at 925 K and 9.25 at 1000 K respectively.

Calculate :

 (i) the standard enthalpy of the reaction *(3 marks)*

 (ii) ∆rGo at 925 K *(3 marks)*

 (b) Calculate the entropy change when 2.0 mol of a perfect gas A and 3.0 mol of a perfect gas B mix spontaneously. *(6 marks)*

**QUESTION 5**

(a) State the third law of thermodynamics *(3 marks)*

(b) Hg2Cl2(s) + H2 (1atm) ⇌ 2Hg(l) + 2H+ (a=1) + 2Cl- (a=1) is E0298.15 = +0.2676 volt and $(\frac{∂ϵ}{∂T}$) at constant pressure is -3.09 x10-4 volt/deg. where T is the Celsius temperature. Given that 2 moles of electrons are involved in the cell reaction, calculate ΔG0, ΔH0, ΔS0 for the cell at 25oC.*(6 marks)*

(c) Giving your reasons, state the conditions in which the reactions will occur spontaneously

i) N2(g) + 3H2(g) → 2NH3(g) (The reaction is exothermic) *(3 marks)*

 ii) O2(g) → 2O(g) (The reaction is endothermic) *(3 marks)*

**QUESTION 6**

1. List the colligative properties and write the corresponding equations and define the terms. *(4 marks)*

 (b) An organic compound W on analysis, gave the following percentage composition. C= 30.5 %, H=1.7% and Br =67.8%. [C=12; H=1; Br=80]. Calculate the emperical formular of W *(2 marks)*

(c) A solution made by dissolving 4.0g of sample W in 50.0g of benzene freezes at 3.74oC. The freezing point of pure benzene is 5.48oC. [ Kf of benzene =5.12 deg molality-1]

 Calculate

* 1. The molality of the solution *(2 marks)*
	2. The number of moles of W *(2 marks)*
	3. Molar mass of W *(2 marks)*