



NATIONAL OPEN UNIVERSITY OF NIGERIA
PLOT 91, CADASTRAL ZONE, NNAMDI AZIKIWE EXPRESSWAY, JABI - ABUJA
FACULTY OF SCIENCES
DEPARTMENT OF PURE & APPLIED SCIENCES
2020_2 EXAMINATION

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

1. a. Mention and explain the classification of systems based on;
 - i. number of phases they have **(3 marks)**
 - ii. exchange of energy and matter with the environment **(4 ½ marks)**b. i. State Zeroth's law of thermodynamics **(2 marks)**
ii. Calculate the heat necessary to raise the temperature of 3.00 mol of butane from 298 to 573 K at constant pressure. Given that the equation for the molar heat capacity of butane is $C_p = (19.41 + 0.233 T) \text{ J mol}^{-1} \text{ K}^{-1}$. **(6 marks)**
- c. Define the following terms and provide their mathematical symbols **(4 ½)**
 - i. Enthalpy
 - ii. Entropy
 - iii. Gibbs Free Energy
 - d. What is Joule- Thomson effect? **(2 marks)**
2. a. Define the following processes
 - i. Isothermal process **(3 marks)**
 - ii. An adiabatic process **(2 marks)**b. i. Mention the four steps of Carnot cycle operation: **(2 marks)**
ii. Define a cyclic process **(2 marks)**
- c. Derive the formula for the total work done, W , as the gas expands isothermally and reversibly from V_1 to a volume V_2 . **(3 marks)**
3. a. Define the following processes
 - i. isobaric process **(2 marks)**
 - ii. isochoric process **(2 marks)**b. i. State the first law of thermodynamics **(2 marks)**
ii. What is meant by pressure-volume work? **(2 marks)**
c. Explain reversible and irreversible Processes **(4 marks)**
4. a. Explain the first two processes of Carnot's cycle **(4 marks)**
b. i. Describe the term Heat capacity **(2 marks)**
ii. what is meant by Internal Energy, U of a system? **(2 marks)**

c. 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? ($R = 8.314 \text{ J mol}^{-1} \text{ K}^{-1}$). **(4 marks)**

5. a.i. Derive the equation for change in internal energy and heat change for a process carried out at constant volume. **(3 marks)**

ii. State the Carnot theorem **(2 marks)**

b. For an ideal gas, prove that C_p and C_v can be related according to the formula $C_p - C_v = nR$. **(4 marks)**

c. Given that $W = -P_{ext}dV$, derive the volume-temperature relationship for an adiabatic irreversible process. **(3 marks)**

6. Prove that the temperature-volume relationship in a reversible adiabatic process can be written as $T_1 V_1^{\gamma-1} = T_2 V_2^{\gamma-1}$ or $TV = \text{Constant}$. **(12 marks)**