



**NATIONAL OPEN UNIVERSITY OF NIGERIA**  
**PLOT 91, CADASTRAL ZONE, NNAMDI AZIKIWE EXPRESSWAY, JABI - ABUJA**  
**FACULTY OF SCIENCES**  
**DEPARTMENT OF PURE & APPLIED SCIENCES**  
**SEPTEMBER, 2020\_1 EXAMINATION QUESTIONS**

**CHM 405-CHEMICAL THERMODYNAMICS**

**Credit Unit:2**

**Duration 2 hours**

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

**Instruction: Unless otherwise stated, the following constants should be used: Standard temperature =298 K, Standard pressure = 102325 Nm<sup>2</sup>, R = 8.314 J/K/mol)**

**QUESTION 1**

- 1(a) What is equation of state and state function in equation of state? **(2 marks)**
- (b) State the gas laws that are applicable to the following conditions:
- (i) Constant temperature and mass of a gas **(1.5 mark)**
- (ii) Constant pressure and mass of a gas **(1.5 mark)**
- (c) Write an expression for Van der Waal equation of state **(1 mark)**
- (d) In an automobile combustion cylinder, fuel-air mixture in a cylinder of 1000 cm<sup>3</sup> capacity experiences a temperature rise from 25 to 2200 °C before and after combustion. Calculate the peak pressure given that normal atmospheric pressure is 101325 P **(3 marks)**
- (e) Using one sentence for each, highlight the three major types of intermolecular forces that operates in molecules **(3 marks)**
- (f) Given a thermodynamic function expressed as  $y = f(x, z)$ , write an equation to represent its exact differential. **(2 marks)**
- (g) Define the terms, thermodynamic system and boundary. **(2 marks)**
- (h) List the three major groups of thermodynamic processes. **(3 marks)**
- (i) State the first law of thermodynamics and show that the heat absorbed at constant pressure is equal to change in enthalpy. **(6 marks)**

**QUESTION 2**

- 2(a) What is entropy? **(1 mark)**
- (b) Using the reaction of oxygen with hydrogen as an example, highlight four features of thermochemical equations **(6 marks)**
- (c) State Laplace and Hess laws of thermochemistry. **(3 marks)**
- (d) Draw a diagram to show the pattern expected for the variation of order number,  $\Omega$  with microstate. **(3 marks)**
- (e) What are the features of Maxwell-Boltzmann statistics with respect to distinguishability of particle? **(2 marks)**

### QUESTION 3

- 3.(a) State Dalton law of partial pressure and write a mathematical equation for the law **(3 marks)**
- (b) Calculate the volume of 1 mole of an ideal gas at 1 atm pressure and at ) °C. What conclusion can you draw from your results **(4 marks)**
- (c) A mixture of 6.5 mol of hydrogen gas and 3.5 mol of oxygen gas was placed in a 3 m<sup>3</sup> container at 273 K. Calculate the partial pressures of the individual gases and the total pressure **(8 marks)**

### QUESTION 4

4. (a) Based on forces of attraction, how would you classify intermolecular forces **(3 marks)**
- (b)(i) A given gas mixture consists of 2.24 mol of nitrogen and 1.37 mol of oxygen; Use the ideal gas equation to calculate the total pressure of 10 m<sup>3</sup> of the gas mixture at 273 K. **(4 marks)**
- (ii) Use the mole fraction of the respective components of the gas mixture to calculate the corresponding partial pressures. **(3 marks)**
- (c) Differentiate between inter molecular and intramolecular forces **(1 marks)**
- (d) State three properties of entropy **(3 marks)**
- (e) State the zeroth law of thermodynamics **(1 mark)**

### QUESTION 5

- 5.(a) What is dipole-dipole interaction and its effect on the potential energy **(2 marks)**
- (b) Consider a piston (whose cross-sectional area is A), compressing a gas (at pressure, P and volume, V). If the piston moves a distance called dx. Show that the work done by the piston can be expressed as,  $W = P(V_2 - V_1)$  **(5 marks)**
- (c) Derive an expression for the work done in isothermal expansion of an ideal and real gases **(5 marks)**
- (d) If the volume of 2 mol of an ideal gas change from 40 to 400 m<sup>3</sup> at 296 K, calculate the work done during the isothermal expansion of the gas. **(3 marks)**