CATHOLIC UNIVERSITY INSTITUTE OF BUEA
2020/2021 ACADEMIC YEAR
Second Semester Examinations – June/July 2021

School		ENGINEERING			
Course Code	CME 201	Course Title	Physical Chemistry		
Status	C	Credit Value	6	Department	CME
Date	29-06-21	Venue	LH 1	Time	15:30 - 17:30
Course Master(s)		Prof. Egbewatt Nkongho			

Instructions: *Answer question ONE and ANY TWO others. Diagram(s) must be in pencil where necessary.*

Data: $R = 8.314 \ J \ K^{-1} \ mol^{-1}$; $8.20574 \times 10^{-2} \ dm^3 \ atm \ K^{-1} \ mol^{-1}$ $\gamma = 1.4$ for air

1a) In an industrial process, nitrogen is heated to 500 K at a constant volume of 1 m³. The gas enters the container at 300 K and 100 atm. The mass of the gas is 92.4 kg. Use the van der Waals equation to determine the approximate pressure of the gas at its working temperature of 500 K. [For N_2, $a = 1.352 \ dm^6 \ atm \ mol^{-2}$, $b = 0.0387 \ dm^3 \ kmol^{-1}$; M. W. 28.013] *[Marks 9]*

b) A vessel of volume 22,4 l contains 2.0 mol H_2 and 1.0 mol N_2 at 273.15 K. Calculate (i) the mole fractions of each component. (ii) their partial pressures and (iii) their total pressure. D. *[Marks 9]*

2) A Carnot cycle uses 1.0 mol of a monoatomic perfect gas as the working substance from an initial state of 10.0 atm and 600 K. It expands isothemrlly to a pressure of 1.0 atm (step 1) and then adiabatically to a temperature of 300 K (step 2). This expansion is followed by an isothermal compression (step 3), and then an adiabatic compression (step 4) back to the initial state. Determine the values of q, w, ΔU, ΔH, and ΔS, for each stage of the cycle. *[Marks 16]*

3) For the thermal decomposition of F_2O by the reaction $2F_2O(g) \rightarrow 2F_2(g) + O_2(g)$ Researchers have suggested the following mechanism:

(1) $F_2O + F_2O \rightarrow F + OF + F_2O$ k_1

(2) $F + F_2O \rightarrow F_2 + OF$ k_2

(3) $OF + OF \rightarrow O_2 + F + F$ k_3

(4) $F + F + F_2O \rightarrow F_2 + F_2O$ k_4

Using the steady state approximation, show that this mechanism is consistent with the experimental rate law $- d[F_2O]/dt = k[F_2O]^2 + k'[F_2O]^{3/2}$ *[Marks 16]*

4) Given a first order reversible reaction of $A \leftrightarrow B$ with the initial concentrations of C_{Ao} and C_{Bo} for reactant and product, respectively and with forward and backward rate constants as k_1 and k_2, develop the rate law, given that at equilibrium, there is C_{Ae} and C_{Be} *[Marks 16]*