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OFFICE OF THE DEPUTY PRINCIPAL
ACADEMICS, STUDENT AFFAIRS AND RESEARCH

UNIVERSITY EXAMINATIONS

2018/2019 ACADEMIC YEAR

FIRST YEAR SECOND SEMESTER REGULAR EXAMINATION

FOR THE DEGREE OF BACHELOR OF EDUCATION SCIENCE

COURSE CODE: CHE 103e

COURSE TITLE: INTRODUCTION TO THERMODYNAMICS AND KINETICS

DATE: 24TH APRIL, 2019 **TIME: 2.00 PM – 5.00 PM**

INSTRUCTION TO CANDIDATES

- SEE INSIDE

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CHE 103e: INTRODUCTION TO THERMODYNAMICS AND KINETICS

STREAM: BED (Science) **DURATION: 3 Hours**

INSTRUCTIONS TO CANDIDATES

i. *Answer **ALL** questions.*

ii. *Use the following physical constants where applicable:*

Physical Constants

R= 0.08206 atm L K^{-1} mol^{-1} *or R= 8.314 J* K^{-1} mol^{-1}, *1°C=273K,* $CO_{2(g)}$, *a = 3.592 a (*L^2*-atm/*mol^2*) and b= 0.04267 (L/mol), N=14*

Question One

a) Define the following terms:

i. Ideality (1 Mark)

ii. Thermodynamics (1 Mark)

iii. Closed and isothermal system (1 Mark)

iv. Extensive Variable (1 Mark)

v. Isochoric process (1 Mark)

vi. Kinetic theory of matter (1 Mark)

vii. Collision Theory (1 Mark)

b) What is an ideal gas? (1 Mark)

c) State two basic properties of gases which differentiate gases from liquids and solids (2 Marks)

d) State four main features of the ideal gas kinetic molecular theory. (2 Marks)

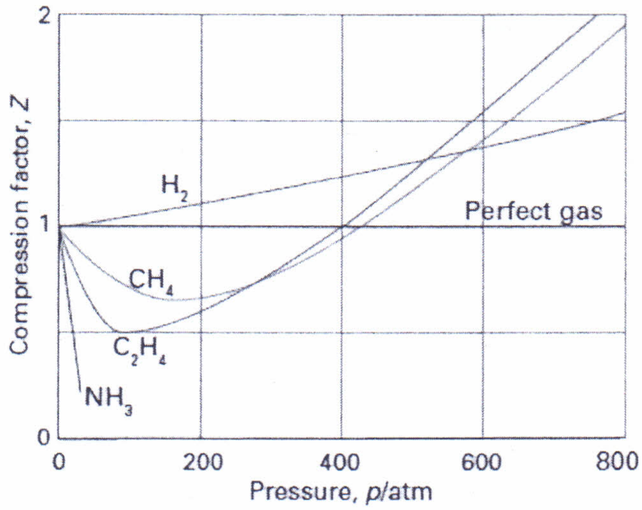
e) Why do real gases deviate from ideal behaviour? Give reasons why (2 Marks)

f) Consider a sample of 1.000 mol of $CO_{2(g)}$ confined to a volume of 3.000 L at 0°C. Calculate the pressure of the gas using:

(i) The ideal-gas equation, and (2 Marks)

(ii) The van der Waals equation. (2 Marks)

g) Explain what is happening in the graph below (2 Marks)



Question Two

a) Differentiate between an ideal and a real gas. (1 Mark)

b) Fifty grams of N_2 occupies a volume of 750 mL at 298.15 K. Assuming the gas behaves ideally, calculate the pressure of the gas in atm. (3 Marks)

c) Using equations differentiate between expansion work and free expansion. (2 Marks)

d) Prove that the relationship between heat capacity at constant pressure (C_p) and heat capacity at constant volume (C_v) is given by $C_p - C_v = R$ (3 Marks)

e) Calculate the heat required to increase the temperature of gaseous O_2 from 0°C to 100°C.

(i) At constant P (2 Marks)

(ii) At constant V (2 Marks)

(iii) Account for the difference in heat absorbed in (i) and (ii). (1 Mark)

f) Calculate the minimum work done at 50 °C on 5 moles of CO_2 to form a precipitate from a volume of 50 L to a volume of 1 L when CO_2 is considered as a perfect gas. (3 Marks)

g) Argon gas at 5 atm expands reverse adiabatically to twice (5×) its initial volume. Calculate its final pressure given that $y = 5 / 3$. (3 Marks)

Question Three

a) 1 mole of methane at 200°C and 10 atm expands adiabatically and reversibly until its temperature was 0°C. If methane is a perfect gas with heat capacity at constant pressure of 15 J mol^{-1} K^{-1}, calculate:

(i) Work done on methane (3 Marks)

(ii) Final pressure of methane gas. (2 Marks)

b) From the thermodynamic definition of enthalpy, $H=U+PV$, prove that $\Delta H=q_p$ (3 Marks)

c) Using suitable equations and examples, differentiate between

(i) Unimolecular reactions (2 Marks)

(ii) Bimolecular reactions (2 Marks)

d) State the laws of thermochemistry. (2 Marks)

e) State Hess law. (1 Mark)

Question Four

a) With relevant examples in chemical equations, differentiate between homogeneous and heterogeneous catalysis. (2 Marks)

b) Define the following terms:

(i) Limiting enthalpy of solution (1 Mark)

(ii) Standard reaction enthalpy (1 Mark)

c) The reaction, $2NO_{(g)} \leftrightarrow N_{2(g)} + O_{2(g)}$, has a value of K= 2400 at 2000 K. If 0.61 g of NO are put in a previously empty 3.00 L vessel, calculate the equilibrium concentrations of NO, N_2, and O_2. (3 Marks)

d) Derive the integrated rate equations for first (1st) order reactions. (2 Marks)

e) Give two practical applications of catalysts in real life. (2 Marks)

f) Calculate the standard enthalpy change for the reaction: (4 Marks)

$2NaHCO_{3(s)} \rightarrow Na_2CO_{3(s)} + CO_{2(g)} + H_2O_{(l)}$

The relevant enthalpy changes of formation are;

$\Delta H_f^\theta[NaHCO_3(s)] = -950.8\ kJmol^{-1}$

$\Delta H_f^\theta\ [Na_2CO_3(s)] = -1130.7\ kJmol^{-1}$

$\Delta H_f^\theta[CO_2(g)] = -393.5\ kJmol^{-1}$

$\Delta H_f^\theta[H_2O(l)] = -285.8\ kJmol^{-1}$

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