UNIVERSITY EXAMINATIONS 2022/2023 ACADEMIC YEAR

SECOND YEAR SECOND SEMESTER MAIN EXAMINATIONS

FOR THE DEGREE OF BED (SCIENCE)

COURSE CODE: SCH 226

COURSE TITLE: CHEMICAL THERMODYNAMICS AND PHASE EQUILIBRA

DURATION: 2 HOURS

DATE: 26/04/2023 **TIME:** 2:00-4:00PM

INSTRUCTIONS TO CANDIDATES

- Answer **QUESTION ONE** (Compulsory) and any other two (2) Questions.
- Indicate **answered questions** on the front cover.
- Start every question on a new page and make sure question's number is written on each page.

QUESTION ONE (30 MARKS)

1 a) Define the following terms (4Marks)

i. Entropy
ii. Thermodynamics
iii. Internal Energy
iv. Isothermal Processes

b) Distinguish between the following as used in thermodynamics (6Marks)

(i) Open and closed system
(ii) Adiabatic wall and diathermal wall
(iii) Thermal equilibrium

c) State four colligative properties (2Marks)

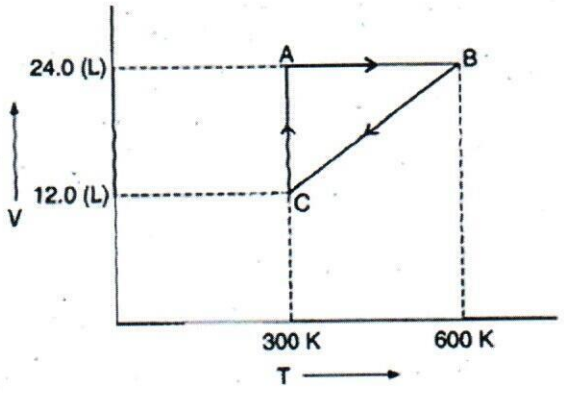
d) Give the Gibbs phase rule and state its variables (2Marks)

e)). Standard vaporization enthalpy of benzene at its boiling point is 30.8 kJ mol"1; for how long would a 100 W electric heater have to operate in order to vaporize a 100 g sample of benzene at its boiling temperature? (3Marks)

f). Calculate the value of ΔE and ΔH on heating 64.0 g of oxygen from 0°C to 100°C. Cv and C p on an average are 5.0 and 7.0 cal mol^{-1} $degree^{-1}$ (4Marks)

g). Calculate the work involved in the expansion of 2 moles of CO_2 gas from 10,0L to 20.0L in an isothermal process at 298k. Assume ideal gas behavior ($R = 8.314JK^{-1}mol^{-1}$) (4Marks)

d). One mole of an ideal gas is put through a series of changes as show in the graph A, B and C mark the three stages of the system. At each stage the variables are shown in the graph. Calculate the pressure at three stages of the system and processes following the changes (5Marks)



QUESTION TWO (20 MARKS)

2. a). i). What is heat capacity of a system (2Marks)

d). Show that heat capacity at constant volume Cv and heat capacity at constant pressure, Cp is related to the universal gas constant, R as follows; $Cp = Cv + nR$ (8Marks)

c) Explain some useful conclusions that can be drawn from the First law of Thermodynamics (10 Marks)

QUESTION THREE (20 MARKS)

3. a) Explain the physical significance of Entropy as used in thermodynamics (6 Marks)

b) Draw and explain the phase diagram of water (7 Marks)

c) Derive the integral Clausius-Clapeyron equation for an ideal gas. (7 Marks)

QUESTION FOUR (20 MARKS)

4 a). Derive the Gibbs Helmholtz equation in terms of free energy and enthalpy change at constant pressure. (10marks)

b). When an acid is neutralized by a base the net reaction is given by; (10 Marks)

$H^+ (aq) + OH^- (aq) — H_2O (l)$ $\Delta H = .57.1Kj$.

Calculate the heat evolved for the following experiments;

i. 0.50 mole of HCl solution is neutralized by 0.50 mole of NaOH solution
ii. 0.50 mole of HNO_3 solution is neutralized by 0.30 mole of KOH solution
iii. 100 mL of 0.2 M of HCl solution is neutralized by100 mL of 0.30 M of KOH solution
iv. 400 mL of 0.2 M of H_2SO_4 solution is neutralized by 600 mL of 0.1 M of KOH solution

QUESTION FIVE (20 MARKS)

5 a). State Hess' law (2 Marks)

b) Differentiate between endothermic and exothermic processes. (4 Marks)

c). Draw and state the four operation or process that comprises the Carnot Cycle (5 Marks)

d) State four applications of Clapeyron Clausius equation (4 Marks)

e) At 25°C for the combustion of 1 mole of liquid benzene the heat of reaction at constant pressure is given by

$C_6H_{6(l)} + 71/2O_{2(g)} \longrightarrow 6CO_{2(g)} + 3H_2O_{(1)}$ $\Delta H = -780980$ cal. Calculate the heat of reaction at constant volume? (5Marks)