KIBABII UNIVERSITY

UNIVERSITY EXAMINATIONS
2021/2022 ACADEMIC YEAR

SECOND YEAR FIRST SEMESTER
MAIN EXAMINATIONS

FOR THE DEGREE OF BED (SCIENCE)

COURSE CODE: SCH 226

COURSE TITLE: CHEMICAL THERMODYNAMICS AND PHASE EQUILIBRA

DURATION: 2 HOURS

DATE: 18/05/2022   **TIME: 2:00PM-4:00PM**

<u>INSTRUCTIONS TO CANDIDATES</u>
- 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.

This paper consists of **3** printed pages. Please Turn Over

QUESTION ONE (30 Marks)

a) Define the following terms as used in chemical thermodynamics   (4 marks)

    i. Exothermic process

    ii. Polymorphism

    iii.Isobaric process

    iv. A phase diagram

b). Explain in which of the following processes whether entropy increases or decreases (3 marks)

    i. A liquid crystallises into a solid

    ii. Temperature of solid is raised from 0 kelvin to 220 kelvin

c). Explain why is not possible to find the absolute value of internal energy   (2 marks)

d). Calculate the degree of freedom for the following   (4 marks)

    i. Mixture of nitrogen and oxygen gases contained in avessel

    ii. Rhombic sulphur in equilibrium with monoclinic sulphur

e). The free energy change involved in a process is -1235 J at 300 K and -1200 J at 310 K. Calculate the change in enthalpy of the process at 306 K. (4 marks)

f).Calculate the increase in entropy in the evaporation of 1 mole of water at 100 ^{0}C. the latent heat of vaporation of water is 2.26 kJ/g   (3 marks)

h). One mole of an ideal gas at 25^{0}C is allowed to expand reversibly at constant temperature from a volume of 20 litres to 40 litres. Calculate the work done by the gas in kilojoules. (3 marks)

i). State the first law of thermodynamics and give the mathematical expression and state each term involved   (3 marks)

i). Distinguish between the following terms as used in chemical thermodynamics   (4 marks)

    i). Homogeneous system and Heterogeneous system

    ii). Isothermal and adiabatic process

QUESTION TWO (20 Marks)

2 a). Derive the expression for molar heat capacities C_v and C_p in terms of internal energy change and enthalpy change hence show that $C_p - C_v = R$ for 1mole of an Ideal gas.   (14 marks)

c).   i. What is Hess's law   (2 marks)

ii. Enthalpies of formation of CO_2 (g) and H_2O (l) under standard conditions are 394.65 kJ and 285.84 kJ per mole. If the standard enthalpy of combustion of acetaldehyde (CH_3CHO) is 1167.62 kJ per mole, find its enthalpy of formation. (4 marks)

QUESTION THREE (20 Marks)

3 a). Draw a well labelled phase diagram of water system and discuss its salient features (10 marks)

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

QUESTION FOUR (20 Marks)

4 a). Explain the criteria for equilibrium in chemical thermodynamics.   (6 marks)

b). A Carnot engine is made to operate as a refrigerator. Explain in detail, with the aid of a pressure-volume diagram all the processes which occur during a complete cycle.   (10 marks)

c). Giving examples differentiate between Extensive and Intensive properties.   (4 marks)

QUESTION FIVE (20 Marks)

a). Give the Clapeyron equation for liquid = vapour equilibrium and write its applications and outline its parameters.   (7 marks)

b). Explain conditions under which heat and work become state function.   (5 marks)

b). A thermally insulated box is separated into two compartments (volumes V1 and V2) by a membrane. One of the compartments contains an ideal gas at temperature T; the other is empty (vacuum). The membrane is suddenly removed, and the gas fills up the two compartments and reaches equilibrium.

i.   What   is   the   final   temperature   of   the   gas
(3marks)

ii. Show that the gas expansion process is irreversible. (5marks)