KIBABII UNIVERSITY

UNIVERSITY EXAMINATIONS
2020/2021 ACADEMIC YEAR

SECOND YEAR SECOND SEMESTER
MAIN EXAMINATIONS

FOR THE DEGREE OF BACHELOR OF CHEMISTRY

COURSE CODE: SCH 226

COURSE TITLE: CHEMICAL THERMODYNAMICS AND PHASE EQUILIBRA

DURATION: 2 HOURS

DATE: 4/10/2021 **TIME:** 8:00-10:00 AM

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.

This paper consists of **4** printed pages. Please Turn Over

Question 1 (30 marks)

a. Briefly explain each of the following terms: (4 marks)
   i. Isolated system
   ii. Entropy
   iii. Isochoric Processes
   iv. A heterogeneous system.

b. Draw and explain the four operation or process that comprises the Carnot Cycle. (4 marks)

c. Calculate the work done by the system during reversible isothermal expansion of two moles of an ideal gas from 2 litres to10 litres at 20^0C (3 marks)

d. Distinguish between equilibrium state and non-equilibrium state (3 marks)

e. What is internal energy of a system? (2 marks)

f. Explain the comparison between isothermal and adiabatic expansion of real gas (4 marks)

g. Calculate the standard enthalpy of formation of n-butane given that the standard enthalpies of combustion of n-butane (g), C(graphite) and H_2 are -2878.5kJmol^{-1}, -393.5kJmol^{-1} and -285.3 kJmol^{-1} respectively (4marks)

h. State the phase rule and explain the terms. (2 marks)

i. Explain importance of second law of thermodynamics (2 marks)

j. Distinguish between triple point and transition point (2marks)

Section B: This section contains FOUR questions. Answer ONLY TWO questions.

Question 2 (20 marks)

a. Sketch the phase diagram for water and explain all the boundary lines. (10 marks)

b. For one component system such as water, give the Claussius-Clapeyron Equation and state the application of the equation (6 marks)

c. The latent heat of fusion of ice per gram is 80 calories and the freezing point of water is 0°C. Calculate the molal depression constant of water. (4 marks)

Question 3 (20 marks)

a. Derive the expression for molar heat capacities C_v and C_p in terms of internal energy change and enthalpy change hence show thermodynamically that C_p-C_v=R for 1mole of an Ideal gas (10mrks)

b. Derive the Gibbs Helmholtz equation In terms of Internal Energy and Work Function at constant volume.
(10marks)

Question 4 (20 marks)

a. One mole of an ideal gas at 25°C is allowed to expand reversibly at constant temperature from a volume of 10 litres to 20 litres. Calculate the work done by the gas in joules and calories. (3 marks)

b. By giving appropriate examples in each case, distinguish between open and closed systems. (3 marks)

c. For the following reaction $N_2\,(g) + 3H_2\,(g) = 2NH_3\,(g)$. The free energy changes at 25°C and 35°C are – 33.089 and – 28.018 kJ respectively. Calculate the heat of reaction. (4 marks)

d. At 25°C for the combustion of 1 mole of liquid benzene the heat of reaction at constant pressure is given by $C_6H_6\,(l) + 7\ 12\ O_2(g) \rightarrow 6CO_2(g) + 3H_2O(1)\ \Delta H = -780980$ cal Calculate the heat of reaction at constant volume? (4marks)

e. Distinguish between reversible and irreversible processes (6 marks)

Question 5 (20 marks)

a. Differentiate between a state function and a path function (3marks)

b. Give a concise statement of the first law of thermodynamics. Deduce its mathematical form and explain the terms involved. (4 marks

c. State the following terms as used in thermochemistry (4marks)

I. Heat of neutralization
II. Heat of vaporization
III. Heat of transition
IV. Heat of combustion

d. Barium hydroxide octahydrate reacts with ammonium chloride endothermically in the equation below.

$$Ba(OH)_2.8H_2O_{(s)} + 2NH_4Cl_{(s)} \longrightarrow BaCl_{2(aq)} + 10H_2O_{(l)} + 2NH_{3(g)}$$

i. Use the table of values below to calculate ΔH and ΔS for the system of the reacting mixture. Hence explain whether the reaction is entropy driven or enthalpy driven. (9 marks)

Substance	**ΔH_f (KJmol^{-1})**	**$\Delta S°$Jmol^{-1}**
$Ba(OH)_{2(s)}$	-1727.3	302
$NH_4Cl_{(s)}$	-314.55	94.85
$BaCl_{(s)}$	-855.0	123.7
$H_2O_{(l)}$	-285.8	70.0
$NH_{3(g)}$	-45.9	192.8

ii. Differentiate between endothermic and exothermic processes. (2 marks)

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