



# **KIBABII UNIVERSITY**

**UNIVERSITY EXAMINATIONS  
2020/2021 ACADEMIC YEAR**

**SECOND YEAR SECOND SEMESTER  
SPECIAL/SUPPLEMENTARY EXAMINATIONS  
FOR THE DEGREE OF BED (SCIENCE)**

**COURSE CODE: SCH 226**

**COURSE TITLE: CHEMICAL THERMODYNAMICS AND PHASE  
EQUILIBRA**

**DATE: 18/1/2022**

**TIME: 8-10AM**

**Instructions:**

1. Answer question 1 (Compulsory) in Section A and ANY other 2 questions in Section B.
2. Candidates are advised not to write on the question paper.
3. Candidates must hand in their answer booklets to the invigilator while in the examination room. Section A This section contains ONE COMPULSORY question

**Question 1 (30 marks)**

- a. Briefly explain each of the following terms: (4 marks)
- Isolated system
  - Entropy
  - Isochoric Processes
  - 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 to 10 litres at 20°C (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<sub>2</sub> are -2878.5 kJmol<sup>-1</sup>, -393.5 kJmol<sup>-1</sup> and -285.3 kJmol<sup>-1</sup> respectively (4 marks)
- 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 (2 marks)

**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 Clausius-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 1 mole of an Ideal gas (10 marks)
- b. Derive the Gibbs Helmholtz equation In terms of Internal Energy and Work Function at constant volume. (10 marks)

**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  $C_6H_6(l) + 7\frac{1}{2}O_2(g) \rightarrow 6CO_2(g) + 3H_2O(l)$   $\Delta H = -780980$  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.



- i. Use the table of values below to calculate  $\Delta H$  and  $\Delta S$  for the system of the reacting mixture. Hence explain whether the reaction is entropy driven or enthalpy driven. (9 marks)

Substance	$\Delta H_f$ (KJmol <sup>-1</sup> )	$\Delta S^\circ$ Jmol <sup>-1</sup>
Ba(OH) <sub>2(s)</sub>	-1727.3	302
NH <sub>4</sub> Cl <sub>(s)</sub>	-314.55	94.85
BaCl <sub>(s)</sub>	-855.0	123.7
H <sub>2</sub> O <sub>(l)</sub>	-285.8	70.0
NH <sub>3(g)</sub>	-45.9	192.8

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