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# KIBABII UNIVERSITY

**UNIVERSITY EXAMINATIONS  
2019/2020 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: 12/2/2021**

**TIME: 11:00-1:00PM**

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### **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



KIBU observes ZERO tolerance to examination cheating

### QUESTION ONE (30 MARKS)

- 1 a) Define the following terms (3marks)
- Cyclic process
  - Open system
  - Entropy
- b) Differentiate between External and Internal process giving an example (3marks)
- c) i. State the application of Clapeyron – Clausius equation (4marks)  
ii. If the vapour pressures of water at 95°C and 100°C are 634 and 760 mm respectively, calculate the latent heat of vaporisation per mole (4marks)
- d) State the application of adiabatic process (2marks)
- e) Explain the physical significance of entropy (3marks)
- f) Four moles of an ideal gas expand isothermally from 1 litre to 10 litres at 300 K. Calculate the change in free energy of the gas. ( $R = 8.314 \text{ JK}^{-1} \text{ mol}^{-1}$ ) (3marks)
- g) i). Differentiate between spontaneous process and non-spontaneous (2marks)  
ii). State three examples of spontaneous process (3marks)
- h). Find the difference in the work done when 500ml of a gas at a pressure of 2atm is compressed to 100ml reversibly and Isothermally. (3marks)

### QUESTION TWO (20 MARKS)

- 2a) State the second law of thermodynamics. (2marks)
- b). For the following reaction  $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$   
The free energy changes at 25°C and 35°C are  $-33.089$  and  $-28.018$  kJ respectively. Calculate the heat of reaction. (4marks)
- c) One mole of perfect gas at 27°C expand isothermally and reversibility from 10 atm against a pressure that is gradually reduced. Calculate  $q$  and  $w$  and each of the thermodynamic quantities  $\Delta E$ ,  $\Delta G$ ,  $\Delta H$ ,  $\Delta S$  (10marks)
- d). The normal boiling point of ethanol,  $C_2H_5OH$ , is 78.3°C, and its molar enthalpy of vaporization is 38.56 kJ/mol. What is the change in entropy in the system when 68.3g of  $C_2H_5OH(g)$  at 1atm condenses to liquid at the normal boiling point? (4marks)

### QUESTION THREE (20 MARKS)

3. a) Define the following terms (6marks)
- Triple point
  - Components
  - Phase rule
- b) Calculate the no of degrees of freedom for the following equilibria (6marks)
- Ice  $\rightleftharpoons$  liquid vapour  $\rightleftharpoons$  water vapour
  - 2- sulphur  $\rightleftharpoons$  Beta sulphur  $\rightleftharpoons$  liquid sulphur  $\rightleftharpoons$  sulphur vapour

iii) White phosphorous  $\longrightarrow$  Red phosphorous

- iv). Give the Gibbs phase rule and state its variables (2marks)
- c) Draw the phase diagram of water and label it (4marks)
- d) State two limitations of phase rule (2marks)

#### QUESTION FOUR (20 MARKS)

- 4a). Derive the Gibbs Helmholtz equation in terms of free energy and enthalpy change at constant pressure (8marks)
- b). i) What is the significance of Clapeyron Equation (2marks)
- ii) Calculate the vapour pressure of water at 90.0°C if its value at 100.0°C is 76.0 cm. The mean heat of vaporisation of water in the temperature range 90° and 100°C is 542 calories per gram. (5marks)
- c). One mole of solid gold is raised from 25 °C to 100 °C at constant pressure.  $C_p / (\text{J/K mol}) = 23.7 + 0.00519T$ . Calculate  $\Delta S$  for the transformation (5marks)

#### QUESTION FIVE (20 MARKS)

- 5a). Differentiate between endothermic and exothermic processes. (3marks)
- b). Define the following (4marks)
- i). Henry's law
- ii). Raoult's law
- c). What pressure is exerted by a mixture of 2.00 g of  $\text{H}_2$  and 8.00 g of  $\text{N}_2$  at 273K in a 10 litre vessel? (4marks)
- d). The equilibrium constant  $K_p$  for a reaction  $A + B \rightarrow C + D$  is  $10^{-12}$  at 327°C and  $10^{-7}$  at 427°C. Calculate the enthalpy of the reaction. ( $R = 8.314 \text{ JK}^{-1} \text{ mol}^{-1}$ ) (5marks)
- e). Draw and state the four operations or processes that comprise the Carnot Cycle (4marks)