MACHAKOS UNIVERSITY

University Examinations 2020/2021 Academic Year

SCHOOL OF PURE AND APPLIED SCIENCES

DEPARTMENT OF PHYSICAL SCIENCES

SECOND YEAR FIRST SEMESTER EXAMINATION FOR

BACHELOR OF SCIENCE (ANALYTICAL CHEMISTRY)

SCH 204: CHEMICAL THERMODYNAMICS AND PHASE EQUILIBRIA

DATE: 19/8/2021 **TIME: 11.00-1.00 PM**

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

Useful data

Molecular weight of water = 18 g/mol

Molar mass of sucrose = 342 g/mol

Vapour pressure of water at 30 ºC is 31.8 mm Hg

R= 0.0821 L atm. $K^{-1}mol^{-1}$

R = 8.314 J. $K^{-1}mol^{-1}$

Molar mass O = 32 $g.mol^{-1}$

Molar mass of H = 1.01 $g.mol^{-1}$

SECTION A: COMPULSORY

QUESTION ONE (30 MARKS)

a) Define the following terms;

i. Triple point

ii. Adiabatic system

iii. Heat capacity

iv. Heterogeneous system

v. Phase rule

vi. Colligative property (6 marks)

b) Calculate the value of ΔE and ΔH on heating 44.0 g of oxygen from -10 °*C* to 140 °*C*. *Cv* and *Cp* on an average are 4.6 and 8.5 J/mol/K. (5 marks)

c) Give a concise statement of the first law of thermodynamics. Deduce its mathematical form and explain the terms involved. (6 marks)

d) Briefly discuss how to derive the pressure volume work for a gas confined by a frictionless piston. (4 marks)

e) Distinguish between state and path functions with examples. (3 marks)

SECTION B ANY TWO QUESTIONS (20 MARKS EACH)

QUESTION TWO (20 MARKS)

a) At 373 K the entropy change for the transition of liquid water to steam is 109 JK^{-1} mol^{-1}. Calculate the enthalpy change ΔH_{vap} for the process. (6 marks)

b) Describe any **THREE** applications of Classius-Clapeyron equation. (3 marks)

c) Derive the relationship between ΔH and ΔE. (5 marks)

d) With the help of suitable examples, differentiate between a closed system and an isolated system. (3 marks)

e) Explain heat capacity at constant volume thermodynamically. (3 marks)

QUESTION THREE (20 MARKS)

a) Calculate the vapour pressure lowering caused by the addition of 100 g of sucrose to 500 g of water if the vapour pressure of pure water at 45 °C is 22.8 mm Hg. (6 marks)

b) Explain the term 'Degree of freedom'. (2 marks)

c) Derive an expression for the work done by a gas in isothermal and reversible work expansion of an ideal gas (6 marks)

d) Find ΔE, q and w if 2.5 g of H_2 at 1200 mm Hg pressure expand isothermally at 50 °C and reversibly to a pressure of 700 mm Hg. (6 marks)

QUESTION FOUR (20 MARKS)

a) 240 g of urea is dissolved in 150 g of water at -50 °C. The lowering of vapour pressure produced is 50 mm Hg. Calculate the molecular mass of urea. The vapour pressure of water at 50 °C is 92 mm Hg. (6 marks)

b) Distinguish between intensive and extensive properties. Give an examples for each category. (4 marks)

c) Using the equation of state, show how you would derive an expression for enthalpy change (ΔH). (4 marks)

d) Draw the phase diagram of any three phase, one component system showing the following:

i. Two phase equilibria (solid-liquid, solid-vapour; liquid-vapour) (3 marks)

ii. Critical pressure and temperature (3 marks)

QUESTION FIVE (20 MARKS)

a) Calculate the amount of heat necessary to raise 635 g of water from 20 º to 115 ºC. Molar heat capacity of water is 18 J/mol/K. (6 marks)

b) For the reaction: $NH_{3\,(g)} \rightarrow H_{2\,(g)} + N_{2\,(g)}$ ΔE = -12.5 kJ/mole at 20 °C.
Calculate ΔH for the reaction. (5 marks)

c) Calculate ΔE for the combustion of one mole of Magnesium in an open container at 298 K and 1 atm pressure, if ΔH *combustion* = – 143.9 kJ. (5 marks)

d) Differentiate between reversible and irreversible processes as used in thermodynamics. (4 marks)