



MACHAKOS UNIVERSITY

University Examinations 2018/2019

SCHOOL OF PURE AND APPLIED SCIENCES

DEPARTMENT OF PHYSICAL SCIENCES

DECEMBER SESSION EXAMINATION FOR

BACHELOR OF EDUCATION

SCH 403: PHASE EQUILIBRIA

DATE: 24/4/2019

TIME: 11.00-1.00 PM

INSTRUCTIONS TO CANDIDATES

- The paper consists of **two** sections.
- Section **A** is **compulsory** (30 marks).
- Answer any **two** questions from section **B** (each 20 marks).

Useful data

Molecular weight of water = 18 g/mol

Molar mass of sucrose = 342 g/mol

Vapour pressure of water at 30 °C is 31.8 mmHg

SECTION A: COMPULSORY (30 MARKS)

QUESTION ONE (30 MARKS)

- a) Define the following terms;
- Entropy
 - Chemical potential
 - Component
 - Degree of freedom
 - Eutectic point (10 marks)
- b) Draw the phase diagram for carbon dioxide system showing the following:
- Two phase equilibria (solid-liquid, solid-vapour; liquid-vapour)
 - Triple point
 - Critical pressure and temperature (6 marks)
- c) How many grams of Urea (H_2NCONH_2) must be added to 450 g of water to give a solution with vapour pressure 2.50 mmHg less than that of pure water at 30°C ? (8 marks)
- d) Explain the meaning of colligative property and state the four properties. (6 marks)

SECTION B (ANSWER ANY TWO QUESTIONS (20 MARKS EACH))

QUESTION TWO (20 MARKS)

- a) Explain any **THREE** applications of Clausius-Clapeyron equation. (6 marks)
- b) If the vapour pressures of water at 95°C and 100°C are 0.8 and 0.91 atm respectively, calculate the latent heat of vaporisation per mole. (5 marks)
- c) At what temperature will water boil under a pressure of 1.1 atm with the latent heat of vaporization of 536 Joules. (4 marks)
- d) Calculate the vapour pressure of water at 90°C if its value at 100°C is 0.91 atm. The mean heat of vaporization of water in the temperature range 90° and 100°C is 542 Joules. (5 marks)

QUESTION THREE (20 MARKS)

- a) Derive the Clapeyron-Clausius equation giving the temperature dependence of water pressure indicating clearly the assumption involved. (6 marks)
- b) 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 vaporization of water in the temperature range 90 °C and 100 °C is 542 Jmol⁻¹. (6 marks)
- c) Calculate the vapour pressure lowering caused by the addition of 100 g of sucrose to 1000 g of water if the vapour pressure of pure water at 25 °C is 23.8 mm Hg. (6 marks)
- d) Explain the term 'Phase diagram'. (2 marks)

QUESTION FOUR (20 MARKS)

- a) Sulphur is a one component system consisting of four phases. State the four phases. (4 marks)
- b) The boiling point of pure toluene is 110.6 °C. A solution containing 5.00 g of diphenyl (C₁₂H₁₀) in 100 g of toluene boils at 111.68 °C. A solution containing 6.00 g of an unknown non-volatile substance in 200 g of toluene boils at 112.0 °C. Calculate the mass per mole of the unknown. (7 marks)
- c) 18.2 g of urea is dissolved in 100 g of water at 50 °C. The lowering of vapour pressure produced is 5 mm Hg. Calculate the molecular mass of urea. The vapour pressure of water at 50 °C is 92 mm Hg. (5 marks)
- d) Distinguish between intensive and extensive properties. (4 marks)

QUESTION FIVE (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) Ethanol boils at 78.4 °C and standard enthalpy of vaporization of ethanol is 42. kJ mol⁻¹. Calculate the entropy of vaporization of ethanol. (6 marks)
- c) State the phase rule. (2 marks)
- d) Using a well labelled diagram, describe the phase diagram of Iodine. (6 marks)