



MACHAKOS UNIVERSITY

University Examinations 2018/2019

SCHOOL OF PURE AND APPLIED SCIENCES

DEPARTMENT OF PHYSICAL SCIENCES

FOURTH YEAR SECOND SEMESTER EXAMINATION FOR

BACHELOR OF EDUCATION (SCIENCE)

SCH 403: PHASE EQUILIBRIA

DATE: 9/5/2019

TIME: 2.00-4.00 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).

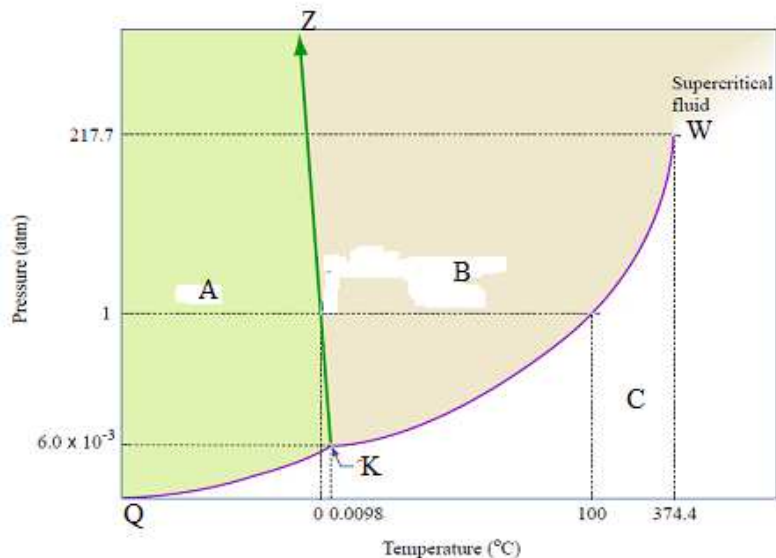
Required data

- Gas Constant, $R = 8.314 \text{ JK}^{-1}\text{mol}^{-1} = 0.08206 \text{ L atm K}^{-1} \text{ mol}^{-1}$
- $0^\circ\text{C} = 273 \text{ K}$

SECTION A – COMPULSORY

QUESTION ONE (30 MARKS) (COMPULSORY)

- a) Distinguish between;
- i) A phase and a component (2 marks)
 - ii) Congruent melting point and incongruent melting point (2 marks)
- b) Show that for a two phase system, $\frac{dP}{dT} = \frac{\Delta H}{T(V_B - V_A)}$. Explain what each of the terms represents (4 marks)
- c) Explain how the Lever Rule can be used to determine the amount of each phase of an A-B alloy system (4 marks)
- d) Study the phase diagram of water system and answer the questions that follow;



- I) i) Identify phases A, B, C and point K (2 marks)
- ii) Show that point K is an invariant point. (2 marks)
- iii) Apply the phase rule to curves KZ, KW and QK. Comment on the results obtained (3 marks)
- II) Describe what happens to a water sample when the following changes are made:
- i) The temperature is increased from -10 °C to 50 °C at constant pressure of 1 atm. (2 marks)
 - ii) The temperature is increased from -20 °C to 78 °C at constant pressure of 0.008 atm and the pressure is then increased from 0.008 atm to 50 atm (3 marks)

- e) Use the following data to draw a phase diagram for a binary system A and B.
- Melting point of A is 700 °C
 - Melting point of B is 500 °C
 - One eutectic point at 450 °C with 30% B and another at 300 °C with 70% B
 - A solid compound AB is formed which melts at 750 °C (6 marks)

SECTION B: ANSWER ANY TWO QUESTIONS

QUESTION TWO (20 MARKS)

- a) Explain three parameters of a system determined by the use of phase diagrams (6 marks)
- b) By the use of cooling curves, explain the behaviours of the following systems upon decrease in temperature
- Pure compounds (2 marks)
 - Binary solid solution (2 marks)
 - Binary eutectic system (2 marks)
- c) i Sketch a Cu-Ni binary phase diagram clearly showing all the phases (4 marks)
- ii Explain how the Lever Rule can be used to determine the amount of each phase of the Cu-Ni alloy mixture (4 marks)

QUESTION THREE (20 MARKS)

- a) Define a eutectic point (1 mark)
- b) Draw a well labelled eutectic diagram of a binary mixture of metals A and B. Explain all the features of the diagram (7 marks)
- c) Using a well labelled phase diagram, explain the eutectic cooling curves of a binary system of metals A and B (8 marks)
- d) By the use of phase diagrams, explain the monotectic Cu-Pb system (4 marks)

QUESTION FOUR (20 MARKS)

- a) i Define colligative properties (1 mark)
- ii Explain three colligative properties of substances and their application in the determination of molecular weight of a solute. (9 marks)
- b) i State Raoult's law (1 mark)

- ii Vapour pressure of chloroform (CHCl_3) and dichloromethane (CH_2Cl_2) at 298 K are 200 mm Hg and 415 mm Hg respectively. A solution was prepared by mixing 25.5 g of CHCl_3 and 40 g of CH_2Cl_2 at 298 K. (RMM of C = 12, H = 1, Cl = 35.5). Calculate;
- I) The number of moles of CH_2Cl_2 (1 mark)
 - II) The number of moles of CHCl_3 (1 mark)
 - III) The total number of moles (1 mark)
 - IV) The mole fractions of CH_2Cl_2 and CHCl_3 (1 mark)
 - V) The vapour pressure of the solution (1 mark)
- c) Calculate the vapour pressure of a solution containing 11.7 g benzene (MW = 78) and 4.6 g methylbenzene (MW = 92) at 50 °C, if the vapour pressure of the pure components at this temperature are $3.6 \times 10^4 \text{ Nm}^{-2}$ and $1.12 \times 10^4 \text{ Nm}^{-2}$, respectively. (4 marks)

QUESTION FIVE (20 MARKS)

- a) Differentiate between Osmosis and Osmotic pressure (2 marks)
- b) Define an ideal solution and briefly describe the properties of ideal solutions (3 marks)
- c) Sketch clearly a well labeled phase diagram of CO_2 . Explain all the phases in the phase diagram and discuss the application of the phase rule in the CO_2 system (9 marks)
- d) Using a Heat vs. Temperature diagram, explain how one mole of ice changes when heat is added to it. (6 marks)