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 $JK^{-1}mol^{-1}$ = 0.08206 L atm K^{-1} mol^{-1}
- 0 ºC = 273 K

SECTION A – COMPULSORY

QUESTION ONE (30 MARKS) (COMPULSORY)

a) Distinguish between;

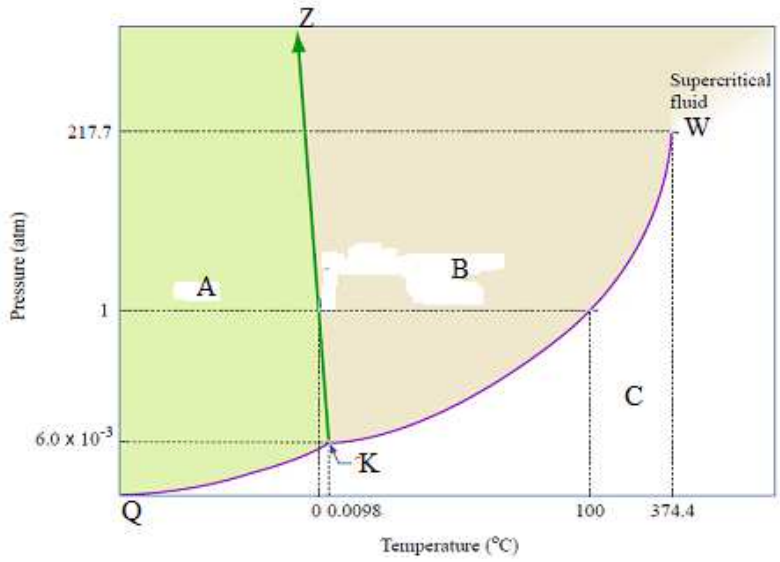
i) A phase and a component (2 marks)

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 ºC to 50 ºC at constant pressure of 1 atm. (2 marks)

ii) The temperature is increased from -20 ºC to 78 ºC at constant pressure of 0.008 atm and the pressure is then increased from 0.00 8 atm to 50 atm (3 marks)

e) Use the following data to draw a phase diagram for a binary system A and B.

i. Melting point of A is 700 ºC

ii. Melting point of B is 500 ºC

iii. One eutectic point at 450 ºC with 30% B and another at 300 ºC with 70% B

iv. A solid compound AB is formed which melts at 750 ºC (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

i. Pure compounds (2 marks)

ii. Binary solid solution (2 marks)

iii. 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) he 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 3.6×10^4 Nm^{-2} and 1.12×10^4 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)