



MACHAKOS UNIVERSITY

University Examinations for 2020/2021 Academic Year

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:

TIME:

INSTRUCTIONS:

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

Section A – Compulsory

1. a) Distinguish between the following terms as used in phase equilibria;
- i) A phase and a component (2 marks)
 - ii) Congruent melting point and incongruent melting point (2 marks)
 - iii) Osmosis and osmotic pressure (2 marks)
- b) Water and Sulphur are known to exhibit a one-component phase diagram system. Using phase diagrams, compare and contrast the phase diagrams of Sulphur and Water. (8 marks)
- c) i) Define a eutectic point (1 mark)
- ii) Draw a well labelled eutectic diagram of a binary mixture of metals A and B. Explain all the features of the diagram. (5 marks)
- d) Use the following data to draw a phase diagram for a substance A and B system:
- i) Melting point of A is 800 °C
 - ii) Melting point of B is 450 °C
 - iii) One Eutectic point at 400 °C with 75% A and another at 200 °C with 30% of A.
 - iv) A solid compound AB is formed which melts at 900 °C. (6 marks)
- e) A certain solution contains 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, determine the vapour pressure of the solution. (4 marks)

Section B

Answer any two questions

2. a) i) Using Cu-Ni equilibrium phase diagram, explain the concept of binary phase diagrams (8 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)

- b) Using a Heat vs. Temperature diagram, explain how one mole of ice changes when heat is added to it. (8 marks)
3. a) Compare and contrast the phase diagrams of compounds exhibiting complete inter-solubility and those with limited solubility (4 marks)
- b) Using diagrams, explain the effect of decreasing temperature on pure compounds, binary solid solutions and binary eutectic systems. (6 marks)
- c) Explain **three** parameters/information of a system determined by the use of phase diagrams (6 marks)
- b) By the use of phase diagrams, explain the monotectic Cu-Pb system (4 marks)
4. a) Using relevant examples, explain the vapour pressure composition diagrams for liquid mixtures (10 marks)
- b) Explain the application of Raoult's law in the determination of total vapour pressure of a solution (5 marks)
- c) Molecular weight determination is a key concept in physical chemistry. Explain the use of colligative properties in the determination of molecular weight of a solute (5 marks)
5. a) Binary systems can have two types of solid solutions /phases i.e. terminal phases and intermediate phases. Using relevant examples and phase diagrams, explain the terminal and intermediate phases of the binary systems (12 marks)
- b) Calcium carbonate decomposes on heating to form calcium oxide and carbon dioxide
- i) Determine the number of phases in the reaction and justify your answer (4 marks)
- ii) Using the Phase Rule, show that the above reaction is univariant (4 marks)