



MACHAKOS UNIVERSITY

University Examinations for 2021/2022 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).

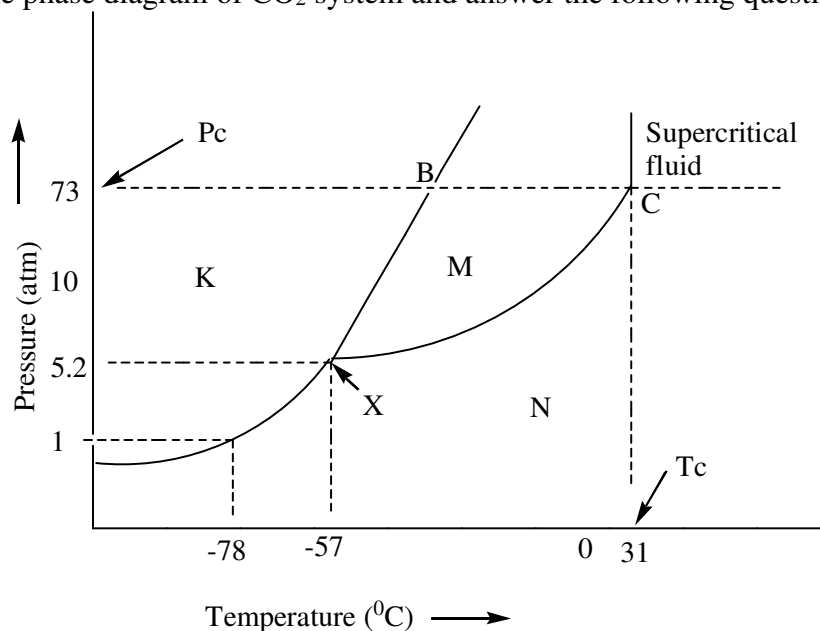
Required data

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

SECTION A – COMPULSORY

QUESTION ONE (30 MARKS)

- a) Distinguish between;
- i) Triple point and Eutectic point (2 marks)
 - ii) A phase and a component (2 marks)
 - iii) Congruent melting point and incongruent melting point (2 marks)
 - iv) Osmosis and osmotic pressure (2 marks)
 - v) Azeotropic mixture and Isomorphous system (2 marks)
- b) State the phase rule and clearly explain the meaning of the terms employed in the rule (4 marks)
- c) Use the following data to draw a phase diagram for a substance A and B system:
- i) Melting point of B is 600 °C
 - ii) Melting point of A is 480 °C
 - iii) One Eutectic point at 170 °C with 20% A and another at 370 °C with 75 % of A.
 - iv) A solid compound BA_2 is formed which melts at 590 °C. (6 marks)
- d) Study the phase diagram of CO_2 system and answer the following questions:



Describe what happens to a CO_2 sample when the following changes are made:

- i) The temperature increased from -100 $^{\circ}C$ to 0 $^{\circ}C$ at constant pressure of 3 atm (2 marks)
- ii) The pressure is reduced from 70 atm to 5 atm at a constant temperature of 28 $^{\circ}C$ (2 marks)

- iii) The pressure is first increased from 3 atm to 68 atm at $-10\text{ }^{\circ}\text{C}$ and the temperature is then increased from $-10\text{ }^{\circ}\text{C}$ to $30.5\text{ }^{\circ}\text{C}$ (2 marks)
- iv) Apply the phase rule at point labeled X and comment on the result obtained. (2 marks)
- v) Identify phases M and N (1 mark)
- vi) State the significance of temperature T_c and Pressure P_c (1 mark)

SECTION B: ANSWER ANY TWO QUESTIONS

QUESTION TWO (20 MARKS)

- a) Sketch clearly a well labeled phase diagram for sulphur system (6 marks)
From the diagram;
 - i) Identify all the triple points and the melting point of each allotrope (2 marks)
 - ii) Discuss the application of the phase rule in the sulphur system (4 marks)
- b)
 - 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)

Water exhibits three phases i.e. ice, liquid water and vapour.

- a)
 - i) Sketch a well labeled phase diagram of water (8 marks)
 - ii) Show that the triple point of water is invariant (2 marks)
- b) Using a Heat vs. Temperature diagram, explain how one mole of ice changes when heat is added to it. (8 marks)
- c) Briefly explain why Pb-Sn alloys are used as solders (2 marks)

QUESTION FOUR (20 MARKS)

- a)
 - i) State the Raoult's Law (1 mark)
 - ii) Calculate the vapour pressure of a solution containing 11.7 g benzene (MW = 78) and 4.6 g methylbenzene (MW = 92) at $50\text{ }^{\circ}\text{C}$, 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)
- b) Explain how the molecular weight of a substance in solution can be determined from its osmotic pressure (5 marks)
- c)
 - 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)