



MACHAKOS UNIVERSITY

University Examinations 2023/2024

SCHOOL OF PURE AND APPLIED SCIENCES

DEPARTMENT OF PHYSICAL SCIENCES

FOURTH YEAR SECOND SEMESTER EXAMINATION FOR BACHELOR OF
EDUCATION (SCIENCE), BACHELOR OF EDUCATION SCIENCE (SPECIAL NEEDS)
AND BACHELOR OF SCIENCE IN ANALYTICAL CHEMISTRY

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).

SECTION A

QUESTION ONE (30 MARKS).

- a) Define the following terms. (3 marks)
- Phase
 - Components
 - Degree of freedom

- b) In a certain phase system, when the substance considered was heated, it changed from one solid form to another. Further heating caused new solid phase to melt into liquid at 120°C .
- Name the substance involved (2marks)
 - Draw the phase diagram of the system described above and indicate phase changes involved (7marks)
 - Determine the number of degrees of freedom in each equilibrium curves between various phases in the system (4marks)
 - How many triple points does a system have (2marks)
 - Show that a triple point is invariant (2marks)
- c) The vapour pressure of benzene is 74.7 torr at 20°C and the vapour pressure of toluene is 22.3 torr at 20°C . at a certain solution of benzene and toluene at 20°C has a vapour pressure of 46.0 torr. Calculate mole fraction of benzene in this solution (5 marks)
- d) Calculate the number of components when one,
- Dissolve 1gm of sodium chloride in 10 litres of water (2marks)
 - Mixes hydrogen gas, oxygen gas and steam in a closed container (3marks)

SECTION B

QUESTION TWO (20 marks).

- a) Distinguish between (6marks)
- Triple point and Eutectic point.
 - Congruent melting and incongruent melting point.
 - Boiling point elevation and freezing point depression of a solution
- b) Sketch the phase diagram for two component system A and B form a compound which melts congruently at 133 K. The system exhibits two eutectics, one at 25 mole percent B and 123 K and a second at 90 mole percent B and 104 K. The melting points of pure A and B are 131 K and 110 K respectively. (6 marks)
- c) The vapour pressure of pure CCl_4 and SnCl_4 at 20°C are 114.9 mmHg and 238.9 mmHg respectively. Assuming ideal behaviour, determine the total vapour pressure of a mixture of 8gms of CCl_4 and 12gm of SnCl_4 liquids respectively (8 marks)

QUESTION THREE (20 MARKS).

- a) Briefly describe steam distillation. (3 marks)
- b) Define the term azeotropic mixture, Using vapour pressure and temperature composition diagrams show positive and negative deviation. (10 marks)
- c) An immiscible liquid A when steam distilled with water gave a distillate 0.2 dm^3 of which contained 0.0572 dm^3 of A. the observed boiling point for the distillation was 98.2°C and atmospheric pressure was 758 mmHg. the vapour pressure of water at 98.2°C was 712 mmHg. If relative density of the liquid was found to be 1.83. calculate the molar mass of unknown liquid. (7marks)

QUESTION FOUR (20 MARKS).

- a) Give clapeyron equation and from this, derive clausius clapeyron equation. (8marks)
- b) Calculate the heat of vapourisation of benzene if the vapour pressure of benzene at 0°C is 26.73 mmHg and at 30°C it is 118.5 mmHg (4marks)
- c) Using vapour pressure against mole fraction graphs explain briefly positive and negative deviation of real solutions (8marks)

QUESTION FIVE (20 MARKS).

- a) State Raoult's law and show that $P_T = X_A [P^{\circ}_A - P^{\circ}_B] + P^{\circ}_B$ where P is the total pressure, P°_A pressure of pure component A and P°_B pressure of pure component B. (8marks)
- b) Define the term osmotic pressure and explain how you would determine the molecular weight of a substance in solution (6marks)
- c) Determine vapour pressure of 35% w/w solution of ordinary cane sugar [$\text{C}_{12}\text{H}_{22}\text{O}_{11}$] 345 g/mol in water if the vapour pressure of pure water at this temperature is 26.0 torr. (6marks)