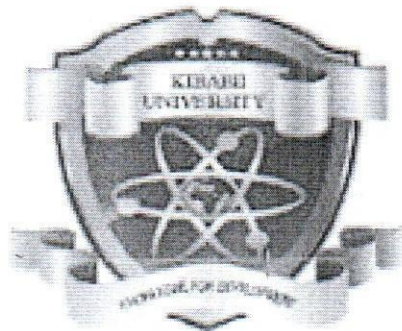# KIBABII UNIVERSITY

UNIVERSITY EXAMINATIONS

2019/2020 ACADEMIC YEAR

THIRD YEAR SECOND SEMESTER

SPECIAL/SUPPLIMENTARY EXAMINATIONS

FOR THE DEGREE OF SCIENCE (PHYSICS)

COURSE CODE: SPH 323

COURSE TITLE: PHASE DIAGRAM

DURATIONS: 2 HOURS

DATE: 3|2|21   **TIME:** 2 - 4Pm

INSTRUCTION TO CANDIDATES

- Answer question one (Compulsory) and any other two (2) Questions
- Indicate Answered questions on the front cover
- Start every question on a new page and make sure question's number is written on each page

This paper consists of one printed pages. Please Turn Over.

QUESTION ONE (30MARKS)

(a) What is a phase? (2marks)

(b) Zirconium has an HCP crystal structure and density of $6.51 g/cm^3$ what is the volume of its unit cell in cubic meters? And if c/a ratio is 1.593, compute the values of c and a (N_A =$6.023x10^{23}$ atoms/mol and A_{zr}= 91.2g/mol) (6marks)

(c) In class structure processing briefly explain each of the following: - melting point, working point, softening point, annealing point and strain point. (5marks)

(d) Show that the atomic packing factor for**HCP** is 0.74. (6marks)

(e) What is a solid solution? Explain Substitutional solid solution and interstitial solid solution, giving examples in each alloy system. (4marks)

(f) A steel alloy is known to contain 93.8wt % Fe-6.0wt %Ni and 0.2wt %C.

   I.   What is the approximate eutectoid temperature of this alloy? (2marks)

   II.   What is the proeutectoid phase when this alloy is cooled to a temperature just below the eutectoid? (2marks)

   III.   Compute the relative amounts of the proeutectoid phase and pearlite.

       α   Assume that there are no alterations in the positions of other phase boundaries with the addition of Ni. (3marks)

QUESTION TWO (20MARKS)

a) Cite three variables that determine the microstructure of an alloy (3marks)

b)   What thermodynamic condition must be met for state of equilibrium to exist? (2marks)

c). A 50wt % Pb-50%wt Mg alloy is slowly cooled from 700^0C to 400`C.

i) At what temperature does the first solid phase form? (2marks)

ii)   What is the composition of this solid phase (2marks)

iii)   At what temperature does the liquid solidify? And what is the composition of this remaining liquid phase (4marks)

d). Derive the lever rule. (7marks)

QUESTION THREE (20MARKS)

(a) What is the difference between the states of phase equilibrium and met stability (2marks)

(b) Determine the degrees of freedom of a system on two components. When the number of phases is one, two, three etc. (5marks)

(c) Cite the phases that are present and phase compositions for 55wt % Ag -45wt % Cu at 900^0C (2marks)

(d) At 30wt % Sn- 70wt % Pb alloy is heated to a temperature within the αα liquid phase region. If the mass fraction of each phase is 0.5 estimate the temperature of the alloy and the compositions of the two phases. (4marks)

(e) What is the carbon concentration of an iron-carbon alloy for which fraction of total ferrite is 0.94? (3marks)

(f) In the phase diagram of lead-tin for 40wt % Sn 60wt %Pb at 150^0C how many phases

(4marks)

QUESTION FOUR (20MARKS)

(a) What is the difference between a crystal structure and crystal system
(2marks)

(b) Show that the minimum cation-to- anion radius for a coordination number of 6for Nacl crystal is 0.414. (5marks)

(c) Compute theoretical density of diamond given that C-C distance and bond angle are 0.154nm and 109.5^0C respectively. How does these value compare with measured value of $3.51g/cm^3$(N_A=6.023x10^{23} atoms/mol and A_c = 12.01 g per mole (6marks)

(d) Calculate the volume of an FCC unit cell in terms of atomic radius R. (3marks)

(e) Iodine has an orthorhombic unit cell for which a,b and c lattice parameters are 0.479, 0.725and 0.978nm respectively. Its atomic packing factor and atomic radius are 0.547 and 0177nm respectively, determine the number of atoms in each unit cell. (4marks)

QUESTION FIVE (20MARKS)

a) Give six factors that govern grain size (6marks)
b) Give five effects of austenite grain growth during heat treatment of steel (5marks)
c) State and explain Gibb's phase rule defining all terms by giving examples (9marks)