KIBABII UNIVERSITY

MAIN UNIVERSITY EXAMINATIONS

ACADEMIC YEAR 2021/2022

THIRD YEAR SECOND SEMESTER EXAMINATIONS

BACHELOR OF SCIENCE

COURSE CODE: SPM 322

COURSE TITLE: STRUCTURAL CHANGES

DATE: 02/09/2022   **TIME**: 2:00PM-4:00PM
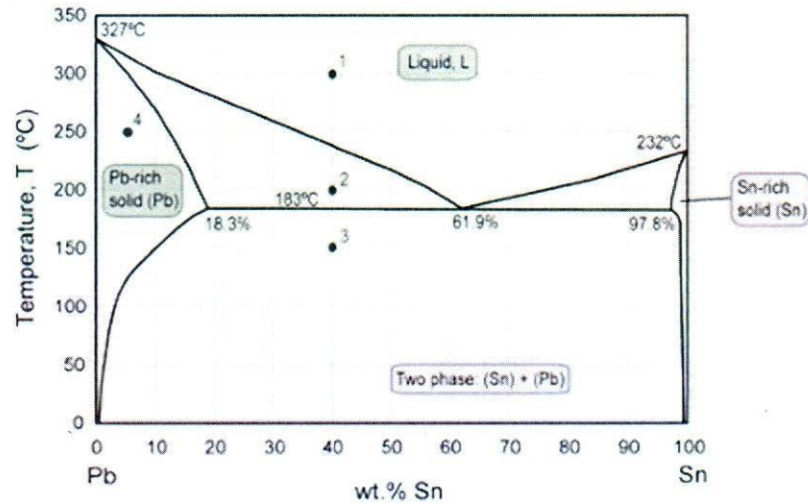

INSTRUCTIONS TO CANDIDATES

Answer question ONE and any TWO of the remaining.

Time: 2 hours

KIBU observes ZERO tolerance to examination cheating

b) Use the Pb-Sn diagram below to answer the questions that follow.

Pb-Sn phase diagram

i) What are the values of the state variables (composition and temperature) at constitution) point 1? (2 marks)

ii) Mark the constitution points for Pb-60wt% Sn and Pb-20wt% Sn alloys at 250°C. What are present in each case. (3 marks)

iii) The alloy at constitution point 1 is cooled very slowly maintaining equilibrium. At which temperatures do changes in the number or type of phases occur? What are present at constitution points 2 and 3? (3 marks)

iv) The alloy at constitution point 4 is cooled slowly to room temperature. Identify the following:
(a) the initial composition temperature and phase(s). (2 marks)
(b) the temperature at which a phase change occurs and the final phase(s). (2 marks)

QUESTION THREE (20 MARKS)

a) Highlight any four common soldering defects (4 marks)

b) Discuss any three soldering methods (8 marks)

c) Soldering process has to go through sequential steps. Discuss the sequential steps that should be carried out as soldering procedure. (8 marks)

QUESTION FOUR (20 MARKS)

a) By analogy with the definitions for eutectic and eutectoid reactions and consideration of phase diagrams, define:
(i) a peritectic reaction (2 marks)
(ii) a peritecloid reaction (2 marks)

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QUESTION ONE (30 MARKS)

a) What is a phase? (1 mark)

b) State the differences between binary alloys and ternary alloys (2 marks)

c) Define the following terms
  (i) Solubility limit (2 marks)
  (ii) Eutectic reaction (2 marks)
  (iii) A grain (1 marks)
  (iv) Sublimation (2 marks)
  (v) Latent heat (1 mark)

d) An alloy consists of X_A at % of A with an atomic weight a_A and X_B at % of B with an atomic weight a_B. Derive an equation for the concentration of B in wt%. (3 marks)

e) State three classes of solders (3 marks)

f) Define nucleation and give an example of phases that my form via nucleation in gases and in liquids. (3 marks)

g) Recrystallization is a common method of purifying a solid. Draw a flow chart summarizing the procedure for recrystallization of a solid. (3 marks)

h) Sand casting is an example of permanent pattern (expendable mould) casting. State any three disadvantages of the sand casting. (3 marks)

i) Pure iron cooled slowly contains 100% ferrite: the eutectoid composition contains 100% pearlite. Estimate the carbon content of the hypo-eutectoid steel shown below and sketch the structure of 0.2 wt% carbon steel after slow cooling to room temperature. (4 marks)

25μm
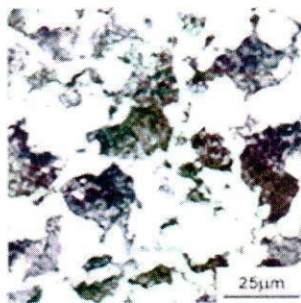
QUESTION TWO (20 MARKS)

a) Derive the lever rule for a general mixture of two phases α and β. Let the composition of the alloy C (wt% of alloying element), the compositions of phases be $C\alpha$ and C_β, and the weight fractions of the phases be W_α and W_β. [Hints: find an expression conserving the mass of the alloying element between the alloy and the two phases then define **a**, **b** and **l** in this notation and use the overall conservation of mass expressed in $W_\alpha \div W_\beta = 1$].

(8 marks)

b) The figure below shows the copper-antimony CU-Sb phase diagram.
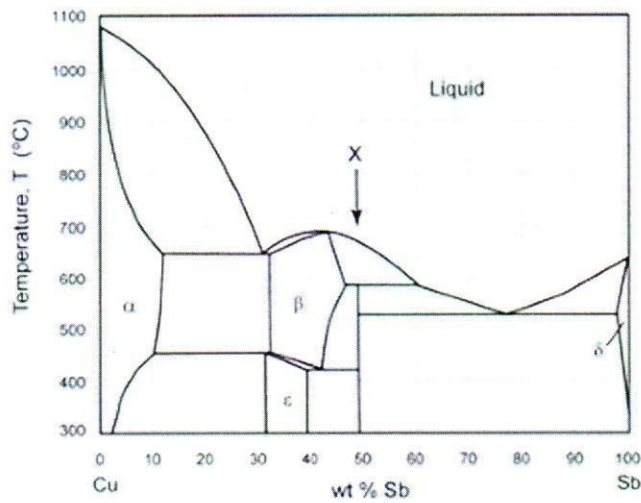
copper-antimony Cu-Sb phase diagram

(i) Find the chemical formula for the compound marked X (atomic weights Cu and Sb are 63:54 and 121: 75 respectively). (3 marks)

(ii) The Cu-Sb system contains 2 eutectics, 1 eutectoid, 1 peritectic and 1 peritectoid. Mark them all on the figure, write down the temperature and composition of each point and identify the phases involved in each reaction on cooling. (4 marks)

(iii) An alloy containing 95 wt% Sb is cooled to room temperature from the melt. Describe the phase changes that occur during cooling, using schematic sketches of the microstructure at key temperatures to illustrate your answer. (5 marks)

(iv) Sketch a temperature-time curve for the 95 wt% Sb alloy over the range 650 to 450 °C and account for the shape of the curve. (4 marks)

QUESTION FIVE (20 MARKS)

a) Discuss the principles of artificial rain making, cloud seeding and its applications.
(12 marks)

b) Seeding can be achieved by either cold clouds or warm clouds. Discuss ways in which seeding of cold clouds and warm clouds are achieved. (8 marks)