



Mansoura University

Department: Biomedical Program



Faculty of Engineering

Course Title: *Biomaterials*

Total Marks : 50 Marks

Date: 12 June 2016 (Second term)

Course Code : PDE 393

Allowed Time: 2 Hours

Level : 300

No. of Pages: (2)

Note: This exam is closed book. No laptops or electronic communication devices are allowed in the exam. This includes cell phones. Calculators ARE allowed (but not on cell phones).

You are expected to provide:

1- Clear explanation of each step of your solution

3- Illustrate all answers with sketches whenever possible

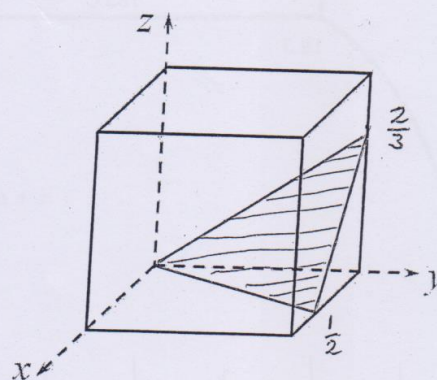
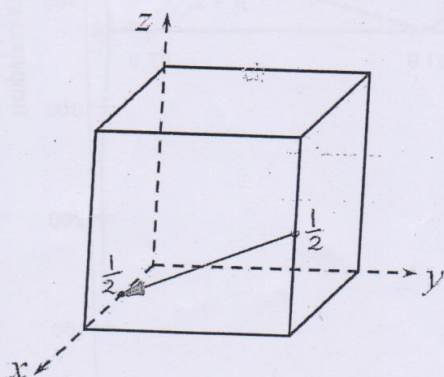
2- Units

4- You have 5 marks over.

Your grades are subject to these items as well as your calculations.

Question 1: (20 Marks)

- What are the four components involved in the design, production, and utilization of materials, and briefly describe the interrelationships between these components? (4 Marks)
- Steel is coated with a thin layer of ceramic to help protect against corrosion. What do you expect to happen to the coating when the temperature of the steel is increased significantly? Explain. (4 Marks)
- Briefly discuss are the types of ceramic crystal structures? (6 Marks)
- Determine the indices for the direction and plane shown in the following cubic unit cells. (6 Marks)

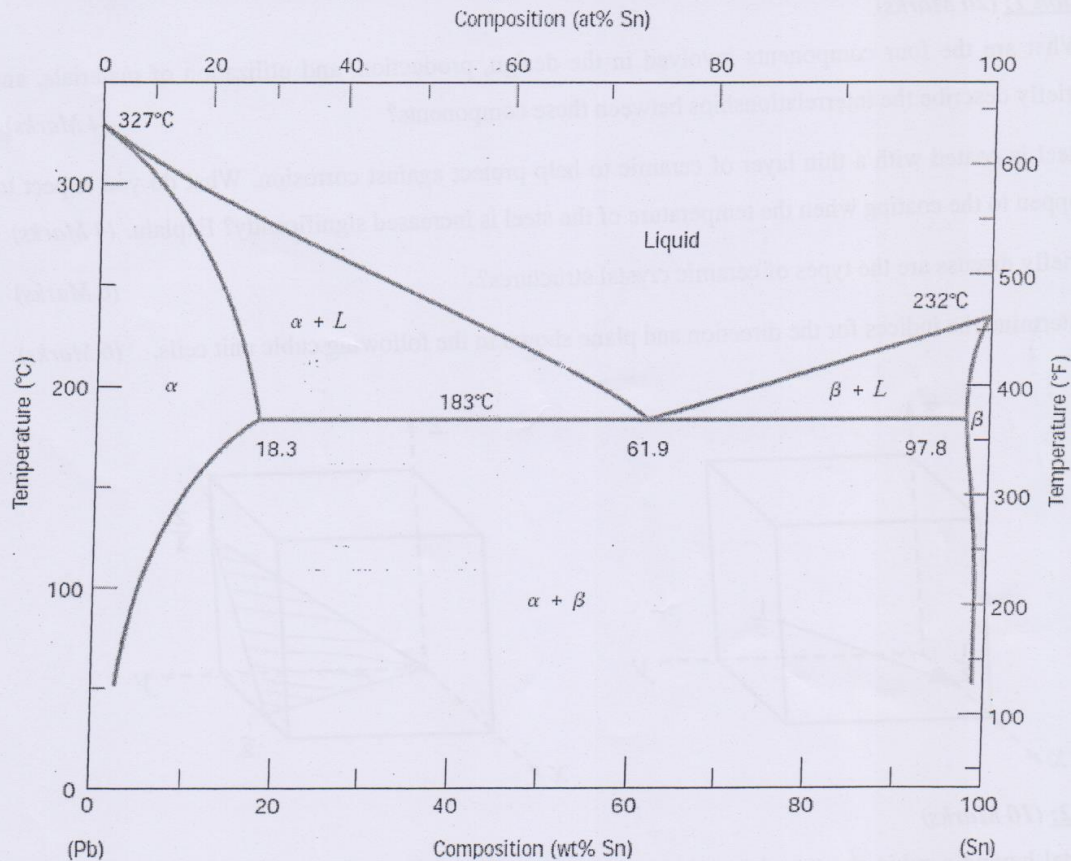


Question 2: (10 Marks)

- A metal having a cubic structure has a density of 2.6 g/cm^3 , an atomic weight of 87.62 g/mol , and a lattice parameter of 6.0849 \AA . One atom is associated with each lattice point. Examine whether the metal has a BCC or FCC crystal structure. (4 Marks)
- Calculate the number of vacancies per cubic meter in iron at 850°C . The energy for vacancy formation is 1.08 eV/atom . Furthermore, the density and atomic weight for Fe are 7.65 g/cm^3 and 55.85 g/mol , respectively. (4 Marks)
- A photomicrograph was taken of some metal at a magnification of $100\times$ and it was determined that the average number of grains per square inch is 16. Compute the ASTM grain size number for this alloy. (2 Marks)

Question 3: (15 Marks)

- (a) Cite two reasons why interstitial diffusion is normally more rapid than vacancy diffusion. (2 Marks)
- (b) The diffusion coefficients for carbon in γ -iron are $5.9 \times 10^{-12} \text{ m}^2/\text{s}$ and $5.3 \times 10^{-11} \text{ m}^2/\text{s}$ given at 900°C and 1100°C respectively. Determine the values of D_0 and the activation energy Q_d ? Determine the approximate time at 1000°C that will produce the same diffusion result (in terms of concentration of C at some specific point in γ -iron) as a 30 hours heat treatment at 900°C . (Note: the gas constant $R = 8.31 \text{ J/mol} \cdot ^\circ\text{K}$) (6 Marks)
- (c) Use the given lead - tin (Sn-Pb) phase diagram shown in figure to answer the following for an alloy contain 60 wt% Pb - 40 wt% Sn: (7 Marks)
- (i) The liquidus temperature, solidus temperature, freezing range and then draw the cooling curve
- (ii) What are the phases present and the phase compositions for this alloy at 200°C ?



Question 4: (10 Marks)

- (a) Briefly discuss the main applications of biomaterials? (3 Marks)
- (b) There are two major types of artificial hip joint cemented and uncemented joints. Briefly discuss the advantages and disadvantages of the uncemented joints? (4 Marks)
- (c) What is the difference between composite and FGM? (3 Marks)