



Mansoura University

Department: Biomedical Program

Total Marks : 50 Marks



Faculty of Engineering

Course Title: *Biomaterials*

Course Code : *PDE 393*

Level : *300*

Date: *28 May 2018 (Second term)*

Allowed Time: *2 Hours*

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

2- Units

3- Illustrate all answers with sketches whenever possible

4- You have 5 marks over.

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

**Question 1:** Fill in the spaces the correct answer

(10 Marks: each space 1 mark)

- (1) ..... investigates the relationships that exist between the structure and properties of materials.
- (2) ..... involves electrons within the individual atoms and interactions with their nuclei.
- (3) In ..... bonds electrons are shared between the molecules, to saturate the valency.
- (4) Face-Centered Cubic (FCC) crystal structure has ..... atoms per unit cell, its coordination number is ..... while its packing factor is .....
- (5) ..... is the state that exists when there are equal numbers of positive and negative charges from the ions.
- (6) ..... is one such type of defect involves a cation-vacancy and a cation-interstitial pair.
- (7) In ..... diffusion, the diffusion flux changes with time.
- (8) ..... are the best method to record the data related to phase changes in many alloy systems.

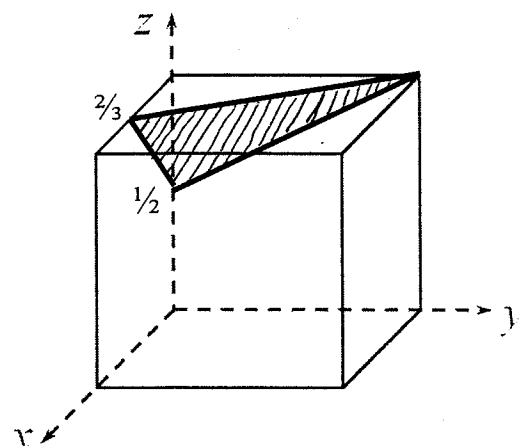
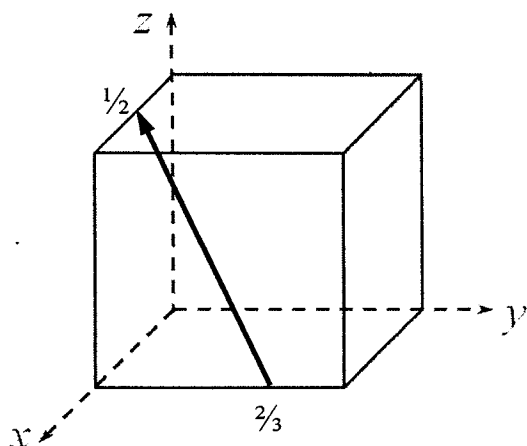
**Question 2: (15 Marks)**

(a) Briefly discuss the types of ceramic crystal structures?

(5 Marks)

(b) Calculate the radius of an iridium atom given that Ir has a FCC crystal structure, a density of  $22.4 \text{ g/cm}^3$  and an atomic weight of  $192.2 \text{ g/mol}$ . (Avogadro's number =  $6.023 \times 10^{23} \text{ atoms/mol}$ ). (4 Marks)

(c) Determine the indices for the direction and plane shown in the following cubic unit cells. (6 Marks)

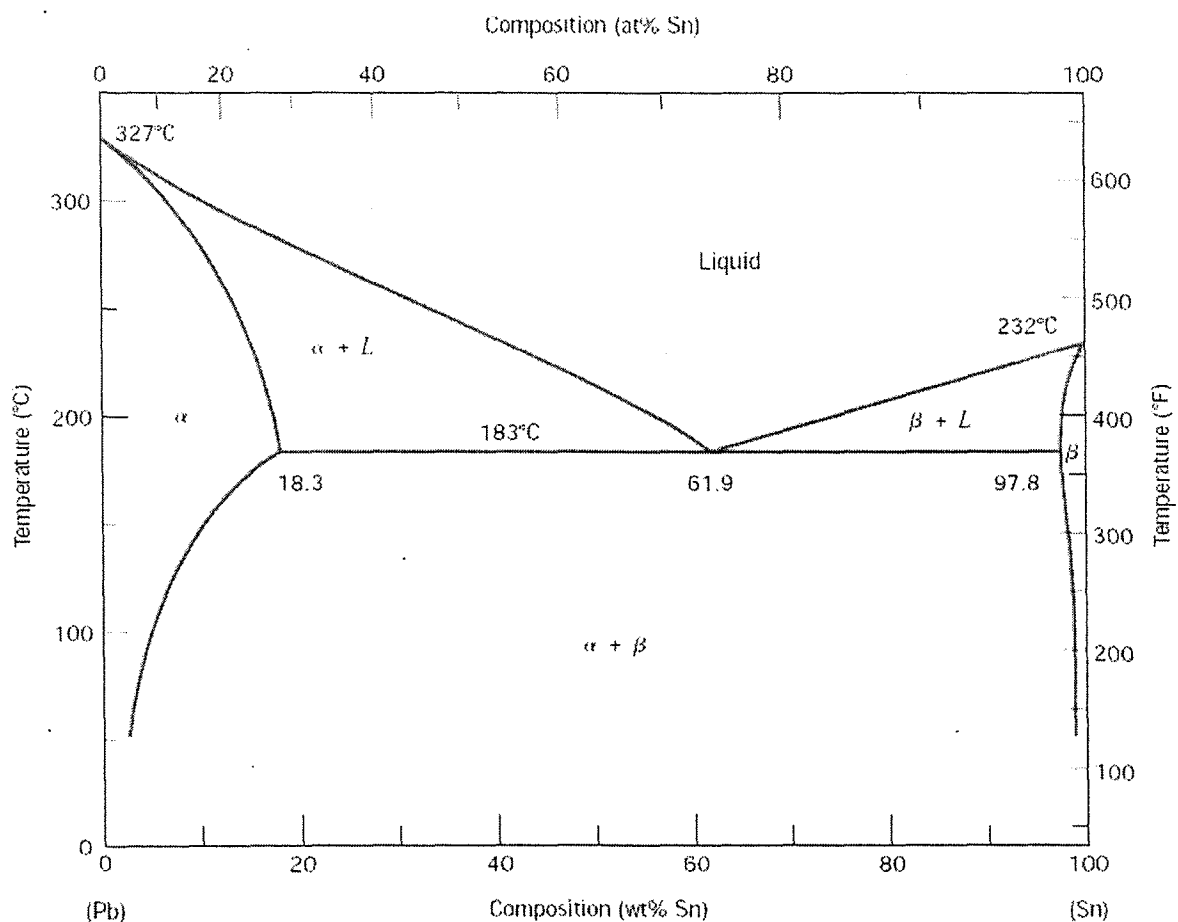


### Question 3: (15 Marks)

- (a) A photomicrograph was taken of some metal at a magnification of 100X and it was determined that the average number of grains per square inch is 16. Compute the ASTM grain size number for this alloy. (3 Marks)
- (b) The density of a sample of FCC palladium (Pd) is  $11.98 \text{ g/cm}^3$ , which has a lattice parameter of  $3.8902 \text{ \AA}$  and an atomic weight of  $106.4 \text{ g/mol}$ . Calculate the following: (4 Marks)
- the fraction of the lattice points that contain vacancies,
  - the total number of vacancies in a cubic centimeter of Pd.
- (c) The diffusion coefficients for silver in copper are  $5.5 \times 10^{-16} \text{ m}^2/\text{s}$  and  $1.3 \times 10^{-13} \text{ m}^2/\text{s}$  given at  $650^\circ\text{C}$  and  $900^\circ\text{C}$  respectively. Determine the values of  $D_0$  and the activation energy  $Q_d$ , then determine the approximate time at  $800^\circ\text{C}$  that will produce the same diffusion result (in terms of concentration of silver at some specific point in copper) as a 10 hours heat treatment at  $900^\circ\text{C}$ . (Note: the gas constant  $R = 8.31 \text{ J/mol} \cdot ^\circ\text{K}$ ). (8 Marks)

### Question 4: (15 Marks)

- (a) Use the given lead - tin (Sn-Pb) phase diagram shown in figure to answer the following for an alloy contain 61.9 wt% Sn: (7 Marks)
- The liquidus temperature, solidus temperature, freezing range and then draw the cooling curve
  - What are the phases present and the phase compositions for this alloy at  $200^\circ\text{C}$ ?



- (b) Discuss briefly the some medical applications of iron dioxide particles? (4 Marks)
- (c) Titanium, cobalt and stainless steel can be used in dental implants, briefly compare the advantages and disadvantages of these dental implant materials? (4 Marks)