



UNIVERSITY OF GHANA
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DEPARTMENT OF BIOMEDICAL ENGINEERING
END OF SECOND SEMESTER EXAMINATIONS: 2013/2014
LEVEL 200: BACHELOR OF SCIENCE IN BIOMEDICAL ENGINEERING
BMEN 202: Intro to structure and properties of materials (3 Credits)

Total Marks: 100 Time allocation: 2 Hours

Attempt all questions

Question 1 [25 marks]

(a) Write down three characteristics of ionic and covalent bonds. [6 marks]

(b) Explain with illustrations how hybrid bonding occurs in the following:

(i) Carbon

(ii) Ammonia [6 marks]

(c) What is cohesive energy of an ionic crystal?

Given the Coulomb energy of attraction per ion-pair U_c and Born repulsive energy U_R to be

$$U_c = -\frac{e^2}{4\pi\epsilon_0 r} \alpha_m \text{ and}$$

$U_R = \frac{B}{r^n}$, respectively, where α_m is Madelung constant, B is a constant and the other symbols have their usual meaning. Show that the lattice energy is given by

$$U_o = -\frac{e^2}{4\pi\epsilon_0 r_o} \alpha_m \left[1 - \frac{1}{n} \right] \quad [13 \text{ marks}]$$

Question 2 [25 marks]

- (a) Name the type of crystal structures of the following
(i) Aluminum (ii) Chromium (iii) zinc (iv) Nickel (v) Sodium Chloride (vi) Diamond [6 marks]
- (b) Show with the aid of sketches, the arrangements of atoms in
(i) Body-centred cubic (ii) Face-centred cubic and (iii) Hexagonal close-packed crystals [6 marks]
- (c) State with reasons the number of atoms per unit cell of each of the cubic crystals in (b) [6 marks]
- (d) Describe the various changes that will occur in the properties and microstructure when stainless steel is annealed and cold worked for orthopedic applications. Give three factors that affect the structure of crystals. [7 marks]

Question 3 [25 marks]

- (a) Indicate the following crystal planes
(i) (110) (ii) (101) (iii) (632) [6 marks]
- (ii) Sodium chloride crystals have FCC structure. The density of NaCl is kg/m³. Calculate the distance between two adjacent atoms. Atomic weight of sodium is 23 and that of chlorine is 35.5. [5 marks]
- (b) Mention the property of X-rays that makes them useful to study crystals? Outline three benefits of X-ray diffraction for studying crystals. [8 marks]
- (c) A FCC structure has an atomic radius of 1.246 Å. What is the d_{200} spacing of the crystal? Explain the effect of d-spacing on the properties of a crystal? [6 marks]

Question 4 [25 marks]

- (a) List and explain the types of crystal point imperfections. Outline three applications of crystal point imperfections. [15 marks]
- (b) Explain three effects of polymer structures on their properties. [6 marks]
- (c) Outline two polymer structural factors that can favour crystallinity. [4 marks]