

Problem 1: (21 points)

Assume that you find the following three materials in the laboratory: 1. Copper (metal), 2. Magnesium oxide, MgO (ceramic), and 3. Polyethylene (C₂H₄)_n (polymer).

- What is the expected main type of primary atomic bonding in each of these materials? (9 points)
- Briefly explain how each of these bonding form? (12 points)

Problem 2: (24 points)

Sketch the following planes and directions within cubic (part a) and HCP (part b) unit cells:

- [1 $\bar{2}$ 0], [$\bar{1}$ 01], ($\bar{2}$ 01), and (31 $\bar{2}$). (12 points)
- [1 $\bar{2}$ 10], [11 $\bar{2}$ 0], (0001), and (0 $\bar{1}$ 10). (12 points)

Problem 3: (26 points)

- Vacancy is one of the point defects in crystalline solids. Explain the effect of temperature on the number of equilibrium vacancy? (7 points)
- Briefly explain the difference between substitutional and interstitial solution solutions? (7 points)
- Determine the concentrations, in both weight percent and atom percent, of zinc and lead elements in an alloy that contains 25.3 kg copper, 37.8 kg zinc, and 10.5 kg lead. The atomic weights are as follow: 63.546 g/mol for copper, 65.38 g/mole for zinc, and 207.2 g/mol for lead. Avogadro number = 6.023 X 10²³ (12 points)

Problem 4 : (29 points)

For a cubic crystalline material, if the ratio of the (110) planar density to the (100) planar density is $\sqrt{2}$ (i. e. $\frac{PD_{(110)}}{PD_{(100)}} = \sqrt{2}$), answer the following:

- c. Determine the crystal structure for this material? (19 points)
- d. Calculate the linear density along [111] given that the radius of the atom is 0.127 nm? (10 points)

Problem 5: Choose the correct answer: (5 points)

1. The chemical bond of rubber material is:

- a) Ionic b) Covalent c) Secondary bond

2. Atomic mass is the sum of masses of:

- a) Proton+ neutron b) Neutron +electron c) Electron + protons

3. The manner in which atoms are specially arranged is:

- a) Atomic structures b) Crystal structure c) amorphous structure

4. There are ----- types of crystal systems.

- a) Four b) Five c) Seven

5. Atomic Packing Factor (APF) must be:

- a) Equal to one b) less than one c) more than one