

※ 考生請注意：本試題不可使用計算機。請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

1. Consider the FCC unit cell of the copper crystal (20%)
 - a. How many atoms are there per unit cell?
 - b. If R is the radius of the Cu atom, show that the lattice parameter is given by $a = 2\sqrt{2} R$
 - c. Calculate the atomic packing factor. For the FCC unit, assuming the atoms to be hard spheres.
 - d. Calculate the atomic concentration (number of atoms per unit volume) in Cu and the density of the crystal given that the atomic mass of Cu is 63.55 g/mol and the radius of the Cu atom is 0.128nm.

2. What are the energies required to ionize H atoms to H^+ ions and further ionize He^+ ions to He^{++} , respectively ? (10%)

3. Find the resistance of a 1 cm^3 pure silicon crystal. What is the resistance when the crystal is doped with arsenic if the doping is 1 in 10^9 , that is 1ppb? Atomic concentration in silicon is $5 \times 10^{22} \text{ cm}^{-3}$, $n_i = 1 \times 10^{10} \text{ cm}^{-3}$, $\mu_e = 1350 \text{ cm}^2 \text{ V}^{-1} \text{ s}^{-1}$, and $\mu_h = 450 \text{ cm}^2 \text{ V}^{-1} \text{ s}^{-1}$. (15%)

4. Please address what is Hall Effect and show that if R_H is Hall coefficient and σ is the conductivity of a metal, then the drift mobility of the conduction electrons is given by $\mu_d = \sigma \times R_H$ (10%)

5. An n-type Si semiconductor containing 10^{16} phosphorus (donor) atom cm^{-3} has been doped with 10^{17} boron atoms cm^{-3} . Calculate the electron and hole concentration in this semiconductor. ($n_i = 1 \times 10^{10} \text{ cm}^{-3}$) (15%)

6. Draw the following direction vectors in cubic unit cells. (10%)
 $[100]$, $[110]$, $[112]$, $[-110]$, $[-32-1]$

7. Explain the following noun. (20%)
 - a). Frenkel defect
 - b). Eutectic point
 - c). Mean free path
 - d). Lattice-scattering-limited drift mobility
 - e). Impurity-scattering-limited drift mobility
 - f). Bragg's Law
 - g). Work function
 - h). Linear combination of atomic orbitals
 - i). Fermi energy
 - j). Schottky effect