**IV$^{th}$ ASSIGNMENT**
**Subject: Physics-II (Semiconductor Physics)**
**Due date: 22/02/2017**

**Date:** **Roll No.** **Name**

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**Review Questions**

1. What is the Kronig–Penney model? What does it represent?
2. What is effective mass? How is effective mass defined in terms of the $E$ versus $k$ diagram?
3. What is a direct bandgap semiconductor? What is an indirect band gap semiconductor?
4. What was the mathematical model used in deriving the density of states function?
5. In general, what is the relation between density of states and energy?
6. What is the meaning of the Fermi–Dirac probability function?
7. What is the Fermi energy?

**Numerical based questions**

8. Two possible conduction bands are shown in the $E$ versus $k$ diagram given in Figure 1 and 2. State which band will result in the heavier electron effective mass; state why.

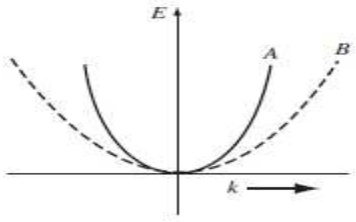


Figure 1 | Conduction bands.

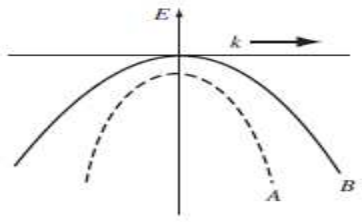


Figure 2 | Valence bands

9. Figure 3.shows the parabolic $E$ versus $k$ relationship in the valence band for a hole in two particular semiconductor materials. Determine the effective mass (in units of the free electron mass) of the two holes.

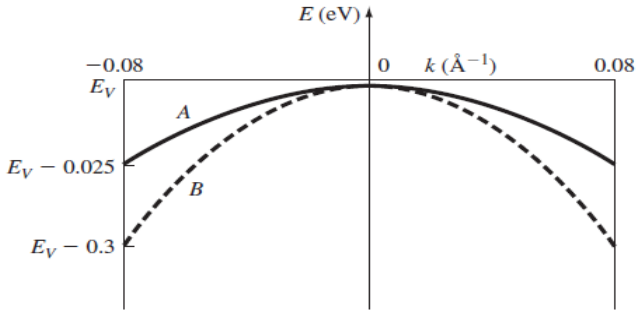


Figure 3

10. Assume that the Fermi energy level for a particular material is 6.25 eV and that the electrons in this material follow the Fermi–Dirac distribution function. Calculate the temperature at which there is a 1 percent probability that a state 0.30 eV below the Fermi energy level will not contain an electron.
11. Let $T$ =300 K. Determine the probability that an energy level 3 $kT$ above the Fermi energy is occupied by an electron.
12. Determine the number (#/cm3) of quantum states in silicon between $Ec$ and $Ec$ -$kT$ at $T$ = 300 K.

13. Determine the total number of energy states in the GaAs between Ec and Ec+kT at T=300 K. For GaAs, $m_n^*$= 0.067$m_0$ , $m_p^*$= 0.48$m_0$.

14. Calculate the density of states per unit volume over a particular energy range between 0 and 1 eV.

15. The lattice constant of a simple cubic lattice is *a*. Sketch the following planes: (i) (110), (ii) (111), (iii) (220), (iv) (321), (v) $(\bar{1}\,00)$ and (vi) $(\bar{1}11)$.

16. The lattice constant of a simple cubic lattice is *a*. Sketch the following directions: (i) [110], (ii) [111], (iii) [220], and (iv) [321]

17. Determine the surface density of atoms for silicon on the (a) (100) plane, (*b*) (110) plane, and (*c*) (111) plane.

18. Write the miller indices for following plane.

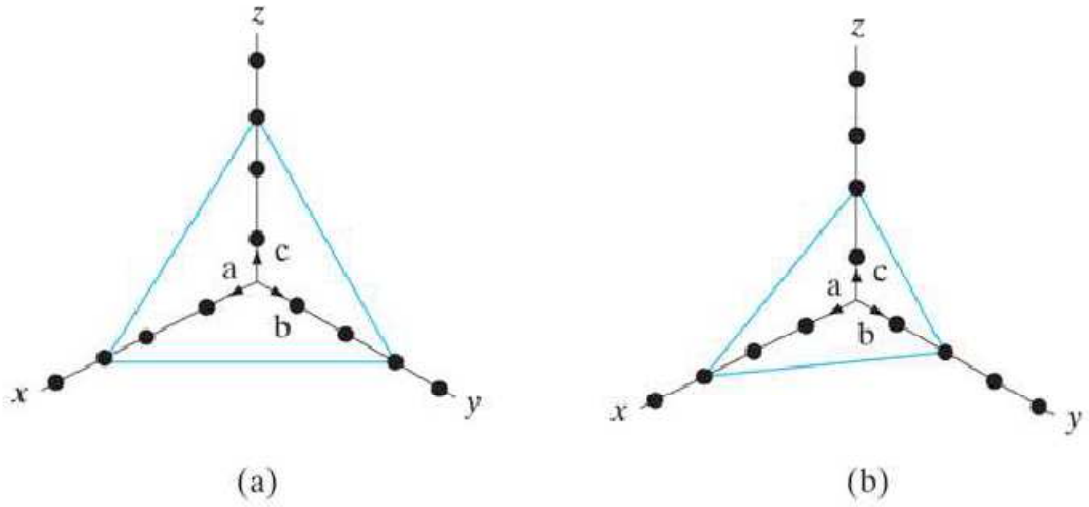


Figure 1.17.1 P1-3