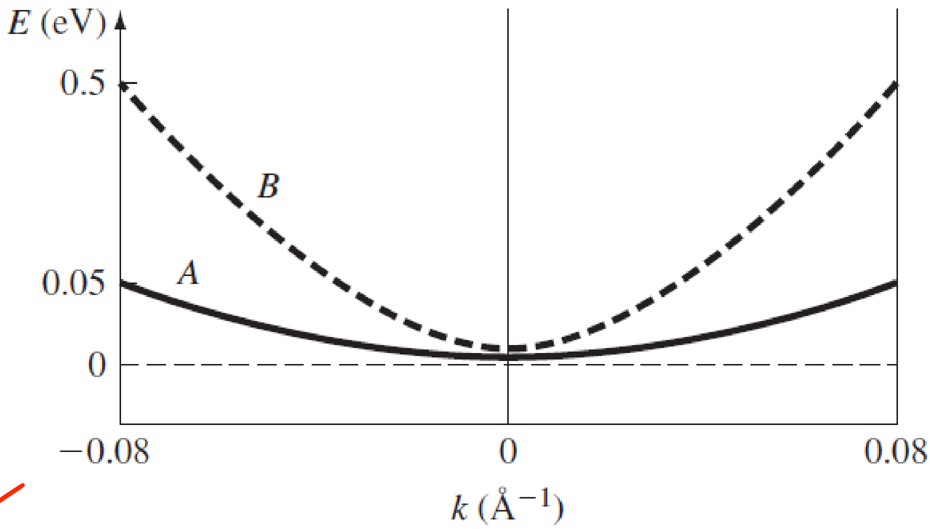
PYL 102 (Tutorial Sheet)

1. Figure 1 shows the parabolic E versus k relationship in the conduction band for an electron in two particular semiconductor materials. Determine the effective mass (in units of the free electron mass) of the two electrons.



2. Derive the density of states function for a one-dimensional electron gas in GaAs ($m_e^* = 0.067 m_0$).

3. (a) Determine the total number ($\#/cm^3$) of energy states in silicon between E_c and $E_c + 2kT$ at (i) T = 300 K and (ii) T = 400 K. (b) Repeat part (a) for GaAs.

4. (a) Determine the total number ($\#/cm^3$) of energy states in silicon between E_v and $E_v - 3\,kT$ at (i) T = 300 K and (ii) T = 400 K. (b) Repeat part (a) for GaAs.

5. The probability that a state at $E_c + kT$ is occupied by an electron is equal to the probability that a state at $E_v - kT$ is empty. Determine the position of the Fermi energy level as a function of E_c and E_v.

6. Six free electrons exist in a one-dimensional infinite potential well of width $a =$ 12 Å. Determine the Fermi energy level at T = 0 K.

7. (a) Five free electrons exist in a three-dimensional infinite potential well with all three widths equal to a = 12 Å. Determine the Fermi energy level at T = 0 K.

8. Assume that the Fermi energy level is exactly in the center of the bandgap energy of a semiconductor at T = 300 K. (a) Calculate the probability that an energy state in the top of the valence band is empty for Si, Ge, and GaAs.

9. Assume that for a non-degenerate semiconductor the peak in the electron distribution versus energy inside the conduction band occurs at $E_c + \frac{kT}{2}$. Expressed as a fraction of the electron population at the peak energy what is the electron population in a non-degenerate semiconductor at $E = E_c + 5kT$.

10. The DOS in the CB of a hypothetical semiconductor is:

$$g_c(E) = constant, for\ E > E_c$$

Sketch the electron distribution in the CB for the above semiconductor.