1. Calculate the approximate donor binding energy for GaAs ($\epsilon_r = 13.2, m^*_n = 0.067m_0$).

2. An unknown semiconductor has $E_g = 1.1\ eV$ and $N_c = N_v$. It is doped with $10^{15}\ cm^{-3}$ donors, where the donor level is $0.2\ eV$ below $E_c$. Given that $E_F$ is $0.25\ eV$ below $E_c$, calculate $n_i$ and the concentration of electrons and holes in the semiconductor at $300\ K$.

3. Calculate the bandgap of Si from $n_i = \sqrt{N_c N_v e^{-E_g/2kT}}$ and plot $n_i$ vs. $1000/T$ (see Fig. 3-17 in Streetman). [Hint: The slope cannot be measured directly from a semilogarithmic plot; read the values from two points on the plot and take the natural logarithm as needed for the solution.]

4. (a) Show that the minimum conductivity of a semiconductor sample occurs when $n_0 = n_i\sqrt{\mu_p/\mu_n}$.
   
   [Hint: Begin with $J_x = q(n\mu_n + p\mu_p)\mathcal{E}_x = \sigma\mathcal{E}_x$, and apply $n_0 p_0 = n_i^2$.]
   
   (b) What is the expression for the minimum conductivity $\sigma_{min}$?
   
   (c) Calculate $\sigma_{min}$ for Si at $300\ K$ and compare with the intrinsic conductivity.

5. (a) A silicon sample is doped with $3 \times 10^{16}\ cm^{-3}$ boron atoms and a certain number of shallow donors. The Fermi level is $0.38\ eV$ above $E_i$ at $300\ K$. What is the donor concentration $N_d$?

   (b) A silicon sample contains $10^{16}\ cm^{-3}$ Indium (In) acceptor atoms and a certain number of shallow donors. The In acceptor level is $0.16\ eV$ above $E_v$, and $E_F$ is $0.26\ eV$ above $E_v$ at $300K$. How many (cm$^{-3}$) In atoms are un-ionized (i.e., neutral)?

6. Reading Assignment: Streetman: Ch. 1 (sections 1.1 and 1.2), Ch. 2 (sections 2.1-2.3), Ch. 3 (all)