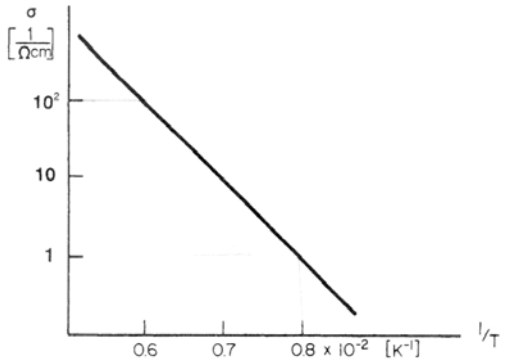
Home Problem Set #8 Due : October 20, 2014

1. Prove the following relationship for intrinsic semiconductors;

$$E_F = E_g/2 + (3/4)k_BT\ln(m_h^*/m_e^*)$$

which represents that since k_BT is small at room temperature, and the effective masses of electrons and holes are not very much different, we can say that the Fermi level is roughly halfway between the valence and conduction bands.

2. In the figure below, σ is plotted as a function of the reciprocal temperature for an intrinsic semiconductor. Calculate the gap energy. (*Hint*: Use (8.14) and take the ln from the resulting equation.)



3. Consider a silicon crystal containing 10^{12} phosphorous atoms per cubic centimeter. Is the conductivity increasing or decreasing when the temperature is raised from 300˚C to 350˚C? Explain by giving numerical values for the mechanisms involved.

4. Consider a semiconductor with 10^{13} donors/cm^3 which has a binding energy of 10 meV.

(a) What is the concentration of extrinsic conduction electrons at 300 K ?

(b) Assuming a gap energy of 1 eV (and m* = m_0), what is the concentration of intrinsic conduction electrons?

(c) Which contribution is larger?