HW#10 due November 29

1. (a) Calculate the number of free electrons per cubic meter for silver, assuming that there are 1.3 free electrons per silver atom. The electrical conductivity and density for Ag are 6.8×10^7 $(\Omega.m)^{-1}$ and 10.5 g/cm^3, respectively.

(b) Now compute the electron mobility for Ag.

2. Germanium to which 10^{24} m^{-3} As atoms have been added is an extrinsic semiconductor at room temperature, and virtually all the As atoms may be thought of as being ionized (i.e., one charge carrier exists for each As atom).

(a) Is this material n-type or p-type?

(b) Calculate the electrical conductivity of this material, assuming electron and hole mobilities of 0.1 and 0.05 m^2/V-s, respectively.

3. At temperatures near room temperature, the temperature dependence of the conductivity for intrinsic germanium is found to be given by (18.35)

$$\sigma = CT^{-3/2} \exp\left(-\frac{E_g}{2kT}\right) \qquad (18.35)$$

where C is a temperature-independent constant and T is in Kelvins.

The room temperature (298 K) conductivity for Ge is 2.2 $(\Omega\text{-m})^{-1}$.

(a) Using Equation 18.35, calculate the intrinsic electrical conductivity of germanium at 175°C.

(b) Determine the temperature at which the electrical conductivity of intrinsic germanium is 40 $(\Omega.m)^{-1}$.

4. Consider a parallel-plate capacitor having an area of 3225 mm^2, a plate separation of 1 mm, and a material having a dielectric constant of 3.5 positioned between the plates.

(a) What is the capacitance of this capacitor?

(b) Compute the electric field that must be applied for 2×10^{-8} C to be stored on each plate.

5. A metal alloy is known to have electrical conductivity and electron mobility values of 1.2×10^7 $(\Omega.m)^{-1}$ and 0.0050 $m^2/V\cdot s$, respectively. A current of 40 A is passed through a specimen of this alloy that is 35 mm thick. What magnetic field would need to be imposed to yield a Hall voltage of -3.5×10^{-7} V?