Home Problem Set #6 Due : October 8, 2014

1. When calculating the population density of electrons for a metal by using (7.26), a value much larger than immediately expected results. Why does the result, after all, make sense? (Take $\sigma=5\times10^5$ $1/\Omega$ cm; $\upsilon_F=10^8$ cm/s and $\tau=3.1\times10^{-14}$ s).

$$\sigma = \frac{1}{3}e^2 v_f^2 \tau N(E_F)$$

$$N(E_F) = \frac{3\sigma}{e^2 v_f^2 \tau} = \frac{3\times5\times10^5}{(4.803\times10^{-10})^2(10^8)^2(3\times10^{-14})} = 2.167\times10^{22}$$

$$unit: \frac{1/\Omega cm}{(cm^{1.5}g^{0.5}/s)^2(cm/s)^2 s} = \frac{9\times10^{11}/s}{cm^3(g/s^2)(cm^2/s)} = \frac{9\times10^{11}\times1.602\times10^{-12}}{1e\,V\cdot\,cm^3}$$

$$\therefore\ 2.167\times10^{22}\times\frac{(9\times10^{11})(1.602\times10^{-12})}{e\,V\cdot\,cm^3} = 3.125\times10^{22}/e\,V\cdot\,cm^3 = 1.95\times10^{47}/J\cdot\,m^3$$

2. Consider the conductivity equation obtained from the classical electron theory. According to this equation, a bivalent metal, such as zinc, should have a larger conductivity than a monovalent metal, such as copper, because zinc has about twice as many free electrons as copper. Resolve this discrepancy by considering the quantum mechanical equation for conductivity.

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