

Physics 330, Spring 2009
HW#10 30 points

1. **(5 points)** Start with $j = \sigma E$ and show the transformation to Ohm's law, $V = IR$.
2. **(5 points)** Atoms are arranged in a cubic lattice where the smallest distance between any two atoms is r_0 . Assuming one free electron per atom, what is the Fermi energy? Calculate E_F in eV when $r_0 = 0.5$ nm.
3. **10-33(5 points)** What type of semi-conductor is obtained if silicon is doped with (a) aluminum and (b) phosphorus.
4. **10-46(5 points)** Estimate the fraction of free electrons in copper that are in excited states above the fermi energy at (a) 300 K, (b) 1000 K.
5. **10-51(5 points)** A doped n -type silicon sample with 10^{16} electrons per cubic centimeter in the conduction band has a resistivity of $5 \times 10^{-3} \Omega \cdot \text{m}$ at 300 K. Find the mean free path of the electrons. Use $0.2 m_e$ as the effective mass of the electron. Compare your result with the mean free path of electrons in copper at 300 K.
6. **(5 points)** With one or two sentences each, explain the Hall effect and the Quantum Hall effect and what is observed for each in experiments.