

I. PROBLEM SESSION 11**A. Problem 11.1**

- Recall the concept of a hole. Compare the properties of holes and electrons.
- Describe the meaning of the concept of effective mass. Why is the effective mass different from the electron mass? Can the effective mass be negative? What does it mean?
- How are energy bands filled? What is the difference between a metal, semi-metal, semiconductor and insulator.
- Describe the concept of impurity doping of a semiconductor. How does the different forms of doping alter the electronic properties of semiconductors?

B. Problem 11.2

Impurity orbits: Indium antimonide has $E_g = 0.23eV$, dielectric constant $\epsilon = 18$ and effective mass $m_e = 0.015m$. Calculate (a) the donor ionization energy; (b) the radius of the ground state orbit. (c) At what minimum donor concentration will appreciable overlap effects between the orbits of adjacent impurity atoms occur? This overlap tends to produce an impurity band- a band of energy levels which permit conductivity presumably by hopping mechanism in which electrons move from one impurity site to a neighbouring ionized impurity site.

C. Problem 11.3

Ionization of donors: In a particular semiconductor there are 10^{13} donors/ cm^3 with an ionization energy E_d of $1meV$ and an effective mass $0.01m$. (a) Estimate the concentration of conduction electrons at $4K$. (b) What is the value of the Hall coefficient? Assume no acceptor atoms are present and that $E_g \gg k_B T$.