Physics 375 **Spring (12) 2003**

Solid State Physics: Problem Set #11

Electronic Properties of Solids: Semiconductors

Due: Friday April 4 by 6 pm

Notes: 1) In our last two class meetings you will each give a 30-minute presentation on a topic of your choice. Here are some topic suggestions: quasi-crystals, superconductivity, quantized Hall effect, semiconductor lasers, magnetism. Please let me know on Monday what topic you will be presenting.

2) This week we will do our final solid state lab: "Measuring the band-gap of a semiconductor". It's pretty quick and easy. I'll have instructions for you on Monday.

Reading assignment: for Monday, 10.1-10.2 (intrinsic semiconductors)
for Wednesday, 10.3-10.5 (doped semiconductors)
for Friday, 10.9 (the pn junction)

Problem assignment:

Chapter 9 Problems: 9.10 motion of electron versus hole states in *k*-space
Chapter 10 Problems: 10.2 band-gap measurement for Ge (plot the data in a semi-log format)
10.4 conductivity of intrinsic and doped Si
10.9 resistivity of pure and doped Ge
*10.10 Hall effect in a semiconductor **[Robert]**

*A1. *De Haas-van Alphen period of potassium*. **[Brian]**
(a) Calculate the de Haas-van Alphen period, $\Delta(1/B)$, expected for potassium, based on the free electron model. How many dHvA oscillations would you measure between B=2.00T and 2.01T?
(b) Determine the real space radius of the extremal orbit for a field of B = 2.00 T.

A2. *Necks, bellies, and dogbones in the Fermi surface of gold.*
(a) Below is experimental de Haas-van Alphen data for gold with the B-field directions [111] and [110]. The [111] orientation gives rise to neck and belly orbits while the [110] orientation results in dogbone orbits. Determine the *k*-space area of each of these three types of extremal orbits from the experimental data. (Note: 1 kilogauss = 0.1 Tesla).
(b) Using our tight-binding model results from last week, plot Fermi surfaces (with Maple) for which these three types of orbits can be visualized (see A4.b from last week).