Physics 238A **Fall 2006**

Condensed Matter Physics **due 9:30 am Tuesday Nov. 14**

PROBLEM SET 7

Reading: Ashcroft and Mermin (AM) Chapter 11

1. Ashcroft and Mermin, Problem 9.5

   It would be useful to read AM Ch. 9 as well as the section in Kittel's, *Introduction to Solid State Physics*, on Construction of Fermi Surfaces in chapter 9. In the 8th edition of Kittel, this section is found on pages 226 to 230. The obvious way to do part (b) is to use a piece of cardboard which can be cut up, but don't turn in the pieces of cardboard. Just draw a picture of the results.

2. For an electron in an s–band in a simple cubic crystal in the tight–binding approximation, the band structure has the form

   $$E(\vec{k}) = \text{const} - \gamma_o(\cos k_x a + \cos k_y a + \cos k_z a)$$

   Consider an electron moving in an ideally pure such crystal at T=0 (i.e., subject to no scattering), which at time zero is described by a wave packet with, approximately, $\vec{k} = 0$ and $\vec{r} = 0$. For $t > 0$ there is a constant electric field $\vec{E}$ applied along a cube axis. Find the subsequent motion of the electron in real space (i.e. $\vec{r}(t)$) and the maximum distance it can travel from the origin, if the total width of the band is 0.06 eV and the electic field E is 1 mV/cm.

   Explain why we should not believe this result for crystals with a realistic number of impurities (even at $T = 0$), and estimate the maximum concentration of impurities which would allow the effect to be observed. (Take the impurity scattering cross section to be $\sim 1\ \mathring{A}^2$.)