

Phys 155, Winter 2007, Homework 5, due Mar 7

(Each problem is 4 points. For problems from the textbook, please note that solutions are included in the textbook. However, use those solutions simply as guide, if necessary. If you do, your answers should show enough details that reflect your own understanding.)

1. Problem 4.6 of H&H
2. Consider a one dimensional crystal. We will consider a free-electron approximation with a weak periodic potential. We will consider states near the zone boundary, $k = \pi/a$, and only the bottom 2 bands.
 - a. Consider the free electron dispersions, folded back but without the crystal potential turned on yet. Show that the dispersions of the two “bands” can be written as $\varepsilon(k) = \varepsilon\left(k = \frac{\pi}{a}\right) \pm \hbar v \times \left(k - \frac{\pi}{a}\right)$ where $m v = \hbar \frac{\pi}{a}$, where m is the free electron mass.
 - b. Now consider the 2x2 matrix problem with an off-diagonal element V , ($\Delta \equiv |V|$). Using the solution of this problem (cf. past homework), express the effective mass m^* in terms of v and Δ .
 - c. Evaluate the ratio of m^*/m using a typical lattice constant $a = 3\text{\AA}$ and $\Delta = 0.5\text{ eV}$. Show that it is a small number, as we discussed in class.
3. Problem 5.3+5.4 of H&H
4. Problem 5.8 of H&H