ECEn 450, Winter 2009
Homework #3
Due January 27, 5:00 pm

From the text Semiconductor Devices, Physics and Technology, do the following problems:

Chapter 2, problem 8

Chapter 12, problems 8, 9

Also complete the following problems:

3.1 Figure 3.1 shows the parabolic E versus k relationship in the conduction band for an electron in two particular semiconductor materials. Determine the effective mass (in units of the free electron mass) of the two electrons.

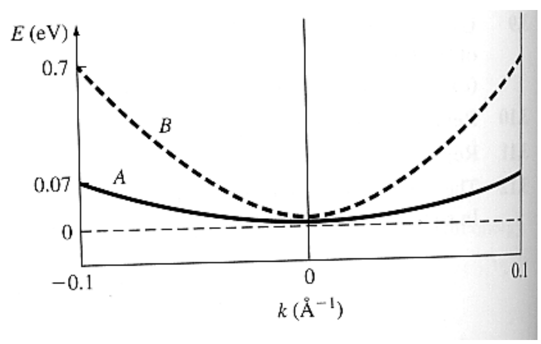

Figure 3.1

3.2 Figure 3.2 shows the parabolic E versus k relationship in the valence band for a hole in two particular semiconductor materials. Determine the effective mass (in units of the free electron mass) of the two electrons.

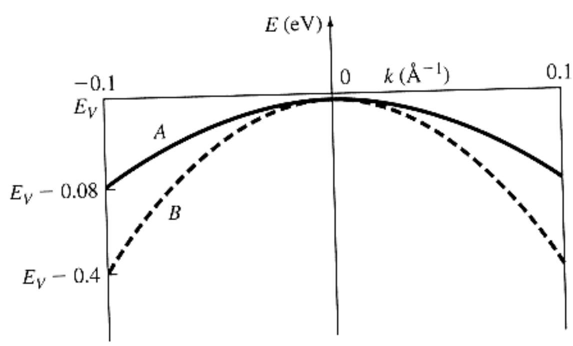

Figure 3.2

3.3 The forbidden energy band of GaAs is 1.42 eV. (a) Determine the minimum frequency of an incident photon that can interact with a valence electron and elevate the electron to the conduction band. (b) What is the corresponding wavelength?

3.4 Point A is at an electrostatic potential of +1 V relative to point B in a vacuum. An electron initially at rest at B moves to A. What energy (expressed in J and eV) does the electron have at A? What is its velocity (m/s)?

3.5 The de Broglie wavelength of a particle $\lambda = h/m\nu$ describes the wave-particle duality for small particles such as electrons. What is the de Broglie wavelength (in nm) of an electron at 100 eV? What is the wavelength for electrons at 12 keV, which is typical of electron microscopes? Comparing this to visible light, comment on the advantages of electron microscopes.

Homework Hint:
For 3.1, the equation to use is E-Ec = (k^2h^2)/2m