VE320 Homework 2

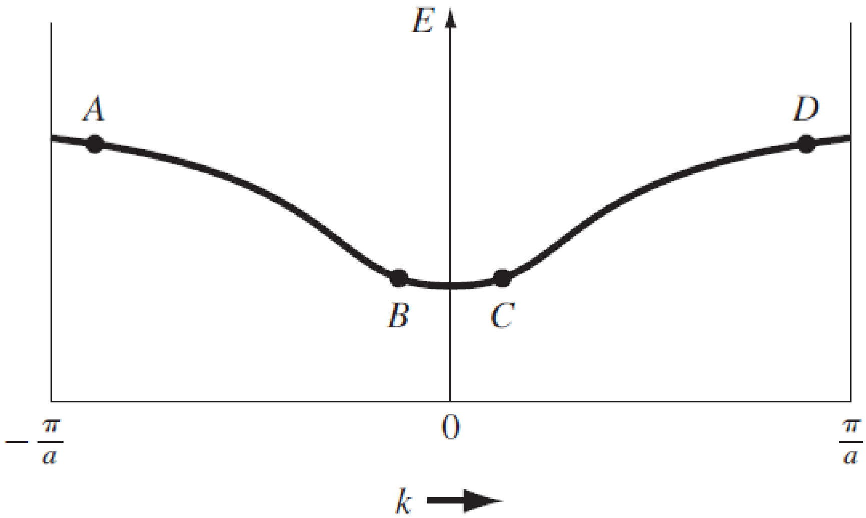
Due Oct. 1, 11:40am

1. The bandgap energy in a semiconductor is usually a slight function of temperature. In some cases, the bandgap energy versus temperature can be modeled by

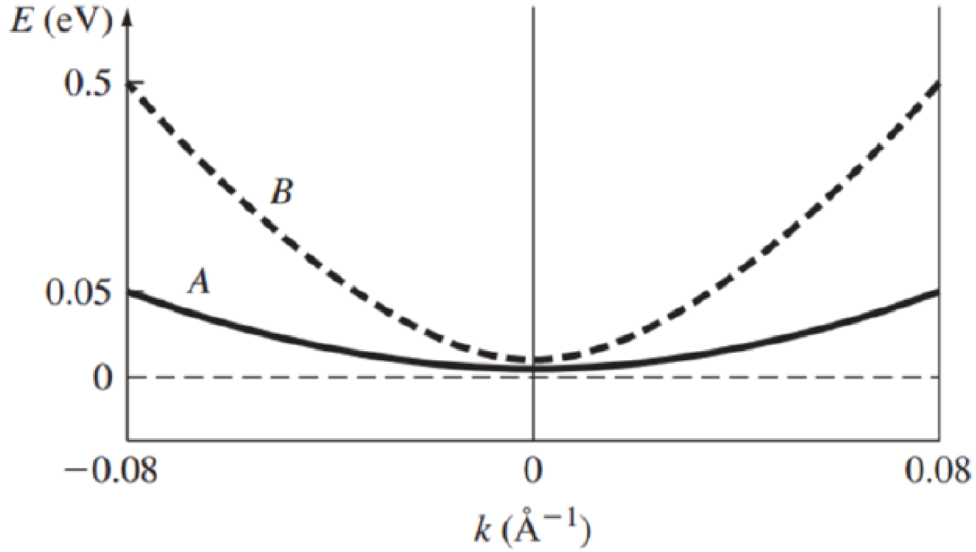
$$E_g = E_g(0) - \frac{\alpha T^2}{\beta + T}$$

where $E_g(0)$ is the value of the bandgap energy at T=0K. For silicon, the parameter values are $E_g(0)$=1.170eV, α=4.73×$10^{-4}eV/K$, and β=636K. Plot Eg versus T over the range 0⩽T⩽600K. In particular, note the value at T=300K.

2. The E versus k diagram for a particular allowed energy band is shown in Figure P3.15. Determine (a) the sign of the effective mass and (b) the direction of velocity for a particle at each of the four positions shown.



3. The figure below shows the parabolic E versus k relationship in the conduction band for an electron in two particular semiconductor materials, A and B. determine the effective mass (in units of the free electron mass) of the two electrons.



4. (a) The forbidden bandgap energy in GaAs is 1.42 eV. (i) Determine the minimum frequency of an incident photon that can interact with a valence electron and elevate the electron to the conduction band. (ii) What is the corresponding wavelength? (b) Repeat part (a) for silicon with a bandgap energy of 1.12 eV.

5.

The energy-band diagram for silicon is shown in Figure 3.25b. The minimum energy in the conduction band is in the [100] direction. The energy in this one-dimensional direction near the minimum value can be approximated by

$$E = E_0 - E_1 \cos \alpha(k - k_0)$$

where k_0 is the value of k at the minimum energy. Determine the effective mass of the particle at $k = k_0$ in terms of the equation parameters.

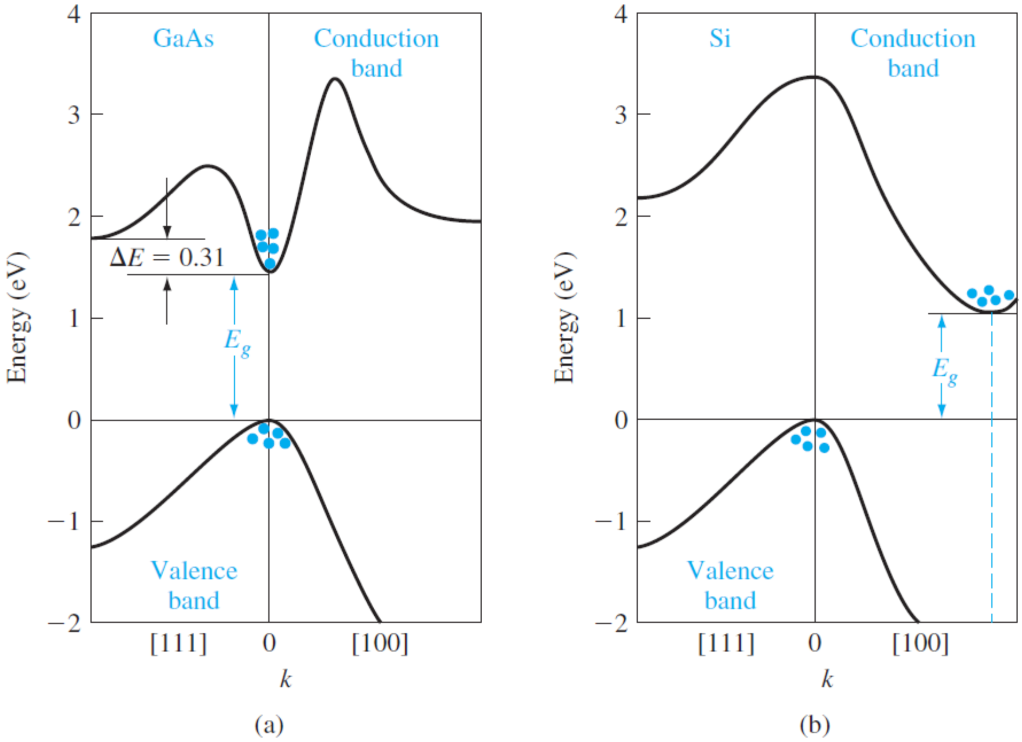


Figure 3.25 | Energy-band structures of (a) GaAs and (b) Si.