

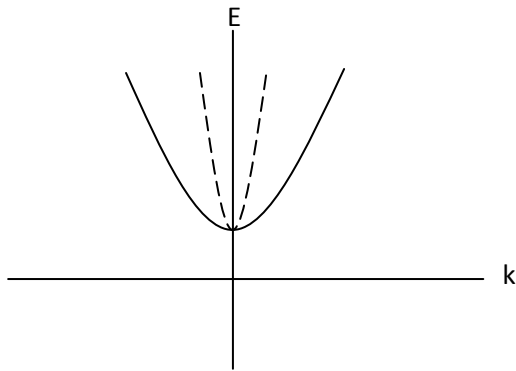
Problem Set #8: Quantum Theory of Electrons

1. Describe the concept of crystal momentum. What is the relationship between crystal momentum and the momentum of electrons in a given energy state?

2.

(a) Describe the concept of effective mass.

(b) The figure below shows an E-k diagram with two different bands. In which of the bands (solid or dashed) would an electron have a higher effective mass?



(c) Qualitatively, what is the relationship between effective mass and the density of states in a band?

3. One band in a particular semiconductor has the dispersion relation: $E = E_0[1 - \cos(ka)]$, where $E_0 = 1.5\text{eV}$ and $a = 5\text{\AA}$.

(a) Draw an E-k diagram from $k = -\pi/a$ to π/a .

(b) Find the effective mass for $k=0$ and $k=\pi/a$.

(c) What is the significance of a negative effective mass?