Physics 8510

Problem Set 11

1) Assuming that N_c and N_v are 1.04×10^{19} cm $^{-3}$ and 0.49×10^{19} cm $^{-3}$ for Ge at 300 K, calculate the corresponding electron and hole density of state mass for Ge? If the corresponding values for Si are 2.8×10^{19} cm $^{-3}$ and 1.05×10^{19} cm $^{-3}$ what are the electron and hole density of state mass in Si?

2) Calculate the intrinsic carrier concentration and resistivity for Ge and Si. Use mobility values from any standard reference. Quote your references. What other parameters will affect these?

3) A semiconductor sample is doped p-type at 10^{17} cm $^{-3}$. The energy gap is 0.3 eV, $m_c = 0.12m_0$ and $m_v = 0.50m_0$. What are the free electron and hole densities at 77, 300 and 800 K?

4) Optical excitation of intrinsic Ge creates an average density of 10^{12} conduction electrons per cm^3, in the material at 77 K. At this temperature, the electron and hole mobilities are equal to 0.5×10^4 cm^2 /Vs. The Ge dielectric constant is 20. If 100 volts is applied across a 1 cm cube of crystal under these conditions, show that about 160 mA current will be observed.

5) Problem 6 from A& M chapter 28.

6) (a) ``A dopant in a semiconductor can be amphoteric". For this statement to be more accurate, a particular type of semiconductor should be considered. What will be your explanation for ``amphoteric" ?

(b) What is ``Autodoping" in a semiconductor?

(c) If 50 micron radiation should be detected, what is the energy gap needed in a semiconductor?

(d) How can you achieve (c) in a semiconductor with about 1 ev forbidden region?

(e) What might be the limiting operating temperature for the above semiconductor? You have to justify your answer.

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