# Physics 8510, Fall 2007

## Problem Set 12

1) Calculate the donor and acceptor binding energies in Si and GaAs assuming an average conductivity mass.

2) The variation of the resistivity of intrinsic Ge with temperature is given below.

| T( K) | 385 | 455 | 556 | 714 |
|---|---|---|---|---|
| $\rho(\Omega m)$ | 0.028 | 0.0061 | 0.0013 | 0.000274 |

It may be assumed that the hole and electron mobilities both vary as $T^{-3/2}$ and that the forbidden gap $E_g$ is independent of temperature. Noting that the carrier concentration is also proportional to $e^{-E_g/2kT}$ .

(a)  Determine the value of $E_g$.

(b)  At about what wavelength, would you expect the onset of optical absorption?

3) A sample of GaAs was doped with excess arsenic to a level calculated to produce a resistivity of 0.05 $\Omega$cm. Owing to the presence of an unknown acceptor impurity the actual resistivity was 0.06$\Omega$cm, the sample remaining n-type. What were the concentrations of donors and acceptors present?

4) Show that in an intrinsic semiconductor the conductivity may be expressed as
$\sigma = \sigma_0 e^{-E_g/2kT}$ . Where $\sigma_0 = 2e(\mu_e + \mu_h) [2\pi kT/h^2]^{3/2} [m_e^* m_h^*]^{3/4}$