1) find the resistance of an intrinsic Ge rod of 1cm long, 1mm wide and 1mm thick at 300k. The intrinsic carrier density is $2.5 \times 10^{19} m^{-3}$ at 300 k and the mobility of e^- and hole are 0.39 and $0.19\ m^2 v^{-1} s^{-1}$.

S/ $l = 1cm = 1\times10^{-2} m$, $b = 1mm = 1\times10^{-3} m$, $t = 1mm = 1\times10^{-3} m$

$T = 300k$, $n_i = 2.5\times10^{19} m^{-3}$, $\mu_e = 0.39\ m^2 v^{-1} s^{-1}$,

$\mu_h = 0.19\ m^2 v^{-1} s^{-1}$.

Conductivity (σ) $= n_i e(\mu_e + \mu_h)$

$= 2.5\times10^{19} \times 1.6\times10^{-19} \times (0.39 + 0.19)$

$= 2.32\ \Omega^{-1} m^{-1}$

Resistivity (ρ_i) $= \frac{1}{\sigma_i} = \frac{1}{2.32} = 0.431\ \Omega m$.

Resistance (R) $= \frac{\rho l}{A} = \frac{0.431 \times 1\times10^{-2}}{1\times10^{-3}\times1\times10^{-3}} = 4310\ \Omega$.

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2) The intrinsic Carrier density $1.5\times10^{16} m^{-3}$. If the mobility of e^- and hole are 0.13 and $0.05\ m^2 v^{-1} s^{-1}$ respectively. Calculate the Conductivity.

S/ $n_i = 1.5\times10^{16} m^{-3}$, $\mu_e = 0.13\ m^2 v^{-1} s^{-1}$, $\mu_h = 0.05\ m^2 v^{-1} s^{-1}$

$\sigma = n_i e(\mu_e + \mu_h)$

$= 1.5\times10^{16} \times 1.6\times10^{-19} \times (0.13 + 0.05)$

$= 4.32\times10^{-3}\ \Omega^{-1} m^{-1}$

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3) For an intrinsic semiconductor with a bandgap of 0.7ev. Determine the position of E_f at $T = 300k$ if $m_h^* = 6m_e^*$

S/ $E_g = 0.7ev. = 0.7\times1.6\times10^{-19} = 1.12\times10^{-19} J$

$T = 300k$.

$$E_f = \frac{E_g}{2} + \frac{3KT}{4}\log\left[\frac{m_h^*}{m_e^*}\right]$$

$$= \frac{1.12\times10^{-19}}{2} + \frac{3\times1.38\times10^{-23}\times300}{4}\log[6]$$

$$= 5.6\times10^{-20} + 5.5634\times10^{-21}$$

$E_f = 6.15634\ J.$ (or) $= \frac{6.15634}{1.6\times10^{-19}} eV = 0.3847 ev$

5) Calculate the cut off wavelength for Si Photodiode if it's bandgap is 1.1ev.

$$\lambda_c = \frac{hc}{E_g} = \frac{6.626\times10^{-34}\times3\times10^{8}}{1.1\times1.6\times10^{-19}} = 1.129\ \mu m.$$

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6) The Conductivity of Ge at 20°C is $2\ \Omega^{-1}m^{-1}$. What is its Conductivity at 40°C. $E_g = 0.72$ ev.

$$\sigma = Ce^{-E_g/2k_BT}$$

$$\frac{\sigma_1}{\sigma_2} = \frac{e^{-E_g/2k_BT_1}}{e^{-E_g/2k_BT_2}}$$

$$\sigma_2 = \sigma_1 \cdot \frac{e^{-E_g/2k_BT_1}}{e^{-E_g/2k_BT_2}}$$

$$= 2\ \frac{e^{(-0.72\times1.6\times10^{-19})/(2\times1.38\times10^{-23}\times313)}}{e^{(-0.72\times1.6\times10^{-19})/(2\times1.38\times10^{-23}\times293)}}$$

$$\sigma_2 = 1.0002\ \Omega^{-1}/m$$