Homework #3

Solution

1. a) $N_D = 10^{15}\ cm^{-3}$

$$E_F - E_C = KT \ln\left(\frac{n}{N_C}\right)$$

$$E_F - E_C = 0.025\ eV \ln\left[\frac{10^{15}}{(2.51\times10^{19})(1.18)^{3/2}}\right]$$

$$\boxed{E_F - E_C = -.259\ eV}$$

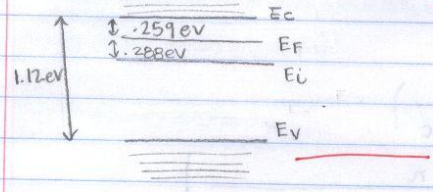
5

$$E_f - E_i = KT \ln\left(\frac{N_D}{n_i}\right)$$

$$E_F - E_i = 0.025eV \ln\left(\frac{10^{15}}{10^{10}}\right)$$

$$\boxed{E_F - E_i = .288\ eV}$$

5



5

b) $N_a = 10^{17}\ cm^{-3}$

$$E_V - E_F = KT \ln\left(\frac{p}{N_V}\right)$$

$$E_V - E_F = 0.025ev \ln\left[\frac{10^{17}}{(2.51\times10^{19})(.81)^{3/2}}\right]$$

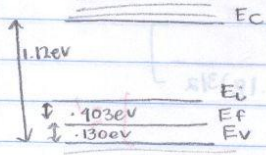
$$\boxed{E_V - E_F = -.130eV}$$

5

$$E_i - E_F = KT \ln\left(\frac{N_A}{n_i}\right)$$

$$E_i - E_F = 0.025eV \ln\left(\frac{10^{17}}{10^{10}}\right)$$

$$\boxed{E_i - E_F = .403eV}$$



5

2. a) $n_i = \sqrt{N_C N_V}\, e^{-E_G/2KT}$

$n_i = \sqrt{(2.51\times10^{19})^2 (1.18)^{3/2} (.81)^{3/2}}\; e^{-1.12/2(8.617\times10^{-5})(273)}$

$n_i = 11.1\times10^8\ cm^{-3}$

$n_i = p_i = 11.1\times10^8\ cm^{-3}$] 12.5'

b) $n_i = \sqrt{N_C N_V}\, e^{-E_G/2KT}$

$n_i = \sqrt{(2.51\times10^{19})^2 (1.18)^{3/2} (.81)^{3/2}}\; e^{-1.12/2(8.617\times10^{-5})(373)}$

$n_i = 6.58\times10^{11}\ cm^{-3}$

$n_i = p_i = 6.58\times10^{11}\ cm^{-3}$] 12.5'

3. a) $E_F - E_c = -.25eV$

$E_F - E_c = KT \ln\left(\frac{n}{N_C}\right)$

$-.28 = 0.025 \ln\left[\frac{n}{(2.51\times10^{19})(1.18)^{3/2}}\right]$

$n = 4.90\times10^{14}\ cm^{-3}$

$\rho \approx 10\ \Omega\text{-cm}$ → from graph P. 86] 15'

b) $\mu_n \approx 1300\ cm^2/V\text{-}s$ → from graph p. 80] 10'

4. a) $\rho = \frac{1}{q\mu_p N_a}$

$\rho = \frac{1}{(1.6\times10^{-19})(380)(8\times10^{17})}$

$\rho = .021\ \Omega\text{-}cm$] 5'

b) $E_F - E_c = KT \ln\left(\frac{n}{N_C}\right)$

$E_F - E_c = 0.025 \ln\left[\frac{8\times10^{17}}{(2.51\times10^{-19})(1.18)^{3/2}}\right]$

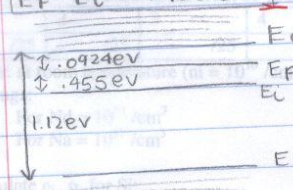
$E_F - E_c = -.0924eV$] 5'

$$E_F - E_i = KT \ln\left(\frac{N_D}{n_i}\right)$$

$$E_F - E_i = 0.025 \ln\left(\frac{8\times10^{17}}{10^{10}}\right)$$

$$E_F - E_i = .455\ eV$$

5'



10'