4.22 The Fermi energy level in silicon at $T = 300$ K is as close to the top of the valence band as to the midgap energy. (*a*) Is the material n type or p type? (*b*) Calculate the values of n_0 and p_0.

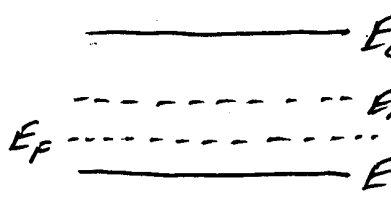

Table B.4

Si @ 300K

$E_g = 1.12$ eV, $m_n^* = 1.08 m_0$, $m_p^* = 0.56 m_0$

a) Per text (sections 4.2 & 4.3), p-type

b) $E_f - E_v = \frac{E_g}{4} = \frac{1.12}{4} = 0.28$ eV

$k_B T = (8.617333 \times 10^{-5}) 300 = 0.025852$ eV

(4.19) $p_0 = N_v e^{-(E_f - E_v)/k_B T}$

(4.18) $N_v = 2\left[\frac{2\pi m_p^* k_B T}{h^2}\right]^{3/2} = 1.0516 \times 10^{25} \frac{\#}{m^3} = 1.0516 \times 10^{19} \frac{\#}{cm^3}$

$p_0 = 1.0516 \times 10^{25} e^{-0.28/0.025852}$

$p_0 = 2.080 \times 10^{20} \#/m^3 = 2.080 \times 10^{14} \#/cm^3$

(4.10) $N_c = 2\left[\frac{2\pi m_n^* k_B T}{h^2}\right]^{3/2} = 2.8165 \times 10^{25} \frac{\#}{m^3} = 2.8165 \times 10^{19} \frac{\#}{cm^3}$

$E_c - E_f = E_g - (E_f - E_v) = 1.12 - 0.28 = 0.84$ eV

(4.11) $n_0 = N_c e^{-(E_c - E_f)/k_B T} = 2.8165 \times 10^{25} e^{-0.84/0.025852}$

$n_0 = 2.1794 \times 10^{11} \#/m^3 = 2.1794 \times 10^{5} \#/cm^3$