3.27 (*a*) Determine the total number (#/cm^3) of energy states in silicon between E_v and $E_v - 3\,kT$ at (*i*) $T = 300$ K and (*ii*) $T = 400$ K.

- Repeat part a) for Germanium.

c) Per (3.75), $g_v(E) = \frac{4\pi(2m_p^*)^{3/2}}{h^3}\sqrt{E_v - E}$. Then, following a process similar to Example 3.4, the number of valence energy states in Germanium between E_v and E_v - $3k_BT$ is

$$N_V = \int_{E_v-3k_BT}^{E_v} g_v(E)\,dE = \int_{E_v-3k_BT}^{E_v} \frac{4\pi(2m_p^*)^{3/2}}{h^3}\sqrt{E_v - E}\,dE$$

$$= \left[\frac{4\pi(2m_p^*)^{3/2}}{h^3}\frac{-2}{3}(E_v - E)^{3/2}\right]\Bigg|_{E_v-3k_BT}^{E_v} = \frac{-8\pi(2m_p^*)^{3/2}}{3h^3}\left[(E_v - E_v)^{3/2} - (E_v - E_v + 3k_BT)^{3/2}\right].$$

$$= \frac{8\pi(2m_p^*)^{3/2}}{3h^3}(3k_BT)^{3/2}$$

Per Table B.4, the density of states effective hole mass for Germanium is $m_p^* = 0.37m_0$. Using this value and other constants, we get

$$N_v = \frac{8\pi\left(2(0.37)9.1093837\times10^{-31}\right)^{3/2}}{3\left(6.62607015\times10^{-34}\right)^3}\left[3(1.380649\times10^{-23})\right]^{3/2}T^{3/2}.$$

$$= 4.248527\times10^{21}T^{3/2}$$

(*i*) At $T = 300$ K, $N_v = 4.248527\times10^{21}(300)^{3/2}$

$\Rightarrow$ **$N_v = 2.2076\times10^{25}$ #/m^3 = 2.2076×10^{19} #/cm^3.**

(*ii*) At $T = 400$ K, $N_v = 4.248527\times10^{21}(400)^{3/2}$

$\Rightarrow$ **$N_v = 3.39882\times10^{25}$ #/m^3 = 3.39882×10^{19} #/cm^3.**