**3.27** (*a*) Determine the total number (#/cm³) of energy states in silicon between $E_v$ and $E_v - 3\,kT$ at (*i*) $T = 300$ K and (*ii*) $T = 400$ K.

a) Per (3.75), $g_v(E) = \dfrac{4\pi(2m_p^*)^{3/2}}{h^3}\sqrt{E_v - E}$

$$N_v = \int_{E_v - 3k_BT}^{E_v} g_v(E)\,dE = \frac{4\pi(2m_p^*)^{3/2}}{h^3}\int_{E_v-3k_BT}^{E_v}(E_v - E)^{1/2}dE$$

$$= \frac{4\pi(2m_p^*)^{3/2}}{h^3}\left(-\tfrac{2}{3}\right)(E_v - E)^{3/2}\Big|_{E_v-3k_BT}^{E_v}$$

$$= \frac{4\pi(2m_p^*)^{3/2}}{h^3}\left(+\tfrac{2}{3}\right)\left[0 + 3k_BT\right]^{3/2}$$

From Table 4.1, $m_p^* = 0.56\,m_0$

$$N_v = \frac{4\pi\left[2(0.56)9.1093837\times10^{-31}\right]^{3/2}}{(6.62607015\times10^{-34})^3}\left(\frac{2}{3}\right)\left[3k_BT\right]^{3/2} \quad (k_B = 1.380649\times10^{-23})$$

$$= 4.30607\times10^{21}\,T^{3/2}$$

(i) $T = 300$ K

$N_v = 4.30607\times10^{21}(300)^{3/2}$

$N_v = 4.11055\times10^{25}\,\#/m^3 = 4.1105\times10^{19}\,\#/cm^3$

(ii) $T = 400$ K

$N_v = 4.30607\times10^{21}(400)^{3/2}$

$N_v = 6.3286\times10^{25}\,\#/m^3 = 6.3286\times10^{19}\,\#/cm^3$