4.12 (*a*) The carrier effective masses in a semiconductor are $m_n^* = 1.21\ m_0$ and $m_p^* = 0.70\ m_0$. Determine the position of the intrinsic Fermi level with respect to the center of the bandgap at $T = 300$ K.

Per (4.26b),

$$E_{F,i} - E_{\text{midgap}} = \frac{3}{4} k_B T \ln\left(\frac{m_p^*}{m_n^*}\right)$$

$$= 0.75\,(8.617333\times10^{-5}\ \text{eV/K})\,300\,\text{K}\,\ln\left(\frac{0.70m_0}{1.21m_0}\right)$$

$$\Rightarrow \quad \underline{\boldsymbol{E_{F,i} - E_{\text{midgap}} = -0.0106115\ \text{eV} = -1.7001511\times10^{-21}\ \text{J}}}$$