between E_D and E_F.

To conclude, E_D > E_F. The Fermi level at T = 0 K lies somewhere above E_F because that would mean all the conduction bands Lorentz with electrons. We know, however, that this would mean p = 0. Likewise, E_F cannot be below E_D because then all the conduction bands are empty of electrons. So, T = 0 K. However, once we consider the Fermi function discussion below, E_D are filled. (The location was brought in to the Fermi function discussion.)

(6) From the leftmost T = 0 K curve there are essentially no filled levels above E_F and all levels below E_F are filled. This situation was first noted in (3), where we estimated the Fermi energy using Eq. 2.02.

Note: 1. K = 8.62 x 10^-5 V/A

<table>
<thead>
<tr>
<th>E (V)</th>
<th>0.00</th>
<th>0.034</th>
<th>0.067</th>
<th>0.099</th>
<th>0.132</th>
<th>0.165</th>
<th>0.198</th>
</tr>
</thead>
<tbody>
<tr>
<td>d(V)</td>
<td>0</td>
<td>0.01</td>
<td>0.02</td>
<td>0.03</td>
<td>0.04</td>
<td>0.05</td>
<td>0.06</td>
</tr>
</tbody>
</table>

(7) E = kT (T^2)
Since the bar is n-type, we conclude from Fig. 3.7 that $N_D \equiv 9 \times 10^{16} \text{cm}^{-3}$, hence $d = \frac{1}{0.1 \Omega \cdot \text{cm}} = \frac{1}{R} = \frac{1}{R} \text{ohm-cm}$

$$v / 1 = R$$

(b)

Because of the lower mobilities in compensated materials (part d) $\mu_p < \mu_n$.

$$\nu_1 = \frac{0.1 \times 10^9 \text{cm} / \text{V-s}}{3.4 \times 10^5 \text{ohm-cm}} = \frac{0.1 \times 10^9}{3.4 \times 10^5} \text{ohm-cm}$$

(c) From inspection from Fig. 3.7, $3.5 \text{ ohm-cm}$.

(d) $3.95 \times 10^5 \text{ ohm-cm}$.

(e) $3.9 \times 10^5 \text{ ohm-cm}$.

(f) $3.9 \times 10^5 \text{ ohm-cm}$.

(g) $3.9 \times 10^5 \text{ ohm-cm}$.

(h) $3.9 \times 10^5 \text{ ohm-cm}$.

(i) $3.9 \times 10^5 \text{ ohm-cm}$.

(j) $3.9 \times 10^5 \text{ ohm-cm}$.

(k) $3.9 \times 10^5 \text{ ohm-cm}$.

(l) $3.9 \times 10^5 \text{ ohm-cm}$.

(m) $3.9 \times 10^5 \text{ ohm-cm}$.

(n) $3.9 \times 10^5 \text{ ohm-cm}$.
(a) By inspection from Fig. P3.7

\[ E_F - E_i = E_G/4 = 0.28 \text{ eV} \quad \text{at } x = L/4 \]
\[ E_F - E_i = 0 \quad \text{at } x = L/2 \]
\[ E_F - E_i = -E_G/4 = -0.28 \text{ eV} \quad \text{at } x = 3L/4 \]

Thus

\[ n = n_i e^{(E_F - E_i)/kT} \]
\[ = 10^{10} e^{0.28/0.0259} = 4.96 \times 10^{14}/\text{cm}^3 \quad \text{at } x = L/4 \]
\[ = 10^{10} e^0 = 10^{10}/\text{cm}^3 \quad \text{at } x = L/2 \]
\[ = 10^{10} e^{-0.28/0.0259} = 2.02 \times 10^5/\text{cm}^3 \quad \text{at } x = 3L/4 \]

(b) The semiconductor is degenerate near \( x = 0 \) and \( x = L \). As can be deduced from geometrical arguments, the degenerate portions of the semiconductor are specifically

\[ 0 \leq x \leq \Delta L \quad \text{and} \quad L - \Delta L \leq x \leq L, \quad \text{where} \quad \Delta L = \frac{3kT}{E_G L} \]

(c) Since \( n = n_i \exp((E_F - E_i)/kT) \) and \( p = n_i \exp((E_i - E_F)/kT) \), at least for the nondegenerate portions of the semiconductor, we conclude

![Graph showing ln(n) and ln(p) vs x](image)

Note that \( E_F - E_i \) is a linear function of \( x \). Consequently, \( \ln(n) \) and \( \ln(p) \) are also linear functions of \( x \).

(d) \( V \) versus \( x \) is just the "upside-down" of \( E_c \) versus \( x \).

![Graph showing V vs x](image)

Note: \( V \) is arbitrary to within a constant.

(e) \( \epsilon \) versus \( x \) is just proportional to the slope of \( E_c \) versus \( x \).

![Graph showing \epsilon vs x](image)

(f) \( \epsilon \) is the same, of course, for all \( x \).

\[ \epsilon = \frac{1}{q} \frac{dE_c}{dx} = \frac{\Delta E_c/q}{\Delta x} = \frac{1.12V}{10^{-2}\text{cm}} = 1.12 \times 10^2 \text{ V/cm} \]

Note: \( \Delta E_c = 1.12 \text{ eV} = (1.12)(1.6 \times 10^{-19}) \) joules

\[ \frac{\Delta E_c}{q} = \frac{(1.12)(1.6 \times 10^{-19})}{1.6 \times 10^{-19} \text{ coul}} = 1.12 \text{ V} \]