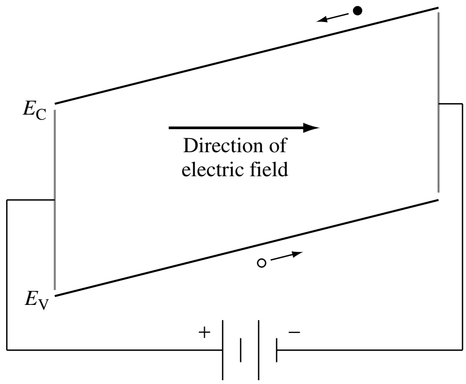

Figure 3.11 Illustration of the concept of drift in a semiconductor. Note that electrons and holes move in opposite directions. The electric field can be created by the internal built-in potential of the junction or by an externally applied bias voltage

The most significant scattering mechanisms in solar cells are lattice (phonon) and ionized impurity scattering. These component mobilities can be written as

$$\mu_L = C_L T^{-3/2} \tag{3.55}$$

for lattice scattering and as

$$\mu_I = \frac{C_I T^{3/2}}{N_D^+ + N_A^-} \tag{3.56}$$

for ionized impurity scattering. These can then be combined using Mathiessen's rule to give the carrier mobility [12]

$$\frac{1}{\mu} = \frac{1}{\mu_L} + \frac{1}{\mu_I}. \tag{3.57}$$

This is a first-order approximation that neglects the velocity dependencies of the scattering mechanisms. These two types of mobility can be distinguished experimentally by their different dependencies on temperature and doping. A better approximation is [12]

$$\mu = \mu_L \left[1 + \left(\frac{6\mu_L}{\mu_I}\right)\left(\mathrm{Ci}\left(\frac{6\mu_L}{\mu_I}\right)\cos\left(\frac{6\mu_L}{\mu_I}\right) + \left[\mathrm{Si}\left(\frac{6\mu_L}{\mu_I}\right) - \frac{\pi}{2}\right]\sin\left(\frac{6\mu_L}{\mu_I}\right)\right)\right], \tag{3.58}$$

where Ci and Si (not to be confused with the abbreviation for silicon) are the cosine and sine integrals, respectively.

When modeling solar cells, it is more convenient to use measured data or empirical formulas. Carrier mobilities in Si at 300 K are well approximated by [12]

$$\mu_n = 92 + \frac{1268}{1 + \left(\dfrac{N_D^+ + N_A^-}{1.3 \times 10^{17}}\right)^{0.91}} \mathrm{cm^2/V\text{-}s} \tag{3.59}$$