Example 1.3 An electron is confined to a 1 micron thin layer of silicon. Assuming that the semiconductor can be adequately described by a one-dimensional quantum well with infinite walls, calculate the lowest possible energy within the material in units of electron volt. If the energy is interpreted as the kinetic energy of the electron, what is the corresponding electron velocity? (The effective mass of electrons in silicon is 0.26 m_0, where m_0 = 9.11 x 10^{-31} kg is the free electron rest mass).

Solution The lowest energy in the quantum well equals:

$$E_1 = \frac{h^2}{2m^*}(\frac{1}{2L_x})^2 = \frac{(6.626\times10^{-34})^2}{2\times0.26\times9.11\times10^{-31}}(\frac{1}{2\times10^{-6}})^2$$

$$= 2.32 \text{ x } 10^{-25} \text{ Joules} = 1.45\ \mu\text{eV}$$

The velocity of an electron with this energy equals:

$$v = \sqrt{\frac{2E_1}{m^*}} = \sqrt{\frac{2\times2.32\times10^{-25}}{0.26\times9.11\times10^{-31}}} = 1.399 \text{ km/s}$$