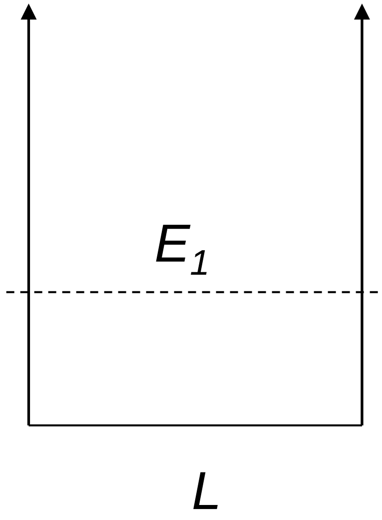
P08: Rectangular quantum well – mass dependence

Compare the **1st** allowed energy level for an electron trapped in an *infinite* **1-dimensional** *rectangular* potential well of a length **L = 1 nm** , created in silicon Si.



$$m_e = 0.916 \cdot m_0$$

$$E_n = \frac{\hbar^2 \pi^2}{2 m_e} \frac{n^2}{L^2}$$

n=1

$$E[eV] = \frac{E[J]}{q}$$

h = 6.626 x 10^{-34} [Js]

$\hbar = \frac{h}{2\pi} = 1.055x10^{-34}$ [Js]

m_0 = 9.11 x 10^{-31} [kg]

q = 1.602 x 10^{-19} [C]

k_B = 1.381 x 10^{-23} [J/K]

ε_0 = 8.854 x 10^{-12} [F/m]

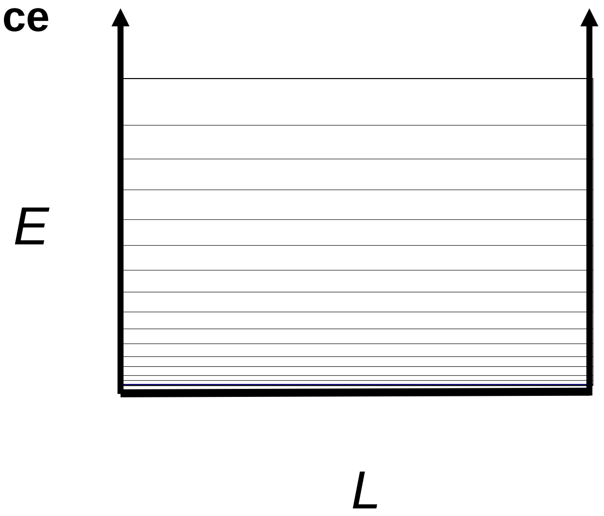
c = 3 x 10^{8} [m/s]

Material	m_e/m_0	E_n [eV]
Si	0.916	0.411

What happens to the energy levels when changing the potential well width?

P08b: Rectangular quantum well – width dependence

Consider an Infinite 1-dimensional rectangular potential well created in silicon. Find the well's length **L**, such that the first **N=100** energy levels for electrons are located below an energy of ***E*** **= 1 eV.**



Solution: $$E_N = \frac{\hbar^2 \pi^2}{2m_e} \frac{N^2}{L^2} < E$$

$$L > \frac{\hbar \pi N}{\sqrt{2m_e E}}$$

$$E[eV] = \frac{E[J]}{q}$$

Material	**m_e/m_0**	**L [nm]**
Si	0.916	64.1

h = 6.626 x 10^{-34} $[Js]$

$\hbar = \dfrac{h}{2\pi} = 1.055x10^{-34}\ [Js]$

m_0 = 9.11 x 10^{-31} $[kg]$

q = 1.602 x 10^{-19} $[C]$

k_B = 1.381 x 10^{-23} $[J/K]$

ε_0 = 8.854 x 10^{-12} $[F/m]$

c = 3 x 10^{8} $[m/s]$