Exercise Sheet 3 due 7 November

1. *finite potential well*

Consider a potential well of width L and depth V_0.

i. Find all eigenenergies $E_n < 0$ for $V_0 = 8$ eV and $L = 15$ Å.

ii. Compare the eigenenergies $E_n + V_0$ measured from the bottom of the well with the eigenenergies for an electron in an infinite potential well of the same width.

2. *potential barrier*

Consider a potential barrier $V(x)$ with width $L = 6$ Å and $V_0 = 2$ eV, where

$$V(x) = \begin{cases} V_0, \text{ for } 0 < x < L \\ 0 \text{ , otherwise} \end{cases}$$

An electron wave is incident from the left: $\varphi_{in}(x) = e^{ikx}$

i. find the solution $\varphi_k(x)$ of the Schrödinger equation by matching waves at $x = 0$ and L

ii. calculate the transmission probability as a function of the energy of the incoming electron $E_k = \hbar^2 k^2 / 2m$

iii. Determine the maximum transmission probability.

iv. At what energies E_n does the transmission probability have a maximum? Calculate $E_n - V_0$. Explain why the barrier becomes transparent at these energies.