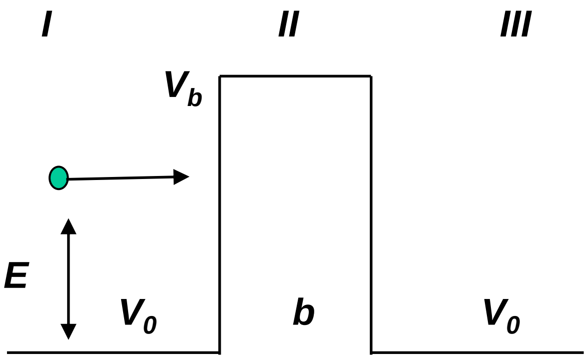
Problem 07: Tunneling



Consider a potential barrier of a width ***b*** and a height ***V_b*,** as in the figure. Assuming: ***$m_I=m_{II}=m_{III}=m^*$***, calculate the probability ***P*** of crossing the barrier by an electron of energy ***E***.
b= 1 nm, ***V_b***=**2 eV**, ***V_0***=**1 eV**, ***m^*= 0.5 m_0***, ***E***=**1.5 eV**

Within the classical physics, since the electron energy ***E*** is smaller than the barrier, the electron could not cross it. However, according to the Q-M approach, the electron may cross (tunnel) the barrier with some probability ***P***.

If **$2\kappa_b b \gg 1$,** the tunneling probability *P* for a system as in the figure (symmetrical barrier) is given by:

$$P = P_0 \exp\left(-2\kappa_b b\right) = \quad 0.024$$

where P_0 *(pre-exponential factor)*

$$P_0 = 16\frac{k^2\kappa_b^2}{\left(k^2+\kappa_b^2\right)^2} = \quad 4.0$$

$$2\kappa_b b = \quad 5.1$$

and ***k*** and ***κ_b*** are the electron wave vectors **outside and within** the barrier, correspondingly:

$$k = \frac{\sqrt{2m^*(E-V_0)}}{\hbar} = \quad 2.560\text{E+09 [1/m]}$$

$$\kappa_b = \frac{\sqrt{2m^*(V_b-E)}}{\hbar} = \quad 2.560\text{E+09 [1/m]}$$

Note the difference between k and κ!