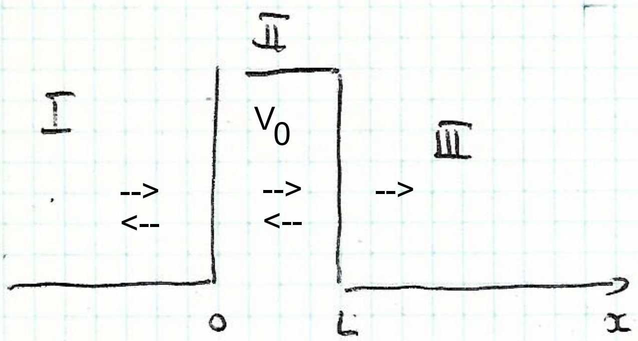

(I) $$-\frac{\hbar^2}{2m_0}\frac{d^2\psi_I(x)}{dx^2} = E\psi_I(x) \Rightarrow \frac{d^2\psi_I(x)}{dx^2} = \frac{-2m_0E}{\hbar^2}\psi_I(x) \Rightarrow \frac{d^2\psi_I(x)}{dx^2} = -\mathcal{E}\psi_I(x)$$

$$\mathcal{E} = \frac{2m_0E}{\hbar^2}$$

$$\frac{d^2\psi_I(x)}{dx^2} + \mathcal{E}\psi_I(x) = 0 \Rightarrow \text{solution: } \psi_I(x) = A_1e^{r_1x} + B_1e^{r_2x}$$

equation caracteristique: $ar^2 + br + c = 0 \Rightarrow r^2 + \mathcal{E} = 0 \Rightarrow r^2 = -\mathcal{E}$

$$r^2 = i^2\mathcal{E} \Rightarrow r_1 = i\sqrt{\mathcal{E}} \text{ and } r_2 = -i\sqrt{\mathcal{E}}$$

$$\psi_I(x) = A_1e^{i\sqrt{\mathcal{E}}x} + B_1e^{-i\sqrt{\mathcal{E}}x}$$

$$\mathcal{E} = \frac{2m_0E}{\hbar^2} = \frac{2m_0\,P^2/2m_0}{\hbar^2} = \frac{P^2}{\hbar^2} = k^2 \Rightarrow \sqrt{\mathcal{E}} = k$$

$$\psi_I(x) = A_1e^{ikx} + B_1e^{-ikx}$$

(II): $$-\frac{\hbar^2}{2m_0}\frac{d^2\psi_{II}(x)}{dx^2} + V_0\psi_{II}(x) = E\psi_{II}(x) \Rightarrow \frac{d^2\psi_{II}(x)}{dx^2}\left(-\frac{2m_0V_0}{\hbar^2} + \frac{2m_0E}{\hbar^2}\right)\psi_{II}(x) = 0$$

$$\mathcal{E} = \frac{2m_0E}{\hbar^2} \text{ and } \mathcal{V}_0 = \frac{2m_0V_0}{\hbar^2}$$

$$\frac{d^2\psi_{II}(x)}{dx^2} + (\mathcal{E} - \mathcal{V}_0)\psi_{II}(x) = 0 \Rightarrow \text{solution } \psi_{II}(x) = A_2e^{r_1x} + B_2e^{r_2x}$$

equation caracteristique: $r^2 + (\mathcal{E} - \mathcal{V}_0) = 0 \Rightarrow r^2 = -(\mathcal{E} - \mathcal{V}_0)$

if $\mathcal{E} < \mathcal{V}_0 \Rightarrow \mathcal{E} - \mathcal{V}_0 < 0 \quad r^2 > 0 \Rightarrow r_1 = +\sqrt{\mathcal{V}_0 - \mathcal{E}} \quad r_2 = \sqrt{\mathcal{V}_0 - \mathcal{E}}$

$r_1 = K$ and $r_2 = -K \Rightarrow \psi_{II}(x) = A_2e^{Kx} + B_2e^{-Kx}$

if $\mathcal{E} > \mathcal{V}_0 \Rightarrow \mathcal{E} - \mathcal{V}_0 > 0 \quad r^2 < 0 \Rightarrow \psi_{II}(x) = A_2e^{-iKx} + B_2e^{+iKx}$