$E > V_0$

$$\boxed{\psi'' = \alpha^2 \psi}$$

$$-\frac{\hbar^2}{2m}\frac{d^2}{dx^2}\psi = (E - V_0)\psi$$

I. $\psi_I(x) = Ae^{ik_1x} + Be^{-ik_1x}$

II. $\psi_{II}(x) = Ce^{ik_2x}$

$$k_1^2 = \frac{2mE}{\hbar^2}$$

$$k_2^2 = \frac{2m}{\hbar^2}(E - V_0)$$

$$\bar{j} = \mathrm{Im}\left[\frac{\hbar}{m}\psi^* \bar{\nabla}\psi\right]$$

(probability current)

$$= \frac{\hbar}{m}\left[\frac{\psi^* \bar{\nabla}\psi - \psi\nabla\psi^*}{2i}\right]$$

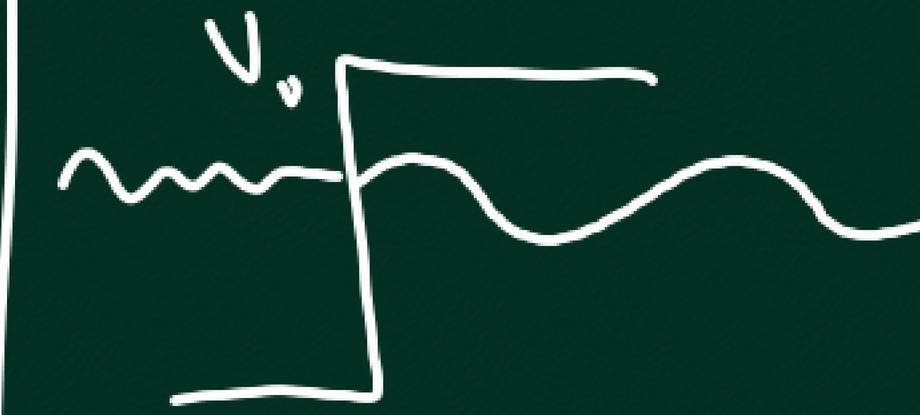
$$\mathrm{Im}\, z = \frac{z - z^*}{2i}$$

$z = a + ib$

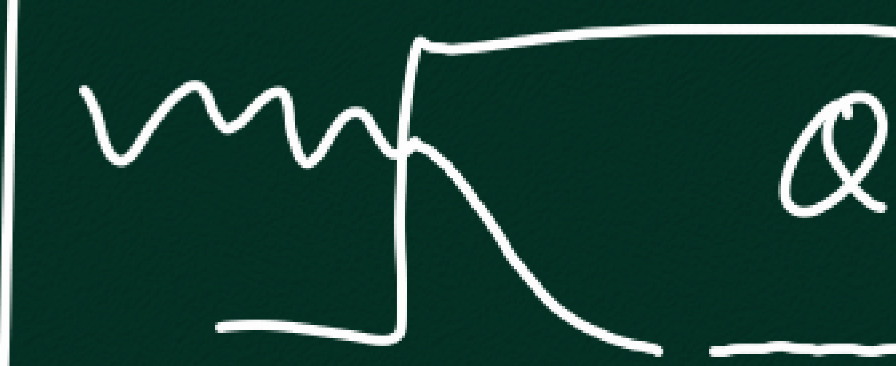
$z^* = a - ib$

$z - z^* = 2ib$

$E > V_0$

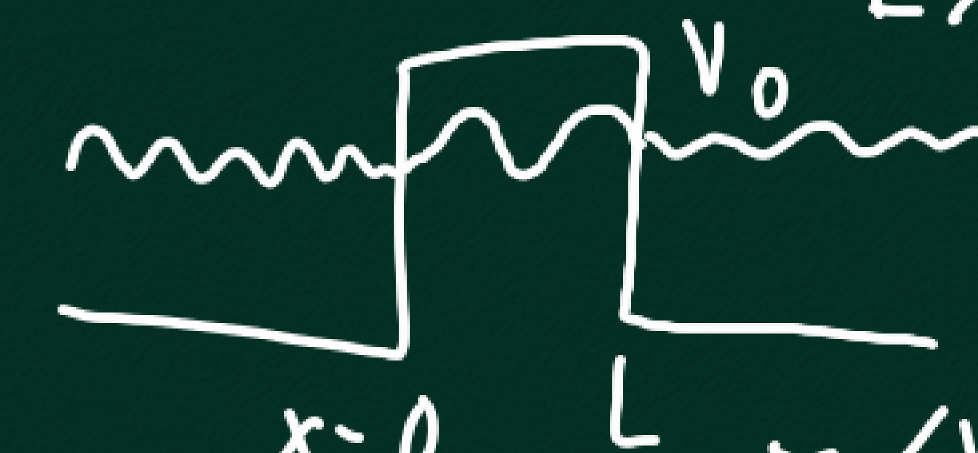


$E < V_0$



Quntm

$E > V_0$



$E < V_0$

Quntm

$$\psi = A e^{ikx} \qquad \hat{i}\,\frac{d}{dx}$$

$$\vec{j} = \frac{\hbar}{2im}\left[\underbrace{\psi^* \bar{\nabla} \psi} - \psi \bar{\nabla} \psi^*\right]$$

$$= \frac{\hbar}{2im}\left[A^* e^{-ikx} A(ik) e^{ikx} - A e^{ikx} A^* (-ik) e^{-ikx}\right]\hat{x}$$

$$= \frac{\hbar}{2im} |A|^2 (2ik)\,\hat{x}$$

$$\vec{j} = |A|^2 \frac{\hbar}{m} k\,\hat{x}$$

$k_1 > k_2$ $\qquad k = 2\pi / \lambda$

$\lambda_1 < \lambda_2$

$$j = |A|^2 \frac{\hbar}{m} k \leftarrow \psi = A e^{ikx}$$

$A \rightsquigarrow j_i \qquad \rightsquigarrow j_T$

$\leftarrow B \qquad C$

j_r

$$1 = \frac{|B|^2 \frac{\hbar}{m} k_1}{|A|^2 \frac{\hbar}{m} k_1} + \frac{|C|^2 \frac{\hbar}{m} k_2}{|A|^2 \frac{\hbar}{m} k_1}$$

$$j_{in} = j_r + j_T$$

$$1 = \frac{j_r}{j_{in}} + \frac{j_T}{j_{in}}$$

R $\qquad$ T coeff

$$k_1\left(\frac{k_1-k_2}{k_1+k_2}\right)^2 + k_2\left(\frac{2k_1}{k_1+k_2}\right)^2$$

$$-2k_1^2k_2 + 4k_1^2k_2$$

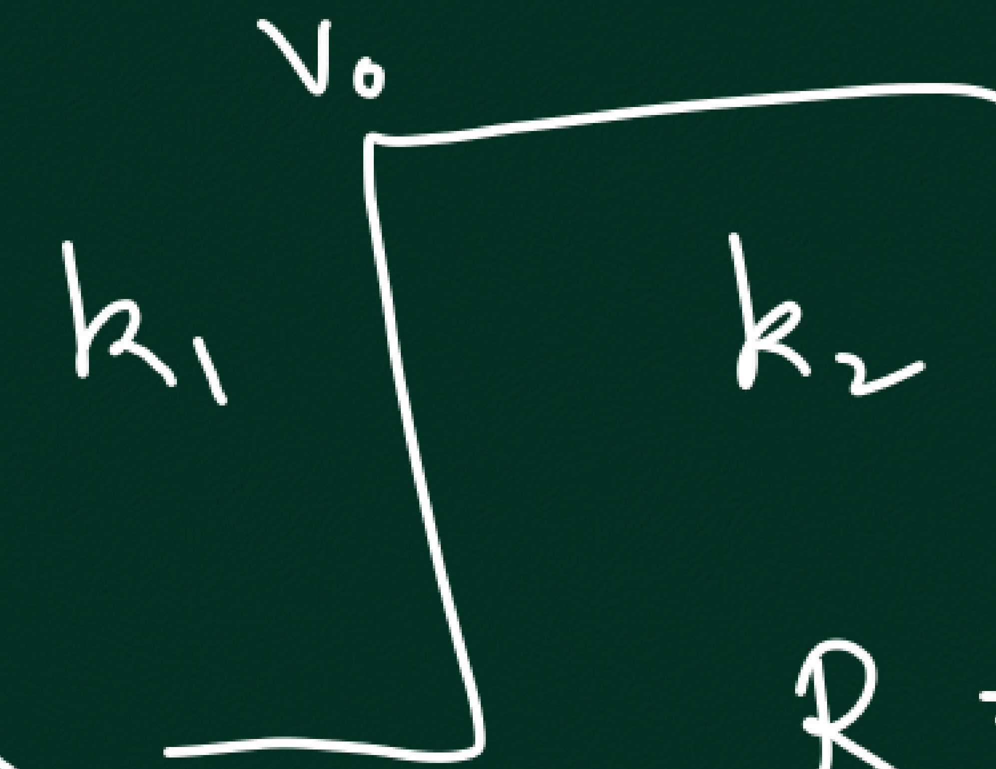
$$k_1\frac{(k_1+\cancel{k_2})^2}{(k_1+\cancel{k_2})^2} \rightsquigarrow$$

$\underline{E < V_0}$

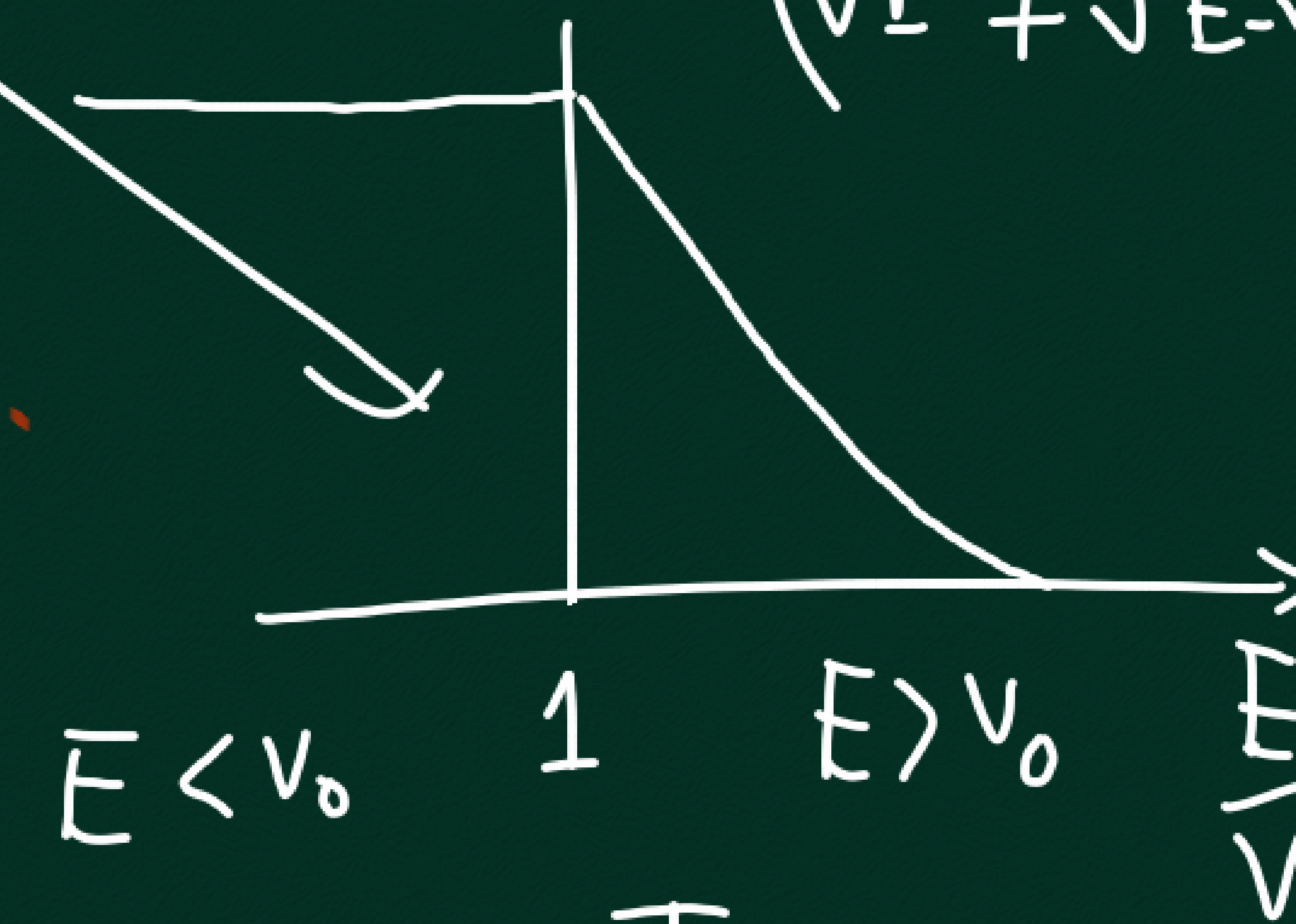
$\underline{E > V_0}$

$$\vec{j} = \frac{\hbar}{2im}\Big[\underbrace{\psi^*\bar{\nabla}\psi - \psi\bar{\nabla}\psi^*}_{=0 \text{ for any real}}\Big] = 0$$

$$R = \frac{J_r}{J_{in}} = \frac{|B|^2 \frac{\hbar k_1}{m}}{|A|^2 \frac{\hbar k_1}{m}} = \left|\frac{B}{A}\right|^2$$

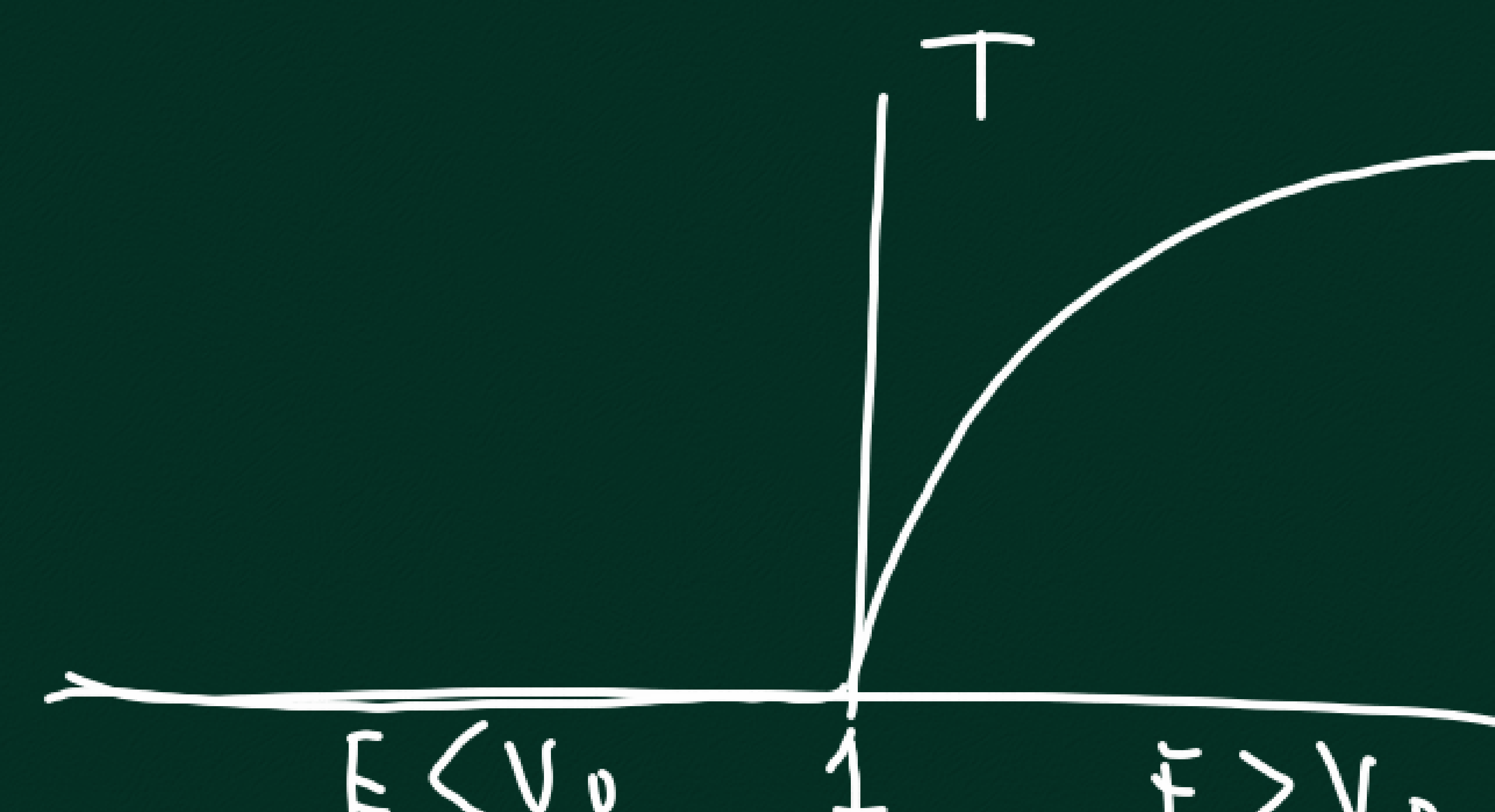


$$R = \left(\frac{\sqrt{E} - \sqrt{E-V_0}}{\sqrt{E} + \sqrt{E-V_0}}\right)^2$$



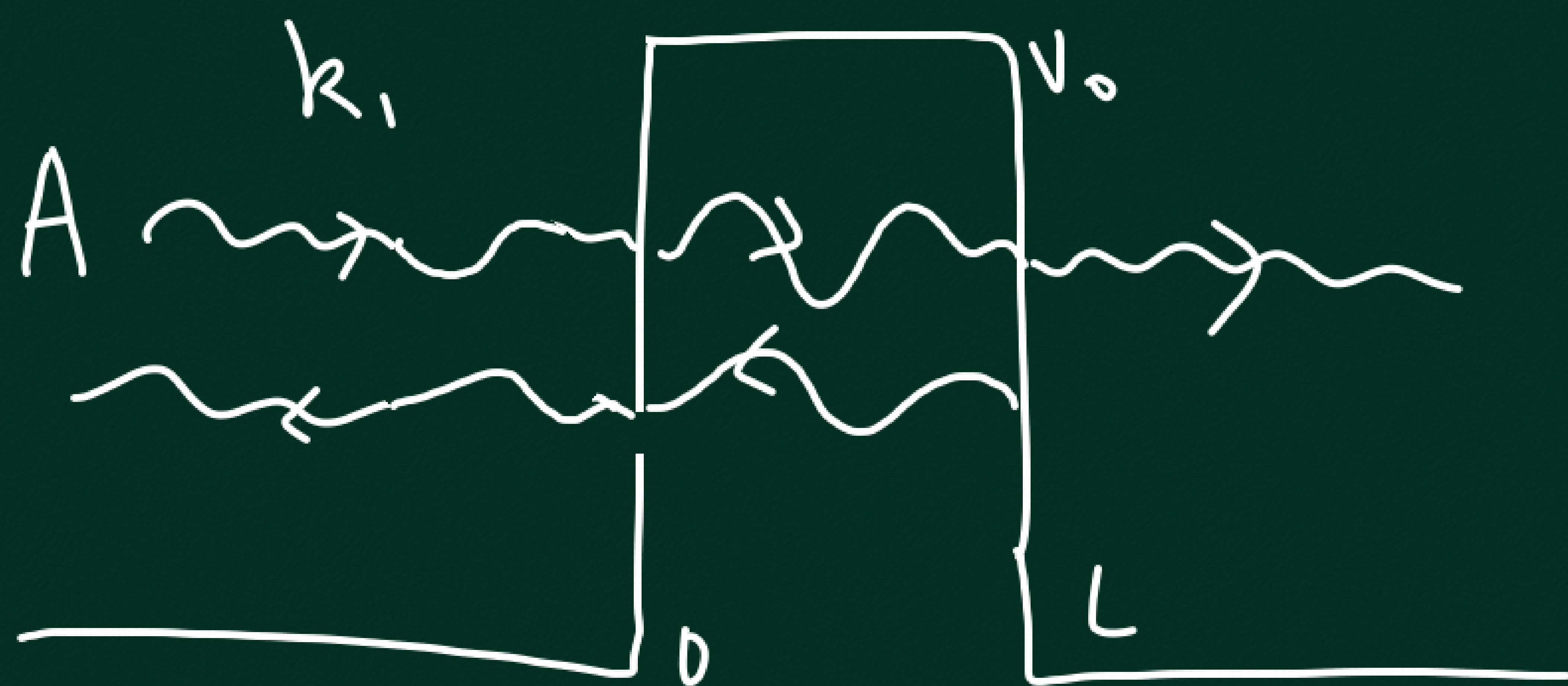
$$T + R = 1$$

$$T = \frac{J_T}{J_{in}} = \frac{|C|^2 \frac{\hbar k_2}{m}}{|A|^2 \frac{\hbar k_1}{m}} = \left|\frac{C}{A}\right|^2 \frac{k_2}{k_1}$$



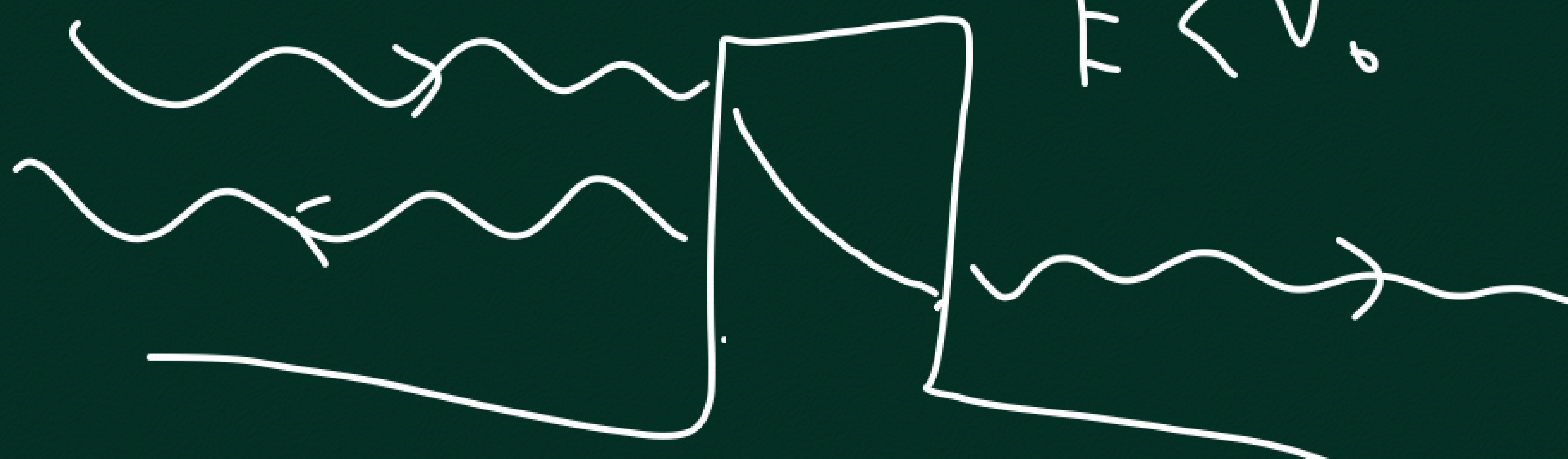
$E > V_0$

$(E - V_0)$



5 coeff but get everything as ratio $\frac{B}{A}, \frac{C}{A}, \frac{D}{A}, \frac{e}{A}$

$E < V_0$



$E < V_0$