

$$V(x) = V_0(a - |x|) \quad E > 0$$

$$V_0 > 0 \quad E < V_0$$

$$\frac{d^2}{dx^2} \psi_I(x) + k^2 \psi_I(x) = 0 \quad k = \frac{\sqrt{2mE}}{\hbar}$$

$$\frac{d^2}{dx^2} \psi_{II}(x) - \kappa^2 \psi_{II}(x) = 0 \quad \kappa = \frac{\sqrt{2m(V_0 - E)}}{\hbar}$$

$$\frac{d^2}{dx^2} \psi_{III}(x) + k^2 \psi_{III}(x) = 0$$

$$\begin{aligned} \text{I)} & A e^{ikx} + B e^{-ikx} \\ \text{II)} & C e^{-\kappa x} + D e^{+\kappa x} \\ \text{III)} & F e^{ikx} \end{aligned}$$

$$\psi_I(-a) = \psi_{II}(-a)$$

$$\psi_{II}(a) = \psi_{III}(a)$$

$$\left. \frac{d\psi_I}{dx} \right|_{x=-a} = \left. \frac{d\psi_{II}}{dx} \right|_{x=-a}$$

$$\left. \frac{d\psi_{II}}{dx} \right|_{x=a} = \left. \frac{d\psi_{III}}{dx} \right|_{x=a}$$

$$1) \begin{pmatrix} A \\ B \end{pmatrix} = M(a) \begin{pmatrix} C \\ D \end{pmatrix}$$

$$2) \begin{pmatrix} F \\ G=0 \end{pmatrix} = \tilde{M} \begin{pmatrix} C \\ D \end{pmatrix} \quad \tilde{M}(a) = M(-a)$$

$$\begin{pmatrix} A \\ B \end{pmatrix} = \underbrace{M(a) M(-a)^{-1}}_M \begin{pmatrix} F \\ G=0 \end{pmatrix}$$

$$M = \begin{pmatrix} (\cosh 2\kappa a + \frac{i\epsilon}{2} \sinh 2\kappa a) e^{2i\kappa a} & \frac{i\eta}{2} \sinh 2\kappa a \\ -\frac{i\eta}{2} \sinh 2\kappa a & (\cosh 2\kappa a - \frac{i\epsilon}{2} \sinh 2\kappa a) e^{-2i\kappa a} \end{pmatrix}$$

$$\epsilon \equiv \frac{\kappa}{k} - \frac{k}{\kappa}$$

$$\eta = \frac{\kappa}{k} + \frac{k}{\kappa}$$

$$A = F (\cosh 2\kappa a + \frac{i\epsilon}{2} \sinh 2\kappa a) e^{2i\kappa a}$$

$$B = F (-\frac{i\eta}{2} \sinh 2\kappa a)$$

$$S(E) \equiv \frac{F}{A} = \frac{e^{-2i\kappa a}}{\cosh 2\kappa a + \frac{i\epsilon}{2} \sinh 2\kappa a}$$

دالة انتقال

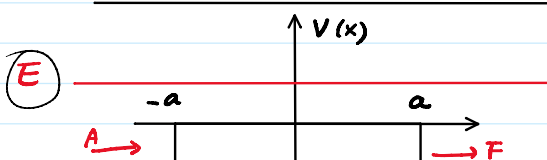
$$|S(E)|^2 = \frac{1}{1 + (1 + \frac{\epsilon^2}{4}) \sinh^2 2\kappa a}$$

$$\kappa a \gg 1 \quad \sinh 2\kappa a = \frac{1}{2} (e^{2\kappa a} - e^{-2\kappa a}) \xrightarrow{\kappa a \gg 1} \frac{1}{2} e^{2\kappa a}$$

$$|S(E)|^2 \approx (1 + \frac{\epsilon^2}{4})^{-1} 4 e^{-4\kappa a} = \frac{16 \kappa^2 k^2}{(\kappa^2 + k^2)^2} e^{-4\kappa a}$$

$$\frac{16 E (V_0 - E)}{V_0^2} \exp\left(-\frac{4a}{\hbar} \sqrt{2m(V_0 - E)}\right) = \left|\frac{F}{A}\right|^2$$

دالة انتقال

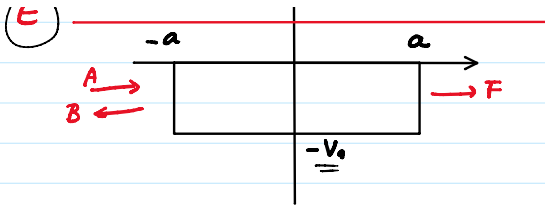


$$V(x) = -V_0 \theta(a - |x|)$$

$$E > 0$$

$$V_0 \rightarrow -V_0$$

دالة انتقال



$\epsilon > 0$   
 $V_0 \rightarrow -V_0$

$$k^2 = \frac{2m(-V_0 - E)}{\hbar^2} = -\frac{2m(V_0 + E)}{\hbar^2} = -q^2$$

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

$\kappa = iq$

$$\epsilon = \frac{iq}{k} - \frac{k}{iq} = i\left(\frac{q}{k} + \frac{k}{q}\right)$$

$$F = S(E) A$$

$$\eta = \frac{iq}{k} + \frac{k}{iq} = i\left(\frac{q}{k} - \frac{k}{q}\right)$$

فرمان گذردی

$$\sqrt{|S(E)|^2} = \left| \frac{F}{A} \right|^2 = \frac{1}{1 + \frac{1}{q} \left( \frac{q}{k} - \frac{k}{q} \right)^2 \sin^2 2qa} = \left( 1 + \frac{\sin^2 2qa}{4 \left( \frac{E}{V_0} \right) \left( 1 + \frac{E}{V_0} \right)} \right)^{-1}$$

فرمان بازتاب

$$|R(E)|^2 = 1 - |S(E)|^2 = \left| \frac{B}{A} \right|^2$$

$$B = \frac{F}{AS(E)} = \frac{i}{2} \left( \frac{q}{k} - \frac{k}{q} \right) \sin 2qa$$

شرط شد

$$|S(E)|^2 = 1$$

$$\sin^2 2qa = 0$$

$$2qa = n\pi \quad n = 0, 1, 2, \dots$$

$$\frac{\sqrt{2m(E+V_0)}}{\hbar} = \frac{n}{2a} \pi \rightarrow$$

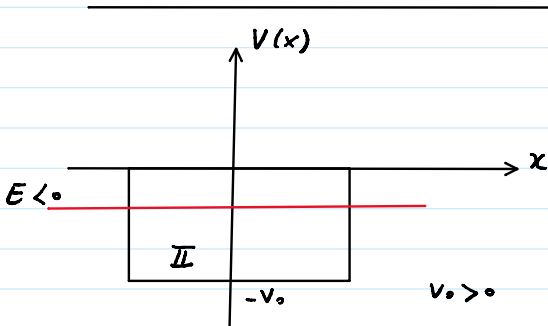
$$E_R = \frac{n^2 \hbar^2 \pi^2}{8ma^2} - V_0$$

ریشه‌ها (شده)  $-|E_R| = -V_0 + \frac{n^2 \hbar^2 \pi^2}{8ma^2}$

$$\zeta^2 = \frac{2mV_0 a^2}{\hbar^2}$$

$$x \equiv \frac{E}{V_0}$$

$$|S(E)|^2 = \left( \frac{4x(1+x) + \sin^2 2\zeta \sqrt{1+x}}{4x(1+x)} \right)^{-1}$$



$$\kappa^2 = \frac{2m|E|}{\hbar^2}$$

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

$$1) \frac{\kappa_B}{q} = \tan qa \quad q \rightarrow E$$

موج تابش

$$2) \frac{\kappa_B}{q} = -\cot qa$$

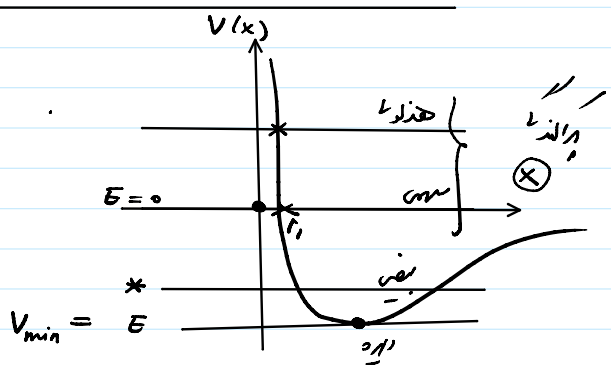
موج جذب

جواب ۱

$$E_n = -V_0 + \frac{(2n+1)^2 \pi^2 \hbar^2}{8ma^2} \quad n = 0, 1, 2, \dots$$

جواب ۲

$$E_n = -V_0 + \frac{n^2 \pi^2 \hbar^2}{8ma^2} \quad n = 1, 2, \dots$$



جواب نهم

$$E_n = -V_0 + \frac{\hbar^2 k^2}{8ma^2} \quad \checkmark \quad n = 1, 2, \dots$$

$$q_l a \sim (l+1)\frac{\pi}{2} \rightarrow \boxed{-} |E_l| \sim -V_0 + \frac{l^2 \pi^2 \hbar^2}{8ma^2}$$

$l = 0, 1, 2, \dots$

نتیجه ۱- انرژی شدید بزرگند و انرژی با انرژی  $|E_l|$  حالت میند در سنده چه پهنای بیدر عین در ارتباط است

نتیجه ۲: