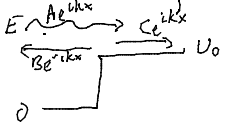


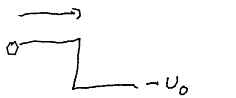
$$k = \frac{\sqrt{2mE}}{\hbar}$$

$$k' = \frac{\sqrt{2m(E-U_0)}}{\hbar}$$

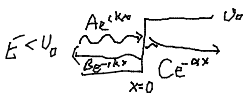
$$R = \frac{|B|^2}{|A|^2} = \left(\frac{k-k'}{k+k'}\right)^2$$

$$T = \frac{|C|^2}{|A|^2}\frac{k'}{k} = \frac{4kk'}{(k+k')^2}$$

$$R + T = 1$$



$$k' = \frac{\sqrt{2m(E+|U_0|)}}{\hbar}$$



$Ce^{ik'x}$

$$k' = \frac{\sqrt{2m(E-U_0)}}{\hbar}$$

$$\alpha = \frac{\sqrt{2m(U_0-E)}}{\hbar}$$

$\psi_L(x) = Ae^{ikx} + Be^{-ikx}$ $\quad \psi_R = Ce^{-\alpha x}$

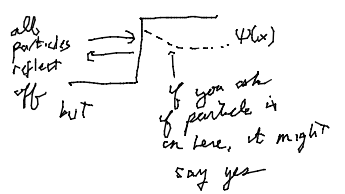
$\psi_L(0) = \psi_R(0)$ $\quad A + B = C$

$\psi_L'(0) = \psi_R'(0)$ $\quad Ak - Bik = -\alpha C = -\alpha(A+B)$

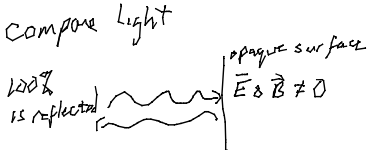
$$B = \frac{\alpha + ik}{\alpha - ik} A$$

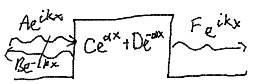
$$R = \frac{|B|^2}{|A|^2} = \left|\frac{\alpha+ik}{\alpha-ik}\right|^2$$

$$= \frac{\alpha+ik}{\alpha-ik}\,\frac{\alpha-ik}{\alpha+ik} = 1$$



compare Light

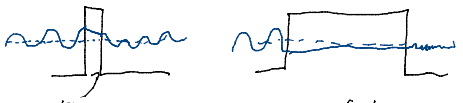




square barrier

$$T = \frac{|F|^2}{|A|^2} > 0 \qquad R = \frac{|B|^2}{|A|^2}$$

Quantum tunneling



$e^{-\alpha x}$ characteristic length of decay

if $\delta = \frac{1}{\alpha} = \frac{\hbar}{\sqrt{2m(U_0 - E)}} \gg$ Width of barrier

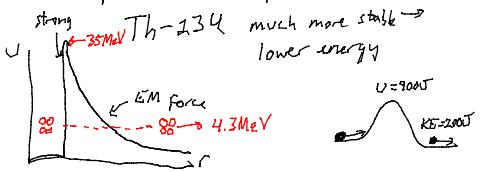
then tunneling occurs readily

if not, it doesn't

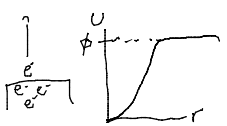
Alpha Decay

e.g. U-238 nucleus - unstable

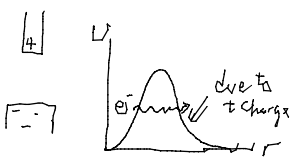
expels an alpha particle ($2p, 2n$)



- Tunnel Diode
- SQUID
- field emission



thermionic emission
- heat up metal
- some e^- can get enough energy to escape



tunneling allowed

field emission
- less noise
- less power

"electron beam"