

Problems in wave mechanics

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1 Step potential

Consider a wave incident from the left on a finite barrier,

$$V = \begin{cases} 0 & x < 0 \\ V_0 & x > 0 \end{cases}$$

Solve the stationary state Schrödinger equation for a plane wave with energy $0 < E < V_0$. Classically the wave would exist only for $x < 0$, but quantum mechanically it penetrates into the barrier. Do not impose any boundary condition at $x = -\infty$, but require the wave function to vanish at $x = +\infty$.

2 Tunneling

Solve the stationary state Schrödinger equation for a positive square well potential – a barrier – when the energy is less than the height of the barrier. Let the potential be

$$V = \begin{cases} +V_0 & 0 < x < L \\ 0 & \text{otherwise} \end{cases}$$

and the energy be $0 < E < V_0$. For $x < 0$ there will be both left- and right-travelling components (e^{ikx} and e^{-ikx}), while on the right, $x > L$, let there be only the transmitted wave, e^{ikx} .