Kwantumfysica I

2008-2009

Hoorcollege dinsdag 16 december 2008

Deze week vooral Hoofdstuk 7 (beetje 8)

Vragen n.a.v. stof vorige week of werkcollege?

Vandaag

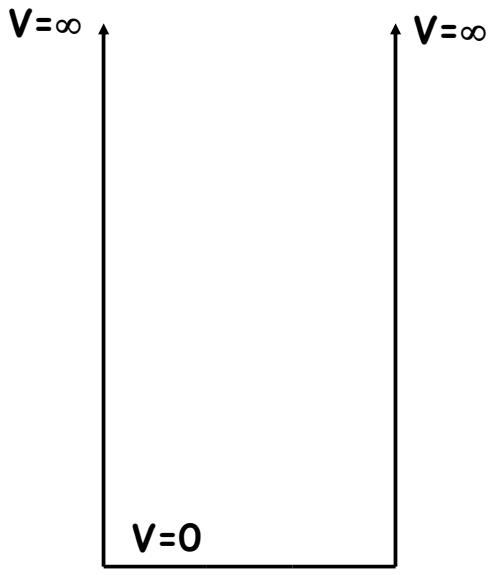
(uitwerking voorbeelden deels op bord, zie werkcollege sommen)

1 Wavefunction incident on finite potential

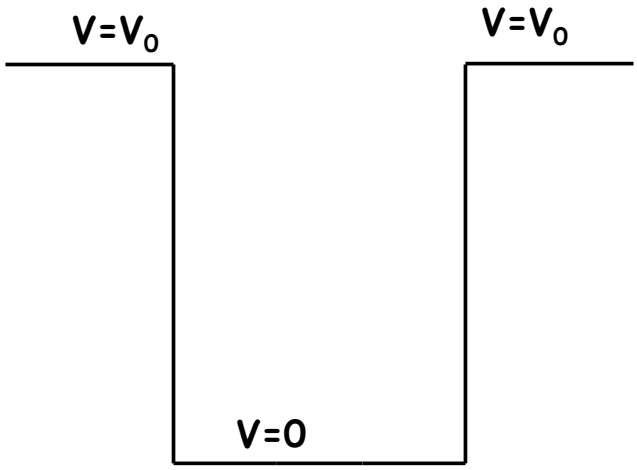
2 Tunnel effect

More on particle in a box,
and scattering on finite potentials

Until now:



More realistic:



What are now the energy eigenfunctions and eigenvalues?

Time-independent Schrodinger equation:

$$\hat{H} = \hat{T} + \hat{V}$$

$$\hat{H} = \frac{\hat{p}_x^2}{2m} + \hat{V}(x)$$

$$\hat{H}\left|\varphi_n\right\rangle = E_n\left|\varphi_n\right\rangle$$

$$-\frac{\hbar^2}{2m}\frac{\partial^2}{\partial x^2}\varphi_n(x) + \hat{V}(x)\varphi_n(x) = E_n\varphi_n(x)$$

$$\frac{\partial^2}{\partial x^2}\varphi_n(x) = -k^2\varphi_n(x)$$

$$k = \sqrt{\frac{2m(E-V)}{\hbar^2}} \qquad \text{voor } E > V \text{ met } \quad e^{\pm ikx} \text{ oplossingen}$$

$$\textit{of} \qquad k' = \sqrt{\frac{2m(V-E)}{\hbar^2}} \qquad \text{voor } V > E \text{ met } \quad e^{\pm k'x} \text{ oplossingen}$$

Solving eigenfunctions:
General case for time-independent Hamiltonian

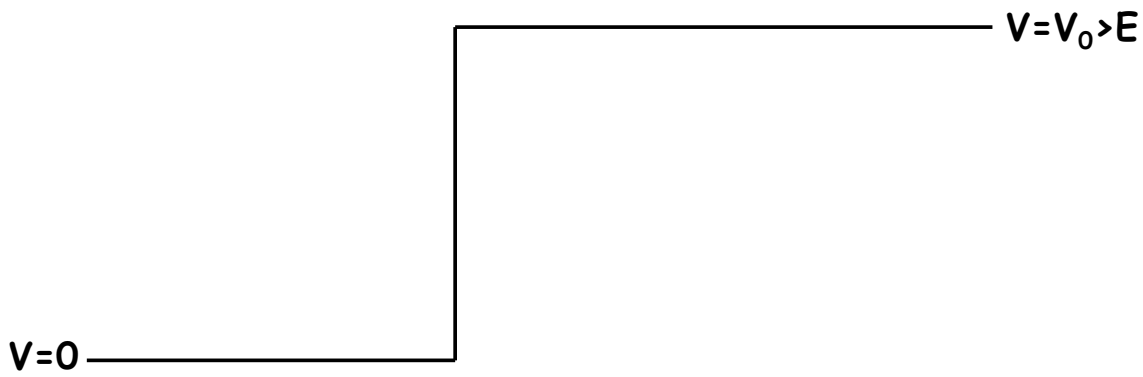
To find Ψ for realistic physical situation,
use these boundary conditions
(here 1D case):

1. Ψ continuous
2. $d\Psi/dx$ continuous

} Otherwise Fourier components with extreme high kinetic energy (high k-values) needed to form Ψ

3. Ψ normalized $\int \Psi^* \Psi \, dx = 1$
4. Ψ limited, no unphysical extremes
5. Ψ is single-valued

What is the behavior of a matter wave coming in form the left?



Remarks:
1) The analysis and language used in describing this type of problem is a somewhat loosely defined mixture of a static and a dynamic picture!
This can indeed be confusing, but still a widely used model. Think of a snapshot taken, while a very long wavepacket is bussy with scattering.
2) Often they plot Re{e^{ikx}}, etc.

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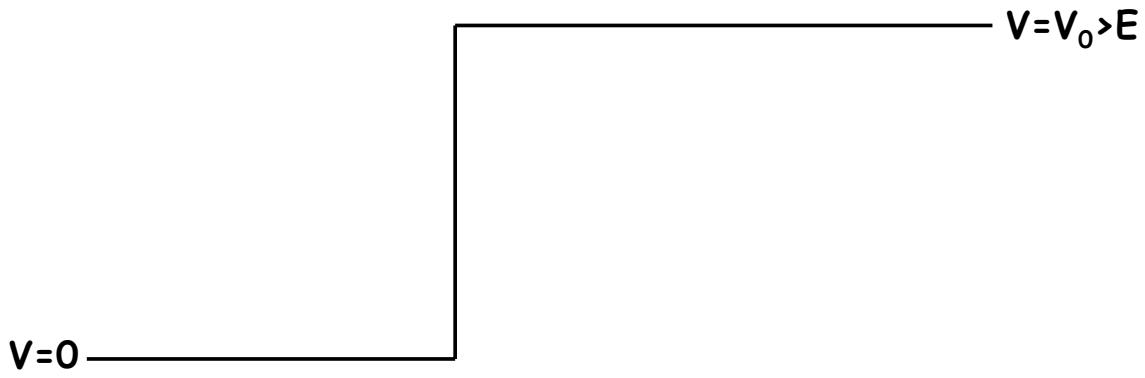
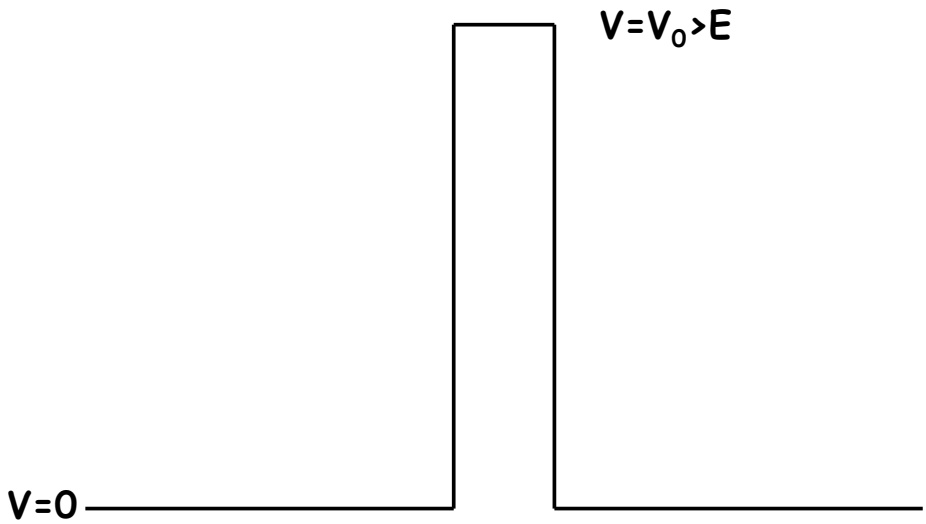


What is the behavior of a matter wave coming in form the left?

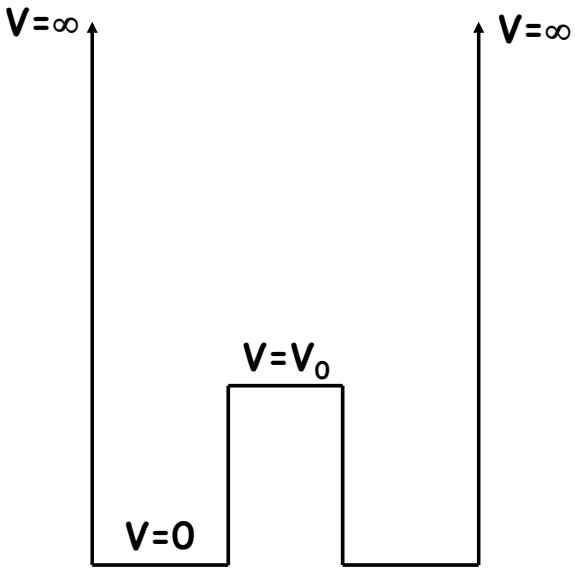
What about the arbitrary phase factor?

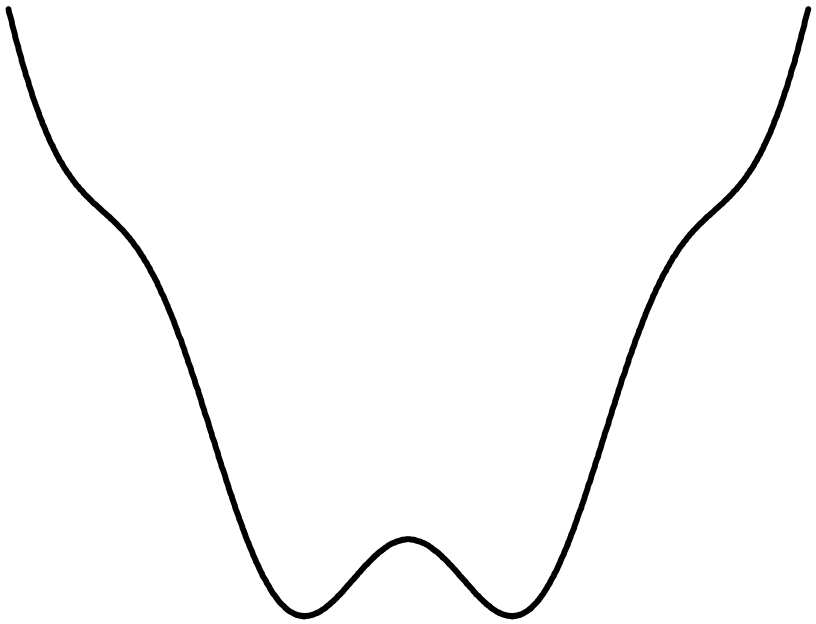
Tunnel effect

What is the behavior of a matter wave coming in form the left?

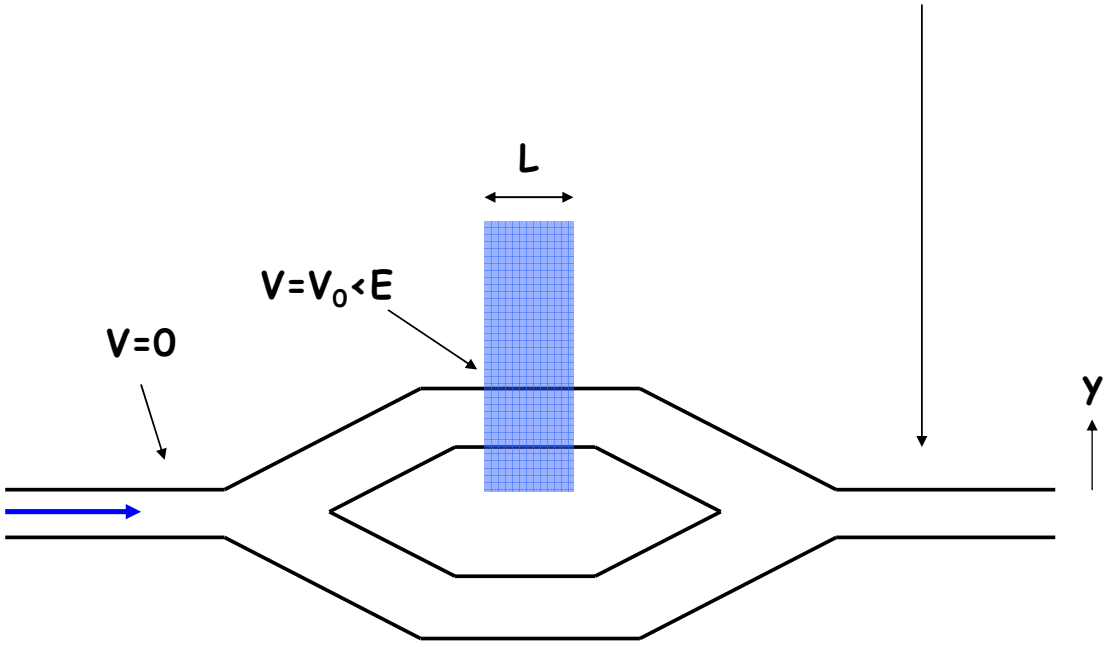


What is the wavefunction for the ground state?





What is frequency of interference in $\int \Psi^* \Psi \, dy$ as a function of V_0?



Samenvatting:

1. Wavefunction incident on finite potential
2. Tunnel effect
3. 1D Harmonic oscillator

Volgende college (H7):

Harmonic oscillator