Dr. Sasha

Please, solve this problem and also show the steps to solve it.

31.05.2015 – N12

1) Consider the following example of a quantum mechanical wavefunction for a particle of mass m moving in one dimension,

$$\Psi(x,t) = A \cdot e^{-\alpha \cdot \left(x^2 + i \cdot \hbar \cdot t/m\right)}$$

where α and A are constants.

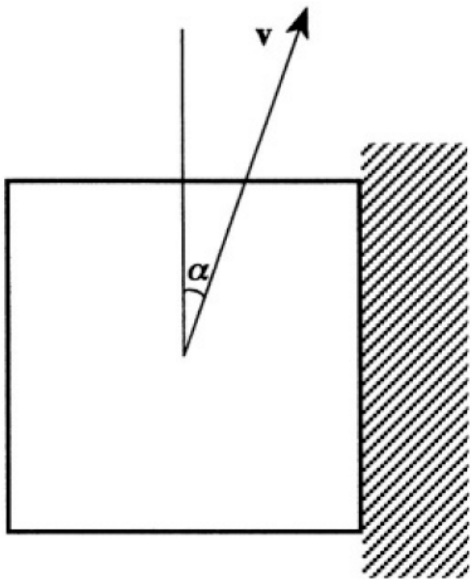
a) Normalize the wavefunction - that is, find a value of A for which $\int_{-\infty}^{+\infty} |\Psi(x,t)|^2 = 1.$

b) The Schrodinger equation is

$$i\hbar \frac{\partial}{\partial t}\Psi(x,t) = -\frac{\hbar^2}{2m}\frac{\partial^2}{\partial x^2}\Psi(x,t) + V(x,t)\cdot\Psi(x,t).$$

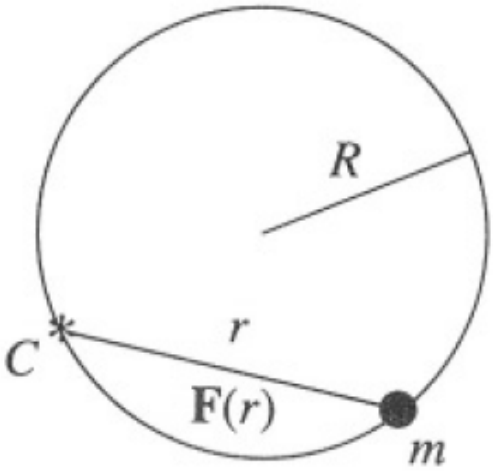
For the wavefunction given, what must the potential $V(x,t)$ be in order for $\Psi(x,t)$ to satisfy the Schrodinger equation?

2) An elastic cube sliding without friction along a horizontal floor hits a vertical wall with one of its faces parallel to the wall. The coefficient of friction between the wall and the cube is μ. The angle between the direction of the velocity v of the cube and the wall is α. What will this angle be after the collision (see figure below for a bird's-eye view of the collision)?

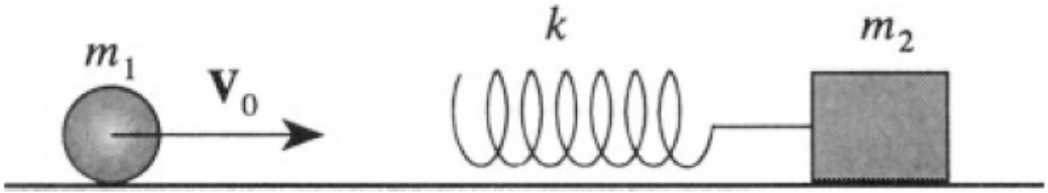


Hint: bird's-eye view – вид сверху.

3) A particle of mass m moves in a circular orbit of radius R under the influence of a central force. The center of force C lies at a point on the circle (see figure below). What is the force law?



4) A mass $\mathbf{m_1}$, with initial velocity $\mathbf{V_0}$ strikes a mass-spring system $\mathbf{m_2}$ initially at rest but able to recoil. The spring is massless with spring constant **k** (see figure below). There is no friction.



If, long after the collision, both objects travel in the same direction, what are the final velocities $\mathbf{V_1}$ and $\mathbf{V_2}$ of $\mathbf{m_1}$ and $\mathbf{m_2}$ respectively?

5) A physicist and an engineer find themselves in a mountain lodge where the only heat is provided by a large wood stove.

The physicist argues that they cannot **increase the total energy** of the molecules in the cabin, and therefore it makes no sense to continue putting logs into the stove. The engineer strongly disagrees, referring to the laws of thermodynamics and common sense. Who is right? Why do we heat the room?