Homework 6

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Permitted Wave Functions

(a) One reason why this function is not permitted is because it violates the normalization condition, $\int_{-\infty}^{\infty} |\psi(x)|^2 \, dx = 1$; more specifically, solving for the boundary conditions makes it violate this:

$$A\cos(kx) = B\sin(kx)$$
$$A\cos(0) = B\sin(0)$$
$$A = 0$$

Differentiating to find B:

$$0 = Bk\cos(kx)$$
$$B = 0$$

Because both constants are zero, the integral over the entire boundary does not equal 1.

(b) $\psi(x) = \dfrac{Ae^{-kx}}{x}$ can not be a solution because it is discontinuous; at the point $x = 0$, the function has a discontinuity.

(c) $A\sin^{-1}(kx)$ can not be a solution because it is discontinuous. $\sin^{-1}$ is only valid for values in the range $\left(-\dfrac{\pi}{2}, \dfrac{\pi}{2}\right)$, and, thus, it must have a discontinuity somewhere in its domain, unless k where to have the value of zero; in such a case, the function would violate the normalization condition, as it would be zero over its whole domain.

(d) $A\tan(kx)$ can not be a solution because it is discontinuous every $n\pi$ values.

The Schrödinger Equation

Expectation Values

A Particle in a 3D Box

Quantum Simple Harmonic Oscillator

(a)

(b)