Quiz #11 (Measurement and Expectation Value)

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Quantum Mechanics
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Prob.1(1)

A particle with mass M is in the following superposition state in a one-dimensional potential well with thickness L and two infinitely large potential barriers, $\psi(x,t)=\sqrt{\frac{1}{2}}\psi_1(x)\exp(-i\frac{E_1}{\hbar}t)+\sqrt{\frac{1}{3}}\psi_2(x)\exp(-i\frac{E_2}{\hbar}t)+\sqrt{\frac{1}{6}}\psi_3(x)\exp(-i\frac{E_3}{\hbar}t)$, where $\psi_1(x),\ \psi_2(x),\ \psi_3(x)$ are three lowest eigen states that are orthornomal and $E_1,\ E_2,\ E_3$ are corresponding eigen energies. What is the probability to find the particle in $\psi_3(x)$?

Prob. 2(2)

An electron with mass M is in a one-dimensional potential well with thickness L and two infinitely large potential barriers. The potential energy insider the well is zero. If the wave function in the well is given as $\psi(x)=A\left(\frac{x}{L}-\frac{x^2}{L^2}\right)$, where A is the normalization constant, what is the expectation value of the energy of the electron?

Prob. 3(1)

When $\psi(x)=\sum_n a_n\psi_n(x)$ where $\psi_n(x)$ is the orthonormal basis with the corresponding eigen energy E_n, determine $\hat{H}^4\psi(x)$, where $\hat{H}$ is the Hamiltonian operator.