NAME:

QM, Test 1 Retake 2005: Open Book

(1) Consider a particle of unit mass, in a box with energy levels $E_n = An^2$, where $A$ is a constant. If the ground state eigenfunction of the particle is $B\sin(3x)$, calculate $A$ and $B$ and determine the energy of the ground state as well as first excited state. For a particle in its ground state at $t = 0$, calculate the wave function of the particle at $t = 2$ sec.

(2) At $t = 0$, the wave function of a harmonic oscillator is $\psi(x, 0) = Axe^{-4x^2}$, where $A$ is a constant. Calculate the energy of the particle. What is the probability that at later time, the particle will be found in its (a) ground state (b) first excited state.

(3) At a given instant of time, the wave function of the particle is $\psi(x) = Ae^{-x^2}$ for $x > 0$ and $\psi(x) = 0$ for $x < 0$. Find the normalization constant $A$. Also determine the expectation value of $x$ and $p$.

(4) At $t = 0$, a harmonic oscillator is equally likely to be found in its ground state as well as in first excited state. Write down the wave function of the particle (a) at $t = 0$, (b) at $t = 10$ sec. (c) What is the energy of the system at these times? (d) What are the expectation values of $x$ and $p$ at these times?