PH 451: Capstone in Quantum Mechanics

Homework 4

Due 2/1/08

1. (Griffiths 2.13) A particle in the harmonic oscillator potential starts out in the state

$$\psi(x,0) = A\left[3\psi_0(x) + 4\psi_1(x)\right]$$

   a) Find A.

   b) Construct $\psi(x,t)$ and $|\psi(x,t)|^2$.

   c) Find $\langle x \rangle$ and $\langle p \rangle$. Check that Ehrenfest's theorem (Eqn. 1.38 Griffiths) holds for this case.

   d) If you measured the energy of this particle, what values might you get, and with what probabilities?

2. (Griffiths 2.41) A particle in the harmonic oscillator potential starts out in the state

$$\psi(x,0) = A\left[1 - 2\sqrt{\frac{m\omega}{\hbar}}x\right]^2 e^{-\frac{m\omega}{2\hbar}x^2}$$

   for some constant *A*.

   a) What is the expectation value of the energy?

   b) At some later time *T* the wave function is

$$\psi(x,T) = B\left[1 + 2\sqrt{\frac{m\omega}{\hbar}}x\right]^2 e^{-\frac{m\omega}{2\hbar}x^2}$$

   for some constant *B*. What is the smallest possible value of *T*?

3. (Griffiths 3.34) A harmonic oscillator is in a state such that measurement of the energy would yield either $\hbar\omega/2$ or $3\hbar\omega/2$, with equal probability. What is the largest possible value of $\langle p \rangle$ in such a state? If it assumes this maximal value at time $t = 0$, what is $\psi(x,t)$?