PHYSICS 631 Autumn 2006 Midterm #1

Write your name on the test booklet. Do NOT simply write an answer. Give a calculation and/or reasoning that supports your answer. Do all work and write all answers in the test booklet. Circle or clearly delineate all relevant work so that I do not take points off for errors in your scratch work.

1) A particle of mass m is confined to: $0 < x < L$. It starts at $t = 0$ in the state:

$$\psi(x) = N\Big[2\ \psi_2(x) - i\ \psi_3(x)\Big].$$

(a) At time $t = t_1$ the energy is measured. What are the possible results and what is the probability for each result? (b) What is $< \hat{P} >$? Give an answer correct at any time t. (c) What is the probability of finding the particle in the right half of the "box," $L/2 < x < L$? Give an answer correct at any time t.

2) A particle of mass m is confined to: $0 < x < L$. It starts at $t = 0$ in the state:

$\psi(x) = N\ \sin\big(\frac{\pi x}{L}\big)$, for $0 \le x \le L/2$;
$\psi(x) = 0$, for $L/2 < x \le 0$.

(a) At time $t = t_1$ the energy is measured. What are the possible results and what is the probability for each result? As a special case, what is the probability of finding the ground state energy, E_1? (b) What is $< \hat{X} >$? Give an answer correct at any time. Use shorthand notation you define for generic integrals that appear and evaluate the generic integrals separately. Do the explicit calculation of the integrals (much work for few points) after you know you have enough time for the whole test.

3) A particle of mass m is "in" a harmonic oscillator potential, $V(x) = \frac{1}{2}\mathrm{m}\omega^2\ x^2$. It starts at $t = 0$ in the state:

$$\psi(x) = N\Big[\psi_1 - 3\psi_2\Big].$$

(a) If the energy is measured at time $t = t_1$, what is the average value? (b) If the position is measured at time $t = t_1$, what is the average value? (c) If the momentum is measured at time $t = t_1$, what is the average value? (d) Does $< \hat{P} >= m\ \frac{d}{dt} < \hat{X} >$?