QUANTUM MECHANICS I

PHYS 516

Problem Set # 2

Distributed: January 20, 2014

Due: January 27, 2014

1. Quantum - Classical Comparison: 1: For a quantum mechanical harmonic oscillator assume $m = k = \hbar = 1$ so that $\hbar\omega = 1, \gamma = 1$, and $E = (n + \frac{1}{2})$.

a. Plot $|\psi_n(x)|^2$ for $n = 50$.

b. For the classical oscillator, show that the probability density has the form $P(x) \simeq \frac{1}{\sqrt{b^2 - x^2}}$, where $\pm b$ are the classical turning points. For $n = 50$, what is b^2?

c. Compute the normalization for the classical probability. Then plot the normalized probability distribution on the same plot as $|\psi_n(x)|^2$.

d. Comments?

2. Quantum - Classical Comparison: 2: On the basis of the plot in **1c**, how can you estimate the classical turning point from the square of the wavefunction? The exterior peaks could be used if you don't have a better idea.

a. Estimate the "quantum turning points" $Q(n)$ from $|\psi_n(x)|^2$ for several values of the energy $E_n = n + \frac{1}{2}$.

b. Construct an expression for the classical turning points $C(n)$.

c. How are $n, C(n), Q(n)$ related? In short, do something with the data that leads to a straight line. Such a plot (straight line) indicates that you "understand" the relation between classical and quantum mechanics.