

Physics 570B, Spring 2011
Assignment 06
Due Tuesday, Mar. 1

1. Two noninteracting particles are confined in a one dimensional harmonic oscillator potential. One particle is in the ground state of the harmonic oscillator, and the other is in the first excited state. For each of the following three cases, write the wave function (in terms of eigenfunctions of H for a single particle), and compute the root-mean-square distance between the two particles: $\sqrt{\langle (x_1 - x_2)^2 \rangle}$.
 - (a) The particles are distinguishable. (The “red” one is in the ground state).
 - (b) The particles are identical bosons in the same spin state
 - (c) the particles are identical fermions in the same spin state

Of course, it is best to use raising and lowering operators to do this problem.

2. Two particles are confined in a one-dimensional box, $-L/2 < x < L/2$. (Note I put the origin in the center of the box. This makes calculations a little easier, but you have to be careful in writing down the wave functions. The ground state is a cosine and the first excited state a sine.) One particle is in the ground state, and the other in the first excited state. There is no force between the two particles. What is the probability that **both** particles are in the left side of the box ($x < 0$) in each of the three cases:
 - (a) The particles are distinguishable. (The “red” one is in the ground statee).
 - (b) The particles are identical bosons in the same spin state
 - (c) the particles are identical fermions in the same spin state
3. Write a wave function for three spin one-half fermions in a one dimensional potential. Two of the particles are in the ground state, and the third is in the first excited state and has $s_z = \frac{\pm 1}{2}\hbar$. You don't need to write the explicit functions of x (and you cannot, since I didn't tell you what the potential is). Just $\Psi_0(x)$ and $\Psi_1(x)$ will suffice.