Homework 8
(due Wednesday, Nov. 13)

1. Schrodinger Equation in 3 Dimensions
   Consider the three dimensional harmonic oscillator,

$$H = \frac{p^2}{2m} + \frac{1}{2}m\omega^2 r^2,$$

   where $p^2 = p_x^2 + p_y^2 + p_z^2$ and $r^2 = x^2 + y^2 + z^2$.

   (a) Based on the solution to the one dimensional harmonic oscillator, what are the energy eigenvalues of the three dimensional harmonic oscillator?

   (b) What is the energy of the ground state? What is the degeneracy of the ground state?

   (c) What is the energy of the first excited state? What is the degeneracy of the first excited state?

   (d) For $E \gg \hbar\omega$, what is the total number of states, N, with energy less that E? (Include both spins.)

   (e) What is the total energy of a $2N$ non-interacting fermion system in this potential? (Add the energies of all occupied states.)

2. Commutators:

   (a) Show that the commutator $[L^2, L_z]$ is equal to zero.

   (b) Compute the commutator $[L_x^2 L_y, L_x]$.

   (c) Compute the commutator $[L_y^3, L_x]$.

   (d) Compute the commutator $[L_z^2 L_y, L_x]$.

   (e) Add the results from (b)-(d) to compute $[L^2 L_y, L_x]$. Does the result make sense?