PHYSICS 632 Winter 2006 SAMPLE Final problems

1) Two spin-1/2 particles are governed by $H = \frac{J^2}{2I} + \omega_0 J_z$, where $J = J_1 + J_2$. At time $t = 0$ the total angular momentum is measured and found to be 0. (a) At time t, J_{1z} is measured. What are the possible results and what is the probability of each? (b) At time $2t$ the total angular momentum is measured, J^2. What are the possible results (follow all possible branches from the measurement at time t) and what is the probability for each result?

2) Two particles are in a one-dimensional well of width a. (a) If the particles are identical bosons with no "spin", what are the energies of the ground state and first excited state and what is the degeneracy of each of these states? What is the first excited state wave-function written using the one-body particle-in-a-well eigenstates? If there is more than one possible first excited state, pick one and tell me which one you are picking. (b) Same problem for two identical fermions with no spin.

3) H_0 is the Coulomb hamiltonian for hydrogen. $H' = -eE_0 z$. Compute the first-order energy shift for the $n = 1$ state and for a complete set of $n = 2$ states.

4) H_0 is the 2-dimensional well, with $0 < x < a$ and $0 < y < a$. $H' = \alpha\delta(x - a/2)\delta(y - a/2)$. (a) Compute $E^{(1)}_{mn}$. (b) Demonstrate whether $E^{(2)}$ is finite or not.