AQM-2013f HW6

1. Read example 5.1 of the textbook and then work out the following questions:
   (a) In that example, the two identical particles do not interact. Assume now that they do interact. Suppose they were distinguishable , the interaction would be given by
   $$H' = 2\beta x_1^2 x_2$$
   Since they are identical, how would you modify H' so that it would be consistent with two identical particles. Does it depend on whether the pair are fermions or bosons?
   (b) If the two particles in the infinite square well are spin ½ electrons, write down the total wavefunction (including spin) of the ground state. What is the degree of degeneracy?
   (c) If the two particles are spin 1 particles, what is the total ground state wavefunction and what is its degeneracy? [Hint: need to find the coupled angular momentum functions of two spin 1 particles and examine their symmetry.]

2. Problem 5. 3 of your textbook.

3. For the infinite square well potential, where V(x)=0 if x is between –a and +a, and V(x)→infinite outside this range. If a small perturbative interaction $V_1(x)=\alpha x$ is present, where α is very small, find the correction to the ground state energy due to the perturbative interaction. [Just approximate answer is enough. Explain why your result should be good approximately.]

   If the potential is given by $V_1(x)=\alpha x^2$, what is the correction?

4. Neglecting electron spin, we know that the 2s and 2p (three of them) states of hydrogen atom are degenerate. If a weak constant electric field of 100 V/cm is applied, how many levels they would split into? Explain but no need to calculate the actual numbers.
   How big is the field needed for you to worry that the perturbation theory probably cannot be used any more? Explain.
   You can do the calculation using atomic units where you set e=m=$\hbar = 1$. To convert atomic units to common units, use the summary in
   http://www.phys.ksu.edu/personal/cdlin/mainpage/atomic-units2.htm