AQM-2013f HW7

1. Follow the procedure of p.269 of Griffiths, calculate the relativistic correction of the hydrogenic 2s and 2p states, respectively. Use Mathematica or equivalents to evaluate the integrals $\langle 1/r \rangle$ and $\langle 1/r^2 \rangle$ to show that they agree with the results given in [6.55] and [6.56]. Express the numerical results in eV.

2. Problem 6.36. Make sure that you understand how to do this problem. Do not just copy down solutions from somewhere.

3. For the harmonic oscillator with potential given by $V(x)=1/2\ kx^2$, if the spring constant increases slightly: $k \to (1+\varepsilon)\ k$,
   (a) Find the **exact** new energy for the **ground state**. Expand your result in power series in ε, up to second order.
   (b) Carry out the 1st and 2nd order perturbation theory in the energy to confirm the results in (a).
   (Hint: To calculate matrix elements, you may want to use creation and annihilation operators , see expression on page 49)

4. (a) Neglect electron spin, what is the total degeneracy for the n=3 states for atomic hydrogen.

   (b) If a constant electric field E is applied to the n=3 states, into how many levels will they split? For each level what is the degeneracy? Do not try to calculate the new level positions. This is an extension of problem 2.