Physics 330, Spring 2009
HW#7 30 points

Problems from Tipler and Llewellyn:

1. **7.36 (5 points)** I hydrogen atom is in the $3D$ state. (a). What are the possible values of j? (b) What are the possible values of the magnitude of the total angular momentum? (c) What are the possible z components of the total angular momentum.

2. **7.39 (5 points)** Consider a system of two electrons $l = 1$ and $s = 1/2$. (a) What are the possible values of the quantum number for the total orbital angular momentum $\vec{L} = \vec{L_1} + \vec{L_2}$? (b) What are the possible values of the quantum number S for the total spin $\vec{S} = \vec{S_1} + \vec{S_2}$? (c) Using the results of part (a) and (b), find the possible quantum numbers j for the combination $\vec{J} = \vec{L} + \vec{S}$. (d) What are the possible quantum numbers j_1 and j_2 for the total angular momentum of each particle? (e) Use the results of part (d) to calculate the possible values of j from the combinations of j_1 and j_2. Are these the same as in part (c)?

3. **7.42 (5 points)** Two neutrons are in an infinte square well with L=2.0 fm. What is the minumum total energy that the system can have? (Neutrons, like electrons, have antisymmetric wave functions. Ignore spin.)

4. **7.44 (5 points)** Write the electron configuration of (a) carbon, (b) oxygen, and (c) argon.

5. **7.55(5 points)** Which of the following transitions in sodium do not occur as electric dipole transitions? Give the selection rule that is violated.

   $4S_{1/2} \rightarrow 3S_{1/2}$ $\quad 4S_{1/2} \rightarrow 3P_{3/2}$ $\quad 4P_{3/2} \rightarrow 3S_{1/2}$ $\quad 4D_{5/2} \rightarrow 3P_{1/2}$

   $4D_{3/2} \rightarrow 3P_{1/2}$ $\quad 4D_{3/2} \rightarrow 3S_{1/2}$ $\quad 5D_{5/2} \rightarrow 4S_{1/2}$ $\quad 5P_{1/2} \rightarrow 3S_{1/2}$

6. **7.67 (5 points)** The wavelengths of the photons emitted by potassium corresponding to transitions from the $4P_{3/2}$ and $4P_{1/2}$ to the ground states are 766.41 nm and 769.90 nm. (a) Calculate the energies of these photons in electron volts. (b) Calculate the energy difference, ΔE, between the $4P_{3/2}$ and $4P_{1/2}$ levels. (c) Estimate the magnetic files that the $4p$ electron in potassium experiences.