Physics 4410 Homework #2
Due Wednesday, Sept. 10, IN CLASS. Recall: late homework will not be accepted.
Be sure to show your work and explain what you are doing.

1) (20 points) A p-electron in an atom is one that has orbital angular momentum quantum number \( l = 1 \). What are the possible angular momentum states of this electron in
   a) the individual-angular momentum basis \( |lm\rangle_{sm}\); and
   b) the total angular momentum basis \( |(ls) jm\rangle \)?
   c) Explicitly derive the linear combinations of \( |lm\rangle_{sm}\) that generate the eigenstates \( |(ls) jm\rangle \), using the appropriate ladder operators. You may do this in the “heuristic” way that we did the two spin-1/2 objects in class. In other words, you do not have to verify that the states you generate are really eigenstates of \( j^2 \) and \( j_z \).

2) (10 points) Two electrons in an atom each have angular momentum \( l_1 = l_2 = 1 \), and are coupled to form the total angular momentum state \( |(l_1l_2)lm\rangle = |(11)2, -2\rangle \). What is the joint probability of finding the two electrons with \( L_{1z} = L_{2z} = -\hbar \)? Be sure to explain your reasoning.

3) (10 points) Two objects (atoms, let’s say) have spins \( j_1 \) and \( j_2 \). They are combined together into a molecule, in which they are not rotating around one another.
   a) Including all “m” quantum numbers, how many angular momentum states are there of the separate atoms, i.e., \( |j_1m_1\rangle |j_2m_2\rangle \)?
   b) Including all “m” quantum numbers, how many total angular momentum states, \( |(j_1j_2) jm\rangle \), are there?