

**ECE 162A, Fall 2007**  
**HW 6**  
**Due: Tuesday, 20<sup>th</sup> November**

1. In the hydrogen atom, what quantum number(s) decide(s) (i) the radial component of the wave-function? (ii) the angular component of the wave-function?

2. Consider an electron in the  $n=4$  state of a hydrogen atom.

(i) Name all states that 'belong' to this quantum number. For e.g. 4s, 4p ... Write the value of the quantum number 'l' that each of these corresponds to.

(ii) According to the model we discussed in class, the  $n=4$  states are all degenerate. Indeed the expression for the energy eigen-values contains only the quantum number 'n'. Are they degenerate in practice? Give reasons.

3. Find the total angular momentum for an electron in each of the following states of the hydrogen atom: (i) 1s (ii) 2p (iii) 3p.

(Neglect spin-orbit coupling.)

4. Consider the 4f orbitals of the hydrogen atom:

(i) What is the value of the quantum number 'l'?

(ii) Write all possible states in 4f in the form  $|m_l, m_s\rangle$  where  $m_l$  is the quantum number corresponding to the z-component of the angular momentum and  $m_s$  is the spin quantum number.

(iii) How many states are there? Group together the degenerate states among these, in the absence of spin-orbit coupling.

(iv) When spin-orbit coupling is included, write down all possible states in the form  $|j, m_j\rangle$  where 'j' is the total angular momentum quantum number and 'm<sub>j</sub>' is the z-component of the same. How many such states are there? Group together the degenerate states among these.

(v)  $|j, m_j\rangle = |5/2, -1/2\rangle$  is one of the states in part (iv) of this question. This state can be written as the linear combination of certain of the no-spin-orbit-coupling states  $|m_l, m_s\rangle$  in question (ii). What are these? You don't need to find the coefficients of expansion, please just mention the states and state why.