1. An electron in a solid has orbital angular momentum $l = 1$ and spin $s = 1/2$. Its total angular momentum is $\vec{J} = \vec{L} + \vec{S}$.
   a. How many possible states can the electron be in?
   b. What are the possible $j$ values for the total angular momentum, and how many possible states exist for each $j$?
   c. What is the state $|j \, m \, l \, s >$ with maximum values of $j$ and $m$?
   d. Find all the remaining states $|j \, m \, l \, s >$ with positive values of $m$, expressing them as linear combinations of the direct product states $|l \, m_l > |s \, m_s >$.

2. Consider three spin 1/2 systems, $j_1 = j_2 = j_3 = \frac{1}{2}$. There are a total of eight direct product states $|j_1 \, m_1 > |j_2 \, m_2 > |j_3 \, m_3 >$. Obtain eight linear combinations of the direct product states which are eigenstates of the total angular momentum $J^2 = (\vec{J}_1 + \vec{J}_2 + \vec{J}_3)^2$ and the $z$-component of total angular momentum $J_z = J_{1z} + J_{2z} + J_{3z}$. Hint: First add two spins together, then add the third to the result. The answers to problem 1 may be useful.

3. Problems 15.2.1 (both parts) and 15.2.2(2) (second part only).