Q.M. H.W. #2

From Griffiths: 4.37, 4.38, 5.14

From OHanlan:

8. For two angular momenta of quantum numbers j_1 and j_2, there are $(2j_1 + 1) \times (2j_2 + 1)$ possible products $|j_1,m_{j_1}\rangle|j_2,m_{j_2}\rangle$ of eigenstates of the individual angular momenta. Count all the possible eigenstates $|j,m_j\rangle$ of the total angular momentum, and show that there are exactly $(2j_1 + 1) \times (2j_2 + 1)$ such eigenstates.

14. Consider two free electrons, with single-particle wavefunctions $e^{ip_1\cdot r_1/\hbar}|\pm\rangle$ and $e^{ip_2\cdot r_2/\hbar}|\pm\rangle$.

(a) Construct the antisymmetric two-electron wavefunction of net spin zero.

(b) Construct the antisymmetric two-electron wavefunction of net spin one. Assume that both spins are up.

13. Consider the following state constructed out of products of eigenstates of two individual angular momenta with $j_1 = \frac{3}{2}$ and $j_2 = 1$:

$$\sqrt{\frac{3}{5}}\,|\tfrac{3}{2},-\tfrac{1}{2}\rangle|1,-1\rangle + \sqrt{\frac{2}{5}}\,|\tfrac{3}{2},-\tfrac{3}{2}\rangle|1,0\rangle$$

(a) Show that this is an eigenstate of the total angular momentum. What are the values of j and m_j for this state?

(b) Construct a (normalized) state of the same j, but a value of m_j larger by 1.

16. Suppose that five electrons are placed in a one-dimensional infinite potential well of length L. What is the energy of the ground state of this system of five electrons? What is (S_z) of the ground state? Take the exclusion principle into account, and ignore the Coulomb interaction of the electrons with each other.