AQM-2013f HW5

1. Problem 4.45 of your book.
   First look up the radius of the proton to confirm that it is quite small compared to the size of the Bohr radius. What will be the radius of a deuteron?
   Then work out the questions and do proper approximation as you need.

2. Calculate $< Y_{\ell m_1} | L_x | Y_{\ell m_2} >$ and $< Y_{\ell m_1} | L_y | Y_{\ell m_2} >$. Recall the states are eigenstates of angular momentum operators L^2 and L_z. Use the properties of angular momentum algebra.

3. The Hamiltonian for an axially symmetric rotater is given by

$$H = \frac{L_x^2 + L_y^2}{2I_1} + \frac{L_z^2}{2I_2}$$

   What are the eigenstates and eigenvalues of H. Sketch the spectrum for $I_1 > I_2$.

4. A particle in a spherically symmetric potential is in a state described by

$$\varphi(x, y, z) = C(xy + yz + zx)e^{-\alpha r^2}$$

   What is the probability that a measurement of the **square** of the angular momentum yields 0? What is the probability that it yields $6\hbar^2$? If the value of ℓ is found to be 2, what are the relative probabilities for m=2,1,0,-1,-2.

5. In the example on page 187,
   (a) Show that $|30> = \frac{1}{\sqrt{5}} |21> |1-1> + \frac{\sqrt{3}}{\sqrt{5}} |20> |10> + \frac{1}{\sqrt{5}} |2-1> |11>$ is correct.
   (b) Do the same expansion for |20> and |10>.
   (c) Show that these states are orthogonal to each other. Use Web tools to find the C-G coefficients.

6. Problem 16 in http://www.phys.ksu.edu/graduate/current/departmental-exams/QM_student.pdf