Advanced Chemistry, 2008
Winter Quarter – Week 8 – Quantum Mechanics Homework

1. Show that $[\hat{L}^2, \hat{L}_x] = [\hat{L}^2, \hat{L}_y] = 0$

2. Calculate the value of the Rydberg constant (R) where $R = \frac{m_e e^4}{2 (4\pi\varepsilon_0)^2 \hbar^2}$ in units of electron volts, Hartees, Rydbergs, and cm^{-1}.

3. Calculate the value of a Bohr radius (a_0) given by $a_0 = \frac{\hbar^2 (4\pi\varepsilon_0)}{m_e e^2}$ in units of angstroms.

4. Given that $\psi_{2p_{-1}} = \frac{1}{8\sqrt{\pi}} \left(\frac{Z}{a}\right)^{5/2} r\ e^{-Zr/2a} \sin\theta\ e^{-i\phi}$ and $\psi_{2p_{+1+}} = \frac{1}{8\sqrt{\pi}} \left(\frac{Z}{a}\right)^{5/2} r\ e^{-Zr/2a} \sin\theta\ e^{i\phi}$ prove that $\psi_{2p_x} = \frac{1}{4\sqrt{2\pi}} \left(\frac{Z}{a}\right)^{5/2} r\ e^{-Zr/2a} \sin\theta\ \cos\phi$ and $\psi_{2p_y} = \frac{1}{4\sqrt{2\pi}} \left(\frac{Z}{a}\right)^{5/2} r\ e^{-Zr/2a} \sin\theta\ \sin\phi$