231B: Angular momentum and hydrogenic atoms

Quiz 2, Winter 2020
(Dated: February 9, 2020)

1. Find $\langle 1|x|2\rangle$ for a harmonic oscillator.
2. For a particle on a ring of radius 2, what is the degeneracy of the 3rd excited state?
3. What is the eigenvalue of L^2 of $Y_1^1(\theta,\phi)$?
4. Repeat previous problem for L_z.
5. What is $[L_x, L_z]$?
6. What is $\langle l, m|L_y|l, m-1\rangle$?
7. What is the transition frequency between the first and second excited states in Li^{2+}?
8. The usual sequence of atomic orbitals is s, p, d, and f. If the next set is g orbitals, what is the lowest principle quantum number which has them?
9. Knowing $E_0 = -Z^2/2$ for the hydrogenic atom, deduce V_0, the expectation value of potential energy.
10. If $\hat{H} = \hat{T} + \lambda\hat{V}$, and $\langle\hat{V}\rangle = 2\lambda^2$, what is E at $\lambda = 1$?