PHY 342 HW Ch.4c

q4.6
For the first three lines in the Lyman series of the He^+ ion, give the numerical values of the photon energies in eV, and the wave numbers in cm^{-1}. What is the limit of this series?

q4.7
(a) For what states $(s, p, d, ...)$ does the wave function of the hydrogen atom vanish at the origin? (b) Briefly explain with classical physics arguments.

q4.8
Show that (a) $[L_+, L_-] = 2\hbar L_Z$; (b) $L^2 = L_-L_+ + \hbar L_Z + L_Z^2 = L_+L_- - \hbar L_Z + L_Z^2$; (c) $L_Z = -i\hbar\partial/\partial\varphi$ in spherical coordinates.

q4.9
The hydrogen atom is in state $n = 3$. What is the energy of the state in eV? What is the degeneracy? List all possible quantum numbers l and m.

q4.10
The wave function of a hydrogen atom is initially $\Psi(t = 0) = A\psi_{200} - \frac{1}{\sqrt{2}}\psi_{300}$. (a) Find A such that Ψ is normalized. (b) What are the probabilities of finding the atom in state $n = 1$, 2, and 3? (c) Graph (on a computer) the wave function $\Psi(t = 0)$ using convenient units. Determine graphically where the maximum radial distribution is.
[extra credit] Animate the evolution of the wave function in time, using Python, for instance.