Physics 330 Example Exam 2
March 5, 2007
100 points total

1) a) (10 pts) Write the Schrodinger equation for the Hydrogen Atom using the
      Laplacian (don't expand into spherical coordinates).
   b) (5 pts) How are $R(r)$, $P(\theta)$ and $F(\phi)$ combined to make $\Psi(r,\theta,\phi)$?
   c) (10 pts) Draw the ground state wavefuntion. What are n,l, and m_l?
   d) (10 pts) If $\Psi(r,\theta,\phi) \propto \exp(-r/3a_o)\sin^2(\theta)\exp(2i\phi)$. What are n, l, and m_l?
   e) (10 pts) For the n, and l found in d) if we now include electron spin, write all
   possible combinations of n,l,m_l,m_s, and all possible combinations of n,l,j,m_j.

2) a) (5 pts) What causes the hyperfine splitting?
   b) (5 pts) Is the transition that gives the 21 cm photon an allowed transition? Explain
   why or why not.

3) For a Helium atom that has one electron n=1, and the other n=2:
   a) (5 pts) What are the possible electron configurations? Use the standard notation.
   b) (5 pts) Estimate the energy to remove the n=2 electron.
   c) (5 pts) Write the possible values of n,l,m_l,m_s for singlet states.
   d) (5 pts) Write the possible values of n,l,m_l,m_s for triplet states.

4) When describing energy level splitting due to external magnetic fields, we worked with
   two regimes: strong and weak.
   a) (5 pts) What is the criterion for being strong or weak?
   b) (10 pts) For a weak field, what is the energy level splitting for a 3p state? Explain
      your reasoning.
   c) (10 pts) For a strong field, what is the energy level splitting for a 3p state? Explain
      your reasoning.