Physics 401 - Homework #12

1) (15 points) A hydrogen atom is in the following state at t = 0:

$$|\psi\rangle = \frac{1}{6}\left(4|1,0,0\rangle + 3|2,1,1\rangle - |2,1,0\rangle + \sqrt{10}|2,1,-1\rangle\right)$$

where $|n,l,m\rangle$ is an energy eigenstate. Calculate the following:

a) Expectation value of energy.

b) Expectation value of L^2.

c) Expectation value of Lz.

d) Expectation value of Ly. (Hint: write the Ly operator in terms of the ladder operators, as on homework #11 problem 2).

e) Write down the fully time-dependent state in Dirac notation.

2) Calculate the expectation value of (r) (the radial coordinate) for the ground state of the hydrogen atom (three points).