Consider the following state for a quantum particle confined to the surface of the unit sphere.

$$\psi(\theta,\phi) = \sqrt{\frac{2}{9}}Y_2^{-2}(\theta,\phi) - \sqrt{\frac{4}{9}}Y_5^{-2}(\theta,\phi) + i\sqrt{\frac{3}{9}}Y_5^{3}(\theta,\phi) \tag{1}$$

1. Write this state in Dirac notation.
2. Write out the energy eigenvalues for particle on a sphere from E_0 to E_5.
3. What is the probability that a measurement of the z-component of angular momentum will return a result of $-2\hbar$?
4. What is the probability that an energy measurement will return a result of E_5?