Problem 5.1

A particle is in the orbital angular momentum state

$$|\psi\rangle = a_{-1}|1,-1\rangle + a_0|1,0\rangle$$

where a_{-1}, a_0 are complex numbers obeying $|a_{-1}|^2 + |a_0|^2 = 1$, and $|l,m\rangle$ are the eigenkets of $\hat{L}^2$ and $\hat{L}_z$ such that $\hat{L}^2|l,m\rangle = \hbar^2 l(l+1)|l,m\rangle$ and $\hat{L}^z|l,m\rangle = \hbar m|l,m\rangle$.

a) Which values can be gotten when measuring the z-component of the angular momentum in this state. Give also their respective probabilities.

b) Compute the probability of finding the particle in state $|\psi\rangle$ north of the 30^0 latitude ($1 > z > 1/2$).

c) Repeat a), but now measuring the angular momentum in the x-direction. (Find the eigenkets of $\hat{L}_x$ in terms of linear combinations of the $|l,m\rangle$ states. Hint: Use $\hat{L}_x = (\hat{L}_+ + \hat{L}_-)/2$).

Problem 5.2

A tritium atom, consisting of a nucleus(one proton and two neutrons) and an electron, is in its ground state. A radioactive decay changes the nucleus suddenly to a ^{3}He nucleus(two protons and one neutron). Assume that the electron wavefunction is unaffected by the radioactive decay.

a) What are the possible values that an energy measurement can give after the radioactive decay?

b) Compute the probability of getting the lowest energy value (finding the atom ^{3}He in its ground state) just after the radioactive decay.