Quantum Mechanics
September, 14 2017, II part

PROBLEM A

The normalized wave function for a particle is

$$\psi(x, y, z) = xK(x^2 + y^2 + z^2)$$

What is the probability that a measure of L^2 gives 0? What are the possible values for a measure of L_z and what are their associated probabilities?

PROBLEM B

A harmonic oscillator is found in a generic superposition of the first and second excited states

$$|\psi\rangle = \alpha|1\rangle + \beta|2\rangle$$

in such a way that its average momentum is zero and its average energy is $2\hbar\omega$. Determine the coefficients α, β.

PROBLEM C

Let us consider a two level system described by the following hamiltonian:

$$H_0 = -\frac{\hbar\omega}{2}|0\rangle\langle 0| + \frac{\hbar\omega}{2}|1\rangle\langle 1|$$

At the time $t = 0$ the system is in the ground state $|0\rangle$ and the perturbation

$$V(t) = \epsilon \left(e^{i\Omega t}|0\rangle\langle 1| + e^{-i\Omega t}|1\rangle\langle 0| \right)$$

is turned on. Determine, using the time-dependent perturbation theory, the probability to find the system at the time t in the excited state $|1\rangle$ at the first order in ϵ. Determine also the time (if any) at which the system returns to the ground state.