

PYL331: Applied quantum Mechanics

(Minor)

1 Oct, 2017 11 AM

Question 1. (a) (5 marks) An oscillator (in units of $m = \hbar = \omega = 1$) is in an external potential $a + a^\dagger$. Find its hamiltonian in the interaction representation.

Question 2. A charged spin $\frac{1}{2}$ particle of mass m is constrained to move in the plane $z = 0$. It is in a uniform magnetic field $B\hat{k}$ and a weak electric field $E\hat{i}$.

(a) (5 marks) Set up the hamiltonian.

(b) (10 marks) Obtain the lowest order correction to the ground state energy and the corresponding wave function upto first order in the weak perturbation.

Question 3. (a) (10 marks) A particle of mass m is in a box of length L is subjected to a harmonic perturbation $V(x) = V_0 \sin kx \sin \Omega t$. Determine the time evolution of the system if, at $t = 0$, it was in its ground state, upto second order in perturbation.

Question 4. (a) (10 marks) A particle of mass m and charge q is scattered by the electric field produced by a localised charge distribution $\rho(r) = kr^2$ upto a radius R . Obtain the differential scattering cross section in the Born approximation. Estimate the minimum energy of the projectile required to probe the interior of charge distribution.

(b) (10 marks) A hydrogen atom in the ground state is ionized by monochromatic radiation of frequency ω , propagating along the z direction. Consider cases of two different linear polarizations. Argue carefully, and thoroughly, how you would distinguish the angular distributions for the photo electron.