

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.