Q1: Show that the equation of the wave function ψ for the electron in hydrogen atom can be separated into two main parts. How many boundary conditions and quantum number we need to describe this electron?

Q2/ Start from the result of part (a) to demonstrate that the azimuthal wave function (Ø) is given by:

m= 0, ±1, ±2,….

Q3/ prove that

Q4/ State the principal postulations of the time independent perturbation theory.

Let ***HO, H1*** are Hamiltonian operators for the system before and after perturbation and ***ε*** is the dimensionless parameter with values 0 ( no perturbation) and 1 (full perturbation) . Prove that the first correction of energy is given by:

, where is a normalized wave function

**Q5**: Calculate the ground state energy with 1st order correction by using the perturbation theory for the system described below:

where,

Q6/ Variation method is an approximate concept to find out the lowest state energy of the system when there is no any closely related problem available. Derive an equation which shows this low level energy.

Q7/ why we need perturbation theory

Q8/ What is WKB method

Q10/ state the basic postulations of variation method

Q11/ Start from Shrodinger equation to show that radial part is given in term of laguerre polynomial

Q12/ Describe hydrogen atom in spherically symmetric potential.

Q13/ Compare between perturbation and variation theories.

Q14/ Start from the time independent Schrodinger equation to show that for one dimensional harmonic oscillator the allowed eigenvalues of energy is

En = (n+1/2) ħw n=0,1, 2, 3,….

Q15/ Find the allowed energy eigen values for 3 D harmonic oscillator.

Q16/State the general postulations of the quantum mechanics and explain each one physically and mathematically..

Q17: Show that:

1. [**x**, **H**]= ( iħ/m) **Px**
2. [**x**,**Lz**]= -iħ**y**

Q18/ For a particle in one dimensional box of length (a) and infinite height the wave function of the particle is describe as**:**

0 ≤ x ≤ a

Q19/ show that the momentum expected value for such particle is zero and explain the physical meaning of it.

Q20/ Define Hermitian operator then prove that the eigenvectors of such operators should be orthogonal.

Q21/ Prove that:

Q22/ Explain briefly low energy scattering theory.