K16P 0426

Reg. No. : .....

Name : .....

Second Semester M.Sc. Degree (Regular/Supplementary/Improvement) Examination, March 2016

PHYSICS (2014 Admn. Onwards)

PHY 2C06 : Quantum Mechanics – I

Time : 3 Hours Max. Marks : 60

SECTION – A

Answer both questions (Either **a** or **b**). **Each** question carries **12** marks.

1. a) Obtain the energy eigen values of a linear harmonic oscillator by the Schrodinger method. How is the zero point energy of a harmonic oscillator explained ?

   OR

   b) Discuss the problem of conservation of angular momentum as a consequence of the rotational invariance of the system.

2. a) Outline the Schrodinger perturbation theory for non degenerate levels and apply it to explain first order Stark effect in hydrogen.

   OR

   b) Discuss the first order time independent perturbation theory for non degenerate stationary state. Obtain the corrected eigen functions and eigen value. **(2×12=24)**

SECTION – B

Answer **any four**. **1** mark for Part – **a**, **3** marks for Part – **b** and **5** marks for Part – **c**.

1. a) Define linear vector space.
   b) Explain the properties of linear vector space.
   c) Show that commuting operators posses simultaneous eigen functions.

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2. a) Out line the interaction picture.
   b) Obtain the equation of motion for the state vector in the interaction picture.
   c) Derive the equation of motion for operator in the interaction picture.
3. a) State the uncertainty principle.
   b) Prove that the simultaneous measurement of potential and kinetic energies is not possible.
   c) The wave function of a particle in a state is $\psi = Ne_{xp}\left(-\frac{x^2}{2\alpha}\right)$. Where $N = \left(\frac{1}{\pi\alpha}\right)^{1/4}$. Evaluate $\Delta P \Delta x$.
4. a) Define a general angular momentum operator.
   b) Explain why the definition of angular momentum given by $\bar{L} = \bar{r} \times \bar{P}$ is not a general one.
   c) Derive expressions for L_+, L_- and L^2 in spherical polar coordinates.
5. a) What do you mean by spin of an electron ?
   b) Explain spin up and spin down states. What are spinors ?
   c) Using Pauli's spin matrix reduce each of the operators :
      i) $S_x^2 S_y S_z^2$
      ii) $S_x^2 S_y^2 S_z^2$.
6. a) Give the principle of time independent perturbation theory.
   b) Determine the first order correction to wave function.
   c) Calculate the ground state energy of an anharmonic oscillator up to the first order. Whose potential energy is

      $V = \frac{1}{2} m w^2 x^2 + ax^3$ where $ax^3 << \frac{1}{2} m w^2 x^2$. **(4×9=36)**