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| **ST. JOSEPH’S COLLEGE (AUTONOMOUS), BANGALORE-27** | | | | | | |
| **M.Sc. PHYSICS - II SEMESTER** | | | | | | |
| **SEMESTER EXAMINATION: APRIL 2019** | | | | | | |
| **PH 8418 – Quantum Mechanics I** | | | | | | |
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| **Time- 2 ½ hrs** | |  | **Max Marks-70** | | |  |
| **This paper contains two printed pages and two parts**  **PART A**  **Answer any FIVE full questions.** (**5x10=50)**  1. a) List the important ways in which the results of Photoelectric effect depart from the         expectations of classical physics. In each of these cases clearly demarcate what one expects         (from classical physics) and what the experiment shows. (5)      b) Explain the nature of eigen value and obtain the normalized eigen function for a linear             momentum operator. (5)  2. a) For the Schrodinger equation in three dimension for a spherically symmetric particle,                      extract the radial part of the equation using separation of variables method. (5)     b) If two operators commute, write the mathematical expression for that and explain the                  physical significance of that. Can kinetic energy and linear momentum of a quantum                   system be determined simultaneously and precisely? Explain. (2+3)  3. Define and obtain expression for creation and annihilation operators .Using the above     operators, deduce normalized wave function and energy eigen value expression for the ground     state of a linear harmonic oscillator. (10)  4. If is the Hamiltonian operator, For any operator , derive      Using the above relation, show that , where and are position and momentum      operators. (7+3)  5. Write down the time independent Schrodinger equation for a free particle (V=0) in one      dimension. What is the solution for this equation? Normalize the solution. (10)  6. For a particle in an infinite potential well of width L, The wave function is given as  ; for 0 < x < L. What is the uncertainty in the position of the particle in      the   ground state? (10)  7. Sketch the step potential of the form:        What are the different regions in this potential and what will be the solution of Schrodinger       equation in these regions for a particle having a total energy E < V0 ? What are the conditions       the wave function needs to satisfy at the boundaries of the various regions? (10)  **PART B**  **Solve any Four of the following: (4x5 = 20)**       Planck’s constant h = 6.626070x10-34JS, speed of light c = 2.99792458x108m/s, electronic      charge e = 1.6x10-19C, mass of electron me = 9.10938356x10-31kg.  8. In a Compton scattering experiment, the scattered photon is observed to have an energy of     69keV and the electron scatters off with a kinetic energy of 3keV. What is the angle at which     the photon is scattered off?  9. A particle with total energy E = E0 at time t = 0 units has a wave function  ; (where x and L have the dimensions of length). What is the wave     function of the particle at time t = 5 units?  10. If the hydrogen atom is modeled as an electron in a one dimensional box with a ground state       energy of 13.6 eV, what will be an estimate for the radius of H-atom. How does it compare       with the Bohr radius?  11. Is the given operator Hermitian?. Give reason.         Find the eigen values of the operator. Calculate Tr(A) and det(A)  12. Let the operator . Consider two functions f1 = sinx and f2 = sin2x with 0 < x < 2π .         i) Show that f1 and f2 are the eigen functions of the given operator. ii) Find their eigen values     iii) Normalize the functions and iv) Show that f1 and f2 are orthogonal  13. An electron in a 2D infinite well needs to absorb electromagnetic wave with wavelength       4040nm to be excited from (nx = 2, ny = 2) state to (nx = 3, ny = 3) state. What is the length of       the box if this potential well is a square. | | | | | | |
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