LOYOLA COLLEGE (AUTONOMOUS), CHENNAI – 600 034

B.Sc.DEGREE EXAMINATION – PHYSICS

FIFTH SEMESTER – **NOVEMBER 2018**

16UPH5MC01– QUANTUM MECHANICS

Date: 25-10-2018   Dept. No.   Max. : 100 Marks
Time: 09:00-12:00

PART-A

Answer **ALL** Questions   **(10x2=20)**

1. Find the de Broglie wavelength associated with an electron subjected to a potential difference of 1.25 kV.

2. Explain the terms 'wave velocity' and 'group velocity'?

3. What is meant by orthonormal wave functions?

4. Write an eigenvalue equation, explaining the meaning of the symbols used.

5. What do you mean by tunneling?

6. What are ladder operators?

7. Write down the eigenvalues of operators $\hat{L}_z$ and $\hat{L}^2$ for the eigenfunction $Y_{l,m}(\theta, \varphi)$.

8. Write Pauli's spin matrices.

9. Explain the term degeneracy.

10. Calculate the degree of degeneracy for 3D isotropic harmonic oscillator, for n=1. Write the possible states that correspond to it.

PART-B

Answer ANY **FOUR** Questions   **(4X7.5=30)**

11. What is Compton effect? Derive an expression for the change in the wave length of a photon scattered by a stationary electron.   **(2+5.5)**

12. i) Use uncertainty principle to prove that the electrons cannot exist inside the nucleus.   **(5)**

    ii) Calculate the uncertainty in position of an electron weighing $9x10^{-28}$ g and moving with an uncertainty in speed of $3x10^9$ cm/sec.   **(2.5)**

13. State and explain the fundamental postulates of quantum mechanics.

14. Derive energy eigenvalues and normalized wave functions for a particle in one dimensional box.

15. With necessary diagram, describe Stern-Gerlach experiment and give its importance in quantum mechanics.

16. Set up Schrodinger wave equation for a rigid rotator. Obtain its eigenfunctions and eigenvalues.

PART–C

Answer **ANY FOUR**Questions :   **(4x12.5 = 50)**

17.i) With a neat diagram, describe how Davisson and Germer's experiment proves the wave nature of moving electrons.   **(7.5)**

   ii) In detail discuss Einstein's explanation of photoelectric effect.   **(5)**

18.   State and prove Ehrenfest's theorems.

19.i)What is hermitian operator? Give an example for it.   **(2+0.5)**

   ii)   Show that a) Hermitian operators have real eigenvalues. b) twoeigenfunctions of   Hermitian operators, belonging to different eigenvalues, are orthogonal.   **(3+3)**

   iii) Show that the probability current density together with probability density satisfies the equation of continuity.   **(4)**

20. Set up Schrodinger equation for a linear harmonic oscillator and solve it to obtain eigenvalue and eigenfunctions. Discuss the significance of zero point energy.

21. Deduce the following commutation relation:

   i) $[\widehat{L_z},\widehat{L_+}]$ **(2)**

   ii) $[\widehat{L_x},\hat{x}]$ **(2)**

   iii) $[\widehat{L_x},\widehat{L_y}]$ **(3.5)**

   iv) $[\widehat{L^2},\widehat{L_x}]$ **(3)**

   v) $[\widehat{L_+},\widehat{L_-}]$ **(2)**

22. Write the equation satisfied by the radial wavefunction for hydrogen atom and solve it to obtain the energy eigenvalues.

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