

SUBJECT : PHYSICS: QUANTUM MECHANICS

Day : Wednesday
Date : 25/10/2017

Time : 3:00 P.M. TO 5:00 P.M.
Max. Marks : 40.

W-2017-0645

N.B.:

- 1) All questions are **COMPULSORY**.
- 2) Figures to the **RIGHT** indicate full marks.
- 3) Draw neat labeled diagrams **WHEREVER** necessary.

Q.1 Attempt any **TWO** of the following: (10)

- a) Show that (i) $[L^2, L_x] = 0$, (ii) $[L_x, L_{\pm}] = \pm \hbar L_{\pm}$.
- b) State Heisenberg's uncertainty principle and using the single slit diffraction experiment prove the Heisenberg's uncertainty principle.
- c) Obtain an expression for the motion of one dimensional harmonic oscillator in detail with energy diagram.

Q.2 Attempt any **TWO** of the following: (10)

- a) Obtain the current density associated with the function $\Psi(x) = A e^{ikx}$.
- b) Obtain an expression for the Schrödinger's time independent wave equation.
- c) Prove the Ehrenfest theorem $d/dt \langle p_x \rangle = - \langle dV/dx \rangle$.

Q.3 Attempt any **TWO** of the following: (10)

- a) Obtain the expression for energy spectrum of free particle if motion of particle is in constant potential.
- b) By using $V_p = \omega / k$, show that the group velocity $V_g = V_p - \lambda dV_p / d\lambda$.
- c) Obtain an expression for the behavior of particle in a potential barrier and calculate the reflection (R) coefficient for it.

Q.4 Attempt any **FIVE** of the following: (10)

- a) Explain the physical significance of wave function Ψ .
- b) If the velocity of the ocean waves is $\sqrt{g\lambda/2\pi}$. Find the group velocity of ocean waves.
- c) Calculate the De- Broglie's wavelength of an electron which has kinetic energy equal to 40 eV (Given $h = 6.063 \times 10^{-34}$ SI and $m = 9.1 \times 10^{-31}$ kg).
- d) Explain requirements of raising and lowering ladder operators.
- e) Explain eigenvalue and eigen function.
- f) What are different characteristics of wave function?

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