Mid-West University

Examinations Management Office

Chance Examinations -2080

Bachelor level/ B.Sc. / 8th Semester — Full Marks: 100

Time: 3hrs — Pass Marks: 50

Subject: Quantum Mechanics (PHY481)

Candidates are required to give their answers in their own words as far as practicable. The figures in the margin indicate full marks.

Group – A

1. **Answer in short (any EIGHT questions). [2x8=16]**
   - **a.** What are the inadequacies of classical mechanics?
   - **b.** State and explain Heisenberg Uncertainty principle.
   - **c.** Find the kinetic energy of a proton whose de Broglie wavelength is 1fm.
   - **d.** What is the significance of normalization of wave function?
   - **e.** Show that rest mass of photon is zero.
   - **f.** Define Hermitian operator.
   - **g.** Find the expectation value $\langle x \rangle$ of the position of a particle trapped in a box L wide.
   - **h.** Write the conclusion of Geiger Nuttal law.
   - **i.** Why the Schrodinger's wave equation is not valid for relativistic particles?
   - **j.** What bearing would you think the uncertainty principle has on the existence of the zero-point energy of a harmonic oscillator?

Group – B

2. **Answer in brief (any SIX questions). [6x6=36]**
   - **a.** Explain the Davision-Germer experiment.
   - **b.** Obtain the relation between group and phase velocities.
   - **c.** Discuss the free particle in a box based on quantum mechanics.
   - **d.** Show that, $[Lx, Ly] = i\hbar L_z$
   - **e.** What are observables? Also discuss about the simultaneous measurability of observables.
   - **f.** What are commutating and non-commutating operators? Also discuss about Eigen value equation.
   - **g.** State Ehrenfest's Theorem. Also show that $\frac{d\langle r \rangle}{dt} = \frac{\langle P \rangle}{m}$.

Group – C

3. Solve the radial part of the Schrodinger equation for the hydrogen atom. Obtain the energy Eigen values and radial wave equation. **[9]**
4. Explain the finite potential barrier. Also obtain the reflection and transmission coefficient of particle entering into it. **[9]**

   OR

   Write the general and normalized wave function of a harmonic oscillator. State the first three normalized wave functions of the oscillator and show them graphically.
5. Derive time dependent Schrodinger equation. **[6]**
6. For hydrogen atom , Ψ_{210}= A[exp{-r/2a_o}]rcosθ. Find A. **[6]**
7. Prove that any two Eigen functions of a Hermitian operator, belonging to different Eigen values are orthogonal. **[6]**

   OR

   Show that p_x^2 is a Hermitian operator.
8. Show that $\frac{\partial P}{\partial t} + \vec{\nabla} \cdot \vec{J} = 0$ where symbols are their usual meanings. **[6]**
9. What is the ratio uncertainty of the velocities of (a) an electron and (b) a proton confined to a one-dimensional box of length 1.8 nm? **[6]**

The End