Mid-West University

Examinations Management Office

End Semester Examinations 2081

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

Time: 3 hours | Pass Marks: 50

Subject: Quantum Mechanics (PHY481)

Candidates are required to give their answer 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. How is the Heisenberg's uncertainty principle used in chemistry?
   b. What is the wave function? Write its boundary condition.
   c. Differentiate between commutating and non-commutating operators.
   d. Photoelectric and Compton effect both arise due to the action of photon on electron but the two effects are not same. Explain?
   e. Establish the energy-momentum relation for a free particle.
   f. Show that rest mass of photon is zero.
   g. Why is uncertainty principle important for microscopic particles but insignificant in practical life?
   h. Why Schrodinger's wave equation is not valid for relativistic particles?
   i. Explain briefly Dirac delta function.
   j. Signify the quantum numbers associated with hydrogen atom in quantum mechanics problem.

Group – B

2. Answer in brief any **SIX** questions **[6x6=36]**
   a. Describe with necessary theory Davisson and Germer's experiment for establishing wave nature of electron.
   b. Show that every function under Hermitian operator with different Eigen values is orthogonal?
   c. Explain the azimuthal component of wave function of hydrogen atom.
   d. State Ehrenfest's theorem and prove that $\langle \hat{p}_x \rangle = m \frac{d\langle x \rangle}{dt}$.
   e. What do you mean by linear harmonic oscillator? Explain its zero-point energy associated with linear harmonic oscillator.
   f. Explain the simultaneous measurability of observables.
   g. Show that $\int_{-\infty}^{\infty} \Psi_m^* \Psi_n dx = 0$.

Group – C

3. Explain the radial component of Schrodinger's wave equation of hydrogen atom. Explain the significance of the quantum number predicted by it. [9]
4. Derive an expression for the transmission and reflection coefficient of a particle through potential barrier of finite height and width.

   OR

   Starting from a particle oscillate simple harmonically then obtain the time dependent and time independent S.W.E. [9]
5. Show that $\frac{\partial P}{\partial t} + \vec{\nabla} . \vec{J} = 0$ where symbols are their usual meanings. [6]
6. Calculate the potential barrier for the α-particle emitted by Rn_{86}^{222} assuming effective nuclear radius $r_o = 1.5A^{1/3}$ Fermi [length of side of cube = $9.08\times10^{-15}m$, mass of α particle = $4\times1.67\times10^{-27}kg$] [6]
7. Find the energy of a proton having de-Broglie wavelength 0.5fm.

   OR

   For hydrogen atom , Ψ_{210}= A[exp{-r/$2a_o$}]rcosθ. Find the value of coefficient A. [6]
8. Show that $[L_x, L_y] = i\hbar L_z$. [6]
9. Show that $(\Delta x)^2 = \langle (x - \langle x \rangle)^2 \rangle = \langle x^2 \rangle - \langle x \rangle^2$, where Δx be the uncertainty in position. [6]

THE END