Progressive Education Society's
Modern College of Arts, Science & Commerce Ganeshkhind, Pune – 16
(Autonomous)
End Semester Examination: MAR / APR 2025
Faculty: Science and Technology

Program: B.Sc. (Gen03) **Semester: VI** **SET: A**
Program (Specific): General B.Sc. **Course Type: DSC**
Class: T.Y.B.Sc. (Gen) **Max. Marks: 35**
Name of the Course: Quantum Mechanics
Course Code: 24-PHY-362 **Time: 2Hr**
Paper: II

Instructions to the candidate:

1) ***All questions are compulsory.***
2) ***Figures to the right indicate full marks.***
3) ***Draw a well labeled diagram wherever necessary.***
4) ***Use of scientific calculator and log table is allowed.***

Q.1. Answer the following. **(5)**

a) What is wave particle duality?
b) State equation of continuity.
c) What is potential barrier?
d) What is a rigid rotator?
e) Define parity.

Q.2. Answer the following. (Any 4/6) **(4)**

a) Define expectation value.
b) State Uncertainty principle.
c) What is tunnelling effect?
d) Write the Schrodinger's time independent equation.
e) Define eigen value and eigen function.
f) State four quantum numbers.

Q.3. Answer the following. (Any 4/6) **(8)**

a) Define phase and group velocity.
b) What is an operator? Explain with the help of an example.
c) What is a free particle?
d) Draw energy level diagram of free rigid rotator.

e) Find the lowest energy of an electron confined to move in one dimensional potential box of 1 Å.

(Given: m = 9.11×10^{-31} kg, $\hbar = 1.054 \times 10^{-34}$ Js and 1eV = 1.6×10^{-19} J)

f) What is raising and lowering operator?

Q.4. Answer the following. (Any 2/4) (8)

a) What is Hamiltonian operator?

If $H = P^2/2m + V(x)$ then show that $[x, [x, H]] = -\hbar/m$.

b) What are Ladder operators?

Prove the commutation of L_z with L_+. Show $[L_z, L_+] = \hbar L_+$

c) The moment of inertia of CO molecule is 1.46×10^{-46} kg-m^2. Calculate the rotational energy and angular velocity in the lowest level of CO molecule.

d) Show that for a free particle the uncertainty relation can also be written as

$$\Delta\lambda\, \Delta x \geq \frac{\lambda^2}{4\pi} .$$

Q.5. Answer the following. (Any 2/4) (10)

a) Explain classical motion of one-dimensional harmonic oscillator.

b) Obtain Schrödinger's time dependent equation.

c) A proton is confined to move in a one-dimensional box of width 0.200 nm. (a) Find the lowest possible energy of the proton. (b) What is the lowest possible energy of an electron confined to the same box? (Given: Mass of proton= 1.66×10^{-27} kg, Mass of electron = 9.1×10^{-31} kg and $\hbar = 1.055 \times 10^{-34}$ Js)

d) Calculate the most probable distance of the particle in the first excited state of the simple harmonic oscillator.