SEMESTER EXAMINATION-2021
CLASS: M.Sc.IYear
SUBJECT: PHYSICS
PAPER TITLE: QUANTUM MECHANICS-I
PAPER CODE: MPH-C103

TIME:3 HOURS **MAX.MARKS**: 70
MINI. MARKS.: 40%

NOTE: Question paper is divided into two Sections A and B. Attempt both Sections. Answer questions as per instructions given.

SECTION-A

(Short Answer Type Questions)

NOTE: Attempt any five questions in about 150 words each. Each question carries 6 marks.

(05x06=30)

Q.1 State and prove Ehrenfest's theorem.
Q.2 Explain the concept of probability current density.
Q.3 Obtain Schrodinger equation for spherically symmetric potential in spherical coordinates.
Q.4 Write down radial wave-function for hydrogen atom and solve it to obtain the expression for bound state.
Q.5 Prove that If two Hermitian operators commute, then their product is also Hermitian operator.
Q.6 Write down the Schroedinger's wave equation in operator form and discuss the Hamiltonian operator in time independent and time dependent forms of a free particle.
Q.7 What are C.G. coefficients? Mention their properties and selection rules.
Q.8 Derive time dependent Schroedinger equation and discuss the concept of stationary state and wave packets.
Q.9 Solve the Schroedinger equation in three dimensions for a free particle and discuss their salient features of the wave function.
Q.10 Show that coefficient of reflection of particles incident on barrier is same whether they approach from right or from left.

SECTION-B

(Long Answer Type Questions)

NOTE: Attempt any four questions in detail. Each question carries 10 marks.

(04x10=40)

Q.1 Solve the Schroedinger equation for a particle moving in one dimensional potential well of finite width. Calculate the possible values of energy the particle can have.
Q.2 Obtain and Solve the Schroedinger's equation for a rigid rotator with free axis and obtain the eigenvalues of energy and the eigenfunctions. How are the results modified it the axis is
fixed.
Q.3 Mentioning the properties of Hermitian operators, explain their significance in Quantum Mechanics and What is the Heisenberg uncertainty principle? Prove the Heisenberg relations where the symbols have their usual meaning.
Q.4 Solve the radial part of the Schrodinger equation for the H-atom and Construct the symmetric and antisymmetric wave functions for hydrogen molecule.
Q.5 What are Unitary and Similarity transformations? Discuss Schrodinger; Heisenberg and Interaction pictures and compare them.
Q.6 Explain the problem of the leakage of a particle through a rectangular potential barrier of finite width and explain the theory of $\underline{\alpha}$- particle decay.
Q.7 Establish Schrodinger equation, for a linear harmonic oscillator and solve it to obtain its

eigenvalues and eigenfunctions . Discuss the significance of zero point energy.

Q.8 What is the significance of operators in quantum mechanics? What do you mean by linear operators; Inverse operators; Singular and non singular operators and Momentum operators.