TB245101F

Reg. No :.....

Name :.....

BACHELOR'S DEGREE (C.B.C.S) EXAMINATION, NOVEMBER 2024

2022 ADMISSIONS REGULAR

SEMESTER V - CORE COURSE (PHYSICS)

PH5B06B18 - Classical and Quantum Mechanics

Time : 3 Hours **Maximum Marks : 60**

Part A

I. Answer any Ten questions. Each question carries 1 marks **(10x1=10)**

1. Differentiate between rheonomous and scleronomous constraints.
2. Determine the number of degrees of freedom for a particle moving on the circumference of a circle.
3. Mention the superiority of Lagrangian mechanics over Newtonian approach.
4. Prove that Hamiltonian of a conservative system is equal to the total energy of the system.
5. Briefly explain Planck's quantum hypothesis.
6. State the difference between photoelectric effect and Compton effect.
7. State the relation between de Broglie wavelength and the velocity of the particle.
8. Differentiate between group velocity and phase velocity.
9. Find the value of probability current density when the wave function is real.
10. Show that the probability current density is a constant in time, for stationary states.
11. Only Hermitian operators are associated with physical quantities. Give reason.
12. Graphically represent the first two eigenfunctions of a one-dimensional harmonic oscillator.

Part B

II. Answer any Six questions. Each question carries 5 marks **(6x5=30)**

13. Discuss the difficulties introduced by constraints in the solution of mechanical problems. Suggest methods to overcome those difficulties.
14. Write the Hamiltonian for a simple pendulum and hence deduce its equation of motion.
15. Derive Euler-Lagrange's equations.
16. Determine the work function of given metal. Given that the threshold wavelength is 700 nm.
17. Find te ratio of the kinetic energy of an electron to that of a proton if their de Broglie wavelengths are equal.
18. Obtain the relation between particle velocity and the group velocity for a non relativistic particle.
19. A particle constrained to move along X-axis in the domain $0 \leq x \leq L$ has a wave function $\psi(x) = \sin(n\pi x/L)$, where n is an integer. Normalize the wave function.
20. Show that eigenvalues of Hermitian operators are real.
21. For an electron in a one dimensional potential well of width 1 Å, calculate (i) the separation between the two lowest energy levels (ii) the frequency and wavelength of the photon corresponds to a transition between these two levels.

Part C

III. Answer any Two questions. Each question carries 10 marks **(2x10=20)**

22. Derive Lagrange's equations from D'Alembert's principle.
23. Describe Compton Effect and obtain the expression for Compton shift.
24. Develop time dependent Schrodinger equation for a particle moving in a field.
25. Solve the Schrodinger equation for a particle in a one dimensional box and find out its energy eigen values.