

TB205405V

Reg. No : .....

Name : .....

**B. Sc. DEGREE (C.B.C.S.) EXAMINATION, NOVEMBER 2022**  
**2020 ADMISSIONS REGULAR AND 2019, 2018 ADMISSIONS SUPPLEMENTARY**  
**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. List the advantages of using generalized coordinates.
3. State Hamilton's principle.
4. Show that the generalized momentum conjugate to a cyclic coordinate is conserved.
5. Write down Planck's radiation law and explain the symbols.
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. Represent a wave packet both graphically and analytically.
9. Briefly discuss the normalization condition for a wave function.
10. Show that the probability current density is a constant in time, for stationary states.
11. Give the operators for energy and momentum in quantum mechanics.
12. Write down the expression for transmission coefficient for one-dimensional square barrier.

**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. A particle slides from rest at one point on a frictionless wire in a vertical plane to another point under the influence of earth's gravitational field. If the particle travels in the shortest time, show that the path travelled by it is a cycloid.
16. Calculate the velocity of photoelectrons when a light of wavelength  $2000 \text{ \AA}$  is incident on a metal surface. Work function of the metal is  $2.5 \text{ eV}$ .
17. Find the K.E of the neutron in units of eV whose de Broglie wavelength is  $1 \text{ \AA}$ . Mass of neutron is  $1.675 \times 10^{-27} \text{ kg}$
18. Obtain the relation between particle velocity and the group velocity for a non relativistic particle.
19. Find the expectation value of the position of a particle enclosed in a box of length L.
20. Show that any two eigenfunctions of a Hermitian operator that belong to different eigenvalues are orthogonal.
21. A  $1 \text{ eV}$  electron is trapped inside the surface of a metal. If the potential barrier is  $4.0 \text{ eV}$  and the width of the barrier is  $2 \text{ \AA}$ , calculate the probability of its transmission

**Part C**

**III. Answer any Two questions. Each question carries 10 marks**

**(2x10=20)**

22. Derive Lagrange's equations using Hamilton's principle.
23. Describe Compton Effect and obtain the expression for Compton shift.
24. State and prove Ehrenfest's theorems.
25. Set up the Schrodinger equation for a particle in a one dimensional box and find the expressions for ground state energy and the corresponding wave function.