(7 pages) Reg. No. : .....

Code No. : 20301 E Sub. Code : CMPH 61

B.Sc. (CBCS) DEGREE EXAMINATION, APRIL 2025.

Sixth Semester

Physics — Core

QUANTUM MECHANICS

(For those who joined in July 2021 and 2022 only)

Time : Three hours Maximum : 75 marks

PART A — (10 × 1 = 10 marks)

Answer ALL questions.

Choose the correct answer :

1. The energies of photoelectron in photo electric effect
   (a) increases with intensity of light
   (b) increases with frequency of light
   (c) increases with the velocity of light
   (d) all the above

2. The energy gap between successive energy in a hydrogen atom
   (a) decreases as in increases
   (b) decreases as in decreases
   (c) increases as in increases
   (d) either (a) or (b)

3. According to debroglie hypothesis
   (a) Particles have wave like characteristics
   (b) Radiation having longer wavelength can never be quantized
   (c) Wave motion are quantized but particles have no wave nature
   (d) Particles have wave nature

4. The debroglie wavelength of an electron whose speed in halt that of light is
   (a) 3.6×10^{-12} m (b) 4.2×10^{-12} m
   (c) 8.4×10^{-12} m (d) 0.12×10^{-12} m

5. The uncertainty in the location of a particle is equal to debroglie wavelength then the uncertainty in its velocity is

(a) $2V$ (b) $\frac{3}{2}V$

(c) $\frac{V}{2}$ (d) V

6. The Heisenberg equation of motion for momentum for a system with Hamiltonian $\hat{H} = \frac{P^2}{2m} + V(\bar{v})$ is

(a) $\frac{dP}{dt} = -\bar{V}V(r)$ (b) $\frac{d\bar{P}}{dt} = -ih\bar{\nabla}V(\bar{r})$

(c) $\frac{d\bar{P}}{dt} = 0$ (d) $\frac{dP}{dt} = \bar{\nabla}V(\bar{r})$

7. Two wave functions ψ_1, and ψ_2 are orthogonal if

(a) $\int|\psi_1|^2 d\tau = 1$ (b) $\int\psi_2\psi_1 d\tau = 1$

(c) $\int\psi_2\psi_1\tau = 0$ (d) $\int|\psi_2|^2 d\tau = 0$

8. In the first excited state of a one dimensional harmonic oscillator with angular frequency ω the energy eigen value is given by

(a) $2h\omega$ (b) $h\omega$

(c) $\frac{1}{2}h\omega$ (d) $\frac{3}{2}h\omega$

9. The degree of degeneracy for 3D isotropic harmonic oscillator is

(a) n^3 (b) $2n^2 + 1$

(c) $\frac{1}{2}(2n+1)(2n+2)$ (d) $\frac{1}{2}(n+1)(n+2)$

10. In case of a potential step of height V_0 for a particle of energy $E < V_0$ the transmittance is

(a) zero (b) finite non zero

(c) infinite (d) 1

PART B — (5 × 5 = 25 marks)

Answer ALL questions by choosing (a) or (b).
Each answer should not exceed 250 words.

11. (a) Describe Black body radiation of Quantum Theory.

Or

(b) Write a note photoelectric effect.

12. (a) State the debroglie hypothesis for matter waves.

Or

(b) Derive the expression of Group Velocity of debroglie waves.

13. (a) Give the Elementary Proof of Heisenberg's Uncertainty Principle.

Or

(b) Outline the consequences of uncertainty relation.

14. (a) Derive the Schrodinger one dimensional time Independent equation.

Or

(b) Define operator in quantum mechanics and explain it with example.

15. (a) Describe particle in one dimensional box.

Or

(b) Describe Transmission across a potential barrier.

PART C — (5 × 8 = 40 marks)

Answer ALL questions by choosing (a) or (b).
Each answer should not exceed 600 words.

16. (a) Explain Bohr's quantization of angular momentum.

Or

(b) Derive Einstein's photoelectric equation.

17. (a) What is meant by matter waves? Give experimental evidence in support of the concept of these waves.

Or

(b) Derive the relation between the Group Velocity and the Phase Velocity.

18. (a) State Uncertainty Principle and from it obtain other two forms of it.

Or

(b) Outline the Idealised experiment to bring out the significance of Heisenberg's Uncertainty Principle.

19. (a) Obtain Schrodinger's time dependent equation.

Or

(b) Solve for the eigen values and the eigen functions of L^2 and L_z operator.

20. (a) Explain particle in a rectangular three dimensional box.

Or

(b) Explain one dimensional simple harmonic oscillator in quantum mechanics.
