2021/TDC/CBCS/ODD/
PHSHCC-501T/155

TDC (CBCS) Odd Semester Exam., 2021
held in March, 2022

PHYSICS

(5th Semester)

Course No. : PHSHCC-501T

(Quantum Mechanics and Applications)

Full Marks : 50
Pass Marks : 20

Time : 3 hours

The figures in the margin indicate full marks for the questions

SECTION—A

Answer any *ten* of the following questions : 2×10=20

1. Give the physical interpretation of wave function.

2. State the principle of superposition of eigenstates.

3. What do you mean by conservation of total probability in quantum mechanics?

4. What are Hermitian operators?

5. Write the operators associated with *(a)* energy and *(b)* momentum.

6. What do you mean by the expectation values of dynamical quantities?

7. What do you mean by the term 'potential barrier' in quantum mechanics?

8. What is zero-point energy of a harmonic oscillator?

9. Mention two applications of Schrödinger equation.

10. What is Larmor's theorem?

11. What is Bohr magneton?

12. Define gyromagnetic ratio.

13. What is Zeeman effect?

14. Define Stark effect.

15. What is Pauli's exclusion principle?

SECTION—B

Answer any *five* of the following questions : 6×5=30

16. Obtain the general solution of three-dimensional Schrödinger time-dependent wave equation.

17. Derive the equation of continuity

$$\frac{\partial \rho}{\partial t} + \vec{\nabla} \cdot \vec{J} = 0$$

where $\rho = \psi^* \psi$ is the probability density and J = current density. What is its significance?

18. Define angular momentum operator and show that $[L_x, L_y] = i\hbar L_z$.

19. Prove Ehrenfest theorem.

20. Write down the Schrödinger equation for a linear harmonic oscillator and obtain the eigenvalues of the energy of the oscillator.

21. A particle is confined in a one-dimensional infinite square well.

$$V(x) = \begin{cases} 0, & 0 < x < a \\ \infty, & x < 0,\ x > a \end{cases}$$

Write down the time-independent Schrödinger equation for $0 < x < a$ and solve it.

22. Write down the Schrödinger wave equation for the motion of the electron in hydrogen atom in spherical polar coordinates and separate it into radial and angular parts.

23. Find the expression for the orbital and the spin magnetic moments associated with an electron.

24. Describe Stern-Gerlach experiment.

25. Describe vector atom model.

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