(Pages : 4) **K – 3157**

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Fifth Semester B.Sc. Degree Examination, February 2021.

First Degree Programme under CBCSS

Physics

Core Course VI

PY 1542 : QUANTUM MECHANICS

(2013, 2015-17 Admission)

Time : 3 Hours Max. Marks : 80

SECTION – A

Answer any **ten** questions, each carries 1 mark

1. What is photo electric effect?
2. Write de Broglie equation.
3. Write the expression for energy of a harmonic oscillator.
4. Write the expression of Compton wavelength? Expression.
5. In a harmonic oscillator write the expression for it ground state energy.
6. Why Rutherford's atom model is called planetary model?
7. State any two properties of wave function.
8. State the uncertainty relation for energy and time.

9. Why $\psi^* \psi$ is always positive and real?

10. Define wave velocity.

(10 × 1 = 10 Marks)

SECTION – B

Answer any **eight** questions, each carries **2** marks

11. Explain Compton scattering.

12. Distinguish between phase velocity and group velocity.

13. What is normalization of a wave function?

14. What is a wave packet?

15. Write and explain the time dependent Schrodinger equation

16. Write the physical significance of $\psi(r,t)$ and it probability interpretation in short.

17. What are commuting operators?

18. What do you mean by expectation values?

19. Explain any two properties of Hermitian operators.

20. Explain Hamiltonian operators.

21. What is the condition in Hilbert space for which two functions are orthogonal?

22. What is momentum space wave function?

(8 × 2 = 16 Marks)

SECTION–C

Answer any **six**, each question carries **4** marks.

23. Ultraviolet light of wavelength 350 nm directed at a potassium surface. Find the maximum energy of photoelectrons. Given that the work function of potassium is 2.2 eV.

24. Find the de Broglie wavelengths of

    (a) a 46-g golf ball with a velocity of 30 m/s, and

    (b) an electron with a velocity of 107 m/s..

25. An electron is in a box of 0.1 nm, which is the order of magnitude of atomic dimensions. Find its permitted energies.

26. Show that the function $y = A \exp\left(-i\omega\left(t - \frac{x}{v}\right)\right)$ is a solution of the wave equation

27. A particle limited to the x axis and has the wave function $\psi = ax$ between $x = 0$ and $x = 1$, all other regions $\psi = 0$.

    (a) Find the probability that the particle can be found in the region $0.45 < x < 0.55$

    (b) Find the expectation value of $\langle x \rangle$ of the particles position

28. Show that the Eigen values of a Hermitian operator are real.

29. What is Hilbert space?

30. Explain the properties of incompatible observables in quantum mechanics, give example

31. Briefly explain the finite square well scattering matrix.

(6 × 4 = 24 Marks)

SECTION–D

Answer any **two**, each question carries **15** marks

32. Discuss Bohr atom model. Derive the expression for energy levels and explain hydrogen spectrum.

33. Obtain the Time dependent and time independent form of Schrodinger equation.

34. Obtain the energy eigen values of a harmonic oscillator. Find the wave functions and the initial energy levels.

35. Explain the generalised statistical interpretation of quantum mechanical formulation.

(2 × 15 = 30 Marks)
