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Fifth Semester B.Sc. Degree Examination, December 2021

First Degree Programme under CBCSS

Physics

Core Course VI

PY 1542 : QUANTUM MECHANICS

(2014, 2016 & 2017 Admission)

Time : 3 Hours Max. Marks : 80

PART – A

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

1. Write the expression for the maximum energy of photo electrons emitting from a metal of work function ω if the frequency of radiation is v.
2. What is Compton effect?
3. Write the value of zero-point energy of a harmonic oscillator.
4. Explain the reason for the failure of Rutherford's atom model.
5. What do you mean by wave function?
6. State the uncertainty principle for momentum and position.
7. Write the time independent Schrodinger equation.

P.T.O.

8. Define Hamiltonian operator.

9. Define group velocity.

10. What are observables in quantum mechanics.

(10 × 1 = 10 Marks)

PART – B

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

11. What do you mean by wave particle duality?

12. How electron diffraction shows the wave nature of electrons?

13. Explain correspondence principle.

14. What are the requirements for a mathematical function to be a wave function?

15. Explain the postulates of Bohr atom model.

16. Write the quantum mechanical operators for momentum and energy.

17. What do you mean by a Hermitian operator?

18. Explain the general uncertainty relation.

19. Briefly explain square well potential.

20. What are linear operators?

21. What do you mean by expectation values?

22. Write the postulates of quantum mechanics.

(8 × 2 = 16 Marks)

PART – C

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

23. In a Compton scattering experiment, x-rays of wavelength 10.00 pm are scattered from a target.

    (a) Find the wavelength of X-rays scattered through 45°.

    (b) Find the maximum wavelength present in the scattered x-rays.

    (c) Find the maximum kinetic energy of the recoil electrons.

24. An electron has de Broglie wavelength of 2.00 pm. Find its kinetic energy and the phase and group velocities of its de Broglie waves.

25. A hydrogen atom is 0.53 $\mathring{A}$ in radius. Use the uncertainty principle to estimate the minimum energy an electron can have in this atom.

26. A measurement determines the position of a proton with an accuracy of $\pm 1.00 \times 10^{-11} m$. Find the uncertainty in the proton's position 1.00 s later. Assume $v << c$.

27. Find the probability that a particle trapped in a box of width L can be found between 0.45 L and 0.55 L for the ground and the first excited state.

28. Show that observables are represented by Hermitian operators.

29. An Eigen function of the operator $\frac{d^2}{dx^2}$ is $\Psi = e^{2x}$. Calculate the corresponding Eigen value.

30. Express Hamiltonian operator. How it is related to the time independent Schrodinger equation.

31. Formulate the time dependent Schrodinger equation.

(6 × 4 = 24 Marks)

PART – D

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

32. Discuss the Compton scattering in detail. Calculate the change in wavelength or frequency by Compton scattering and explain Compton wavelength.

33. Obtain the energy and wave functions of particle in a finite potential well.

34. With necessary explanation Explain the Schrodinger equation and obtain its solutions of a free particle.

35. What do you mean by Hilbert space and how it is related to the formulation of quantum mechanics? Give the idea of inner product, orthogonality and orthonormality of functions in Hilbert space. What is the condition for a set of functions in Hilbert space to be complete?

(2 × 15 = 30 Marks)
