U – 2392

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Reg. No. : .....

Name : .....

Fifth Semester B.Sc. Degree Examination, December 2024

First Degree Programme under CBCSS

Physics

Core Course — V

PY 1541 : QUANTUM MECHANICS

(2018 Admission Onwards)

Time : 3 Hours

Max. Marks : 80

PART – A

Answer **all** the questions. **Each** carries **1** mark.

1. What is uncertainty principle?
2. Write 1D time independent Schrödinger equation.
3. What is photoelectric effect?
4. Give the specific heat of solids.
5. What is the basis of Einstein's theory of photoelectric effect?
6. Write the characteristics of a wave function.
7. Write the probability current density of wavefunction.

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8. Define correspondence principle.

9. What is de Broglie hypothesis?

10. What is wave packet?

(10 × 1 = 10 Marks)

PART – B

Answer **any eight** questions. **Each** carries **2** marks.

11. Sketch black body radiation curve.

12. What is Compton effect?

13. Give the important conclusion of photoelectric effect.

14. Write a note on inadequacy of quantum theory.

15. Define expectation value.

16. Explain Plank's quantum hypothesis.

17. Explain eigen value and eigen functions.

18. What is linear operator? Explain commuting and anti-commuting operators.

19. What are Hermitian operators?

20. Write the postulates of quantum mechanics.

21. Define continuous and discrete spectra in terms of eigen values.

22. What happens to the wave function associated with a particle in an infinitely deep potential well?

(8 × 2 = 16 Marks)

PART – C

Answer **any six** questions. **Each** carries **4** marks.

23. Show that:

    (a) Operators having common set of eigenfunctions commute;

    (b) Commuting operators have common set of eigenfunctions.

24. If the position of a 5 keV electron is located within 2 Å, what is the percentage uncertainty in its momentum? (Given: Plank constant = 6.626×10^{-34} Js; mass of electron = 9.11×10^{-31} kg).

25. If a photon has wavelength equal to the Compton wavelength of the particle, show that the photon energy is equal to the rest energy of the particle.

26. A metallic surface when illuminated with light of wavelength 3333 Å emits electrons with energies up to 0.6 eV. Calculate the work function of the metal. (Given: Plank constant = 6.626×10^{-34} Js).

27. A harmonic oscillator moves in a potential $V(x) = \frac{1}{2}kx^2 + cx$, where c is a constant. Find the energy eigenvalues.

28. What is the difference between Schrodinger representation and momentum representation of equation of motion?

29. Normalize the wave function $\Psi(x) = A\exp(-ax^2)$, A and a are constants over the domain $-\infty \leq x \leq \infty$.

30. For an electron in a one-dimensional infinite potential well of width 1Å, calculate:

    (a) The separation between the two lowest energy levels

    (b) The frequency and wavelength of the photon corresponding to a transition between these two levels. (Given: Plank constant $h = 6.626 \times 10^{-34}$ Js)

31. An electron in a 1D infinite potential well, defined by $V(x) = 0$ for $-a \leq x \leq a$ and $V(x) = \alpha$ otherwise, goes from the $n = 4$ to $n = 2$ level. The frequency of the emitted photon is 3.43×10^{14} Hz. Find the width of the box.

(6 × 4 = 24 Marks)

PART – D

Answer **any two** questions. **Each** carries **15** marks.

32. Obtain energy eigen value and eigen function of a linear harmonic oscillator.

33. Briefly discuss the spectral distribution of energy density in a black body.

34. Derive the expression for square well potential with infinite walls.

35. Derive time dependent and independent Schrödinger equations.

(2 × 15 = 30 Marks)
