S – 1648

Reg. No. : ....

Name : ....

Fifth Semester B.Sc. Degree Examination, December 2023

First Degree Programme under CBCSS

Physics

Core Course V

PY 1541 : QUANTUM MECHANICS

(2018 Admission onwards)

Time : 3 Hours

Max. Marks : 80

SECTION – A

Answer **all** questions; each question carries **1** mark.

1. What is photoelectric effect?

2. State Planck's quantum theory.

3. Give expression for fine structure constant α.

4. Define threshold frequency.

5. Write the de-Broglie relation.

6. Define phase velocity.

7. Write the operator corresponding to energy.

8. Define zero point energy.

9. Give the condition for two functions to be orthogonal.

10. What is Hilbert's space?

(10 × 1 = 10 Marks)

P.T.O.

SECTION – B

Answer any **eight**; each question carries **2** marks.

11. State and explain Einstein's photoelectric equation.

12. Explain how uncertainty principle accounts for the natural line width of spectral lines.

13. Prove the non-existence of electrons in the nucleus on the basis of uncertainty principle.

14. Outline the various admissibility conditions on the wavefunction of a system.

15. Define a Hermitian operator and name its two properties.

16. Distinguish between co-ordinate representation and momentum representation.

17. Derive time independent shrodinger equation for a linear harmonic oscillator.

18. Write the operators corresponding to angular momentum components.

19. What are linear operators?

20. Outline the probability interpretation of the wavefunction.

21. Write the equation of continuity for probability current density.

22. What is the difference between Einstein's and Debye's theory of specific heat?

$$(8 \times 2 = 16 \text{ Marks})$$

SECTION – C

Answer any **six**; each carries **4** marks.

23. X-ray with wavelength 1A° are scattered from a carbon block. The scattered radiation is viewed at 90° to the incident beam. What is the compton shift.

24. Calculate the photelectric work function for sodium metal given that the threshold wavelength is 6800 A° and $h = 6.625 \times 10^{-34}$ Js.

25. What is the de-Broglie wavelength of an electron which has been accelerated from rest through a potential difference of 100 V?

26. Calculate the velocity and frequency of revolution of the electron of the Bohr hydrogen atom in its ground state.

27. Normalize the wave function $\psi(x) = A\exp(-ax^2)$ where a, A are constant over the domain $-\infty \leq x \leq \infty$.

28. Show that phase velocity of a relativistic electron is $v_p = c\left[1 + \dfrac{m_0^2 c^2 \lambda^2}{h^2}\right]^{1/2}$ where λ is its de-Broglie wavelength.

29. Show that any eigenvalues of a Hermitian operator belong to different eigen values are orthogonal.

30. If A and B are Hermitian operators, show that $(AB+BA)$ is Hermitian, and $(AB-BA)$ is not Hermitian.

31. For an electron in a one dimensional infinite potential well of width 1 A°. 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.

$$(6 \times 4 = 24 \text{ Marks})$$

SECTION – D

Answer any **two**; each carries **15** marks.

32. What do you mean by a free particle? Write down the Schrodinger equation for a free particle, discuss its solution.

33. What is Compton effect? Derive an expression for Compton shift.

34. Outline different postulates of Quantum mechanics.

35. What is a harmonic oscillator? Obtain expression for its energy. Discuss its importance.

$$(2 \times 15 = 30 \text{ Marks})$$

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