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TRIVANDRUM

Fifth Semester B.Sc. Degree Examination, February 2021

First Degree Programme under CBCSS

Physics

Core Course V

PY 1541 : QUANTUM MECHANICS

(2018 Admission Regular)

Time : 3 Hours Max. Marks : 80

PART – A

Answer **all** the questions. Answer should not exceed two sentences. Each question carries **1** mark :

1. Give the Planck's distribution law.
2. What is meant by dual nature of matter?
3. Mention the properties of the wave function.
4. What is meant by normalised wave function?
5. Write down the Schrodinger's time independent wave equation in three dimensions and explain the symbols.
6. What is meant by zero point energy?
7. What is a wave packet?

P.T.O.

8. Define a Hermitian operator.

9. What is a linear operator?

10. What do you mean by Phase velocity?

(10 × 1 = 10 Marks)

PART – B

Answer **any eight** questions. Answer should not exceed one small paragraph. Each question carries **2** marks :

11. What is Compton wavelength? Discuss the importance of Compton effect.

12. Derive the energy time uncertainty relation.

13. Brief the give the physical interpretation of the wave function.

14. Write note on black body radiation. Give examples.

15. Explain the discrepancy of Rutherford hydrogen atom and the Bohr model explanation.

16. Mention any four uses of electron diffraction.

17. Give the evidence for finite width of the spectral lines.

18. Write note on the orthogonality of eigen functions.

19. Explain the orthogonality and normalization condition of wave functions.

20. Write note on probability density.

21. Discuss about the linear vector space.

22. Define the Hamiltonian operator.

23. Discuss the purpose of Davisson–Germer experiment.

24. What do you understand by box normalization?

25. Write the normalized wave function for particle in a infinite square potential well and draw diagram showing its amplitude wave and probability density.

26. Write down the Schrodinger's wave equation in momentum representation and explain the terms.

(8 × 2 = 16 Marks)

PART – C

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

27. An X-ray beam of wavelength 5 pm is Compton scattered from a target. Determine the minimum and maximum wavelength of the scattered x-rays.

28. Using the uncertainty principle, estimate the ground state energy of the harmonic oscillator.

29. Calculate the permitted energy levels of an electron in a box 1 $\mathring{A}$ wide.

30. The energy required to remove an electron from sodium is 2.5 eV. Does sodium exhibit photoelectric effect from a radiation having wavelength 300 mm.

31. X-rays of wavelength 2 $\mathring{A}$ are scattered from a carbon block. The scattered photons are observed at right angles to the direction of the incident beam. Determine

    (a) the wavelength of the scattered photon

    (b) the recoil energy of the electron.

32. The photoelectric threshold for a certain metal is 200 mm. Estimate the maximum energy of the electrons emitted by a radiation of wavelength 40 mm.

33. Calculate the de-Broglie wavelength associated with an electron of energy 5 eV.

34. Calculate the expectation value $\langle p_x \rangle$ of the momentum of a particle trapped in a one dimensional box.

35. Derive the time independent form of Schrodinger equation.

36. Show that eigen functions of a hermitian operator that belong to distinct eigen values are orthogonal.

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

38. Normalize the wave function $\psi(x)=Ae^{-ax2}$ between over the domain $-\infty \leq x \leq \infty$, where A and a are constants.

(6 × 4 = 24 Marks)

PART – D

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

39. Discuss the important conclusions on photoelectric effect. Give Einstein's explanations of the different effects.

40. Discuss quantum mechanically the problem of a particle in a finite square potential well. Draw diagram showing the amplitude wave and probability density for the same.

41. Explain the postulates of quantum mechanics.

42. Explain the properties of Hermitian operator.

43. Discuss the inadequacy of classical mechanics and explain the discrepancy of Rutherford hydrogen atom and the Bohr's model explanation.

44. Derive the Schrodinger's time dependent equation for a free particle.

(2 × 15 = 30 Marks)
