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Reg. No. : .....

Name : .....

Fifth Semester B.Sc. Degree Examination, October 2015
First Degree Programme under CBCSS
PHYSICS
Core Course – VI
PY 1542 : Quantum Mechanics
(2013 Admission)

Time : 3 Hours Max. Marks : 80

SECTION – A

This Section contains very short answer questions of **one** mark **each**. Answer **all** questions.

1. Which law corresponds to the high frequency limit of Planck's radiation law ?
2. What is the relation between energy of the photoelectrons and the frequency of incident light ?
3. What was the purpose of the Davisson-Germer experiment ?
4. What is Bohr's correspondence principle ?
5. What is the quantum mechanical operator representing energy ?
6. When the number of waves forming a wave packet is increased, what happens to the width of the wave packet ?
7. The zero point energy is a manifestation of which principle
8. What is meant by basis vectors ?
9. What is meant by a linear operator ?
10. What is the condition for two eigenfunctions to be orthonormal ? **(10×1=10 Marks)**

P.T.O.

SECTION – B

This Section contains short answer questions of **2** marks **each**. Answer **8** questions.

11. Draw the spectrum of a black body. Write down the Planck's distribution formula.
12. Discuss the terms (i) work function and (ii) threshold frequency in photoelectric effect.
13. What is the significance of Compton effect ?
14. What are the admissibility conditions on a wavefunction ?
15. What do you mean by expectation value of an operator ? What is the expression for the same ?
16. Discuss two properties of stationary states.
17. Explain the energy-time uncertainty principle.
18. Explain what is meant by a Hilbert space.
19. Discuss the term degeneracy of eigenfunctions.
20. Illustrate the terms phase velocity and group velocity.
21. Explain what is meant by quantum mechanical tunneling.
22. Write short note on scattering matrix. **(8×2=16 Marks)**

SECTION – C

This Section contains short essay questions of **4** marks **each**. Answer **6** questions.

23. The energy required to remove an electron from sodium is 2.5eV. Does sodium exhibit photoelectric effect from a radiation of wavelength 300 nm ?
24. X-rays of wavelength 5 pm (pico meter) are Compton scattered from a target. Determine the minimum and maximum wavelength of the scattered X-rays.
25. Determine the de Broglie wavelength of an electron having a kinetic energy 1000 eV.
26. An eigenfunction of the operator $\frac{d^2}{dx^2}$ is e^{2x}. Find the corresponding eigen value.

27. An electron has a speed of 500 m/s with an accuracy of 0.004%. Calculate the certainty with which we can locate the position of the electron.

28. Obtain the expectation value of the momentum of a particle enclosed in a one-dimensional box.

29. A proton in a one-dimensional box has energy of 400 keV in its first excited state. Determine the width of the box.

30. Prove that any two eigenfunctions of a Hermitian operator that belong to different eigenvalues are orthogonal.

31. Prove that operators having common set of eigenfunctions commute. **(6×4=24 Marks)**

SECTION – D

This Section contains long essay questions of **15** marks **each**. Answer **2** questions.

32. Discuss the concepts of the Rutherford planetary model. What are its limitations ? Explain Bohr's postulates and their consequences with respect the hydrogen atom.

33. What do you mean by a free particle ? Write down the Schroedinger equation for a free particle. Discuss its solutions.

34. Setup the Schroedinger equation for a one dimensional harmonic oscillator. What are its eigenfunctions and eigenvalues ? Plot the eigenfunctions and the probability densities for the lowest three eigenvalues.

35. Discuss the following :

    i) Determinate states

    ii) Discrete and continuous spectrum of a Hermitian operator

    iii) Schwarz inequality and

    iv) Minimum uncertainty wave packet. **(2×15=30 Marks)**
