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Reg. No. : .....

Name : .....

Fifth Semester B.Sc. Degree Examination, November 2016
First Degree Programme under CBCSS
PHYSICS
Core Course – VI
PY 1542 : Quantum Mechanics
(2013 Admission Onwards)

Time: 3 Hours Max. Marks: 80

SECTION – A

Answer **all** questions in **a word** or **one** or **two sentences**. **Each** question carries **one** mark :

1. What is meant by a Hamiltonian operator ?
2. Write down any two application of uncertainty relation.
3. What is Compton effect ?
4. Write a note on wave properties of matter.
5. Define the terms work function and threshold frequency in photoelectric effect.
6. Explain the postulates of Bohr with regard to hydrogen atom.
7. Explain de Broglie relation.
8. What is Hilbert space ?
9. Explain function spaces.
10. Define probability current density. **(10×1=10 Marks)**

SECTION – B

Answer **any eight** questions, not exceeding a paragraph. **Each** question carries **two** marks :

11. Write a note on black body radiation.
12. Write a note on existence of stationary states.

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13. Define a Hermitian operator. Show that the eigen functions of a Hermitian operator are real.
14. What is a Bohr atom ?
15. Explain correspondence principle.
16. Distinguish between group velocity and phase velocity.
17. How particle nature of radiation was confirmed by the photoelectric effect and Compton effect ?
18. Explain properties of matter and electron diffraction.
19. Outline different postulates of quantum mechanics.
20. Outline the probability interpretation of the wave function.
21. State and explain the uncertainty principle.
22. Show that the energies of a linear harmonic oscillator are integral multiples of $h\nu_0 = \hbar\omega$. **(8×2=16 Marks)**

SECTION – C

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

23. A hydrogen atom in a state having a binding energy of 0.85 eV makes a transition to a state with an excitation energy of 10.2 eV. Calculate the energy of the emitted photon.
24. What potential difference must be applied to stop the fastest photoelectrons emitted by a surface when electromagnetic radiation of frequency 7.5×10^{15} Hz is allowed to fall on it. The work function of the surface is 15 eV.
25. The work function of barium and tungsten are 2.5 eV and 4.2 eV respectively. Check whether these materials are useful in a photocell, which is to be used to detect visible light.
26. Calculate the de Broglie wavelength of an electron having a kinetic energy of 1000 eV. Compare the result with the wavelength of X-rays having the same energy.
27. A particle constrained to move along x-axis in the domain $0 \leq x \leq L$ has a wave function $\Psi(x) = \sin(n\pi x / L)$, where n integer. Normalize the wave function and evaluate the expectation value of its momentum.

28. Show that the linear momentum is not quantised.

29. For a particle of mass m, Schrödinger initially arrived at the wave equation.

$$\frac{1}{c^2}\frac{\partial^2\Psi}{\partial t^2} = \frac{\partial^2\Psi}{\partial x^2} - \frac{m^2c^2}{\hbar^2}\Psi$$

Show that a plane wave solution of this equation is consistent with the relativistic energy momentum relationship.

30 Show that Cartesian coordinates (r_1, r_2, r_3) and the Cartesian components of angular momentum (L_1, L_2, L_3) obey the commutation relation.

$$[L_k, r_k] = 0$$

31. Prove that the operators i d/dx and d^2/dx^2 are Hermitian. **(6×4=24 Marks)**

SECTION – D

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

32. Discuss Bohr atom model. Derive an expression for energy levels.

33. Deduce time independent Schrödinger equation for a free particle.

34. What are stationary states. In stationary states, show that the probability current density is constant in time.

35. Define the uncertainty (Δ A) in the measurement of dynamical variable. State and explain the general uncertainty relation. **(2×15=30 Marks)**
