K24U 2759

Reg. No. : .....

Name : .....

V Semester B.Sc. Degree (C.B.C.S.S. – O.B.E. – Regular/ Supplementary/ Improvement) Examination, November 2024
(2019 to 2022 Admissions)
CORE COURSE IN PHYSICS
5B06 PHY : Quantum Mechanics

Time : 3 Hours Max. Marks : 40

PART – A

Short answer questions. Answer **all** questions. **Each** carries **1** mark.

1. Give the relation between the amplitudes of electric and magnetic fields of an electromagnetic wave moving through vaccum.
2. What is meant by ultraviolet catastrophe ?
3. State the de Broglie hypothesis.
4. What is meant by Zeeman effect ?
5. Write down the radial part of Schrodinger equation for hydrogen atom.
6. What is meant by Bohr magneton ? Give its equation. **(6×1=6)**

PART – B

Short essay questions. Answer **any six** questions. **Each** carries **2** marks.

7. Explain the pair production. For this process to occur, a heavy nearby atom is required. Why ?
8. State Bohr's correspondence principle. What is its significance ?
9. Describe the Heisenberg position-momentum uncertainty principle.
10. What does the amplitude of the Broglie wave represent ?
11. Distinguish between phase velocity and group velocity of a wave packet.

P.T.O.

12. Write down the time independent one dimensional Schrodinger equation. Can it be derived from any previous laws or postulates ? Explain.
13. What is meant by expectation values in quantum mechanics ? Give the equation for the expectation value of a function f(x).
14. Using the Schrodinger equation show that the energy of a free particle is not quantized. **(6×2=12)**

PART – C

Problems. Answer **any four** questions. **Each** carries **3** marks.

15. X rays of wavelength 0.240nm are Compton-scattered and the scattered beam is observed at an angle of 60° relative to the incident beam. Find the wavelength of the scattered X rays.
16. Find the wavelengths of the transitions from $n_1 = 3$ to $n_2 = 2$ and from $n_1 = 4$ to $n_2 = 2$ in atomic hydrogen. (Rydberg constant is $1.097 \times 10^7 m^{-1}$).
17. Estimate the minimum velocity for a billiard ball ($m \approx 100g$) confined to a billiard table of dimension 1m.
18. An electron is bound to a region of space by a spring-like force with an effective spring constant of k=15.31 N/m. Calculate the ground-state energy.
19. Compute the magnitude of the angular momentum vectors that represent the orbital motion of an electron in a quantum state with $l = 1$ and in another state with $l = 2$.
20. Find the possible values of the total angular-momentum quantum number J under LS coupling of two atomic electrons whose orbital quantum numbers are $l_1 = 1$ and $l_2 = 2$. **(4×3=12)**

PART – D

Long essay questions. Answer **any two** questions. **Each** carries **5** marks.

21. Explain photoelectric effect. Which experimental results disagree with the wave theory ? Explain the quantum theory of the photoelectric effect.
22. Derive the Rutherford scattering formula.
23. Discuss the motion of a particle trapped in a one dimensional infinite potential energy well. Derive the energy eigen values and corresponding eigen functions.
24. Describe Sturn-Gerlach experiment. How the results were explained ? **(2×5=10)**

———————