K21U 4559

Reg. No. : .....

Name : .....

V Semester B.Sc. Degree CBCSS (OBE) Regular Examination, November 2021
(2019 Admission Only)
CORE COURSE IN PHYSICS
5B06 PHY : Quantum Mechanics

Time : 3 Hours Max. Marks : 40

PART – A
(Short Answer)

Answer **all**. **1** mark **each**. Maximum **6** marks. **(6×1=6)**

1. Maximum wavelength shift in Compton scattering is _____pm.
2. The hydrogen series in the visible region of the electromagnetic spectrum is
3. Cite an experimental evidence for the wave nature of electron.
4. Write time-independent Schrodinger equation for a particle moving in a one-dimensional region of potential energy V.
5. Write the expression for the quantized values of the z-component of the orbital angular momentum of the electron in hydrogen atom, in terms of magnetic orbital quantum number.
6. What is the number of spin orientations of a free electron in a magnetic field ?

PART – B
(Short Essay)

Answer **any 6**. **2** marks **each**. Maximum **12** marks. **(6×2=12)**

7. In Compton scattering experiment, plot the wavelength of the scattered radiation along the y-axis and $(1-\cos\theta)$ along the x-axis where θ is the angle of scattering of the radiation. How do you find the value of the Planck's constant from the graph ?
8. Explain pair production and pair annihilation.
9. Briefly discuss Bohr's correspondence principle.
10. State Heisenberg's uncertainty relation between the position and momentum of a particle. Write the relationship between the uncertainties in position and momentum of the particle.
11. Explain the normalization of the wave function of a particle.

P.T.O.

12. What do you mean by quantum mechanical tunneling ? For a beam of particles of energy E incident on a potential barrier of height U, such that E < U, plot the wave functions on either side of the barrier and within the region of the barrier.
13. What is normal Zeeman effect ? How is it explained ?
14. State and explain Pauli's exclusion principle.

PART – C
(Problems)

Answer **any 4. 3** marks **each**. Maximum **12** marks. **(4×3=12)**

15. What are the energy and momentum of a photon of red light of wavelength 650nm ?
16. X-rays of wavelength 0.24nm undergo Compton scattering. The scattered beam is observed at an angle of 60° relative to the incident beam. Find the energy of the scattered X-ray photon.
17. What is the shortest wavelength present in the Balmer series of spectral lines of hydrogen atom ?
18. Obtain the de Broglie wavelength of an electron accelerated through 600V potential difference.
19. Calculate the expectation value of the position of a particle trapped in a one-dimensional box of infinite potential well when it is in the n^{th} quantum state.
20. The electron in the hydrogen atom is in the ground state. The ground state radial wave function is $R_{1,0}(r) = \frac{2}{a_0^{3/2}} e^{-r/a_0}$ where a_0 is the Bohr radius of hydrogen atom and r is the radial distance from the nucleus. Find the most probable radial distance of the electron from the nucleus.

PART – D
(Long Essay)

Answer **any 2. 5** marks **each**. Maximum **10** marks. **(2×5=10)**

21. What are the different experimental features of photoelectric effect ? How does the classical electromagnetic theory of radiation fail to explain these features ? How does Einstein's quantum theory of radiation explain them ?
22. Write the expression for the quantized energy values of hydrogen atom and draw the energy level diagram. Discuss Frank – Hertz experiment. How does it prove that the atomic energy levels are quantized ?
23. Obtain an expression for the group velocity of the wave packet representing a matter wave and show that it is equal to the velocity of the moving particle.
24. Derive the energy values and normalized wave functions for a particle in a one-dimensional "box" of infinite potential well. Plot the energy values and wave functions of the first three states.
