

LOYOLA COLLEGE (AUTONOMOUS), CHENNAI – 600 034



B.Sc. DEGREE EXAMINATION – PHYSICS

FIFTH SEMESTER – NOVEMBER 2019

PH 5510 – QUANTUM MECHANICS AND RELATIVITY

Date: 29-10-2019

Dept. No.

Max. : 100 Marks

Time: 09:00-12:00

Part – A

Answer ALL questions

(10 x 2 = 20 marks)

1. Only good conductors of electricity exhibit photoelectric effect. Justify the statement.
2. What is meant by wave-particle duality?
3. How do you define the orthogonality condition between two (wave) functions?
4. State superposition theorem in quantum mechanics.
5. Define angular momentum. What is its direction?
6. What do you understand by spherical harmonics? Give example.
7. Show that acceleration is invariant under Galilean transformation.
8. What is meant by space – time continuum?
9. What is the mass of a 1 GeV electron in terms of its rest mass?
10. How does gravitation affect the flow of time?

Part – B

Answer any FOUR questions

(4x 7.5 = 30 marks)

11. Apply uncertainty principle to estimate the ground state energy of Hydrogen atom and the radius of first Bohr's orbit.
12. Define probability current density and obtain the equation of continuity in quantum mechanics.
13. Discuss the concept of quantum mechanical tunneling and its application to α – decay to obtain Geiger-Nuttal law.
14. Define a Hermitian operator. i) Show that the eigenvalues of Hermitian operators are real. ii) Two eigenstates of a Hermitian operator with distinct eigenvalues are orthogonal to each other.
15. With a neat sketch, explain Michelson – Morley experiment. What was the significance of its result?
16. Prove that gravitation introduces curvature of space-time.

Part – C

Answer any Four questions

(4x 12.5 = 50 marks)

17. What is Compton effect? Explain in detail how Compton effect established the particle nature of electromagnetic radiation.
18. State Ehrenfest's theorem and prove Newton's second law for a wave packet.
19. Set up Schrodinger wave equation for the rigid rotator. Solve it to obtain its eigenvalues and eigenfunctions.
20. Derive Lorentz transformation equations and discuss its consequences..
21. What is meant by relativistic aberration of light? Derive an expression for the angle through which the direction of light appears to have changed due to relative motion. From this arrive at the change in frequency due to longitudinal and transverse Doppler effects
22. Explain the following: Bending of light, Gravitational lensing, precession of perihelion of mercury.
