



LOYOLA COLLEGE (AUTONOMOUS), CHENNAI – 600 034

B.Sc. DEGREE EXAMINATION – PHYSICS

FIFTH SEMESTER – NOVEMBER 2017

PH 5510 – QUANTUM MECHANICS AND RELATIVITY

Date: 01-11-2017

Dept. No.

Max. : 100 Marks

Time: 09:00-12:00

PART-A

Answer ALL the questions

(10x2=20)

- 1) What was Planck's assumption to explain Black body radiation?
- 2) Find the change in wavelength of an electron getting scattered, in Compton scattering, at 180 degrees.
- 3) Define Group velocity.
- 4) Define self adjoint operator.
- 5) Define stationary states.
- 6) The energy of hydrogen atom in the state $n=2, l=1, m_l = 1$ and $m_s = +1/2$ is E eV, what is its energy in the state $n=2, l=0, m_l = -1$ and $m_s = -1/2$.
- 7) State the postulates of special relativity.
- 8) A meter stick moves with a speed of $\frac{\sqrt{3}}{2}c$, what is its length to a stationary observer?
- 9) Give the relativistic expression of Newton's law.
- 10) State equivalence principle.

PART-B

Answer any FOUR questions

(4x7.5=30)

- 11) Describe G.P. Thompson's experiment.
- 12) Prove the eigen values of a hermitian operator are real and the eigen vectors corresponding to distinct eigen values are orthogonal..
- 13) State the condition under which the time dependent Schrodinger equation can be reduced to the time independent Schrodinger equation, hence obtain the time independent Schrodinger equation from the time dependent Schrodinger equation.
- 14) Obtain the expression for time dilation. If the proper life time of a mu meson is 2×10^{-6} sec., find its life time in a frame in which it moves with a speed $\frac{1}{\sqrt{2}}c$.
- 15) Explain gravitational red shift.
- 16) Derive Einstein's mass-energy relation. Give the energy equivalence of 1 kg.

PART-C

Answer any **FOUR** questions (4x12.5=50)

- 17) a) Obtain an expression for the change in the wave length of a scattered photon, in Compton effect.
b) Using Heisenberg's uncertainty relation argue that an electron cannot be inside a nucleus.
- 18) a) Normalize the wave function $\psi_n = A \sin\left(\frac{n\pi}{L}x\right)$; $0 \leq x \leq L$.
b) Obtain the continuity equation for the probability density and hence prove the total Probability is conserved.
- 19) Represent angular momentum operators L^2 and L_z in spherical polar coordinate system. Obtain the eigen value spectrum of L^2 and L_z . Write down the 1st three eigen functions of L^2 and L_z .
- 20) Discuss the Michelson –Morley experiment and discuss the reasons forwarded to explain the null result.
- 21) Discuss the following: a) Bending of light, b) Gravitational lensing and c) Precision of perihelion of Mercury.
- 22) Explain aberration in the context of relativity. Derive expressions for longitudinal and transverse Doppler effect
