LOYOLA COLLEGE (AUTONOMOUS), CHENNAI – 600 034

M.Sc. DEGREE EXAMINATION - **PHYSICS**

THIRD SEMESTER – NOVEMBER 2011

PH 3811/3808 - RELATIVITY AND QUANTUM MECHANICS

Date : 02-11-2011 Dept. No. Max. : 100 Marks
Time : 9:00 - 12:00

PART – A

Answer **ALL** the questions (10 X 2 = 20)

1) Define "the invariant interval" of two events in special theory of relativity.
2) What is a 4-vector? Illustrate with an example.
3) What are the components of a current density 4-vector? Write down the equation of continuity in covariant form.
4) What is Lorentz condition? State the condition also in tensor notation.
5) Define differential scattering cross section.
6) Write down the Schroedinger equation for the radial wave function.
7) Distinguish between the first order and the second order transitions of time dependent perturbation theory with schematic diagrams.
8) What is dipole approximation in emission/absorption process of an atom?
9) Write down the Dirac matrices in terms of the (2x2) Pauli spin matrices and unit matrix.
10) Explain briefly the significance of the negative energy states of the Dirac equation.

PART – B

Answer any **FOUR** questions (4 X 7.5 =30)

11) (i) Define the energy-momentum 4-vector and obtain the relation between relativistic energy and momentum. (ii) If a particle's kinetic energy is one fourth its rest energy, what is its speed?
12) Establish the invariance of **E.B** under Lorentz transformation.
13) Outline the Green's function method of obtaining a formal solution of the Schroedinger wave equation in scattering theory.
14) Discuss the time-dependent perturbation theory to obtain an expression for the amplitude of first order transition.
15) Establish that the total angular momentum (orbital + spin) of the electron is a conserved quantity in Dirac's theory.

PART – C

Answer any **FOUR** questions (4 X 12.5 =50)

16) (i) Explain how the laws of conservation of relativistic energy and momentum establish the observed change in wavelength of X-ray in Compton scattering
(ii) Establish the work-energy theorem of relativity.

17) Obtain the transformation equations among the components of electric and magnetic fields of the special theory of relativity.
18) Outline the partial wave analysis of the scattering theory to obtain an expression for the scattering amplitude.
19) Discuss the interaction of an atom with radiation field and obtain an expression for the transition probability per unit time in terms of energy density of the radiation field.
20) Set up the Dirac's wave equation. Obtain its plane wave solutions and the energy spectrum.

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