Exam. Code: 0905
Sub. Code: 6645

1079

B. Engg. (1st Year)-1st Semester

Bio Technology

APH-103: Quantum and Statistical Physics

(Common with IT and CSE)

Time allowed: 3 Hours Max. Marks: 50

NOTE: *Attempt five questions in all, including Q. No. 1 which is compulsory and selecting atleast two questions from each Part.*

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I. Attempt any five of the following:

(a) Why the mass of the photon is considered to be zero in special theory of relativity?

(b) What was the failure of Galilean transformations?

(c) What are black holes? How can we detect them?

(d) What is the difference between continuous and characteristic X- rays?

(e) Why a particle cannot be at rest in the infinitely deep potential well?

(f) Under what circumstances, if any, is Lz equal to L?

(g) What factors led to the introduction of spin quantum number?

(h) Calculate the number of different arrangements of of 6 Bosons among 4 cells of equal a priori probability. (2x5=10)

Part A

II. (a) Deduce the Einstien relativistic velocity addition theorem. Show that it is consistent with second postulate of relativity. (4)

(b) A driver is caugtht going through red light. The driver claims to the judge that the colour she actually saw was green (f= 5.60×10^{14} Hz) and not red (fo= 4.80×10^{14} Hz) because of the Doppler effect. The judge accepts this explanation and instead fines her for speeding at the rate of Rs 1000 for each km/h she exceeded the limit of 100km/h. What was the total fine? (3)

(c) Show that $(x^2+y^2+z^2-c^2t^2)$ is invariant under lorentz transformation. (3)

III. (a) What do you understand by Heisenberg Uncertainity Principle? Using this principle show that the electron cannot be a part of the nucleus. (4)

(b) Derive an expression for the Compton shift. Find the maximum energy of the recoil electron. (6)

IV. (a) Derive Schrodinger time indepent wave equation. Will it be valid for relativistic particles? (6)

(b) The wave function of a certain particle is $\psi = A\cos^2 x$ for $\frac{-\pi}{2} < x < \frac{\pi}{2}$. Find the value of A and also find the probability that the particle be found between x=0 and x= $\pi/4$. (4)

Part B

V. (a) Show that the evenly spaced energy levels of quantum harmonic oscillator are given by equation: $E_n = \left(n + \frac{1}{2}\right)\hbar\omega$ where n is quantum number. What is zero point energy? (6)

(b) Show that the Pauli exclusion principle is a consequence of antisymmetric wave function? (4)

VI. (a) Write the wave function for hydrogen atom. Discuss the significance of quantum numbers. (5)

(c) How did Plank's hypothesis for black body radiation solve the ultraviolet catastrophe? (5)

VII. (a) Show that the average kinetic energy of a three dimensional gas of N free electrons at 0°K is $\overline{E_0} = \frac{3}{5} N E_F$. (5)

(b) Compare Maxwell-Boltzmann, Bose- Einstein and Fermi-Dirac statistics. (5)

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