Exam.Code:0906
Sub. Code: 6668

1058

B.E. (Mechanical Engineering)
Second Semester
APH-203: Quantum and Statistical Physics
(Common with ECE, IT and EEE)

Time allowed: 3 Hours

Max. Marks: 50

NOTE: Attempt five questions in all, including Question No. I which is compulsory and selecting two questions from each Section. Calculator is allowed.

x-x-x

I. Answer the following briefly:

a) What is stationary in the stationary states of time-independent Schrodinger equation?
b) Explain briefly the origin of the four quantum numbers associated with the hydrogen atom.
c) Why is it easier to accelerate an electron to a speed that is close to the speed of light, compared to accelerating a proton to the same speed?
d) Why one uses the inhomogeneous magnetic field in Stern-Gerlach experiment?
e) Explain the phenomenon of tunneling. Give some practical examples of it.

(5 x 2 =10)

SECTION-A

II (a) An observer sees two objects moving away from each other. One object moves to the right with a velocity of 1.8×10^8 m/s, and the second object moves to the left with a velocity of 2.3×10^8 m/s. (i) According to this observer, how fast are the two objects moving away from each other? (ii) According to an observer on one object, how fast is the other object moving away from him?

(5)

(b) Consider an X-ray beam, with $\lambda = 1.00$ Å. If the radiation scattered from free electron is viewed at 90^0 to the incident beam: (i) What is the Compton wavelength shift? (ii) What kinetic energy is given to a recoiling electron? (iii) What percentage of the incident photon energy is lost in the collision?

(5)

III (a) Describe Michelsen-Morely experiment in detail. What are the aim and the conclusion of the experiment?

(5)

(b) Show that the de Broglie wavelength of a particle, of charge e, rest mass m_0, moving at relativistic speeds is given as a function of the accelerating potential V as

$$\lambda = \frac{h}{(2m_0eV)^{1/2}}\left(1+\frac{eV}{2m_0c^2}\right)^{-1/2}$$

(5)

IV (a) Prove that a free electron cannot completely absorb a photon and conserve both energy and momentum.

(4)

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IV (a) Prove that a free electron cannot completely absorb a photon and conserve both energy and momentum. (4)

(b) What are the conditions imposed on an acceptable wavefunction? (3)

(c) Distinguish between Inertial and non-inertial frames of reference with examples. (3)

SECTION-B

V (a) Explain the phenomena of Thermionic emission. Derive an expression for the Richardson Dushmann equation. (5)

(b) A particle of mass m and energy E moves inside an infinite potential well. Prove that the expectation values $< xp_x >$ and $< p_x x >$ in the nth state are related by

$$< xp_x > - < p_x x > = ih/2\pi \quad (5)$$

VI(a) What are the postulates used by Planck's in black body radiation? Derive Planck's Black body radiation formula. (10)

VII (a) Obtain an expression for the thermodynamic probability of a system obeying Maxwell Boltzmann statistical law. (5)

(b) Mention the significance of the Stern-Gerlach experiment. How does this experiment lead to the space quantization due to spin? (5)

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