[35] **Seat No.:**_____ **No. of Printed Pages :** 2

SARDAR PATEL UNIVERSITY
Semester V, T.Y. B.Sc. Examination
Date & Day: 11-11-2019 & Monday
Time: 10:00 am to 01:00 pm
Applied Physics, Course Code- US05CAPH01
Course title- Quantum and Statistical Mechanics

Maximum Marks: 70

Q-1 Write answers to the following multiple choice questions in your answer book by selecting the proper option. [10]

(1) As the temperature increases the spectral energy density of the radiations _____ in black body radiation-
(a) Increases (b) decreases (c) remains constant (d) None of these

(2) The kinetic energy of the ejected electrons depends on the _____in photoelectric effect.
(a) frequency (b) Intensity (c) both a and b (d) temperature

(3) The phase and group velocity are equal if phase velocity-
(a) in non-dispersive medium (c) both a and b
(b) not depend on the wavelength (d) None of these

(4) The energy operator for a free particle in Schrodinger equation is given by-
(a) $-i\hbar\nabla$ (b) $i\hbar\nabla$ (c) $i\hbar\,\partial/\partial t$ (d) $-i\hbar\,\partial/\partial t$

(5) For a particle in a square well potential, $V(x) = -V_0$ if
(a) $-a < x < a$ (b) $x < -a$ (c) $x > a$ (d) none of these

(6) In the Micro-canonical ensemble independent systems have-
(a) Same energy, volume and number of particles.
(b) Same temperature, volume and number of particles.
(c) Same temperature, volume, and chemical potential
(d) None of the above

(7) What type of system energy is related to the molecular structure of a system?
(a) Macroscopic form of energy (c) Internal energy
(b) Microscopic form of energy (d) External energy

(8) Deduction of Planck's law is possible on the basis of-
(a) Bose Einstein statistics (c) Classical Statistics
(b) Maxwell Boltzmann Statistics (d) Fermi Dirac statistics

(9) Maxwell Boltzmann statistics is-
(a) Classical phenomenon (b) Only for gas (c) Quantum phenomenon (d) Only for Solid

(10) From Fermi Dirac statistics $n_i = ?$
(a) $\frac{g_i}{e^{\alpha+\beta E_i}+1}$ (b) $\frac{2g_i}{e^{\alpha+\beta E_i}+1}$ (c) $\frac{g_i}{e^{\alpha+\beta E_i}-1}$ (d) $\frac{2g_i}{e^{\alpha+\beta E_i}-1}$

Q-2 Answer the following questions in brief. (Answer any ten questions) [20]

(1) Define the photoelectric effect?
(2) Brief the De Broglie hypothesis.
(3) Write the energy-time and position-momentum terms used in Heisenberg's uncertainty principle.
(4) Write the Schrodiner's equation for a free particle in three dimension.
(5) Give the generalized Schrodinger's equation in terms of Hamiltonian.
(6) Write the time independent Schrodinger's equation
(7) Write a note on statistical mechanics and explain why we need it.
(8) Write the condition for application of Maxwell Boltzmann statistics.
(9) What do you mean by canonical ensemble? What type of system is suitable for it?
(10) Write a short note on Bosons.

(P.T.O.)

(11) Define the symmetric and antisymmetric wave function for quantum statistics.
(12) Write the significance of partition function in statistical mechanics.

Q-3 (a) What is blackbody radiation? Explain the spectral energy density dependency on temperature with the necessary figure. [6]
(b) Discuss the conclusions made on the basis of photoelectric effect. [4]

OR

Q-3 (a) Derive the value of Rydberg's constant for hydrogen atom according to the Bohr's model. [10]

Q-4 (a) Discuss the conservation of probability of wave function. [6]
(b) Derive the expectation value of a particle using the Ehrenfest's theorem. [4]

OR

Q-4 (a) Discuss the motion of a particle in a square well potential. [10]

Q-5 (a) Derive the partition function's relation with entropy. [6]
(b) Write a short note on particle distribution function. [4]

OR

Q-5 (a) Derive the M. B. distribution function for an ideal gas. [6]
(b) Sketch the Canonical, grand canonical and micro-canonical ensemble. [4]

Q-6 (a) Obtain an expression for Bose-Einstein distribution law. [6]
(b) Compare the M.B., B.E., and F.D. statistics. [4]

OR

Q-6 (a) Derive the Fermi Dirac distribution law. [6]

(b) Explain Plank's law of radiation. [4]

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