

B. Sc. Semester VI (Honours) Examination, 2020 (CBCS)
Subject: Physics
Paper: CC-XIV (Statistical Mechanics)

Time: 2 Hours

Full Marks: 40

The figures in the margin indicate full marks. Candidates are required to give their answers in their own words as far as practicable.

Answer any eight of the following questions:

$5 \times 8 = 40$

1. Give statistical definition of entropy. Derive an expression for entropy of a perfect gas using microcanonical ensemble. 5
2. Define phase space. A particle is enclosed in a square of side L. Calculate the number of microstates available to this system if total energy of the system lies between E to $E + \Delta E$. 5
3. What do you mean by partition function? Show that the relation between the partition function Z and mean energy $\bar{\epsilon}$ is given by $\bar{\epsilon} = kT^2 \frac{\partial}{\partial T} (\ln Z)$ where the symbols have usual meaning. 5
4. Obtain Planck's radiation formula from Bose-Einstein statistics. What particles are bosons? Are they fundamental ones? 5
5. (a) Write down Fermi Dirac distribution function. Define Fermi level at absolute zero and at a finite temperature.
(b) Starting from the MB velocity distribution of a system of gas particles, find the number of particles having kinetic energy between E and $E + dE$. 5
6. Write down the properties of thermal radiation. What is ultraviolet catastrophe? 5
7. Consider a system of six particles filling up energy levels $\epsilon = 0, \epsilon_1 = \epsilon$ and $\epsilon_2 = 2\epsilon$ unit. Each energy level is 3-fold degenerate and total energy of the system is 6ϵ . Enumerate the possible number of microstates of the system according to (i) BE statistics (ii) FD statistics. 5
8. Write down the expression for energy density of states of an electron gas in a metal. Hence, find the Fermi energy at absolute zero temperature. 5
9. What is Bose Einstein condensation? Is it a first order phase transition? Under what condition BE and FD distribution reduces to classical MB distribution? 5
10. What do you mean by symmetry property of a wave-function for a system of (i) indistinguishable (ii) distinguishable particles? Discuss the physical significance of negative temperature for a two level system. 5