LOYOLA COLLEGE (AUTONOMOUS) CHENNAI – 600 034

M.Sc. DEGREE EXAMINATION – **PHYSICS**

THIRD SEMESTER – **NOVEMBER 2024**

PH 3814 – STATISTICAL MECHANICS

Date: 12-11-2024 Dept. No. Max. : 100 Marks

Time: 01:00 pm-04:00 pm

SECTION A

Answer ANY FOUR of the following **4 x 10 = 40 marks**

1. Write down the description of the macrostate of an open system.
2. Distinguish between degeneracy and density of states.
3. Why should the chemical potential of the photon gas be zero?
4. Express the grand canonical distribution function P_{N_i} in terms of the grand canonical potential Ω_g.
5. The pressure exerted by a Bose gas below the transition temperature is independent of its volume. Justify.
6. What does the positive chemical potential of a Fermi gas indicate?
7. Consider a system of N non-interacting indistinguishable particles of integral spin distributed over all possible quantum energy levels. What is the total number of microstates the system can have?
8. Bring out the conditions for the thermodynamical equilibrium between two systems.

SECTION B

Answer ANY THREE of the following **3 x 20 = 60 Marks**

9. Discuss Fermi-Dirac statistics, degenerate systems, and their applications in thermionic emission, white dwarfs, and nuclear matter.
10. Using the Taylor series method, derive the grand canonical partition function, write down the grand canonical potential and relate it to the thermodynamic properties of the system using the first law of thermodynamics.
11. State and prove Liouville's theorem. Prove that the physical properties of an isolated system are independent of time.
12. State and prove equipartition theorem. Applying the result, obtain Dulong Petit's law for the specific heat capacity of one mole of a monoatomic crystalline solid.
13. Describe Gibbs paradox. How is it resolved? Applying correct Boltzmann counting, derive the Sakur-Tetrode equation for the correct entropy of a classical ideal gas.
14. Compare the superfluid phases of Helium 3 and Helium 4, highlighting their distinctive quantum properties.

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