A-0588

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MSCPH–504

M.Sc. PHYSICS (MSCPH)

(Statistical Mechanics)

1st Semester Examination, Session December 2024

Time : 2:00 Hrs. Max. Marks : 70

Note* :–** This paper is of Seventy (70) marks divided into Two (02) Sections 'A' and 'B'. Attempt the questions contained in these Sections according to the detailed instructions given therein. ***Candidates should limit their answers to the questions on the given answer sheet. No additional (B) answer sheet will be issued.

Section–A

Long Answer Type Questions 2×19=38

***Note* :–** Section 'A' contains Five (05) Long-answer type questions of Nineteen (19) marks each. Learners are required to answer any *two* (02) questions only.

1. What do you understand by statistical, thermal equilibrium ? Establish relation between statistical and thermodynamical quantities. Show that $F = -kT \log Z$ Where Z is the partition function and F is Helmholtz free energy.

2. Explain Gibbs paradox. How it can be resolved by the concept of indistinguishability of the molecules or particles.

3. What is partition function ? Obtain it for a monoatomic perfect gas represented by the canonical ensemble. Find expressions for free energy, entropy and internal energy of the gas in terms of its partition function.

4. Explain Bose-Einstein condensation. How does it differ from ordinary condensation ? Derive the critical temperature at which this phenomenon sets in.

5. What are the phase transitions of first and second kind ? Discuss Ising model for phase transitions of second kind.

Section–B

Short Answer Type Questions 4×8=32

***Note* :–** Section 'B' contains Eight (08) Short-answer type questions of Eight (08) marks each. Learners are required to answer any *four* (04) questions only.

1. State and Prove Liouville's theorem.
2. Write down the expression of Maxwell-Boltzmann distribution law.
3. A system consisting of 3 independent particles localized in space. Each particle has two states of energy 0 and ε. When the system is in thermal equilibrium with a heat reservoir at temperature T, calculate its partition function ?
4. State and prove the principle of equipartition principle.
5. Prove that energy fluctuations in canonical ensemble are related to the specific heat.
6. Compare the three statistics Base- Einstein, Fermi-Dirac and Maxwell Boltzmann Statistics.

7. Obtain the expression for the chemical potential $\mu(T, P)$ for an ideal gas of non-relativistic particles in a grand canonical ensemble.

8. Explain Landau theory of phase transitions.

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