A–0431

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MSCPH-504

Master of Science Physics (MSCPH)

Statistical Mechanics

Examination, June 2025

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. Obtain an expression for speed distribution of particles in classical statistical mechanics. Also deduce the expression for the most probable, average and root mean square speeds.

2. Show that a system of classical harmonic oscillators Helmholtz free energy is NkTln($\hbar\omega/k$T)and also show its complete agreement with the equipartition theorem.

3. Deduce the equation of state and the entropy of an ideal classical gas in a grand canonical ensemble. Show that the results are the same as obtained in a canonical ensemble. What do you infer from this ?

4. (a) What do you understand by Fermi Dirac statistics ? Find an expression for it ?

   (b) What do you understand by electrons gas ? Show that at normal temperature, the pressure of the gas is sufficiently high.

5. Write short notes on :

   (a) Virial equation of states

   (b) Weiss theory of Paramagnetism

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. Explain the meaning of:

   (a) Microstate

   (b) Macrostate

   (c) Ensemble in statistical mechanics

2. State and Prove Boltzmann's theorem connecting entropy and probability.

3. What do you understand by ensemble ? How this concept of ensemble is utilized to obtain the properties of a statistical system.

4. What are the postulates of statistical mechanics ?

5. Consider a system of two particles each having only 3 quantum states of energy 0, ε, 2ε system is in contact with a heat reservoir at temperature T. Write down the partition function for the system obeys

   (a) Fermi Dirac statistics.

   (b) Bose Einstein statistics.

6. Compare the basic postulates of the Maxwell-Boltzmann, Bose-Einstein and Fermi-Dirac statistics.

7. Show that the mean speed of an electron in an electron gas at T = 0K is $\bar{v} = \frac{3V_F}{4}$, where V_F is the speed of an electron at the Fermi energy.

8. Define Phase Transition ? Distinguish between first and second order phase transitions with suitable examples.

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