A–1177

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MSCPH-504

M.Sc. Physics (MSCPH)

Statistical Mechanics

Examination February, 2026

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. Explain the Bose-Einstein condensation. For a strongly degenerate Boson gas, show that condensation temperature is :

$$T_B = \frac{0.084}{\gamma^{2/3}} \frac{h^2}{mk} \left(\frac{N}{V} \right)^{2/3}$$

where N and V are the number of atoms and volume of the gas and $y = 25 + 1$, where S is the spin of particles.

2. Describe the ergodic hypothesis. Why is it essential for the foundation of statistical mechanics ? Discuss its limitations.

3. Compare classical and quantum treatment of harmonic oscillator in canonical ensemble.

4. From Maxwell – Boltzmann speed distribution, obtain expression for :

   (a) Most probable speed Vp

   (b) Average speed V_{av}

   (c) *rms* speed V_{rms}

5. Write short notes on any *three* of the following :

   (a) Symmetry breaking during phase transitions

   (b) Exchange interactions

   (c) Chemical potential

   (d) Ensemble equivalence

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. Derive the Virial equation of state from statistical mechanics.

2. How can equation of state be obtained from partition function ?

3. Explain why fluctuations are negligible for macroscopic systems.

4. Write short notes on any two of the following :

   (a) Phase space volume

   (b) Accessible states

   (c) Ensemble probability distribution

5. Starting from B-E energy distribution law, derive Planck's Law of black body radiation.

6. Explain why the canonical ensemble is used for closed systems and the grand canonical ensemble for open systems.

7. Explain the concept of statistical equilibrium. Discuss the role of principle of equal a priori probabilities in determining equilibrium distribution.

8. Explain the concept of thermodynamic probability and derive the relation :

$$S = k \ln W$$

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