K26P 1221

Reg. No. : .....

Name : .....

Second Semester M.Sc. Degree (C.B.C.S.S. – O.B.E. – Reg./Supple./Imp.) Examination, April 2026
(2023 Admissions Onwards)
PHYSICS/PHYSICS WITH COMPUTATIONAL AND NANO SCIENCE SPECIALIZATION PROGRAMME
MSPHY02C09/MSPHN02C09 : Statistical Mechanics

Time : 3 Hours Max. Marks : 60

SECTION – A

Answer **any five** questions. **Each** carry **3** marks. **(5×3=15)**

1. Explain what is meant by thermodynamic limit. Distinguish between microstate and macrostate of a system with example.
2. Why does the Boltzmann entropy relation remove the need for an additive constant ? How is this related to the third law of thermodynamics ?
3. What is meant by a particle-energy reservoir ? Explain the conditions required for equilibrium between a system and the reservoir.
4. State Planck's radiation law for the spectral energy density of blackbody radiation and sketch the corresponding spectral energy distribution curve.
5. Explain the concepts of Fermi energy and Fermi temperature for a system of fermions.
6. What is order parameter, and how does it characterize phase transitions ?

SECTION – B

Answer **any three** questions. **Each** carry **6** marks. **(3×6=18)**

7. Two particles are to be distributed between two energy levels E_1 and E_2.
   a) If the particles are distinguishable, list all possible microstates. Determine the number of microstates corresponding to each macrostate (n_1, n_2), where n_1 and n_2 are the numbers of particles in levels E_1 and E_2, respectively.
   b) Repeat the above if the particles are indistinguishable.
   c) Compare the total number of microstates in both cases and comment on the difference.

P.T.O.

8. Sketch the phase-space trajectory of the representative point (q, p) for a one-dimensional harmonic oscillator. Show that the phase-space area corresponding to one eigenstate of the linear harmonic oscillator is equal to h.
9. Obtain the canonical partition function for a system of N monoatomic ideal gas molecules enclosed in a volume V, and express the Helmholtz free energy in terms of it.
10. Briefly describe the specific heat of conduction electrons in metals at low temperatures based on Fermi-Dirac statistics, and discuss its temperature dependence.
11. Discuss briefly the concept of critical exponents in phase transitions.

SECTION – C

Answer **any three** questions. **Each** carry **9** marks. **(3×9=27)**

12. Explain the Gibbs paradox and describe its resolution by deriving the Sackur-Tetrode formula.
13. Derive the equipartition law and the virial theorem within the framework of the canonical ensemble.
14. Explain the statistical mechanical treatment of a classical ideal gas in the grand canonical ensemble and obtain expressions for its macroscopic thermodynamic quantities.
15. Discuss the thermodynamic properties of an ideal Bose gas and derive the condition for Bose-Einstein condensation.
16. What is meant by a continuous phase transition ? Explain the Ising model that describes a magnetic phase transition.

———————