Exam. Code: 0474
Sub. Code: 3717

2021

M.Sc. (Physics)-3rd Semester

PHY-7002: Statistical Mechanics

Time allowed: 3 Hours | Max. Marks: 60

NOTE: *Attempt five questions in all including Q. No.-IX (Unit-V) which is compulsory and select one question each from Unit I-IV.*

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UNIT-I

I. (a) What is Gibb's paradox? Using the correct entropy formula $S = Nk\ln\frac{V}{N} + \frac{3}{2}Nk\left(\frac{5}{3} + \ln\frac{2\pi mKT}{h^2}\right)$ work out the entropy of mixing for the case of different gases and for the case of identical gases, thus showing explicity that there is no Gibb's paradox.

(b) For extreme relativistic gas show that $\gamma = 4/3$. (7+5)

II. (a) Discuss Liouville's theorem and its consequences.

(b) State and prove equipartition theorem. (5+7)

UNIT-II

III. (a) What is an ensemble? Discuss various types of ensembles.

(b) Explain the energy fluctuations in canonical ensembles. (7+5)

IV. (a) Obtain an expression for the energy density for a system in a canonical ensemble using the method of most probable values.

(b) Analyse the problem of solid-vapour equilibrium using grand partition function. (7+5)

UNIT-III

V. (a) Set up the equation of state for an ideal Fermi gas. Hence determine its various properties in terms of particle density and temperature. Establish the condition leading to the complete degeneracy of the system.

(b) Define Fermi energy. Calculate zero point energy of Fermi gas and show that it is purely due to a quantum effect. (7+5)

VI. (a) Discuss in details of Landau's theoretical scheme for explaining the behavior of liquid Helium. Also discuss the spectrum of excitations in liquid Helium

P.T.O.

(b) Derive an expression for the fugacity of an ideal Bose gas and show that it decreases asymptotically as a function of temperature. (6+6)

UNIT-IV

VII. (a) Discuss the Ising and Heisenberg models of interaction energy of a lattice.

(b) Describe the first order and second order phase transition. Compare by giving at least one example of each. (6+6)

VIII. (a) What do you mean by fluctuation? Explain with examples. Hence find an expression for the probability of fluctuation of particles in two halves of a box from most probable distribution.

(b) Discuss an experimental observation on spontaneous magnetization of ferromagnetic materials, which shows that the phenomenon of ferromagnetism is associated only with the spins of the electrons and not with their orbital motions. (6+6)

UNIT-V

IX. (a) Define critical opalescence. What are the conditions leading to it?

(b) Compare graphically the specific heats of a classical ideal gas and an ideal Bose gas as a function of temperature.

(c) In context of white dwarf stars, what is Chandera Sekhar Limit and how it is related to the mass of the sun?

(d) What is the minimum size of a phase-space cell in classical and quantum statistics? Discuss.

(e) What governs the onset of negative temperatures in magnetic materials? Explain.

(f) What is thermodynamic limit? Explain its importance. (6×2)

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