Roll No. .....

(05/25)

15431

M.Sc. EXAMINATION

(For Batch 2021 & Onwards)

(Fourth Semester)

PHYSICS

MSc/Phy/4/CC15

Statistical Mechanics

Time : Three Hours *Maximum Marks :* 70

Note : Attempt *Five* questions in all, selecting *one* question from each Unit. Q. No. **1** is compulsory.

1. (a) Show that absolute zero temperature is unattainable on the basis of the third law of thermodynamics.

(b) Distinguish between classical gas and photon gas at normal temperature.

(c) What is Gibbs paradox ? Which feature of classical statistic is responsible for this ?

(d) What is the difference between Brownian motion and diffusion ?

(e) What do you mean by an ensemble ? Which type of ensemble would be used to describe the behavior of electron gas. **2×5=10**

Unit I

2. (a) Derive Sackur Tetrode formula for entropy of a perfect gas. Show that it is free from the Gibbs paradox. **8**

(b) What is the postulate of equal priori probability ? Why is it acceptable ? 7

3. (a) State and derive the law of equipartition of energy. What are the conditions for the law to be valid ? 8

(b) Derive the four Maxwell's relation from the fundamental potentials and explain the physical significance of each of the thermodynamical potential. 7

Unit II

4. (a) Derive an expression for entropy of an ideal gas in canonical ensemble. Is it free from Gibbs paradox. If not, how to remove the paradox. 10

(b) Calculate the partition function and energy for a classical system of N particles and three energy levels 0, E, 2E. **5**

5. (a) State and Prove Liouville's Theorem. **10**

(b) What do you understand by partition function ? Derive expressions for internal energy, entropy and specific heat in terms of partition function. **5**

Unit III

6. (a) What are the basic assumptions of Plank's theory of black body radiation ? Derive the Plank's law of black body radiation. Under what conditions does this law reduce to the Rayleigh Jean's law and Wiens's law. **10**

(b) Show all the possible microstates for a system having two particles and two quantum states, if it obeys : **5**

(i) Maxwell-Boltzmann statistics

(ii) Bose-Einstein statistics

(iii) Fermi-Dirac statistics.

7. (a) What is the number of ways in which N_i Fermions can be distributed in g_i states ? Find the average occupation number of fermions in a state with energy E_i. **10**

(b) Plot and explain the variation of distribution function for a fermi gas. **5**

Unit IV

8. Discuss about the Landau theory of phase transition. Show that in Landau theory, at the transition point, entropy and total energy are continuous whereas the specific heat at constant pressure is discontinuous. **15**

9. (a) Explain the concept of fluctuations and underline its significance. Derive the expression for energy fluctuations. **10**

(b) A 1-D random walker takes 1,00,000 steps of unit length towards left and right with a probability of 1/3 and 2/3 respectively : **5**

(i) What is the probability that it will take 1200 steps toward right ?

(ii) What is the probability that it will return to its initial position after 1,00,000 steps.

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