Register Number:

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ST. JOSEPH'S COLLEGE (AUTONOMOUS), BANGALORE-27
M.Sc. PHYSICS – II SEMESTER
SEMESTER EXAMINATION : APRIL 2017
PH 8315 : STATISTICAL PHYSICS

Time: 2 1/2 hours **Maximum Marks:70**

This question paper contains 2 parts and 2 printed pages.
Use of Clark's tables and scientific calculators permitted.

Instructions : *Draw appropriate figures wherever necessary.*

PART - A

Answer any 5 questions. Each carries 10 marks. (5 x 10 = 50)

1. In quantum statistical mechanics, the basic expression for the partition function for a system is given by $Z=\sum_R e^{-\beta E_R}=\sum_R e^{-\beta(n_1\epsilon_1+n_2\epsilon_2+.....)}$. . Obtain an expression for $\overline{(\Delta n_s)^2}$ (dispersion of the number of particles in state s) in terms of Z. (10)

2. Discuss the problem of one dimensional random walk and show that it reduces to a binomial distribution. (10)

3. For a system of electromagnetic radiation in thermal equilibrium inside an enclosure, write the Planck distribution and hence obtain Wien's displacement law. (10)

4. For a system of dilute gas in equilibrium, derive the expression for Maxwell velocity distribution and hence obtain the expression for Maxwell distribution of speeds. (10)

5. Consider a solid consisting of N atoms. Write the Hamiltonian for this system using the "normal coordinates" of the system. Obtain an expression for the specific heat and show that in the high temperature limit, the specific heat approaches the result given by Dulong-Petit law. (1+9)

6. a) What is meant by the term ensemble?
   b) What is a canonical ensemble?
   c) Give the partition function for a canonical ensemble. Obtain the expression for mean energy and entropy of a canonical ensemble in terms of the partition function. (1+2+7)

7. a) Write the quantum distribution function for Fermi-Dirac statistics.
   b) What is "Fermi sphere"? Write the total number of states in this sphere at T=0.
   c) Using Fermi-Dirac statistics, obtain an expression for molar specific heat of electrons in metals. (1+2+7)

PART - B

Answer any 4 questions. Each carries 5 marks. (4 x 5 = 20)

8. Consider a system consisting of two particles, each of which can be in any one of three quantum states of respective energies 0, Є, and 3Є. The system is in contact with a heat reservoir at temperature T. Write an expression for the partition function Z if the particles obey classical MB statistics and are considered distinguishable.

9. A gas of molecules, each of mass m, is in thermal equilibrium at the absolute temperature T. Denote the velocity of a molecule by $\vec{v}$, its three cartesian components by v_x, v_y, v_z . Calculate $\overline{v_x^2}$.

10. One kilogram of water at $0^o C$ is brought into contact with a large heat reservoir at $100^0 C$. When the water has reached $100^0 C$ compute the change in entropy of the water?

11. Two similar dice A and B each having six equally likely faces marked as 1, 2, 3, 4, 5, 6 are thrown simultaneously. Calculate the probability of getting the faces of both the dice up marked with same number.

12. What is the probability of drawing three cards of the same series in succession from a pack of cards?

13. The occupation probability for an electron of energy ϵ in a metal is given by the Fermi function $f(\epsilon)=\frac{1}{e^{(\epsilon-\epsilon_F)/kT}+1}$. Obtain an expression for the energy of the state where the occupation probability is 0.01.