This question paper contains **4** printed pages]

Roll No. | | | | | | | | | | | |

S. No. of Question Paper : **956**

Unique Paper Code : **222602** **E**

Name of the Paper : **Statistical Physics (PHHT-620)**

Name of the Course : **B.Sc. (Hons.) Physics**

Semester : **VI**

Duration : **3 Hours** Maximum Marks : **75**

(Write your Roll No. on the top immediately on receipt of this question paper.)

Attempt *Five* questions in all.

Question No. **1** is compulsory.

All questions carry equal marks.

Symbols have their usual meanings.

1. Attempt any *five* of the following : 5×3=15

(*a*) What is Gibbs' paradox ? Which feature of classical statistics is responsible for this ?

(*b*) State the postulate of 'Equal a Priori Probability' of Statistical Physics. Apply it on a four particle system, with two possible states (left half of the container, and the right half of the container) and find the most probable particle distribution.

P.T.O.

(*c*) Determine the wavelength corresponding to the maximum emissivity of a black body at a temperature T equal to 3°K and 5000°K. Take b = 2898 μmK. In what spectral region will the wavelengths be found ?

(*d*) Explain Bose-Einstein condensation. How does it differ from ordinary condensation ?

(*e*) Derive conditions for a strongly degenerate gas. How does the degeneracy depend upon the temperature, number density and mass of particles ?

(*f*) Derive the expression for the Fermi momentum of a collection of electrons with number density n.

(*g*) Calculate the partition function, energy and specific heat for a classical system of N particles and three energy levels 0, ϵ, 2 ϵ.

(*h*) The Fermi energy for metal-A is 3.15 eV. Find its value for metal B given that the free electron density in metal B is nine times that in metal A.

2. (*a*) State and derive the law of equipartition of energy. Discuss its relevance and limitations with respect to the specific heat of a diatomic gas.

(*b*) What do you understand by partition function ? Derive expressions for internal energy (U), entropy (S) and specific heat (C_V) in terms of partition function. 10,5

3. (*a*) What is the thermodynamic definition of temperature ? Explain the emergence of negative temperatures in a system of magnetic dipoles with spin half in a magnetic field.

(*b*) How is entropy related to probability ? Derive a relation between them. 11,4

4. (*a*) What are the basic assumptions of Planck's theory of black body radiation ? Derive Planck's law of black body radiation. Under what conditions does this law reduce to Rayleigh Jeans's law and Wien's law ?

(*b*) Deduce the expression for Stefan's constant from Planck's black body radiation formula. 10,5

5. (*a*) What is Bose-Einstein distribution law ? Derive expressions for energy, entropy, specific heat and pressure of strongly degenerate Bose gas.

(*b*) Discuss an example of Bose-Einstein condensation.

(*c*) Calculate the number of ways of arranging four Bosons in seven different states. 10,3,2

6. (*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 $\in_i$.

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

(*c*) Evaluate the temperature at which there is 1% probability that a state, with energy 0.5 eV above Fermi energy, will be occupied by an electron. 8,4,3

7. (*a*) Show that the matter in white dwarf stars behaves like a strongly degenerate relativistic electron gas. Obtain an expression for mass radius relationship.

(*b*) What is the physical significance of Chandershekhar mass limit ? 12,3