This question paper contains 4 printed pages]

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

S. No. of Question Paper : **1601**

Unique Paper Code : **222602** **C**

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 : $3 \times 5 = 15$

(*a*) What do you mean by an ensemble ? Which type of ensemble would be used to describe the behaviour of a photon gas ?

(*b*) Define the terms : microstate, macrostate and thermodynamic probability.

(*c*) Differentiate between $-100°C$ and $-100K$. Which of the two is hotter ?

(*d*) Distinguish between classical gas and a photon as at normal temperature.

P.T.O.

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

(*i*) M-B,

(*ii*) B-E, and

(*iii*) F-D statistics.

(*f*) Give *two* unique properties of He-II.

(*g*) What do you mean by Ultraviolet catastrophe ? Explain with the help of a diagram.

(*h*) What are white dwarf stars ? What is the significance of Chandrasekhar mass limit ?

2. (*a*) Obtain the expression for the thermodynamic probability of a system obeying M-B statistics and hence evaluate the M-B distribution function.

(*b*) Show that the single particle partition function for an ideal monoatomic gas is given by : 10,5

$$Z = V\left(\frac{2\pi mkT}{h^2}\right)^{3/2}$$

3. (*a*) Obtain the expressions for the pressure exerted by normal and diffuse radiation.

(*b*) Derive Wien's displacement law.

(*c*) Calculate the wavelength corresponding to the maximum emission from the Sun's surface, at a temperature of 6000 K. 5,8,2

4. (*a*) Write down the single particle partition function for a system having two energy levels with energies :

$$\epsilon_1 = -\mu B \text{ and } \epsilon_2 = \mu B$$

(*b*) Evaluate the thermodynamic functions—internal energy, entropy, specific heat and magnetization, for such a system. Show with the help of graphs, the variation of these as a function of $kT/\mu B$. 3,12

5. (*a*) What is Bose-Einstein condensation ? Derive the expression for the condensation temperature of a Bose gas.

(*b*) Give Bose's derivation of Planck's law.

(*c*) Using this, show that the Stefan's constant is given by : 6,6,3

$$\sigma = \frac{2\pi^5 k^4}{15c^2h^3}$$

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

(*b*) Apply this law to find out the specific heat capacities of monoatomic and diatomic gases.

(*c*) Why does the specific heat so obtained for a diatomic gas not agree with the experimentally observed values ? 9,4,2

7. (*a*) Define Fermi energy. Obtain the expression for the Fermi energy of an electron gas.

(*b*) Find out the zero-point energy and the zero-point pressure of a Fermi gas and hence deduce its equation of state.

(*c*) Given that the electron density in potassium is 1.4×10^{28} m^{-3}, find out the average energy of an electron in the metal. 5,7,3