B.Sc. S.Y. CBCS Pattern Semester-III

USPHT06 - Physics Paper-II : Radiation and Statistical Physics

P. Pages : 3 **GUG/W/23/11617**

Time : Three Hours * 6 5 9 8 * Max. Marks : 50

Notes : 1. All questions are compulsory.
2. Draw neat labeled diagram wherever necessary.

Either:

1. a) i) State Planck's law for black body radiation. Calculate average energy of Planck's oscillator and derive Planck's radiation from it. **7**

ii) A spherical body has a radius of 0.01 m. this is maintained at 873 K. Calculate the rate at which energy is radiated from its surface assuming it to be a perfectly black body. **3**

OR

b) i) Draw the energy distribution in black body spectrum. What are the conclusions drawn from it. **2½**

ii) State and explain Wien's displacement law. **2½**

iii) A body at 1500 K emits maximum energy at wavelength 20,000 $\mathring{A}$. If the Sun emits maximum energy at wavelength at $6666\,\mathring{A}$, what would be the temperature of the Sun? **2½**

iv) Derive Stefan's Boltzmann law from Planck's radiation law. **2½**

Either:

2. a) i) Explain the concept of phase space and μ – space. **3**

ii) Discuss the constraints in thermodynamic system. **2**

iii) What is most probable macrostate? **2**

iv) In a system, 8 distinguishable particles are distributed in two equal sized compartments. Calculate the probability of the macrostate (3, 5), (4, 4) and (2, 6) **3**

OR

b) i) Explain the statistical meaning of entropy. **2½**

ii) Explain the term principle of equal a priori probability. **2½**

iii) Calculate the number of accessible microstate W of a system having entropy $10\,\text{cal K}^{-1}$ in the equilibrium state. **2½**

iv) Define thermodynamic probability and state its minimum value. **2½**

Either:

3. a) i) Using M. B. distribution law, $n_i = g_i e^{-\alpha} e^{-(Ei/kT)}$ derive an expression for Maxwell Boltzmann energy distribution law for the particles of an ideal gas, By evaluating the multiplier α. **8**

ii) Calculate the most probable velocity of a hydrogen at 27° C. **2**

Given: Boltzmann's constant k = 1.38×10^{-23} J / deg and

Mass of hydrogen molecule = 3.34×10^{-27} kg

OR

b) i) State the characteristics of a particle obeying M. B. Statistics. **2½**

ii) Using Maxwell's law of distribution of speeds of molecules in a gas, obtain an expression for most probable speed. **2½**

iii) At what temperature will the average speed of molecules of hydrogen gas be double the average speed of oxygen at 300 K? **2½**

iv) Derive an expression for root mean square speed of a molecules of ideal gas. **2½**

Either:

4. a) i) Derive an expression for Fermi Dirac distribution law for particles obeying F. D. statistics. **6**

ii) Derive an expression for B. E. energy distribution law for continuous variation of energy from B. E. distribution. **2**

iii) Five bosons are distributed in two compartments. The first having 3 cells and the second 4. Find thermodynamic probability for the microstate (5, 0). **2**

OR

b) i) Write the fundamental postulates of Bose-Einstein statistics. **2½**

ii) Differentiate between M. B. and F. D. statistics. **2½**

iii) Show that the Fermi energy of electron in metal at absolute zero is **2½**
$E_{F(0)} = (3n/8\pi)^{2/3} h^2 / 2m$ Where, the symbols have their usual meanings.

iv) Calculate the number of different arrangements of 10 indistinguishable particles in 15 cells of equal a priori probability considering that one cell contains only one particle. **2½**

5. Solve **any ten** from the following.

a) Define Black body. **1**

b) State Planck's radiation law in terms of frequency. **1**

c) State Stefan-Boltzmann law. **1**

d) Define most probable distribution. **1**

e) Two coins are tossed simultaneously. Find the probability of getting one head and two tails. **1**

f) Define statistical weight. **1**

g) Give the limitations of M. B. statistics. **1**

h) The speed of ten particle in m/sec is 0, 1, 2, 3, 3, 4, 4, 4, 5 and 6 respectively. What is their most probable speed? **1**

i) Define average speed of gas molecules. **1**

j) What are Fermions. **1**

k) What is occupation index? **1**

l) Give the postulates of Fermi-Dirac statistics. **1**

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