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

USPHT06 - Physics Paper-II Radiation and Statistical Physics

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

Time : Three Hours * 1 7 4 8 * Max. Marks : 50

Notes : 1. All questions are compulsory.
2. Draw neat and well labelled diagrams wherever necessary.

Either:

1. i) State and Prove Planck's radiation law for distribution of energy in the black body. **5**

ii) What is perfectly black body? Explain the temperature dependence of black body radiation. **3**

iii) A black sphere of diameter 9 cm is heated to 550K when the surrounding temperature is 300 K. What is the rate at which energy is radiated? **2**
(Stefan's constant is $6\times10^{-8}\,\mathrm{W\,m^{-2}K^{-4}}$).

OR

a) Deduce Rayleigh – Jeans law from Planck's law. **2½**

b) State and explain Stefan's – Boltzmann law. **2½**

c) Derive Wein's displacement law from Planck's law of radiation. **2½**

d) Calculate the surface temperature of sun if the wavelength of maximum intensity in solar spectrum is $4753\,\mathrm{A}^0$ and Wien's constant is $0.2898\times10^{-2}\,\mathrm{mK}$. **2½**

Either:

2. i) Derive the condition of equilibrium between two systems in thermal contact with each other. **5**

ii) Explain the terms microstate and microstates with suitable examples. **2**

iii) In a system in thermal equilibrium at temperature T, two states with energy difference $4.8\times10^{-14}\mathrm{erg}$ occur with relative probability $\mathrm{e}^2\mathrm{erg}\cdot\mathrm{deg}^{-1}$. Calculate the temperature. **3**
(Given $\mathrm{k}=1.38\times10^{-16}\,\mathrm{erg/deg}$).

OR

a) Discuss the constraints in thermodynamic system. **2½**

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

c) Write a short note on thermodynamic probability. **2½**

d) A card is drawn from a well shuffled pack of 52 cards. Calculate the probability for this card to be either a queen or king. **2½**

Either:

3. i) Explain in detail Maxwell – Boltzmann energy distribution for gas molecules. **5**

ii) State basic postulates of large number of particle distribution in MB statistics. **3**

iii) Calculate the most probable speed of nitrogen at 27ºC. Given $N = 6\times10^{23}$ molecules / mole $K = 1.38\times10^{-16}$ erg / 0K. **2**

OR

a) If $V_p, \overline{V}, V_{rms}$ are the most probable average and root mean square speeds respectively. Show that, for the Maxwell's distribution: **2½**

$$\frac{V_{rms}}{V_p} = \sqrt{\frac{3}{2}}$$

b) Derive an expression for mean speed of molecules of ideal gas. **2½**

c) Deduce an expression for the most probable speed of molecules of ideal gas. **2½**

d) At what temperature will the mean speed of hydrogen molecules be the same as that of Nitrogen molecules at 36ºC. Molecular weight of $N_2 = 28$ and that of $H_2 = 2$. **2½**

Either:

4. i) Deduce an expression for most probable distribution of FD statistics. **5**

ii) What are Fermions? State the basic postulates of Fermi-Dirac Statistics. **3**

iii) The number of conduction electrons per C. C. in Beryllium is 24.2×10^{22} and in Cesium is 0.91×10^{22}. If the Fermi energy of conduction electrons in Beryllium is 14.44 eV, Calculate Fermi energy of conduction electrons in Cesium. **2**

OR

a) Derive an expression for Fermi energy of electrons in a metal at absolute temperature. **2½**

b) How does F.D. Statistics differ from B.E. Statistics? **2½**

c) Explain the concept of distinguishable and indistinguishable particles with suitable examples? **2½**

d) A system consists of 5 particles arranged in 2 compartments. The first compartment is divided into 6 cells and the second into 8 cells. The cells are of equal size. Calculate the No. of microstates in the macro – state (2, 3), if the particles obey FD statistics. **2½**

5. Attempt **any ten** questions from the followings.

a) What is Thermal Radiation? **1**

b) Give Planck's Postulates. **1**

c) What is emissive power and absorptive power of body? **1**

d) What do you mean by Probability? **1**

e) Give the difference between accessible states and inaccessible states. **1**

f) What is in – distinguishability of particulars? **1**

g) Write the possible arrangement of 3 particles in 2 cells for MB statistics. **1**

h) What is root mean square (RMS) velocity of the gas molecules? **1**

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

j) What do you mean by Bosons? Give examples. **1**

k) Define occupation index in BE statistics. **1**

l) Is neutron a Bosons or Fermion? **1**

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