Bachelor of Science (S.Y. B.Sc.) (CBCS Pattern) Third Semester CBCS

USPHT06 -Physics Paper-II Radiation and Statistical Physics

P. Pages : 3 **GUG/W/18/11617**

Time : Three Hours * 3 8 6 4 * Max. Marks : 50

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

1. Either:

a) i) Derive the Planck's law for distribution of energy in the black body. **5**

ii) Obtain the Wein's displacement law from Planck's law. **3**

iii) Calculate the surface temperature of sun if the wavelength of maximum intensity in solar spectrum is 4753AU and Wien's constant is $0 \cdot 2898 \times 10^{-2}$ mK . **2**

OR

b) a) Derive Rayleigh-Jeans law from Planck's law. **2½**

b) What is perfectly black body? Explain the temperature dependence of black body radiation. **2½**

c) State and explain Stefan's - Boltzmann law and black body radiation. **2½**

d) A black body at a temperature of 1646K has the wavelength corresponding to the maximum emission is 1.78 micron. Calculate the temperature of moon- if λ_m for the moon is 14 micron. **2½**

2. Either:

a) i) Derive the condition of equilibrium between two systems in thermal contact. **5**

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

iii) In a system in thermal equilibrium at temperature T, two states with energy difference $4 \cdot 8 \times 10^{-14}$ erg occur with relative probability e^2 erg deg^{-1}. Calculate the temperature. **3**
$\left(\text{Given } k = 1 \cdot 38 \times 10^{-16} \text{ erg/deg}\right)$.

OR

b) a) Explain macrostate and microstates with suitable examples. **2½**

b) State and explain principle of equal a priori probability. **2½**

c) Explain the term thermodynamic probability. **2½**

d) For a single particle of mass 'm' enclosed in a volume V, show that the number of accessible microstates in the energy range E to E + dE is given by: **2½**

$$\Omega(E) = \frac{4\sqrt{2}\,\pi V}{h^3}\, m^{3/2}\, E^{1/2}\delta E .$$

3. Either:

a) i) Derive Maxwell's law of distribution of velocities of the molecules of an ideal gas. **5**

ii) Obtain an expression for mean speed of molecules of ideal gas. **3**

iii) At what temperature will the mean speed of hydrogen molecules be the same as that of Nitrogen molecules at 35ºC. Molecular weight of $N_2 = 28$ and that of $H_2 = 2$. **2**

OR

b) a) Show that, for the Maxwell's distribution **2½**

$$\frac{V_p}{\sqrt{2}} = \frac{\overline{V}}{\sqrt{8/\pi}} = \frac{V_{rms}}{\sqrt{3}}$$

where V_p, $\overline{V}$, V_{rms} are the most probable, average and root mean square speeds respectively.

b) State basic postulates of large number of particle distribution in MB statistics. **2½**

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

d) Calculate the value of root mean square speed of a molecule of hydrogen at NTP. **2½**
(Given $k = 1{\cdot}38\times10^{-16}$ erg/deg. and Avogadro's number is 6×10^{23} per gm-mol.)

4. Either:

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

ii) Derive an expression for most probable distribution of FD statistics. **5**

iii) 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. **2**

OR

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

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

c) What do you mean by distinguishable and indistinguishable particles with suitable examples? **2½**

d) Fermi energy of conduction electrons in silver is 5.48eV. Calculate the number of such electrons per cm^3 given that $h = 6 \cdot 62 \times 10^{-27}$ erg $\cdot$ sec. and $\ell eV = 1 \cdot 62 \times 10^{-12}$ erg. **2½**

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

a) State Planck's postulates. **1**

b) What is black body? **1**

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

d) Define Probability. **1**

e) Differentiate accessible and inaccessible states. **1**

f) What is μ-space? **1**

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

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

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

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

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

l) State basic assumption of BE statistics. **1**

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