

B.Sc. S.Y. (CBCS Pattern) Sem-III  
**USPHT06 : Physics Paper-II : Radiation and Statistical Physics**

P. Pages : 3

Time : Three Hours



**GUG/W/22/11617**

Max. Marks : 50

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

**Either:**

1. a) i) Derive the Plank's law for distribution of energy in black body radiation. 5  
ii) Derive Wein's displacement law from Plank's law. 3  
iii) Filament of bulb is emitting radiation of maximum energy at  $3.09 \times 10^{-5}$  cm. 2  
Calculate filament temperature.  
(Given  $b = 2.884 \times 10^{-3}$  mk)

**OR**

- b) a) Explain spectral distribution for black body. 2½  
b) Derive Rayleigh – Jean's law from Plank's law. 2½  
c) Calculate the number of modes of vibrations in frequency range  $5 \times 10^{14}$  Hz and  $5.02 \times 10^{14}$  Hz in an enclosure of volume  $200 \text{ cm}^3$  ( $c = 3 \times 10^8$  m/s). 2½  
d) Derive Stefan's Boltzmann law from Plank's radiation formula. 2½

**Either:**

2. a) i) Explain macrostates and microstates with suitable examples. 3  
ii) Calculate the probability that in tossing a coin 10 times, we get 6 heads and 4 tails. 2  
iii) Derive the condition of equilibrium between two systems in thermal contact. 3  
iv) State and explain principle of equal a priori probabilities. 2

**OR**

- b) a) Define accessible and inaccessible microstates. Give its examples. 2½  
b) Distinguish between mathematical probability and thermodynamical probability. 2½  
c) Explain the concept of  $\mu$ -space and phase space. 2½  
d) Assuming that in a six faced die, the probability of getting any face uppermost is equal. If 5 dice are tossed simultaneously. Calculate the probability of getting the number 2 uppermost in any one die. 2½

**Either:**

3. a) i) Derive Maxwell's law of distribution of speed for the molecules of an ideal gas using M – B energy distribution formula. 2
- ii) Derive an expression for 6
- a) Most probable speed and
- b) Root mean square speed
- iii) Calculate the rms velocity of H<sub>2</sub> at 27°C. Given  $k = 1.38 \times 10^{-23}$  J/deg and mass of hydrogen molecule =  $3.34 \times 10^{-27}$  kg. 2

**OR**

- b) a) Draw the Maxwell-Boltzmann velocity distribution curve and state any three features of distribution curve. 2½
- b) Show that mean speed of molecule of an ideal gas is given by  $\bar{V} = \sqrt{\frac{8KT}{\pi m}}$ . 2½
- c) State the postulates of classical statistical mechanics. 2½
- d) At what temperature is the root mean square velocity of hydrogen molecule is equal to the escape velocity from the surface of the earth. 2½
- (Given escape vel. = 11.2 km/sec and mass of hydrogen molecule =  $3.34 \times 10^{-27}$  kg).  
 $k = 1.38 \times 10^{-23}$  J/deg

**Either:**

4. a) i) What is Bose – Einstein statistics? What are its basic postulates? 3
- ii) Derive an expression  $n_i = \frac{g_i}{e^{\alpha + \beta \epsilon_i} - 1}$  for the most probable distribution of the particles of system obeying B.E. statistics. 5
- iii) Find the number of distributions for three particles in four energy levels if particles obey Bose-Einstein statistics. 2

**OR**

- b) a) Derive an expression for Fermi energy of electron in a metal at absolute zero. 2½
- b) What are Fermions? and state the basic postulates of Fermi – Dirac statistics. 2½
- c) Explain comparison between M – B and F – D statistics. 2½
- d) Fermi energy of conduction electrons in silver is 5.48 eV. Calculate number of electrons per cm<sup>3</sup>. Given  $m = 9.1 \times 10^{-28}$  gm,  $h = 6.62 \times 10^{-27}$  erg sec and  $1 \text{ eV} = 1.62 \times 10^{-12}$  erg. 2½

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

- a) Define perfectly black body. 1
- b) State SI unit of Stefan's constant. 1
- c) Two stars A and B emit radiations of blue and yellow colour respectively. Which is at a higher temperature? 1
- d) Define most probable microstate. 1
- e) A vessel contain 4 black and 7 white balls. If a ball is taken out of vessel at random. What is probability for it to be a black ball? 1
- f) State the relation between entropy and thermodynamic probability. 1
- g) According to Maxwell's law of distribution of speed, the number of molecules corresponding to zero speed is zero. Is it right statement? 1
- h) State limitations of M.B. statistics. 1
- i) Find the number of possible arrangements of three particles in two cells for M. B. statistics. 1
- j) What are Bosons? Give examples. 1
- k) Write down the Fermi – Dirac distribution function. 1
- l) State the volume of one phase cell in classical statistics and quantum statistics. 1

\*\*\*\*\*

