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**3 (Sem-6/CBCS) PHY HC 2**

**2024**

**PHYSICS**

(Honours Core)

Paper : PHY-HC-6026

**(Statistical Mechanics)**

Full Marks : 60

Time : Three hours

**The figures in the margin indicate  
full marks for the questions.**

1. Answer the following questions : 1×7=7

(a) What is the degeneracy of each quantum state for photon ?

(b) Find the possible number of arrangements of 5 bosons in 3 cells.

Contd.

- (c) If  $N_i$  is the identical, independent particles in the  $i$ th energy state with degeneracy  $g_i$ , then classical statistics can be applied if

(i)  $\frac{N_i}{g_i} \approx 1$

(ii)  $\frac{N_i}{g_i} \ll 1$

(iii)  $\frac{N_i}{g_i} \gg 1$

(iv)  $g_i \approx 0$

- (d) Fill in the blanks :

Quantum statistics tends to classical one when temperature is \_\_\_\_\_ and particle density is \_\_\_\_\_.

- (e) Which law in thermodynamics is used to explain Fraunhofer lines in solar spectrum ?
- (f) Name the statistics obeyed by phonons.
- (g) Write the relationship between radiation pressure and radiation energy density.

2. Answer the following questions :  $2 \times 4 = 8$

- (a) What is partition function ? State its significance.
- (b) Mention *any two* characteristics of blackbody radiation.
- (c) Give the basic concepts of canonical and microcanonical ensemble.
- (d) Give *two* examples of fermions.

3. Answer *any three* questions from the following :  $5 \times 3 = 15$

- (a) Deduce Stefan-Boltzmann law from Planck's law of blackbody radiation.
- (b) Differentiate M-B, B-E and F-D statistics mentioning the wave function, distribution function and nature of particles in each of the *three* cases.
- (c) What do you mean by ultraviolet catastrophe ? Explain.
- (d) Deduce the expression for Maxwell's distribution of speeds in case of an ideal classical gas.
- (e) Mention the important postulates of Planck's theory of blackbody radiation. Deduce Wien's distribution law from the expression for energy distribution in blackbody spectrum.

4. Answer **any three** questions :  $10 \times 3 = 30$

(a) Mention Gibbs paradox. Deduce Sackur-Tetrode formula and explain its significance.  $2 + (6 + 2) = 10$

(b) Discuss statistically the case of two-level energy system for a paramagnetic substance in an external magnetic field and explain negative temperature.

$7 + 3 = 10$

(c) Derive an expression showing temperature dependence of Fermi energy. Show that the probability of occupation for an electron state at Fermi energy is equal to 50% for all finite temperature.  $8 + 2 = 10$

(d) Using B-E statistics, derive an expression of pressure of a perfect gas. Under what condition, does Bose-Einstein condensation occur?  $8 + 2 = 10$

(e) Derive Fermi-Dirac distribution law.

(f) Write short notes on :  $5 + 5 = 10$

(i) White dwarf stars

(ii) Macrostate and microstate