3 (Sem–6/CBCS) PHY HC 2

2025

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 minimum volume of the phase cell in quantum statistics ?

(b) Write *one* limitation of Maxwell-Boltzmann statistics.

(c) In how many ways, 2 particles can be distributed in 2 energy states according to F-D statistics ?

(d) A blackened platinum wire, when gradually heated, appears first dull red, then blue and finally white, why ?

(e) Name the statistics, which is used to study the density of electrons in copper at room temperature.

(f) If n_i are the number of particles in the ith energy state with degeneracy g_i, then B-E statistics can be applied if—

(i) $\frac{n_i}{g_i} \geq 1$

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

(iii) $\frac{n_i}{g_i^2} \ll 1$

(iv) None of the above

(Choose the carrect answer)

(g) Under what condition, quantum statistics approaches to classical statistics ?

2. Answer the following questions : 2×4=8

(a) Define phase space and phase line.

(b) The wavelength of maximum emissive power of heat radiation of Sun is 4750Å. Find the surface temperature of the Sun.

[Wien's displacement constant = 0.2892 *cm-K*]

(c) What is generate Bose gas ?

(d) Write *one* similarity and *one* difference between Bose-Einstein and Fermi-Dirac statistics.

3. Answer ***any three*** questions from the following : 5×3=15

(a) Define microstate and macrostate. Three distinguishable particles, each of which can be in one of the ε, 2ε, 3ε, 4ε energy states, have total energy 6ε. Find all possible number of distributions of all the particles in the energy states. Also find the number of microstates in each case. 2+3=5

(b) Write statistical definition of entropy and derive the relation between entropy and thermodynamic probability. 1+4=5

(c) Deduce Sackur-Tetrode formula and explain its significance. 4+1=5

(d) Write a note on Bose-Einstein condensation.

(e) What is Fermi energy ? For copper, $n = 8.48 \times 10^{28}$ electrons $/m^3$. Estimate the value of Fermi energy (E_F) in eV. 1+4=5

4. Answer ***any three*** questions : 10×3=30

(a) Derive Maxwell-Boltzmann energy distribution law for on ideal gas.

(b) What is radiation pressure ? Prove that the diffuse radiation exerts a pressure on the walls of the container, equal to $\frac{1}{3}$rd of the energy density. 2+8=10

(c) Write the differences between photon gas and ideal gas. Starting from B-E statistics distribution law, derive Planck's law. 3+7=10

(d) What is electron gas ? Derive the expression of energy distribution of free electrons in a metal using Fermi-Dirac statistics. 2+8=10

(e) From Planck's law of black-body radiation, derive— 4+6=10

(i) Wien's displacement law

(ii) Stefan-Boltzmann law

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

(i) White dwarf stars

(ii) Ensemble
