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







**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 $i$ th 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 correct 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 4750*A*. 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 $\varepsilon$, $2\varepsilon$, $3\varepsilon$, $4\varepsilon$ energy states, have total energy $6\varepsilon$. 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