7. (a) Derive the expression for pressure exerted by diffuse radiation. (10)

(b) Evaluate the temperature at which there is 5% probability that a state with energy 0.1 eV above fermi energy, will be occupied by an electron. (5)

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May-2026

B.Sc. Physics, Semester-VI

STATISTICAL MECHANICS

(BPH-602A)

Time: 3 Hours] [Max. Marks : 75

Instructions :

1. *It is compulsory to answer all the questions (1.5 marks each) of Part-A in short.*
2. *Answer any four questions from Part-B in detail.*
3. *Different sub-parts of a question are to be attempted adjacent to each other.*

PART-A

1. (a) Calculate the number of ways of arranging 6 fermions in eight different states. (1.5)

(b) State Kirchhoff's law of thermal radiation and give one application. (1.5)

(c) Explain Wein's displacement law. (1.5)

(d) Differentiate three types of ensemble. (1.5)

(e) What is microstate and macrostate? Illustrate with the help of an example. (1.5)

(f) What do you mean by thermodynamic probability? (1.5)

(g) Give two unique properties of He-II (1.5)

(h) What do you mean by ultraviolet catastrophe? (1.5)

(i) Define phase space and phase trajectory. (1.5)

(j) How entropy behaves during expansion of gas? (1.5)

PART—B

2. (a) Explain how negative temperature can be attained in the system of N particles each having a magnetic moment μ, that can either be parallel or anti parallel to an external magnetic field B. (10)

(b) What is Sackur-Tetrode equation? How it fixes Gibb's Paradox? (5)

3. (a) Derive condition for a strongly degenerate boson gas. How does the degeneracy depend upon the temperature, number density and mass of particles? (10)

(b) In context of Bose Einstein condensation show that "The fraction of particles condensed in ground state varies as temperature changes relative to transition temperature", with the help of appropriate diagram. (5)

4. (a) Show that the partition function for translational motion of monoatomic gas molecule is given by $Z_T = V(\, ^1/\lambda/_3)$, where λ is thermal de Broglie wavelength. (10)

(b) Deduce the Boltzmann's entropy probability relation $S = k \ln \Omega(E)$, where S is entropy, $\Omega(E)$ is the number of microstates in the energy interval between E and E + dE, and k is Boltzmann's constant. (5)

5. (a) State and derive Equipartition theorem. Also discuss its validity at different temperature. (10)

(b) Derive thermodynamic proof of Stefan's law. (5)

6. (a) Find the number of ways in which n_i fermions can be distributed in g_i states. Also find the average occupation number of fermions in a state with energy E_i. (10)

(b) Plot and explain the variation of distribution function for a Fermi gas. (5)