

2121

B.A./B.Sc. (General) Third Semester

Physics

Paper – A: Statistical Physics and Thermodynamics – I

Time allowed: 3 Hours

Max. Marks: 44

NOTE: Attempt five questions in all, including Question No. VII (Unit-III) which is compulsory and selecting two questions each from Unit I - II. Use of non-programmable Calculator is allowed.

x-x-x

UNIT – I

- I.
 - a) Derive an expression for probability of a macrostate (N_1, N_2, \dots, N_k) corresponding to distribution of N distinguishable particles in K compartments of unequal sizes.
 - b) A bag contains 4 white and 5 black balls. Two balls are drawn in succession from the bag. Calculate the probability that the two balls drawn are both white. (7.2)
- II.
 - a) What do you mean by most probable macrostate? Derive an expression for the probability of this state corresponding to distribution of N particles in two identical compartments.
 - b) 5×10^{10} gas molecules are enclosed in a cubical volume. Imagine the volume to be divided into two equal halves. Calculate the probability for a state in which the number of molecules in a given state are only 0.001% different from that of equilibrium state. (6,3)
- III.
 - a) Prove that the fraction of time spent by a system in a macrostate is equal to probability of system to exist in that macrostate.
 - b) 8 distinguishable particles are distributed in 2 compartments of unequal sizes. The first compartment is further divided into 2 cells of equal sizes. Calculate probability of
 - i) Macrostate
 - ii) Most probable macrostate (6,3)

P.T.O.

(2)

UNIT - II

- IV. a) Explain in detail about experimental verification of Maxwell-Boltzmann Distribution of molecular speeds.
- b) Derive an expression for phase space volume of energy compartment. (6,3)
- V. a) Derive Fermi-Dirac distribution law
- b) 12 fermions are distributed in three compartment having energies $-E, 0, E$. Find energy of Macrostate
- (i) (6,4,2)
- (ii) (5,2,5) (7,2)
- VI. a) Derive an expression for Planck's law for energy distribution of Black body radiation.
- b) Obtain the short and long wavelengths limits of Planck's law for black-body radiation. (6,3)

UNIT - III

- VII. Attempt any eight of the following:-
- (a) How does classical statistics differ from quantum statistics?
- (b) Do electrons have zero energy at 0 K? If not, explain why?
- (c) Does Fermi energy depend upon size or volume of conductor?
- (d) What is occupation index? What is its functional form at $T = 0K$ for a system of fermions?
- (e) Why there is need to divide compartments into cells if we take the concept of phase space?
- (f) What is difference between Macrostate and Microstate?
- (g) What is difference between static and dynamic system?
- (h) Distinguish between position, momentum and phase space.
- (i) What is the importance of most probable macrostate?
- (j) What is the maximum probability for an event to occur? (8x1)