STATISTICAL PHYSICS AND THERMODYNAMICS - I

Time : Three Hours] [Maximum Marks : 75

Note : Attempt *one* question each from Sections A, B, C, and D carrying 15 marks each, and *five* questions from Section E consisting of *eight* short answer type questions carrying 3 marks each.

Section : A

1. (a) Taking the case of n particle distributed in two compartments, discuss he variation of probability of a macrostate on account of small deviation from the state of maximum probability. 10

   (b) In a system of 8–distinguishable particle, distribution is in two equal size compartments. Calculate the probability of the macrostate (2, 6). 5

2. (a) Discuss the distribution n-distinguishable particle in k compartment of unequal size which are further sub-divided into cells of equal apriori probability. 10
(b) Prove that for dynamic system, the fraction of total time spent in any particular microstate is proportional to the thermodynamical probability of that state. 5

Section : B

3. Treating an ideal gas as a system governed by classical statistics, derive the Maxwell-Boltzmann law of distribution of molecular speed. 15
4. (a) Discuss Planck's law for the energy distribution of the black body. 10
(b) Find the number of phase-space cells in the energy interval E and E + dE. 5

Section : C

5. (a) Derive an expression for entropy of a perfect gas. 10
(b) Show that he entropy of a thermodynamic system remains constant in any reversible process. 5
6. (a) Explain in brief Carnot cycle and S–T diagram for Carnot cycle. What is the efficiency of Carnot's heat engine. 3+3+4
(b) Discuss the heat death of universe. 5

Section : D

7. (a) Show that $C_p - C_v = -TE\alpha^2V$, where T is temperature, E = Bulk modulus of elasticity, α = Coefficient of expansion and V = Specific volume. 10
(b) Calculate the temperature of inversion for a real gas whose constant afe a = 0.0245 m^4 $Nmole^{-2}$, b = 2.67×10^{-5} m^3 $mole^{-1}$ and R = 8.4 J mol^{-1} K^{-1}. 5
8. (a) Explain Joule Thomson effect. Derive expression of its coefficients. 10
(b) Calculate the Coefficient of performance of a refrigerator operating between the temperature 5°C and 35°C. 5

Section : E

9. Attempt any *five* questions in short of the following :
(i) Eight similar coins are tossed for a large no. of times. Calculate probability of getting the heads of 5 coins uppermost. 3
(ii) What is the role of Elementary cell in Statistical Physics ? 3
(iii) Calculate the r.m.s. velocity and most probable velocity of nitrogen at 0°C. Given K = 13.8 × 10^{23} J/K. 3
(iv) What do you understand by Fermi energy level of metal ? 3
(vi) What are Reversible and Irreversible processes ? 3
(v) What does the internal energy of an ideal gas differ from that of real gas ? 3
(vii) Derive relation between Adiabatic and Isothermal elasticity. 3
(vii) Write four thermodynamical relations. 3