

DEPARTMENT OF SCIENCES, IV SEMESTER M.Sc. (PHYSICS)

Thermodynamics and Statistical Mechanics

(REVISED CREDIT SYSTEM-2017)

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Answer all the Questions.

1. (a) Show that the following two statements of second law of thermodynamics are same:

(i) The entropy of closed systems never decrease.

(ii) No process is possible whose sole result is the transfer of heat from a reservioir at one temperature to another reservoir at a higher temperature

(b) (i) In how many independent ways can molecules be divided evenly between two halves of a box? (ii) How many microstates are there that correspond to 150 molecules in one half of the box and 50 in the other? Calculate entropy in each case. (5M)

- 2. Show that the differentials of the three thermodynamic functions U,H and F may be written written as
 - (a) $dU = (C_P PV\beta)dT + V(\kappa P \beta T)dP$
 - (b) $dH = C_P dT + V(1-\beta T) dP$
 - (c) $dF = -(PV\beta + S) dT + PV\kappa dP$

where terms have the usual meaning.

(5M)

3. (a) Explain the term – Gibbs paradox. (b) If w denotes the speed of a molecule in an ideal gas consisting of N molecules, then show that the average speed is given by $\langle w \rangle = \sqrt{\frac{8kT}{m\pi}}$. Where the terms have their usual meaning. (5M)

- 4. Derive an expression for mean number of particles $\overline{n_s}$ in a particular state s at an arbitrary temperature T, in the case of Bose Einstein gas. Hence obtain an expression for corresponding number fluctuation. 5M
- 5. Consider a system of two free (independent) particles. Assuming that there are only two single-particle energy levels ϵ_1 , ϵ_2 , by enumerating all possible two body microstates, determine the partition functions Z if these two particle are (a) distinguishable and (b) indistinguishable. And determine average energy in each case. 5M

