K23P 0505

Reg. No. : .....

Name : .....

II Semester M.Sc. Degree (CBSS – Reg./Supple./Imp.) Examination, April 2023
(2019 Admission Onwards)
PHYSICS
PHY 2C08 : Statistical Mechanics

Time : 3 Hours Max. Marks : 60

SECTION – A

Answer **both** the questions (Either **a** or **b**).

1. a) Discuss the Gibbs's paradox of a classical ideal gas. How is resolved ?

   OR

   b) For a system in thermal equilibrium with the surrounding, obtain the canonical distribution. Hence prove the theorem of equipartition.

2. a) Considering the ideal gas as a quantum mechanical microcanonical ensemble, obtain the Maxwell – Boltzmann, Fermi – Dirac and Bose-Einstein statistics. Comment on the thermodynamic properties.

   OR

   b) Describe the Ising model of phase transition. Briefly mention how it is applicable to binary alloy. **(2×12=24)**

SECTION – B

Answer **any four** questions (**1** mark for Part **a**, **3** marks for Part **b**, **5** marks for Part **c**).

3. a) Give two examples for thermodynamic state function.

   b) Define the four thermodynamic potentials and hence explain the relationship among them.

   c) For an ideal gas obeying the equation of state $PV = nRT$ and molar specific heat at constant volume $C_v = \frac{3}{2}R$, find the Helmholtz free energy as a function of number of moles – n, volume – V and temperature – T, where R is the gas constant.

P.T.O.

4. a) Define ensemble average.

   b) Draw the phase space diagram of a quantum harmonic oscillator.

   c) Two classical distinguishable particles are distributed among three energy levels with energy $E_1 = 0$, $E_2 = 1$, $E_3 = 2$, such that total energy of the system is $E_T = 2$. Calculate the entropy of the system.

5. a) State Virial theorem.

   b) For a system in equilibrium with a particle-energy reservoir, obtain probability function of the Grand canonical ensemble.

   c) Show that the average energy of a three-dimensional classical harmonic oscillator in thermal equilibrium with the surroundings at temperature T is 3kT, where k is the Boltzmann's constant.

6. a) What do you understand by Fermi energy at non-zero temperature ?

   b) Write a brief note on Pauli para magnetism.

   c) A certain system at temperature 3000 K has electron number density 13×10^{28} per cubic meter. Are the electrons degenerate ? Explain.

7. a) What is phase transition ?

   b) Explain Bose-Einstein Condensate.

   c) Using Bose-Einstein statistics, obtain the black body distribution. Hence calculate Stefan constant.

8. a) What do you understand by the term lattice gas ?

   b) Write a short note on Landau's phenomenological theory of phase transition.

   c) Obtain the partition function of Ising model in one dimension. **(4×9=36)**

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