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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