K-414

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MSCPH-504

STATISTICAL MECHANICS

M.Sc. Physics (MSCPH)

1st Semester Examination, 2023 (Dec.)

Time : 2 Hours] **Max. Marks : 70**

Note : This paper is of Seventy (70) marks divided into two (02) Sections A and B. Attempt the questions contained in these sections according to the detailed instructions given therein. Candidates should limit their answers to the questions on the given answer sheet. No additional (B) answer sheet will be issued.

SECTION–A

(Long Answer Type Questions)

Note : Section 'A' contains Five (05) long answer type questions of Nineteen (19) marks each. Learners are required to answer any Two (02) questions only.

(2×19=38)

1. What do you understand by statistical, thermal equilibrium? Establish relation between statistical and thermodynamical quantities.

Show that $F = - kT \log Z$

Where Z is the partition function and F is Helmholtz free energy.

2. Obtain partition function for Gibbs canonical ensemble. What is the effect of (a) shifting the zero level of energy? (b) decomposition of the system, on the partition function.

3. Compare the basic postulates of the Maxwell-Boltzmann, Bose-Einstein and Fermi-Dirac statistics. Deduce the law of distribution of energy of particles according to Fermi-Dirac statistics.

4. What type of elementary excitations have been assumed for liquid helium problem by Landau? How has Landau's theory been successful in explaining some important properties of liquid helium below 1.6 K?

5. Write short notes on :

(a) Entropy in statistical mechanics.

(b) Principle of equilibrium of energy in a classical system.

(c) Microcanonical ensemble.

SECTION–B

(Short Answer Type Questions)

Note : Section 'B' contains Eight (08) short answer type questions of Eight (08) marks each. Learners are required to answer any Four (04) questions only. (4×8=32)

1. State and Prove Liouville's theorem.

2. State and Prove Boltzmann's theorem connecting entropy and probability.

3. Explain the term ensemble and its application for approximation.

4. Calculate the probability that the speed of oxygen molecule lies between 100 and 101 metre/sec at 200 K.

5. Apply Bose-Einstein Statistics to black body radiation and derive Planck's radiation law.

6. Define occupation index and compare M-B, B-E and F-D statistical distribution with its help.

7. Explain Gas Degeneracy for He atom and its application.

8. What are the phase transitions of first and second kind? Discuss Ising model for phase transitions of second kind.
