(i) Printed Pages : 3 Roll No. .....

(ii) Questions : 9 Sub. Code : 3717

Exam. Code : 0474

M.Sc. Physics 3rd Semester

(1129)

STATISTICAL MECHANICS

Paper—PHY–7002

Time Allowed : Three Hours] **[Maximum Marks : 60**

Note :— Attempt **five** questions in all, selecting **one** question each from Units–I to IV and the compulsory question from Unit–V.

UNIT—I

1. (a) State and prove Liouville's Theorem. Discuss its role in the description of a microcanonical and a canonical ensemble. 6

   (b) A thermally insulated box of volume 2V has a partition which divides it into two chambers of equal volume. Each chamber contains He gas at temperature T and pressure P. On removing the partition, the gas molecules in the two chambers mix with each other. Find the change in entropy of the system. 6

2. (a) Find the expression for fundamental volume w_0 for one dimensional harmonic oscillator. 6

   (b) Derive the expression of partition function for mono atomic non-interacting ideal gas and derive expressions for various thermodynamical quantities. 6

UNIT—II

3. (a) Discuss the details of quantum mechanical ensemble theory. Show that expectation value of any physical quantity G is independent of the choice of the basis $\{\phi_n\}$. 8

   (b) By drawing curve between mean occupation number $<n_E>$ versus $\left(\frac{E-\mu}{KT}\right)$, differentiate between the three statistics M.B., F.D. and B.E. 4

4. (a) Discuss details of an ideal gas in quantum mechanical canonical ensemble. 6

   (b) Deriving necessary relations discuss energy fluctuations in a Grand Canonical ensemble. 6

UNIT—III

5. (a) Explain the phenomenon of Bose-Einstein condensation. Also discuss the temperature dependence of the fractions of the normal phase and the condensed phase in an ideal Bose gas. 8

   (b) Compare the pressure of an ideal Bose gas, ideal Fermi gas and Maxwell Boltzmann gas. Which one exerts lowest pressure and why ? 4

6. (a) Obtain expressions for the susceptibility of an ideal Fermi gas in the presence of an external magnetic field B for (i) finite but low temperatures (ii) large but finite temperatures. 9

   (b) Write a short note on the heat capacity of free electron gas at low temperatures. 3

UNIT—IV

7. (a) Describe what are first order and second order phase transitions. Compare by giving at least one example of each. 6

   (b) Discuss the Einstein-Smoluchowski theory of the Brownian motion and show that the ensemble of Brownian particles, initially concentrated at the origin diffuses out as the time progresses. 6

8. (a) Describe the Ising model in one dimension. 6

   (b) Derive probability distribution law for the fluctuations in entropy S and volume V for a system embedded in a reservoir with which it can exchange energy and volume, keeping the number of particles fixed. 6

UNIT—V

9. (a) What is the drawback of microcanonical ensemble ?

   (b) What is the value of entropy for equilibrium state ?

   (c) What is thermodynamic limit ? Explain its importance.

   (d) Why fermi systems are quite live even at $T = 0K$?

   (e) What is critical opalescence ?

   (f) Why is the choice of cell size immaterial as far as classical statistics is concerned ? $6 \times 2 = 12$