LOYOLA COLLEGE (AUTONOMOUS), CHENNAI – 600 034

M.Sc. DEGREE EXAMINATION - **PHYSICS**

THIRD SEMESTER – **NOVEMBER 2013**

PH 3814 - STATISTICAL MECHANICS

Date : 05/11/2013 Dept. No. Max. : 100 Marks

Time : 9:00 - 12:00

PART - A

Answer **ALL** Questions. (10x2=20)

1. Define an ensemble. What is meant by a stationary ensemble?
2. Evaluate ln10!
3. Discuss the asymptotic behaviour of Langevin function.
4. What do you mean by energy fluctuation?
5. Represent density matrix for grand canonical ensemble.
6. Differentiate between canonical and grand canonical ensemble.
7. What is the significance of the critical temperature for an ideal Bose gas?
8. Why is the transition from He I to He II known as lamda transition?
9. Plot for Fermi-Dirac statistics, the probability function with respect to energy at T=0 K.
10. What are the advantages of using Fermi-Dirac statistics over Maxwell-Boltzmann statistics for free electron theory of metals?

PART - B

Answer any **FOUR** questions (4 x 7.5 = 30)

11. Establish the connection between statistical mechanics and thermodynamics.
12. From a discussion on the thermodynamics of magnetic systems account for the significance of the negative temperature.
13. Obtain the EOS for an ideal gas using grand canonical partition function.
14. Show that for a classical oscillator defined by $E = \frac{P^2}{2m} + \frac{m\omega^2 q^2}{2}$ the microcanonical partition function is $z = \frac{2\pi kT}{h\omega}$. Hence calculate the Helmholz free energy for a set of N independent oscillators.
15. Show that a Fermi gas exerts pressure even at absolute zero temperature.

PART - C

Answer any **FOUR** questions (4 x 12.5 = 50)

16. State and prove Liouville's theorem.
17. State and prove equi-partition theorem. Use it to calculate the energy of a classical oscillator.
18. Obtain the distribution functions for i) classical gas, ii) Bose gas and iii) Fermi gas.
19. Discuss in detail the Debye's theory of lattice heat capacity.
20. Show that the specific heat capacity of an ideal Fermi gas is directly proportional to temperature when the temperature is very small compared to its Fermi temperature.