LOYOLA COLLEGE (AUTONOMOUS), CHENNAI – 600 034

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

FIRST SEMESTER – **APRIL 2013**

PH 1815/1810 - STATISTICAL MECHANICS

Date : 06/05/2013 Dept. No. Max. : 100 Marks

Time : 9:00 - 12:00

PART A

Answer **ALL** questions 10 x 2 = 20

1. Write down the form of second law of thermodynamics for a system for which the number of particles in not a constant.
2. State any two postulates of Statistical Mechanics.
3. Write down the canonical partition function of a two level system of energies 0 and ε.
4. Distinguish between canonical and grand canonical ensemble.
5. Why does ^{4}He show super-fluidity at very low temperatures?
6. What would be the pressure exerted by a Boson gas on the walls of the container at absolute zero? Justify your answer.
7. Define Fermi energy.
8. Sketch the Fermi-Dirac distribution law for an ideal gas at absolute zero and at a temperature slightly above absolute zero.
9. Define mean square deviation.
10. State Nyquist theorem.

PART B

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

11. Obtain the condition for chemical equilibrium between two systems.
12. State and prove equipartition theorem.
13. Apply the BE statistics to photons and obtain Planck's formula for the energy density of black body radiation.
14. Derive an expression for the electronic contribution to specific heat capacity of a metal. Why is this contribution insignificant at high temperature?
15. Obtain expression for the concentration fluctuation in a grand canonical ensemble. Show that for an ideal gas it increases as the volume decreases.

PART C

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

16. State and prove Liouville's theorem. Use it to arrive at the principle of conservation of density in phase space.
17. a) Obtain Grand canonical distribution function.

    b) Consider an ideal gas in grand canonical ensemble. Show that its fugacity is directly proportional to concentration.
18. Explain the super-fluidity of liquid helium using the spectrum of phonons and rotons.
19. What is second sound? Obtain an expression for it based on the two-fluid model.

Obtain the expressions for the mean square velocity and mean square displacement of a Brownian particle employing method of random walk. Graphically represent the variation of these quantities with time