LOYOLA COLLEGE (AUTONOMOUS), CHENNAI – 600 034

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

FIRST SEMESTER – **NOVEMBER 2013**

PH 1815 - STATISTICAL MECHANICS

Date : 13/11/2013 Dept. No. Max. : 100 Marks

Time : 1:00 - 4:00

PART - A

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

1. What are the dimensions of μ – space and Γ – space of a system of 100 classical gas molecules?
2. Calculate the equal – a – priori probability associated with a microcanonical ensemble occupying a phase space volume of Ω.
3. What is the statistical weight associated with the distribution $\{m_{N_i}\}$, for a grand canonical ensemble.
4. Differentiate between density of states g(ϵ) and degeneracy g_i.
5. Distinguish between Bosons and Fermions.
6. What is fountain effect?
7. What happens to the entropy of a Fermi gas at absolute zero?
8. How is the super-fluidity of ^{3}He explained?
9. Why is statistical thermodynamics unsuitable for a small system at low temperatures?
10. Give Einstein's relation for the particle diffusion constant.

PART - B

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

11. a) What is a Slater determinant? How is Pauli's exclusion principle incorporated into the Fermion wave function?

    b) In a one dimensional box of length 2a, a particle is mirror reflected at the walls. Draw its phase trajectory
12. Obtain Maxwell's velocity distribution formula.
13. Derive Planck's radiation law. Show that the partition function $z = \frac{2\pi kT}{h\omega}$ for an oscillator defined by $E = \frac{P^2}{2m} + \frac{m\omega^2 q^2}{2}$
14. Roughly estimate the Fermi temperature associated with nuclear matter. Thus establish that nuclear matter is degenerate.
15. Obtain an expression for the energy fluctuation in a canonical ensemble.

PART - C

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

16. a) Explain Gibb's paradox. How is it resolved?

    b) Prove Liouville's theorem
17. Obtain the entropy of a system that exchanges energy with the surroundings, but not mass.
18. What is Bose-Einstein condensation? Show how a system of Bosons condenses when cooled below the critical temperature.
19. Define Chandrasekhar limit. Treating the white dwarf as an ideal Fermi gas, obtain an expression for it.
20. Discuss Brownian motion in one dimension and obtain an expression for the particle concentration as a function of (x, t). Explain how Einstein estimated the particle diffusion constant.