LOYOLA COLLEGE (AUTONOMOUS), CHENNAI – 600 034

M.Sc. DEGREE EXAMINATION – **PHYSICS**

THIRD SEMESTER – NOVEMBER 2016

PH 3814 - STATISTICAL MECHANICS

Date: 01-11-2016 Dept. No. Max. : 100 Marks
Time: 09:00-12:00

SECTION – A

Answer **all** the questions. **(10 x 2 = 20 Marks)**

1. Show that pressure of ideal gas is $\frac{2}{3}$ of its energy density. What will be the relation in 1D?
2. What is meant by correct Boltzmann counting?
3. Write down the rotational partition function for a single quantum harmonic oscillator.
4. Explain the negative temperature concept with reference to a system of dipoles.
5. Represent the density matrix for grand canonical ensemble.
6. Write down the wave function of a two particle system when the particles are i) classical ii) Bosons iii) Fermions.
7. Why is the chemical potential for photons zero?
8. State Planck's law of radiation.
9. If $g(E)dE = 2\pi Vg \left(\frac{2m}{h^2}\right)^{3/2} E^{1/2}\, dE$, evaluate N for an ideal Fermi gas.
10. Estimate the Fermi energy, If E_1, E_2, E_3 etc are various energy levels of a system of 5 electrons.

SECTION – B

Answer **any four** questions. **(4 x 7.5 = 30 Marks)**

11. Prove ideal gas law using micro canonical ensemble theory.
12. Obtain the partition function of a system with rotational and vibrational degrees of freedom.
13. Establish the link between thermodynamics of the given system with statistics of the corresponding grand canonical ensemble after evaluating the Lagrange's multipliers α and β.
14. Discuss the lambda transition in liquid He^4.
15. Derive an expression for the magnetic susceptibility of a free electron gas.
16. Show that the mean energy U in the canonical ensemble is the same as in the micro canonical ensemble.

SECTION – C

Answer **any four** questions. **(4 x 12.5 = 50 Marks)**

17. Explain Gibb's paradox. How is it resolved?
18. Obtain the thermodynamic parameters for a system of quantum harmonic oscillator in the canonical ensemble.
19. Derive an expression for number fluctuation and hence explain critical opalascence.
20. Obtain the expression for the specific heat capacity of a fully degenerate Boson gas.
21. Obtain an expression for the variation of chemical potential of a degenerate Fermi gas and demonstrate the result using graphs.
22. Discuss quantum theory of paramagnetism.

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