LOYOLA COLLEGE (AUTONOMOUS), CHENNAI – 600 034

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

THIRD SEMESTER – NOVEMBER 2015

PH 3814 - STATISTICAL MECHANICS

Date : 03/11/2015 Dept. No. Max. : 100 Marks

Time : 09:00-12:00

Part – A

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

1. Define phase space.
2. How do you define statistical equilibrium of an ensemble?
3. State equi-partition theorem
4. Write down the canonical partition function of a two level system of energies 0 and ε.
5. Show that density matrix is diagonal in energy representation.
6. Parity operator can have only two eigen values. Justify.
7. State Stefan – Boltzmann law for blackbody radiation.
8. Why is the pressure exerted by a Boson gas below condensation temperature independent of its volume?
9. How many spin $\frac{3}{2}$ particles can be accommodated in a four-fold degenerate energy level?
10. What is the average energy per particle for a system of five non-interacting Fermions at absolute zero, if the chemical potential of the system at that temperature is 15 eV?

Part – B

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

11. Prove ideal gas law using microcanonical ensemble theory.
12. Obtain the thermodynamic parameters for a classical harmonic oscillator in the canonical ensemble.
13. Using the method of most probable distribution in Grand Canonical ensemble theory, show that the most probable mode of distribution $\{n^*_{r,s}\}$ for a system to have N_r particles and energy E_s is given by $n^*_{r,s} = N \exp(-\alpha N_r - \beta E_r)/\sum \exp(-\alpha N_r - \beta E_r)$
14. Derive BE distribution function.
15. Obtain an expression for the specific heat capacity of a fully degenerate Bose gas. What is its value at the transition temperature?
16. With necessary theory establish that a system of free electron gas exhibit paramagnetic property.

Part – C

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

17. Discuss quantum theory of paramagnetism.
18. State and prove Liouville's theorem.
19. Calculate the entropy of an ideal gas using canonical partition function and hence obtain the Equation of state.
20. Derive an expression for number fluctuation and hence explain critical opalascence.
21. What is BE condensation? Obtain an expression for the total number of particles in a system of Boson gas below condensation temperature. Show the variation of BE distribution function with temperature.
22. Obtain the expressions for the thermodynamical properties viz., chemical potential, internal energy and specific heat capacity of a degenerate Fermi gas

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