LOYOLA COLLEGE (AUTONOMOUS), CHENNAI – 600 034

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

THIRD SEMESTER – **NOVEMBER 2019**

16/17/18PPH3MC01 – STATISTICAL MECHANICS

Date: 29-10-2019 Dept. No. Max. : 100 Marks

Time: 09:00-12:00

PART – A

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

1. Show that pressure of ideal gas is 2/3 of its energy density. For a system in which the number of particles in not a constant, write down the second law of thermodynamics
2. Write down the canonical partition function for a one dimensional classical harmonic oscillator.
3. If A= NKT ln (ħω/KT) for a system, then evaluate μ and P for it.
4. Show that density matrix is diagonal in energy representation.
5. Express the average number of particles $\overline{N}$ and $\overline{E}$ in terms of grand canonical partition function.
6. The pressure exerted by a system of Boson gas below critical temperature is independent of its volume. Validate this statement.
7. What is the significance of the critical temperature for an ideal Boson gas?
8. If $g(E)\,dE = 2\pi Vg\,(\frac{2m}{h^2})^{3/2} E^{1/2}\,dE$, evaluate N for an ideal Fermi gas.
9. Show that nucleons for a degenerate Fermi gas.

PART – B

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

11. Establish the relation S = K ln Ω in statistical mechanics.
12. Obtain the thermodynamic parameters for a classical harmonic oscillator in the canonical ensemble.
13. For a gas of non-interacting indistinguishable particles, outline the quantum mechanical description of a system and find the weight factor associated with a distribution set $\{n_i\}$.
14. Discuss the temperature dependence of energy, number of particles of an ideal Boson gas at high temperature.
15. Derive an expression for the magnetic susceptibility of a free electron gas.
16. Prove that for a Fermi gas at T = 0 K, average energy per particle is not zero, but 3/5 of E_F where E_F is the Fermi energy.

PART – C

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

17. State and prove Liouville’s theorem.
18. Express various thermo dynamical parameters in terms of free energy in canonical ensemble.
19. Outline Einstein's theory of specific heat capacity.
20. Calculate all the thermodynamic properties of an ideal gas using grand canonical partition function and hence obtain the EOS.
21. Derive Debye’s T^3 law for the lattice heat capacity.
22. Obtain an expression for the variation of chemical potential of a degenerate Fermi gas and demonstrate the result using graph.

****