LOYOLA COLLEGE (AUTONOMOUS), CHENNAI – 600 034

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

THIRD SEMESTER – **APRIL 2019**

17/16PPH3MC01/PH 3814 – STATISTICAL MECHANICS

Date: 05-04-2019 Dept. No. Max. : 100 Marks

Time: 09:00-12:00

PART - A

Answer **ALL** questions (10×2=20)

1. Draw the phase diagram of a harmonic oscillator.
2. Relate the thermo dynamical variables **P**, **T** and **μ** as partial derivatives of entropy.
3. Write down the canonical partition function for a magnetic dipole oriented at an angle θ with respect to the external magnetic field.
4. State virial theorem.
5. Using grand canonical partition function, express the average number of particles $\bar{N}$ and average energy $\bar{E}$.
6. What is critical opalescence?
7. Why is the pressure exerted by a system of Boson gas below critical temperature independent of its volume?
8. State Stefan's law.
9. Define Fermi energy, Fermi momentum and Fermi temperature.
10. Show that the average energy per particle is $(3/5)^{th}$ of the Fermi energy for a Fermi gas at zero K.

PART - B

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

11. Establish the fact that entropy is an extensive property of the system.
12. Derive Curie law using Langevin's classical theory of paramagnetism.
13. Using the method of most probable distribution, show that the most probable mode of distribution $\{n^*_{r,s}\}$ is given by $n^*_{r,s} = N \exp(-\alpha N_r - \beta E_s)/\sum \exp(-\alpha N_r - \beta E_s)$
14. Derive an expression for Bose temperature at which all particles are in the excited states.
15. Explain thermionic emission and hence derive the Richardson-Dushmann equation.
16. Obtain the thermodynamic parameters like S, P, μ, V, C_v as partial derivatives of Helmholtz free energy starting from the definition of P_r in the canonical ensemble.

PART - C

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

17. State and prove Liouville's theorem.
18. Derive the thermodynamic parameters for a system of quantum harmonic oscillator using the canonical ensemble.
19. Using energy fluctuation concept, show that the mean energy is the same in grand canonical or microcannonical ensemble. Show that in the $N \rightarrow \infty$, the canonical distribution function resembles the delta function.
20. For a black body, derive Planck's distribution law and show that Wein and Rayleigh –Jean's laws are special cases of Planck's law. Derive Wien's displacement law.
21. Show for a white dwarf of radius $>>10^8$ cm, its size is inversely proportional to its mass.
22. State and prove equipartition theorem.

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