**D2APH2203** **(2 Pages)** **Name.....**
**Reg.No.....**

**SECOND SEMESTER M.Sc. DEGREE EXAMINATION, APRIL 2023**
**(Regular/Improvement/Supplementary)**

**PHYSICS**
**FPHY2C07: STATISTICAL MECHANICS**

**Time: 3 Hours** **Maximum Weightage: 30**

**Part A: Short answer questions. Answer *all* questions. Each carries 1 weightage.**

1. Write Boltzman formula for entropy. If the number of microstates of a system in equilibrium is $10^{10}$, find the entropy of system (Boltzman constant is 1.38 X $10^{-23}$ SI units).
2. A closed system has two non-degenerate energy levels *0* and *E* .If the temperature of the system is T. Find the Helmholtz's free energy of the system.
3. Distinguish between canonical and Grand canonical ensembles.
4. The single particle partition function of classical ideal gas is Vf(T). If 'z' is the fugacity, obtain the grand partition function of classical ideal gas.
5. Write the equation of motion of density matrix. How it modifies in the case of system in equilibrium?
6. Distinguish between Maxwell Boltzman and Bose-Einstein statistics.
7. Compare electronic specific heat and lattice specific heat in metals at low temperatures.
8. Draw the variation of specific heat capacity of an ideal Bose gas with temperature (T). Write its values as T tends to zero and T tends to infinity.

**(8 × 1 = 8 weightage)**

**Part B: Essay questions. Answer any *two* questions. Each carries 5 weightage.**

9. a) State and prove Liouville's theorem.
   b) Explain Gibb's paradox. How can it be resolved?
10. Explain the equilibrium between a system and heat reservoir and hence discuss the physical significance of various statistical quantities in canonical ensemble.
11. Discuss an ideal gas in quantum mechanical micro-canonical ensemble. Obtain the expression for thermodynamic pressure of system and show that the relation reduces to PV= NkT for Maxwell=Boltzman case.
12. Explain the thermodynamics of ideal Fermi gas.

**(2 × 5 = 10 weightage)**

**(P.T.O.)**

**Part C: Problems. Answer any *four* questions. Each carries 3 weightage.**

13. A system has four energy levels 0, E, 2E and 3E.The total energy of the system is 5E and it contains 4 particles. Each energy level can occupy any number of particles. Find the number of microstates of the system.
14. State and prove equi-partition theorem.
15. Explain the statistics of paramagnetism and obtain Curie's law (classical treatment only).
16. Obtain the density matrix of an electron in a magnetic field.
17. Briefly explain Pauli paramagnetism.
18. What is Bose-Einstein condensation? Write the condition for onset of Bose-Einstein condensation. Draw the variation of number of particles (fraction of particles) of the normal phase and condensed phase in an ideal Bose gas with temperature.
19. Show that the specific heat capacity (at constant volume) of a black body radiator is three times its entropy.

**(4 × 3 = 12 weightage)**