QP CODE: 22000391

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Reg No : .....

Name : .....

MSc DEGREE (CSS) EXAMINATION , JANUARY 2022

Second Semester

CORE - PH010203 - STATISTICAL MECHANICS

M Sc PHYSICS,M.Sc.SPACE SCIENCE

2019 Admission Onwards

8E15E246

Time: 3 Hours | Weightage: 30

Part A (Short Answer Questions)

*Answer any **eight** questions.*

*Weight **1** each.*

1. Explain the statistical definition of pressure.
2. List the constraints on E_r and $n_{r,s}$, where E_r the energy of the systems and $n_{r,s}$ number of systems for which the energy is E_r in cannonical ensemble.
3. Obtain the relation between the canonical partition function and Helmholtz free energy.
4. State and explain the equipartition theorem.
5. Write down and explain the grand canonical partition function.
6. What is meant by density operator?
7. Write down the Slater determinant for a three particle system.
8. Show that for a reversible adiabatic process for an ideal Bose gas $Pv^{\frac{5}{2}}$ is a constant where v is the specific volume.
9. Discuss the nature of specific heat capacity in solids.
10. Discuss qualitatively the basic ideas behind the paramagnetic behavior of an ideal Fermi gas.

(8×1=8 weightage)

Part B (Short Essay/Problems)

*Answer any **six** questions.*

*Weight **2** each.*

11. Using the Sakur Tetrode relation for entropy, obtain the thermodynamic relation for energy $E = \frac{3NkT}{2}$.
12. Explain the possible solutions of ρ for satisfying the Liouville's theorem for a system in equilibrium i.e $[\rho, H] = 0$.

13. Obtain the density of states $g(\epsilon)d\epsilon$ for a free particle confined in an area A whose energy is lying in between ϵ and $\epsilon + d\epsilon$.

14. Obtain the specific heat capacity C_V for ideal gas in grand canonical ensemble. The single particle canonical partition function has the form $Q_1(V,T) = Vf(T)$, where $f(T)$ is a function of temperature alone.

15. Show that for a system in grand canonical ensemble, $\frac{\overline{(\Delta n)^2}}{\overline{n}^2} = \frac{kT}{V}K_T$, where $n = N/V$ and K_T is the isothermal compressibility.

16. Show that radiation pressure is one third the energy density of a black body radiation.

17. For ideal Fermi gas for high but finite values of temperature (for small z) show that the equation of state takes the form of $Virial\ expansion$.

18. Show that for energy of the incident light quanta greater than the work function of the metal, phototelectric current density is independent of temperature.

(6×2=12 weightage)

Part C (Essay Type Questions)

*Answer any **two** questions.*

*Weight **5** each.*

19. Discuss the fluctuations of energy in the canonical ensemble. Show that in the thermodynamic limit, the micro canonical and the canonical ensembles coincide.

20. Discuss the density matrix formulation in quantum statistics for various ensembles.

21. Using the concepts of quantum microcanonical ensemble arrive at the equation of state of the classical ideal gas.

22. Discuss the salient features of first order phase transition. Deduce Clapeyron equation.

(2×5=10 weightage)