APRIL - 2016

M.Sc. Physics Examination Semester - 3

Phys-C302 : Statistical Mechanics

Paper Code- 4704

Time : 2 Hours 30 min — Maximum Marks 70

1.	A. Derive the partition function of an ideal classical gas. B. Determine the phase trajectory for a particle of unit mass and unit charge moving under the influence of Coulomb attraction towards affixed unit charge of +1 at a distance r_0. C. Consider a system of N identical but distinguishable particles each of which has two energy levels, 0 or $\varepsilon > 0$ to occupy. The upper energy level has a g-fold degeneracy while the lower level is non-degenerate. If the total energy of the system is fixed at E, i) find the occupation number n_+ and n_0 in terms of the temperature of the microcanonical system. ii) Consider g = 2 and E= 0, 75 N ε is brought into contact with a heat bath at constant temperature, T= 500^0 K, in what direction does the heat flow?	[07] [03] [04]
OR		
1.	A. State and prove Liouville's theorem in classical statistical mechanics. B. Consider a system of 4 indistinguishable particles which can have energies, 0,1,2,3 units. The total energy of all the 4 particles together is 3 units. List all the accessible microstates. C. Derive the equation of state of an ideal classical gas and determine other thermodynamic properties like the total internal energy, specific heat at constant volume and entropy of the system.	[04] [05] [05]
2.	A. Explain how various thermodynamic quantities can be found if the partition function is evaluated. B. Derive Bose distribution and Fermi distribution using grand canonical ensemble.	[08] [06]
OR		
2.	A. Find the chemical potential of an ideal classical gas, Given three states of energy 0, E, and 3E and two particles at an absolute temperature T, find the partition function when a. Particle obey M-B distribution b. Particle obey B-E distribution c. Particle obeys F-D distribution B. Give difference between M-B, B-E and F-D distribution C. How the density operator for a grand canonical ensemble is computed? Compute the ensemble average of its total energy.	[04] [04] [06]
3.	A. Derive the Planck's radiation law using BE statistics. B. Discuss the super fluidity with reference to the thermodynamic properties of liquid helium at very low temperature.	[07] [07]
OR		

3.	A. For the Debye model of phonons in a three dimensional isotropic solid, obtain expression for the limiting behavior of C_V at very high and very low temperatures. B. Compute heat capacity of non-interacting free electrons in a three dimensional metal	[07] [07]
4.	A. Discuss in detail the basic thermodynamic behavior of an ideal Fermi gas. B. Show that fermion gas even at 0^0K exerts huge pressure which can even compensate the gravitational contraction of White dwarf stars.	[07] [07]
OR		
4.	A. Define Fermi energy. Get an expression to compute the same. Also derive the temperature dependence of the Fermi energy. B. Explain Pauli para-magnetism by considering free electron gas in an external magnetic field. Show that the limiting susceptibility is independent of temperature. How is it different from the classical Langevin para-magnetism?	[06] [08]
5.	Illustrate the nature of the critical behavior displayed by a Van der Waals system undergoing the gas-liquid phase transition.	[14]
OR		
5.	A. What is the relation between Pc, Vc and Tc for ideal gas and real fluids . B. Explain First Order Phase Transition in terms of Gibbs free energy . C. Describe any three Thermodynamic Potentials briefly.	[06] [04] [04]

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