Statistical Mechanics

Quiz 1

(Time – 1 hr Total Marks: 40 ,10 marks each)

Q1.

A two level system has energies 0 and 1 KT with total number of particles N. Consider a micro-canonical ensemble at constant energy E to calculate the number of ways N particles can be divided into n_1 particles in state 1 and n_2 particles in state 2. Obtain the entropy and average number of particles in each state. Calculate the specific heat of the system.

$$\frac{I}{T}=\left(\frac{\delta S}{\delta U}\right)_N ; S_p=\left(\frac{\delta U}{\delta T}\right)_N$$

Q2.

Consider an ideal gas of N particles of mass m confined to a volume V at a temperature T. Using the classical approximation for the partition function and assuming the particles are indistinguishable, calculate the chemical potential μ of the gas.

$$\mu=\left(\frac{\delta F}{\delta N}\right)_{V,T}$$

where F is the Helmholtz free energy $F=-K_B T \ln Z$.

Q3.

A spin system can have two possible values of spins either +1 and -1. In a micro-canonical ensemble, total number of particles N and the total magnetization M are fixed. Obtain the average number of spins in +1 and -1 states respectively. Also obtain the internal energy and specific heat of the system.

Q4.

Starting with the line of zero energy and working in the phase space of a classical harmonic oscillator with mass m and frequency ω, draw lines of constant energy and number of micro states that divide phase space into cells of "volume" *h* in a two dimensional space. Calculate the entropy and temperature of the system for N number of oscillators.