PH2202 Thermal Physics
Fall Semester - 2024
Indian Institute of Science Education and Research, Kolkata
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Homework: 7 Submission Date: 16/04/2024

The hand written solutions must be submitted at the start of the tutorial.

1. There are three particles and three quantum states. Distribute the particles according to (a) Maxwell-Boltzman distribution, ie. the particles are distinguishable and arbitrary number of particles can occupy any state (b) Bose-Einstein distribution, i.e the particles are indistinguishable and arbitrary number of particles can occupy any state (c) Fermi-Dirac distribution, i.e the particles are indistinguishable and only one particle can occupy any state. For each case, count the number of microstates.

2. Consider a system of three distinguishable particles. Each particle can be in two states: 'UP' and 'DOWN'. If a particle is in UP state, its energy is $-E$, and if it is in the DOWN state, its energy is $+E$.

   (a) List all possible microstates of the system and write the associated energy of each microstate.

   (b) Suppose, the system is in thermal equlibrium with energy $-E$. (i) What is the probability for the system of being in any of the microstate consistent with energy $-E$? (ii) What is the probability for the first particle to be in the 'UP' state?

3. Consider a system composed of two 1-dimensional simple harmonic oscillators. For each oscillator, the energy eigenvalues are given by $\epsilon_i = (\nu_i + \frac{1}{2})\hbar\nu$. where the value of ω is same for both the oscillators. There is no interaction between the oscillators. Suppose the total energy of the system is $E_\nu = (\nu + 1)\hbar\omega$. How many microstates would correspond to this energy?

4. The volume of a system changes but the number of particles and internal energy remain constant. Show that the number of accessible microstates changes exponentially with volume. It is given that $S = k_B ln(\Omega)$.