DEBRE MARKOS UNIVERSITY COLLEGE OF NATURAL AND COMPUTATIONAL SCIENCE DEPARTMENT OF PHYSICS

STATISTICAL PHYSICS II(Phys3092) ASSIGNMENT 1(10%)

Solve the following questions clearly.

1. Many impurity atoms in a semiconductor exchange energy and electrons with the electrons in the conduction band. Consider the impurity atoms to be in thermal and chemical equilibrium with the conduction band, which can be considered to be an energy and particle reservoir. Assume that Δ is the ionization energy of the impurity
   atom. Find the probability that an impurity atom is ionized.
2. Consider an ideal gas of N = 3 identical fermions in equilibrium with a heat bath at temperature T. Assume that each particle can be in one of four possible states with energies ϵ_1, ϵ_2, ϵ_3 and ϵ_4.
   a) list all possible microstates of the system.
   b) Calculate the partition function of of the system.
3. State the basic differences in the fundamental assumptions underlying Maxwell-Boltzman (MB) and Fermi-Dirac (FD) statistics?
4. Consider a system consists of two particles, each of them can be in any of three quantum states of respective energies 0,ϵ, 3ϵ. RThye system is in contact with heat reservoir at temperature $T = (kT)^{-1}$
   a) Write an expression for the partition function Z if the particles obey classical MB-statistics and particles are distinguishable.
   b) What is Z if the particles obey BE-statistics?
   b) What is Z if the particles obey FD-statistics?
5. Consider a system consisting of two distinguishable particles. Each particles has two states with single particle energies 0 and ϵ. The quantity ϵ is called the energy gap. The system is in equilibrium with a heat bath a temperature T.
   a) Find the partition function of the system.
   b) Write the partition function of one particle.
   c) Find the probability that the system is in each of its two possible states.
   d) Find the mean energy of each particle.