2^{nd}-HOMEWORK

1. Describe the following concepts(do not use equations, use words)

   Ergodic Hypothesis

   Microcanonical Ensemble

   Canonical Ensemble

   Distribution function

   Closed system

   Subsystem

2. Consider a mixture consisting of two different kinds of molecules, molecule A and molecule B. These molecules can undergo the reaction $2A \leftrightarrow 3B + energy$ where the energy released is ϵ. Let n_A be the number of A molecules per unit volume and n_B be the number of B molecules per unit volume. Assume that the molecules are distributed uniformly. The A molecules can be treated to form a subsystem of the whole system, similarly for B molecules. In this problem we will neglect the internal structure of the molecules, and hence treat them as point like particles. This will limit the approach to temperatures $T << \epsilon$

   a) The total number of molecules and the energy available for thermalization is no longer conserved, since the reaction changes the number of molecules and is exothermic. What are the new conserved quantities? (Hint: if the reaction would have been $2O_3 \leftrightarrow 3O_2$, it would not be the total number of molecules but the total number of atoms that is conserved)

   b) Show that in equilibrium, the temperature of both of the subsystems (that formed by the A molecules, and that formed by the B molecules) are equal.

   d) Write down the total entropy of the system.

   e) By equating the derivative of the total ientropy with respect to the changing number of particles to zero, derive a relation for the particle densities of the A and B type molecules, in equilibrium (Let the equilibrium temperature be denoted by T_{eq}, and sketch the general behavior of n_B^3/n_A^2)

   f)(10 points) Show that if the equilibrium temperature is raised by some external influence, the density of B molecules in equilibrium gets reduced.