Assignment - II

1. ~~For~~ In a system consisting of N particles, the first excited state of a particle is 1.5 eV above the ground state. The ground state is doubly degenerate while the first excited state is four-fold degenerate. Find out the fraction of particles in the excited state if the system is at a temperature of 7000 °K.

2. Given an isolated system of four distinct particles each particle restricted to energies $0, \epsilon, 2\epsilon, \ldots$ If the system has energy $E = 3\epsilon$ (a) ~~find the~~ enumerate the microstates of the system and determine the thermodynamic probability (b) what is the probability that a given particle has energy ϵ? (c) Given that particle 1 has energy ϵ, what is the probability that particle 2 has energy 0?

3. A mixed 'Bosonic' system consists of N_R number of red balls, and N_b number of blue balls. Any number of these can be placed in any of g number of boxes. Find the number of distinct microstates of the system.

4. Consider an isolated system of $N >> 1$ distinct particles, each with possible energy states 0, and ~~ϵ~~ and ~~ϵ~~ 2ϵ.
   (a) Give the range of energies for which the system has negative temperature.
   (b) If A and B are two subsystems of the given system ↑ ~~and~~ each having N/2 particles. If A has energy $E_A = N\epsilon/8$ and B has $E = 5N\epsilon/8$, which of these has positive / negative temperature
   (c) The two systems are kept in thermal contact

4. What can you say about the equilibrium temperature of the ~~composite system~~ two subsystems?

5. An ideal gas of R_b^{87} particles at 100°K is compressed isothermally. Find out the number density of the gas at which Bose-Einstein condensation ~~takes place~~ starts.

6. An ideal Bose gas with spinless particles of mass of 6.65×10^{-27} kg has particle-density $n = 10^{26}\ m^{-3}$. Find the percentage of particles in the ground energy-level at 0.043°K

7. Out of the following :- separate the bosons and fermions - Li^6, K^{40}, K^{41}, Li^7, He^3, He^4, R_b^{87}, Na^{23}

8. A crystaline dielectric solid is at a temperature of 300°K. Calculate the contribution of the blackbody radiation to its molar specific heat. Compare it with the classical molar specific heat of 3R.

9. The cosmic microwave background radiation left after the Big-Bang fills the Universe with radiation at T = 2.76°K. What is the mean number density of photons.

10. A cavity of volume 1 cm^3 is filled with black-body radiation at temperature 727°C. What is the average number of photons in the cavity?

11. Find an expression for the energy density of a hypothetical photon-gas confined to a two-dimensional area A and is in equilibrium at temperature T.