

Phys 430 - 1st HOMEWORK

1. Discuss the following concepts (just writing formulas is not enough, use words)

Ergodic principle

Ensemble

Distribution function

Microcanonical Distribution Function

Subsystem

2. Suppose you have N books of equal mass and 3 shelves to place the books onto. Let the potential energy of a book on shelf 1 be zero, of a book on shelf 2 be U_0 and the potential energy of a book on shelf 3 be $2U_0$.

(i) If there is no restriction on the way you can distribute the books on the shelves, in how many ways can you distribute the books on the shelves?

(ii) Assume that all possible distributions of the books among the shelves are equally probable. What is the probability, P_n that the books will have a total potential energy $U = nU_0$? (It is enough that you write an expression which would let you calculate the probability)

(iii) Using the expression that you have obtained in part (ii), plot the probability P_n for $N = 5$, $N = 20$ and $N = 40$. (Do use computers to do these plots. You can use mathematica, or maple (both available in orca.cc.metu.edu.tr, or any other program). Normalize your plots so that the maximum value of your plots is 1 and the x axes goes from 0 to 1 so that you will see that as N increases, the graph gets narrower)

(iv) For $N = 10$, what is the entropy of the system if the potential energy of the system is known to be $U = 15U_0$? (take the Boltzman constant $k = 1$)

3. Consider two different quantum systems: system A and system B . Both of the systems can be only in two different states. If the wave function of the whole system is given by

$$\Psi = a_1 \Psi_A^1 \Psi_B^1 + a_2 \Psi_A^1 \Psi_B^2 + a_3 \Psi_A^2 \Psi_B^2 \quad (1)$$

where $|a_1|^2 + |a_2|^2 + |a_3|^2 = 1$ and Ψ_X^i ($X = A, B, i = 1, 2$) is the wavefunction of the i^{th} state of the X system. What is the quantum statistical matrix of system A ? What is the quantum statistical matrix of system B ?