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

   Enthropic principle

   Closed system

   Subsystem

   Distribution function

   Microcanonical distribution function

2. Consider N identical non-interacting 1D harmonic oscillators. The energy levels of the system will be given by:

$$E = \hbar\omega \left(\sum_{i=1}^{N} n_i + \frac{N}{2} \right) \tag{1}$$

   a For N=2, calculate the total number of states that have energies less then or equal to $E = \hbar\omega(M + \frac{N}{2})$.

   b Generalize the previous result for arbitrary N and obtain an expression for $\Gamma_N(E)$.

   c Calculate the total number of states, $\Delta\Gamma$ that the system can be in if the total energy is exactly $E = \hbar\omega(M + \frac{N}{2})$. How is this result related to $\Gamma(E)$

   d Calculate entropy, S. What is the temperature T of the state?

   d What is the probability that a particular harmonic oscillator is in the n^{th} excited state?

   e Given a subsystem consisting of 2 harmonic oscillators, what is the probability that this subsystem has total energy, $\epsilon = \hbar\omega(n + 1)$

   Hint: In calculating the probabilities, express you result in terms of temperature and try to obtain an expression which is proportional to $e^{-\frac{\epsilon}{kT}}$