2-1 Derive the formula for an Einstein solid in the low temperature limit: q << N.

2-2 Use the Stirling's approximation, $N! \approx N^N e^{-N} \sqrt{2\pi N}$ to show that the multiplicity of an Einstein solid with large values of *N* is:

$$\Omega(N,q) \approx \frac{\left(\frac{q+N}{q}\right)^q \left(\frac{q+N}{N}\right)^N}{\sqrt{2\pi q(q+N)/N}}$$

(For somewhat large values of *N*, the approximation does not apply:

$\frac{(q+N-1)!}{q!(N-1)!} \neq \frac{(q+N)!}{q!N!}$. First show that $\Omega = \frac{N}{q+N}\frac{(q+N)!}{q!N!}$)

2-3 Consider two identical Einstein solids, each with *N* oscillators, in thermal contact with each other. Suppose the total number of energy units of the combined system is exactly 2*N*.

(a) Find the number of different macrostates (the possible values for the energy in the first solid).

(b) Use the result of Problem 2-2 to find the expression for the total number of microstates for the combined system. (Hint: treat the combined system as a single Einstein solid.)

(c) Find the multiplicity of the most probable macrostate.

(d) Assume that the distribution of the multiplicity function is a rectangular. The height of the rectangular is the result of (c) while the total area is the result of (b). In this case, how wide would it be?