\[ f ) \ \frac{S}{k_b} = \ln S \]

\[ \Delta S = \ln S_{\text{tot}} - \ln S_{\text{most likely}} = \ln \frac{2^{4N}}{\sqrt{8\pi N}} - \ln \frac{2^{4N}}{4\pi N} \]

\[ = \left( \ln 2^4 - \ln \sqrt{8\pi N} \right) - \left( \ln 2^4 - \ln 4\pi N \right) \]

\[ = \ln 4\pi N - \ln \sqrt{8\pi N} \ll \left( \frac{S}{k_b}\right)_{\text{total}} \]

this means that there is very little difference between the total number of microstates and the most likely

for \( N = 10^{23} \)

\[ \text{total: } \ \frac{S}{k_b} = 2.77 \times 10^{23} \]

\[ \text{most likely: } \ \frac{S}{k_b} = 2.77 \times 10^{23} - 55.5 \]