CW2HWST-8)

We start with g_{Nei} states for the neon on the left and g_{Ari} for the argon on the right. We don't know these numbers, but assume that they are extremely large.

A) The expectation is that the most probable distribution will have 150 neon atoms and 350 argon atoms on each side.

B) When we allow the volume available to each type of gas to double, the number of states available will increase by a factor of 2^N with N the number of particles of each type: $g_{Nef} = 2^{300} g_{Nei}$ and $g_{Arf} = 2^{700} g_{Ari}$. Then,

$$\begin{aligned}\Delta S = {} & k_B \ln g_{Nef} + k_B \ln g_{Arf} - k_B \ln g_{Nei} - k_B \ln g_{Ari} \\ & = k_B(\ln(2^{300} g_{Nei}) + \ln(2^{700} g_{Ari}) - \ln g_{Nei} - \ln g_{Ari}) \\ & = k_B(300 \ln 2 + \ln g_{Nei} + 700 \ln 2 + \ln g_{Ari} - \ln g_{Nei} - \ln g_{Ari}) \\ & = (1.38 \times 10^{-23})(1000 \ln 2) = 9.57 \times 10^{-21}\ \mathrm{Jeq/K}.\end{aligned}$$

C) The probability of both scenarios is the product of the probabilities of each:

$$P = 0.5^{300} 0.5^{700} = 0.5^{1000} = 9.33 \times 10^{-302}$$