1 Entropy of mixing

Suppose that a system of N atoms of type A is placed in diffusive contact with a system of N atoms of type B at the same temperature and volume.

(a) Show that after diffusive equilibrium is reached the total entropy is increased by $2Nk \ln 2$. The entropy increase $2Nk \ln 2$ is known as the entropy of mixing.

(b) If the atoms are identical ($A = B$), show that there is no increase in entropy when diffusive contact is established. The difference has been called the Gibbs paradox.

(c) Since the Helmholtz free energy is lower for the mixed AB than for the separated A and B, it should be possible to extract work from the mixing process. Construct a process that could extract work as the two gasses are mixed at fixed temperature. You will probably need to use walls that are permeable to one gas but not the other.

Note This course has not yet covered *work*, but it was covered in Energy and Entropy, so you may need to stretch your memory to finish part (c).