# Homework 2 (Due Thursday, February 2nd)

1. An engine is represented by the cyclic transformation shown in the $T - S$ diagram below. The variable A denotes the area of the shaded region and B the area of the region below it. Find the efficiency in terms of the ratio of the areas A and B; show that this engine is not as efficient as a Carnot engine operating between the highest and lowest available temperatures.

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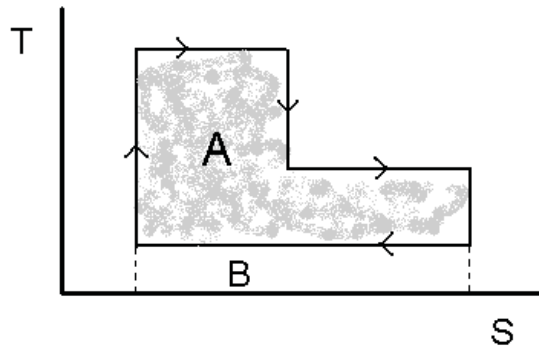
2. Systems $\mathcal{A}$ and $\mathcal{A}'$ are isolated from the rest of the world but are in thermal and mechanical contact with each other (i.e., equal temperature and pressure). The total energy, $U_\Sigma = U + U'$, and total volume $V_\Sigma = V + V'$ are constant. The entropy for system $\mathcal{A}$ is $S(U, V) = k \ln(C U^a V^b)$ Similarly, for system $\mathcal{A}'$, $S'(U', V') = k \ln(C' U'^c V'^d)$ where a, b, c, d, C, and C' are constants. Find U and V, the energy and volume of system $\mathcal{A}$ at thermodynamic equilibrium in terms of U_Σ, V_Σ and the constants a, b, c, d.