[tex6] **Retrievable and irretrievable energy put in heat reservoir**

Consider the amount $n = 1$mol of a monatomic classical ideal gas inside a cylinder with a piston on one side. This system is in thermal contact with a heat bath at temperature $T_0 = 293K$. An external work source pushes the piston from position 1 ($V_1 = 5$m^3) in to position 2 ($V_2 = 3$m^3) and then back out to position 1.

Calculate the work ΔW_{12} done by the source during step $1 \to 2$ and the (negative) work ΔW_{21} done during step $2 \to 1$ under three different circumstances: Compression and expansion of the gas take place (a) quasi-statically, i.e. isothermally; (b) rapidly, i.e. adiabatically, and in quick succession; (c) adiabatically again, but with a long waiting time between the two steps.

For each case calculate also the energy E_W waisted in the heat bath after one full cycle. Find the highest temperature T_H and the lowest temperature T_L reached by the gas in (c).

The equation of state is $pV = nRT$, and the heat capacity is $C_V = \frac{3}{2}nR$. During the adiabatic process: $pV^\gamma = \text{const}$ with $\gamma = \frac{5}{3}$.