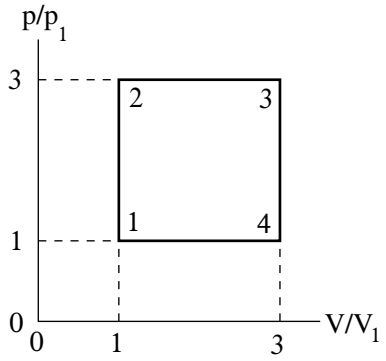
[tex149] Square heat engine

Consider 1 mol of a monatomic classical ideal gas [$pV = RT$, $U = \frac{3}{2}RT$] confined to a cylinder by a piston. The cylinder is in thermal contact with a heat bath of adjustable temperature. The gas undergoes a quasistatic, cyclic process $1 \to 2 \to 3 \to 4 \to 1$ as shown. Use p_1, V_1, T_1 as units for pressure, volume, and temperature, respectively.
(a) Find p_2, V_2, T_2, p_3, V_3, T_3, and p_4, V_4, T_4 in these units.
(b) Find the work performance, $\Delta W_{12}, \Delta W_{23}, \Delta W_{34}, \Delta W_{41}$, the change in internal energy, ΔU_{12}, ΔU_{23}, ΔU_{34}, ΔU_{41}, and the heat transfer, $\Delta Q_{12}, \Delta Q_{23}, \Delta Q_{34}, \Delta Q_{41}$, along the legs of the cycle. Express these quantities in units of RT_1.
(c) Find the net work ΔW_{net} performed during the cycle. Find also the heat ΔQ_{in} absorbed and the heat ΔQ_{out} expelled by the gas during the cycle.
(d) Find the efficiency η_S of this cycle in the role of heat engine.



Solution: