

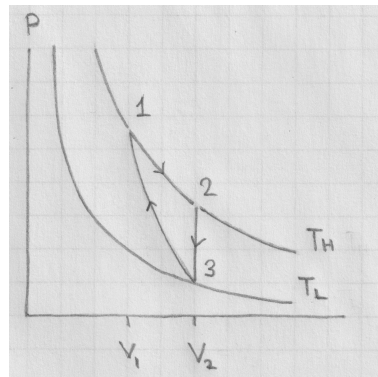
[tex198] Ideal-gas engine with three-step cycle II

Consider the three-step cycle $1 \rightarrow 2 \rightarrow 3 \rightarrow 1$ shown for 1mol of a monatomic classical ideal gas. Given for this exercise are the relations,

$$pV = RT, \quad C_V = \frac{3}{2}R, \quad U = C_V T, \quad pV^{5/3} = \text{const (adiabate)}.$$

The first step 12 is an isothermal expansion at the higher temperature T_H , the second step 23 is an isochoric cooling ending at the lower temperature T_L , and the third step 31 is an adiabatic compression back to the higher temperature T_H . The three destinations have volumes $V_1 < V_2 = V_3$.

- Express the heat transfer ΔQ , the work performance ΔW , and the change in internal energy $\Delta U = \Delta Q + \Delta W$ for each step. Indicate for each quantity whether it is positive, zero, or negative.
- Express the volume ratio V_2/V_1 as a function of T_H/T_L .
- Express the efficiency of the cycle $\eta \doteq \Delta W_{out}/\Delta Q_{in}$ as a function of T_H/T_L .
- Find the change of entropy ΔS in each of the three steps, expressed as functions of T_H/T_L .



Solution: