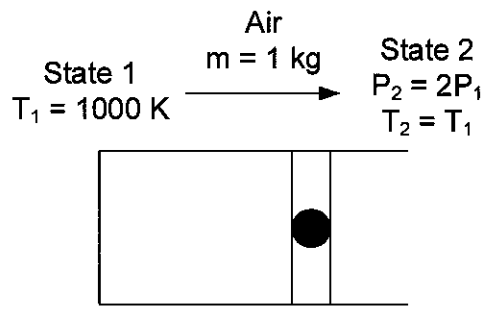
Sample Short Calculations

Answer the following questions. You must write all relevant equations (including basic equations) supporting your answer to get any credit. However, you do not need to write assumptions or show your system and mass and/or energy interactions on the sketch for this problem.

(a) Air (m = 1 kg) contained in a closed, piston cylinder device is compressed at constant temperature of 1000 K such that its pressure doubles during the process. Heat transfer of 198.93 kJ occurs from the air to the surroundings.



Calculate the entropy generation for air in the cylinder, in kJ/K. Assume a boundary temperature of 1000 K.

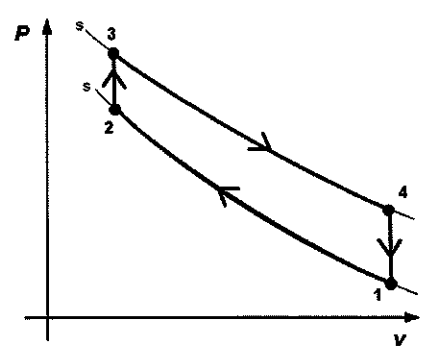
Entropy balance: $\Delta S = \frac{Q}{T_b} + \sigma \Rightarrow \sigma_{12} = m(s_2 - s_1) - \frac{Q_{12}}{T_b}$

$\sigma_{12} = m(s_2^o - s_1^o - R_{air} \ln \frac{P_2}{P_1}) - \frac{Q_{12}}{T_b}$, $T_2 = T_1$

$\sigma_{12} = -1 kg * 0.287 \frac{kJ}{kg-K} * \ln 2 - \frac{-198.93 kJ}{1000 K}$

$\boxed{\sigma_{12} = 0}$

(b) Air is at an absolute pressure of 100 kPa and an absolute temperature of 300 K (State 1) at the start of the compression process in a gasoline engine modeled using the air-standard Otto cycle. The compression ratio (v_1/v_2) of the engine is 10.



Find the absolute pressure of air the end of the compression process, in kPa.

Isentropic compression:

$\frac{v_2}{v_1} = \frac{v_{r_2}}{v_{r_1}} \Rightarrow v_{r_2} = \frac{621.2}{10} = 62.12 \Rightarrow T_2 \cong 730 K$

$\frac{P_2}{P_1} = \frac{P_{r_2}}{P_{r_1}} \Rightarrow P_2 = 100 kPa * \frac{33.72}{1.386} \Rightarrow \boxed{P_2 = 2433 kPa}$