b.) If $T$ is cooled and piston could move (say with $P = \text{const}$) then volume would decrease.

\Rightarrow \text{top will not rise.}

\text{top rests as is and process is constant volume.}

\begin{align*}
\text{Initial} & \quad P_2 V_2 = m_2 R T_2 \\
\text{Final} & \quad \left\{ \begin{array}{l}
V_2 = V_f \\
m_2 = m_f \\
P_f V_f = m_f R T_f
\end{array} \right. \\
\Rightarrow & \quad \frac{P_f V_f}{P_2 V_2} = \frac{m_f}{m_2} \frac{T_f}{T_2} \\
& \quad \frac{P_f}{P_2} = \frac{T_f}{T_2} = \frac{T_f}{T_i} \left( \frac{1}{\frac{L_1 A_1}{L_1 A_1 + L_2 A_2}} \right) \\
& \quad \Rightarrow \text{but } P_2 = P_i \\
& \quad \frac{P_f}{P_i} = \left( \frac{L_1 A_1}{L_2 A_2} + 1 \right) \frac{T_f}{T_i}
\end{align*}