A cylinder with a piston contains 0.150 mol of nitrogen at $1.8 \times 10^5$ Pa and 300K. The nitrogen may be treated as an ideal gas. The gas is first compressed isobarically to $\frac{1}{2}$ its original volume. It then expands adiabatically back to its original volume, and finally it is heated isochorically to its original pressure.

a) Draw the p-V diagram,

b) Compute the temperatures at the beginning and end of the adiabatic expansion,

c) Compute the minimum pressure.
Isobaric compression to $V_0/2$
adiabatic expansion to $V_0$
isochoric heating to $p_0$
b) Compute the temperatures at the beginning and end of the adiabatic expansion

\[
P_0 V_0 \frac{V_0}{2} = n \times T_0 = 300 K
\]

Given

\[
T_i \quad V_{0/2} \quad T_f \quad V_0
\]

\[
\begin{align*}
p_0 &= 1.80 \times 10^5 \text{ Pa} \\
T_0 &= 300 K
\end{align*}
\]
b) Compute the temperatures at the beginning and end of the adiabatic expansion

Given:
- \( n = 0.150 \)
- \( p_0 = 1.80 \times 10^5 \text{ Pa} \)
- \( T_0 = 300 \text{ K} \)

Get \( T_i \) from ideal gas law:
\[
p_0 V_0 = nRT_0
\]
\[
p_0 \frac{V_0}{2} = nRT_i
\]
\[
T_i = \frac{T_0}{2} = 150 \text{ K}
\]

Get \( T_f \) from:
\[
T_i V_i^{\gamma - 1} = T_f V_f^{\gamma - 1}, \quad \frac{T_0}{2} \left( \frac{V_0}{2} \right)^{\gamma - 1} = T_f V_0^{\gamma - 1}
\]
\[
T_f = \frac{T_0}{2^{\gamma}} = \frac{300 \text{ K}}{2^{1.4}} = 114 \text{ K}
\]
c) Compute the minimum pressure.

\[ p_{\text{min}} V_0 = nRT_f \]
\[ p_0 V_0 = nRT_0 \]

\[ p_{\text{min}} = p_0 \frac{T_f}{T_0} = (1.80 \times 10^5 \text{ Pa}) \frac{113.7 \text{ K}}{300 \text{ K}} \]

\[ p_{\text{min}} = 6.82 \times 10^4 \text{ Pa} \]