problem 1, Solution

Suppose the total amount of gas is \( N \) mole

a) check the process by 1st Law of Therm.

For open system \( \Delta H = \Delta Q + W_S \)

The device is thermally and mechanically insulated

So \( W_S = 0, \Delta Q = 0 \), thus \( \Delta H = 0 \)

the practical process is:

Energy in: \( N C_p H_1 \), Energy out: \( 0.5N C_p H_2 + 0.5N C_p H_3 \)

So \( \Delta H = 0.5N C_p H_2 + 0.5N C_p H_3 - NC_p H_1 \)

\[ = N C_p (0.5T_2 + 0.5T_3 - T_1) \]

\[ = N C_p [0.5 \times (235 + 355) - 295] \]

\[ = 0 \quad \text{ok!} \]

b) check the process by 2nd Law: \( \Delta T S \geq 0 \)

\[ ds = \frac{dQ}{T} + \frac{P}{T} dV \]

Note: \( dV = nC_v dT \) for const. volume process

\[ \frac{P}{T} = \frac{nR}{V}, \quad C_p - C_v = R \quad \text{for ideal gas} \]

So \( \Delta S = nC_v \ln \frac{T_2}{T_1} + nR \ln \frac{V_2}{V_1} = nC_p \ln \frac{T_2}{T_1} - nR \ln \frac{P_2}{P_1} + nR \ln \frac{V_2}{V_1} \)

\[ = nC_p \ln \frac{T_2}{T_1} - nR \ln \frac{T_2 V_2}{T_1 V_1} \]

\[ = nC_p \ln \frac{T_2}{T_1} - nR \ln \frac{P_2}{P_1} \]

Here \( \Delta T S = \Delta S_1 + \Delta S_2 \)

\[ = 0.5N [C_p \ln \frac{T_2}{T_1} - R \ln \frac{P_2}{P_1} + C_p \ln \frac{T_3}{T_1} - R \ln \frac{P_2}{P_1}] \]