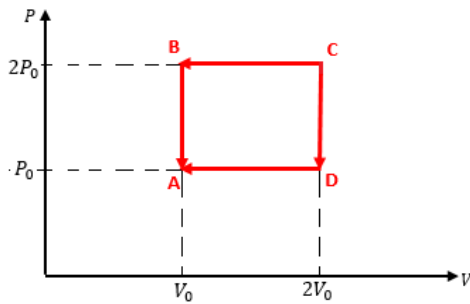


Exercice 1 :

1. Le diagramme de Clapeyron donne :



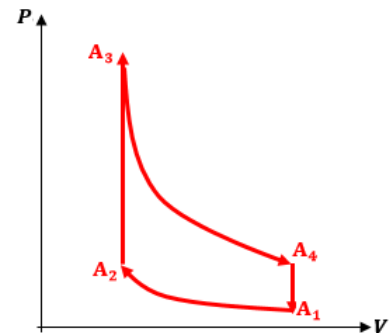
2. AB : transformation isochore $\Rightarrow \frac{P_A}{P_B} = \frac{T_A}{T_B}$
 $\frac{P_0}{2P_0} = \frac{T_0}{T_B} \Rightarrow T_B = 2T_0$
 BC : transformation isobare $\Rightarrow \frac{V_B}{V_C} = \frac{T_B}{T_C}$
 $\frac{V_0}{2V_0} = \frac{2T_0}{T_C} \Rightarrow T_C = 4T_0$
 CD : transformation isochore $\Rightarrow \frac{P_C}{P_D} = \frac{T_C}{T_D}$
 $\frac{2P_0}{P_D} = \frac{4T_0}{T_D} \Rightarrow T_D = \frac{2P_D}{P_0} T_0$
 DA : transformation isobare $\Rightarrow P_D = P_A = P_0$
 $T_D = \frac{2P_D}{P_0} T_0 \Rightarrow T_D = 2T_0$
3. AB : transformation isochore $\Rightarrow W_A^B = 0$
 $Q_A^B = 1,5nR(T_B - T_A) = 1,5P_0V_0$
 BC : isobare $\Rightarrow W_B^C = -P_B(V_C - V_B)$
 $W_B^C = -2P_0(2V_0 - V_0) \Rightarrow W_B^C = -2P_0V_0$
 $Q_B^C = 2,5nR(T_C - T_B) \Rightarrow Q_B^C = 5P_0V_0$
 CD : transformation isochore $\Rightarrow W_C^D = 0$
 $Q_C^D = 1,5nR(T_D - T_C) = -3P_0V_0$
 DA : isobare $\Rightarrow W_D^A = -P_D(V_A - V_D)$
 $W_D^A = -P_0(V_0 - 2V_0) \Rightarrow W_D^A = P_0V_0$
 $Q_D^A = 2,5nR(T_A - T_D) \Rightarrow Q_D^A = -2,5P_0V_0$
4. $Q_1 = Q_A^B + Q_B^C \Rightarrow Q_1 = 6,5P_0V_0$
 $Q_2 = Q_C^D + Q_D^A \Rightarrow Q_2 = -5,5P_0V_0$
5. A pression constante, on a :
 $dP = 0 \Rightarrow \delta Q = C_p dT \Rightarrow dS = \frac{C_p dT}{T}$
 $\frac{dT}{T} = \frac{1}{C_p} dS \Rightarrow \ln T = \frac{1}{C_p} S + C^{te}$

$$T(S) = k \cdot \exp\left[\frac{S}{C_p}\right] \text{ avec } k \text{ constante réelle.}$$

Les fonctions T et S ont la même monotonie.

Exercice 2 :

- 1) Gaz parfait $\Rightarrow P_1 = \frac{RT_1}{V_1} \Rightarrow P_1 = 2,49 \text{ bar}$
 2) Compression adiabatique $\Rightarrow P_2 V_2^\gamma = P_1 V_1^\gamma$
 $P_2 = \left(\frac{V_1}{V_2}\right)^{1,4} P_1 \Rightarrow P_2 = 23,7 \text{ bar}$
 $T_2 = \frac{P_2 V_2}{R} \Rightarrow T_2 = 570 \text{ K}$
 3) Transformation isochore $\Rightarrow \frac{P_2}{P_3} = \frac{T_2}{T_3}$
 $T_3 = \frac{P_3}{P_2} T_2 \Rightarrow T_3 = 2429 \text{ K}$
 4) Détente adiabatique $\Rightarrow P_3 V_3^\gamma = P_4 V_4^\gamma$
 $P_4 = \left(\frac{V_3}{V_4}\right)^{1,4} P_3 \Rightarrow P_4 = \left(\frac{V_2}{V_1}\right)^{1,4} P_3$
 $P_4 = 10,6 \text{ bar}$
 $T_4 = \frac{P_4 V_4}{R} \Rightarrow T_4 = \frac{P_4 V_1}{R} = 1276,1 \text{ K}$
 5) Le diagramme de Clapeyron donne :



- 6) A_1A_2 : Compression adiabatique $\Rightarrow Q_{12} = 0$
 A_2A_3 : isochore $\Rightarrow Q_{23} = C_V(T_3 - T_2)$
 $Q_{23} = \frac{5}{2}R(T_3 - T_2) \Rightarrow Q_{23} = 38,6 \text{ kJ}$
 A_3A_4 : Compression adiabatique $\Rightarrow Q_{34} = 0$
 A_4A_1 : isochore $\Rightarrow Q_{41} = C_V(T_1 - T_4)$
 $Q_{41} = \frac{5}{2}R(T_1 - T_4) \Rightarrow Q_{41} = -20,3 \text{ kJ}$
- 7) Rendement du cycle η vaut : $\eta = 1 + \frac{Q_{41}}{Q_{23}}$

$$\eta = 0.47 = 47\%$$