

Exercice 1 :

On a :

Etat 1	Etat 2	Etat 3
P_1, V_1, T_1	P_2, V_1, T_2	P_1, V_3, T_2

Processus 1 à 2 : transformation isochore

$$W_{1-2} = 0 \text{ J}$$

Processus 2 à 3 : transformation isotherme

$$W_{2-3} = nRT \ln \left(\frac{V_1}{V_2} \right) = nRT_2 \ln \left(\frac{P_2}{P_1} \right)$$

Déterminons T_2

$$1-2 \text{ isochore} \implies \frac{P_1}{P_2} = \frac{T_1}{T_2} \implies T_2 = \frac{P_2}{P_1} T_1$$

L'air est supposée comme un gaz parfait, alors :

$$P_1 V_1 = nRT_1 \implies T_1 = \frac{P_1 V_1}{nR} \implies T_2 = \frac{P_2 V_1}{nR}$$

$$nRT_2 = P_2 V_1 \implies W_{2-3} = P_2 V_1 \ln \left(\frac{P_2}{P_1} \right)$$

Processus 3 à 1 : transformation isobare

$$W_{3-1} = P_1 (V_1 - V_3) = P_1 \left(V_1 - \frac{nRT_2}{P_1} \right)$$

$$W_{3-1} = P_1 \left(V_1 - \frac{P_2}{P_1} V_1 \right) = \left(1 - \frac{P_2}{P_1} \right) P_1 V_1$$

Ainsi :

$$W_{\text{cycle}} = W_{1-2} + W_{2-3} + W_{3-1}$$

$$W_{\text{cycle}} = P_2 V_1 \ln \left(\frac{P_2}{P_1} \right) + \left(1 - \frac{P_2}{P_1} \right) P_1 V_1$$

$$\Delta U_{\text{cycle}} = 0 \implies Q_{\text{cycle}} = -W_{\text{cycle}}$$

Applications numériques :

$$P_1 = 100 \text{ kPa}; \quad P_2 = 800 \text{ kPa}; \quad V_1 = 0,08 \text{ m}^3$$

$$W_{\text{cycle}} = 77,1 \text{ kJ} \implies Q_{\text{cycle}} = -77,1 \text{ kJ}$$

Exercice 2 :

a) Nous savons que :

$$\frac{dH}{dT} = mc_p \implies \Delta H = \int_{T_1}^{T_2} c_p dT = c_p (T_2 - T_1)$$

$$\text{avec } T_1 = 300 \text{ K} = 573,15^\circ\text{C}; \quad T_2 = 973^\circ\text{C};$$

$$\Delta H = 402,4 \text{ J/kg}$$

b) Nous avons :

$$\Delta H = \int_{T_1}^{T_2} c_p(T) dT$$

$$\Delta H = [0,946T + 0,1065T^2 - 1,033 \cdot 10^{-8}T^3]_{T_1}^{T_2}$$

$$\Delta H = 436,7 \text{ J/kg}$$

Exercice 3 :

a) Procédé *ab* : transformation isochore

$$W_{ab} = 0 \implies \Delta U_{ab} = \Delta Q_{ab} = 150 \text{ J}$$

b) Procédé *bd* : transformation isobare

$$W_{abd} = W_{ab} + W_{bd} = W_{bd} = -P_b (V_d - V_b)$$

$$P_b = 8 \cdot 10^4 \text{ Pa}; \quad V_b = 0,002 \text{ m}^3; \quad V_d = 0,005 \text{ m}^3$$

$$W_{bd} = -240 \text{ J} \implies W_{abd} = -240 \text{ J}$$

$$Q_{abd} = Q_{ab} + Q_{bd} = 150 + 600 = 750 \text{ J}$$

$$\Delta U_{abd} = W_{abd} + Q_{abd} = 510 \text{ J}$$

c) Nous avons :

$$\Delta U_{abdca} = 0 \implies \Delta U_{abd} + \Delta U_{dca} = 0$$

$$\Delta U_{dca} = -\Delta U_{acd} \implies \Delta U_{acd} = 510 \text{ J}$$

Exercice 4 :

On est en présence d'un échauffement isochore.

$$\text{Ainsi : } \Delta S = C_v \ln \left(\frac{T_2}{T_1} \right)$$

$$\text{avec } C_v = mc_v \implies \Delta S = mc_v \ln \left(\frac{T_2}{T_1} \right)$$

Application numériques :

$$T_1 = 273,15 \text{ K}; \quad T_2 = 373,15 \text{ K};$$

$$c_v = 4190 \text{ J} \cdot \text{kg}^{-1} \cdot \text{K}^{-1}; \quad m = 1 \text{ kg}$$

$$\Delta S = 1,3 \cdot 10^3 \text{ J} \cdot \text{K}^{-1}$$