CORRIGE DE L'EXAMEN DE RATTRAPAGE DE CHIMIE 02

EXERCICE N°1 (11 Points).

$\boxed{1}$ Coordonnées (P, V, T) des états 1, 2, 3, 4.

* A l'état 1, le gaz parfait est donc dans les Conditions Normales de température et de Pression (CNTP) qui correspondent à $T_1 = 273{,}15\ K$ et $P_1 = 1\ atm$ (0,75). En outre pour $n = 1$ mole on a $V_1 = 22{,}4$ litre (0,25)

* Etape $1 \rightarrow 2$: adiabatique : $Q_1^2 = 0$

$$T_1 V_1^{\gamma-1} = T_2 V_2^{\gamma-1} \Rightarrow V_2 = \left(\frac{T_1}{T_2}\right)^{\frac{1}{\gamma-1}} \cdot V_1 \quad (0{,}25) \qquad V_2 = 7{,}5\ l \quad (0{,}25)$$

$$* \ P_2 = \frac{nRT_2}{V_2} \qquad P_2 = 4{,}6\ atm$$

* Etape $2 \rightarrow 3$: $P = const$, $\frac{V}{T} = const$

$$\frac{V_2}{T_2} = \frac{V_3}{T_3} \Rightarrow V_3 = \left(\frac{T_3}{T_2}\right) V_2 \quad (0{,}25) \qquad V_3 = 6{,}2 \text{ litre} \quad (0{,}25)$$

$V_3 = V_4$

* Etape $4 \rightarrow 1$: $T = constante$, $PV = constant$.

$$P_4 V_4 = P_1 V_1 \Rightarrow P_4 = \left(\frac{V_1}{V_4}\right) P_1 \quad (0{,}25) \qquad P_4 = 3{,}6\ atm \quad (0{,}25)$$

$\boxed{2}$ Calcul des Energies W, Q ΔU et ΔH :

Etape $1 \rightarrow 2$: adiabatique $Q_1^2 = 0$ (0,25)

$$W_1^2 = \frac{P_2V_2 - P_1V_1}{\gamma - 1} = \frac{nR(T_2 - T_1)}{\gamma - 1} \quad (0{,}25) \qquad W_1^2 = +3116{,}25\ J \quad (0{,}25)$$

$$\Delta U_1^2 = W_1^2 \quad (0{,}25) \qquad \Delta U_1^2 = +3116{,}25\ J \quad (0{,}25)$$

$$\Delta H_1^2 = nC_p(T_2 - T_1) = \gamma\, \Delta U_1^2 \quad (0{,}25)$$

$$C_p = \frac{\gamma R}{\gamma - 1} \quad (0{,}25) \qquad C_p = 29{,}085\ \frac{J}{mol K} \quad (0{,}25) \qquad \Delta H_1^2 = +4362{,}75\ J \quad (0{,}25)$$

Etape 2 → 3 : P = constante. (0,25)

$W_2^3 = -P_2(V_3 - V_2) = +nR(T_2 - T_3)$ (0,25) $W_2^3 = +606{,}63$ J

$Q_2^3 = nC_p(T_3 - T_2)$ (0,25) $Q_2^3 = -2123{,}205$ J (0,25)

$\Delta U_2^3 = W_2^3 + Q_2^3 = nC_p(T_3 - T_2)$ (0,25) $C_v = \frac{R}{\gamma - 1}$ (0,25)

$C_v = 20{,}775$ J/mole K (0,25) $\Delta U_2^3 = -1516{,}575$ J (0,25)

$\Delta H_2^3 = nC_p(T_3 - T_2) = \gamma \Delta U_2^3$ (0,25) $\Delta H_2^3 = -2123{,}205$ J (0,25)

Etape 3 → 4 : V = constant.

$W_3^4 = -\int P\,dV = 0$ (0,25) $\Delta U_3^4 = Q_3^4$ (0,25)

$\Delta U_3^4 = nC_v(T_4 - T_3)$ (0,25) $\Delta U_3^4 = -1599{,}675$ J (0,25)

$\Delta H_3^4 = nC_p(T_4 - T_3) = \gamma \Delta U_3^4$ (0,25) $\Delta H_3^4 = -2239{,}545$ (0,25)

Etape 4 → 1 : T = constant. $T_1 = T_4 = 273{,}15$ K

$\Delta U_4^1 = 0$ (0,25) $\Delta H_4^1 = 0$ (0,25) $W_4^1 = -Q_4^1$ (0,25)

$W_4^1 = +nRT \ln \frac{V_4}{V_1}$ (0,25) avec $V_4 = V_3$ $W_4^1 = -2914$ J (0,25)

$Q_4^1 = +2914$ joule (0,25)

$\boxed{3}$ Verifier le 1er principe pour tout le cycle.

$\Delta U_{cycle} = W_{cycle} + Q_{cycle} = 0$

$W_{cycle} = W_1^2 + W_2^3 + W_3^4 + W_4^1$

$= +3116{,}25 + 606{,}63 + 0 + (-2914)$ (joule)

$W_{cycle} = +808{,}88$ joule (0,25)

$Q_{cycle} = Q_1^2 + Q_2^3 + Q_3^4 + Q_4^1$

$= 0 - 2123{,}205 - 1599{,}675 + 2914$ (joule)

$Q_{cycle} = -808{,}88$ joule (0,25)

$\Delta U_{cycle} = +808{,}88 - 808{,}88 = 0$ est verifié (0,25)