Corrigé de l'examen de chimie 2

Exercice 1 : (09)

Ⓐ $\xrightarrow{Q=0}$ Ⓑ $\xrightarrow{dV=0}$ Ⓒ

Ⓐ	Ⓑ	Ⓒ
n	n	n
$V_A = 10\,l$	$V_B = 20\,l$	$V_C = V_A = 20\,l$
$T_A = 300\,K$	$T_B =$	$T_C = T_A$
$P_A = 1\,atm$	$P_B = 0{,}33\,atm$	$P_C =$

1) $n = ?$ à l'état Ⓐ : $P_A V_A = n R T_A$

$$n = \frac{P_A V_A}{R T_A} = \frac{1\,at \times 10\,l}{0{,}082 \times 300\,K}$$

$$\boxed{n = 0{,}406\,mol}$$ (0,5)

$T_B = ?$ à l'état Ⓑ : $P_B V_B = n R T_B$

$$T_B = \frac{P_B V_B}{n R} = \frac{0{,}33\,atm \times 20\,l}{0{,}406 \times 0{,}082}$$

$$\boxed{T_B = 198{,}24\,K}$$ (0,5)

$P_C = ?$ à l'état Ⓒ : $P_C V_C = n R T_C$

$$P_C = \frac{n R T_C}{V_C}$$ (0,5)

Sinon : $dV = 0 \Rightarrow \frac{P}{T} = \text{const}$ (0,25)

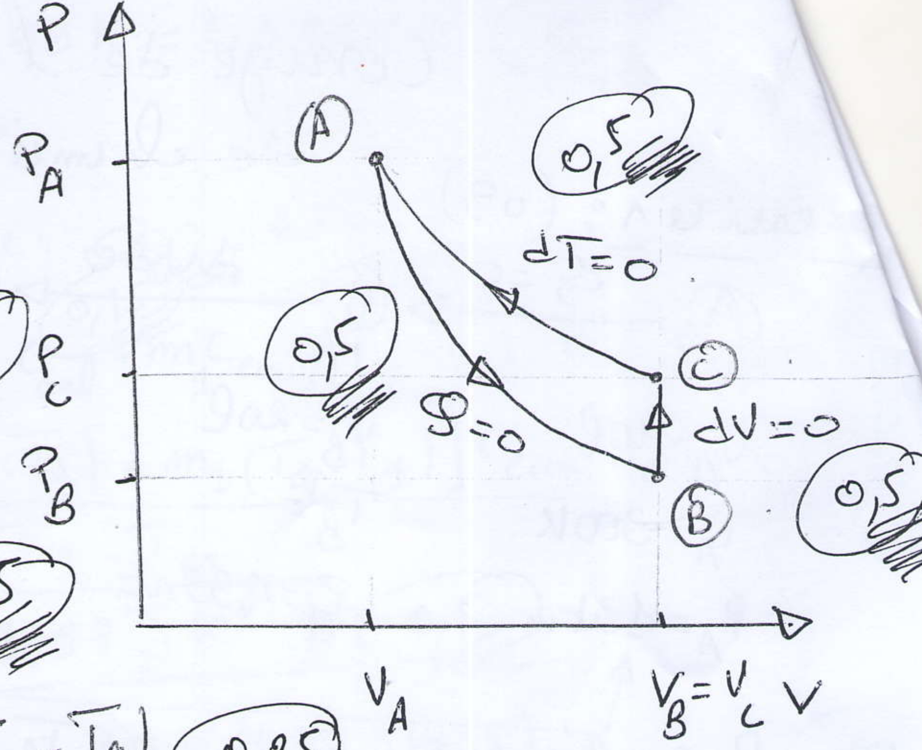
$$\frac{P_B}{T_B} = \frac{P_C}{T_C} \Rightarrow P_C = P_B \frac{T_C}{T_B} = 0{,}33 \times \frac{300\,K}{198{,}24\,K}$$

$$\boxed{P_C = 0{,}5\,atm > P_B = 0{,}33\,atm}$$

2) Diagramme (P, V) :

Ⓐ (1 at, 10 l), Ⓑ (0,33 at, 20 l), Ⓒ (0,5 at, 20 l).

3) Q, W, ΔU, ΔH



Ⓐ $\xrightarrow{Q=0}$ Ⓑ

* $Q_{A-B} = 0$ Joul (0,25)

$\Delta U_{A-B} = \underset{0}{Q_{A-B}} + W_{A-B}$ (0,5)

$\Delta U_{A-B} = W_{A-B} = n C_v (T_B - T_A)$ (0,25)

$\Delta U_{A-B} = W_{A-B} = n \frac{R}{\gamma-1}(T_B - T_A) = 0{,}406\,mol\ \frac{8{,}314}{1{,}6-1}(198{,}24-300)$ (0,25)

* $\boxed{\Delta U_{A-B} = W_{A-B} = -572{,}206 \text{ Joul}}$ (0,25) (0,25)

* $\Delta H_{A-B} = n C_p (T_B - T_A) = n \frac{\gamma R}{\gamma-1}(T_B - T_A) = \gamma \Delta U_{A-B}$ (0,25)

$\boxed{\Delta H_{A-B} = \gamma \Delta U_{A-B} = -915{,}53 \text{ Joul}}$ (0,25)

Ⓑ $\xrightarrow{dV=0}$ Ⓒ

$dV = 0 \Rightarrow W_{B-C} = -\int P_{ext}\, dV = 0$ Joul (0,25)

$\Delta U_{B-C} = Q_{B-C} + \underset{0}{W_{B-C}} = n C_v (T_C - T_B)$ (0,5)

$\Delta U_{B-C} = Q_{B-C} = n \frac{R}{\gamma-1}(T_C - T_B) = \boxed{-\Delta U_{A-B} = +572{,}206 \text{ Joul}}$ (0,25)

$\boxed{\Delta H_{B-C} = \gamma \Delta U_{B-C} = +915{,}53 \text{ Joul}}$ (0,25)

Ⓒ $\xrightarrow{dT=0}$ Ⓐ (0,5)

$dT = 0 \Rightarrow W_{C-A} = -nRT_A \ln \frac{V_A}{V_C} = -nRT_A \ln \frac{P_C}{P_A}$

$W_{C-A} = -0,406 \times 8,31 \times 300 \ln \frac{10\,l}{20\,l}$

$\boxed{W_{C-A} = +701,574 \text{ Joul}}$ (0,25)

$\Delta U_{C-A} = Q_{C-A} + W_{C-A} = n C_V (T_A - T_C) = 0 \text{ Joul}$ (0,25)

$\Delta U_{C-B} = 0 \text{ Joul} \Rightarrow Q_{C-A} = -W_{C-A} = \boxed{-701,574 \text{ Joul}}$ (0,25)

(0,25) $\Delta H_{C-A} = \gamma \Delta U_{C-A} = \boxed{0 \text{ Joul}}$ (0,25)

4) $W_{cycl} = W_{A-B} + W_{B-C} + W_{C-A} = -572,206 + 0 + 701,574$

$\boxed{W_{cycl} = +129,368 \text{ Joul}}$ (0,25)

$Q_{cycl} = Q_{A-B} + Q_{B-C} + Q_{C-A} = 0 + 572,206 - 701,574$

$\boxed{Q_{cycl} = -129,368 \text{ Joul}}$ (0,25)

Exercice 2 : (05,5)

1) $T_1 = 22°C < T_2 = 80°C \Rightarrow$ La masse m_2 cède de la chaleur (0,5)

$Q_{cédée} = Q_2 = m_2 C_{eau} (T_{eq} - T_2)$ (0,5)

$Q_{reçue} = Q_1 = (C_{cal} + m_1 C_{eau})(T_{eq} - T_1)$ (0,5)

avec $C_{cal} = 0 \text{ JK}^{-1}$

$Q_{reçue} = Q_1 = m_1 C_{eau} (T_{eq} - T_1)$ (0,5)

à l'état d'équilibre $\Rightarrow Q_{cédée} + Q_{reçue} = 0$ (0,5)

$m_2 C_{eau} (T_{eq} - T_2) + m_1 C_{eau} (T_{eq} - T_1) = 0$

$T_{eq} = \frac{m_2 T_2 + m_1 T_1}{m_2 + m_1} = \frac{300 \times 353 + 250 \times 295}{300 + 250}$ (0,5)

$T_{eq} = 326{,}63\,K = 53{,}63\,°C$ (0,5)

$T_{eq} = 50\,°C$, $C_{cal} = ?$

à l'état d'équilibre : $Q_{cédé} + Q_{reçu} = 0$

$m_2 C_{eau}(T_{eq} - T_2) + (C_{cal} + m_1 C_{eau})(T_{eq} - T_1) = 0$ (0,25) (0,25) (0,5)

$$C_{cal} = \frac{[m_2(T_{eq} - T_2) + m_1(T_{eq} - T_1)]\,C_{eau}}{T_1 - T_{eq}}$$ (0,5)

$\boxed{C_{cal} = 298{,}57\,J\,K^{-1}}$ (0,5)

Exercice 3 : (05,5)

$2CH_4(g) \longrightarrow C_2H_2(g) + 3H_2(g)$ (0,5)

$\Delta H^\circ_R(298K) = \sum_{i=1} \nu_i \Delta H^\circ_f(\text{Produits}) - \sum_{j=1} \nu_j \Delta H^\circ_f(\text{Reactifs})$

$= 1\,mol\,\Delta H^\circ_f(C_2H_2)_g + 3\,mol\,\Delta H^\circ_f(H_2)_g - 2\,mol\,\Delta H^\circ_f(CH_4)_g$ (0,5)

$\Delta H^\circ_f(H_2)_g = 0\,J\,mol^{-1}$ (corps simple)

$\Delta H^\circ_R(298K) = 376{,}6\,kJ > 0$ Réaction endothermique (1)

(0,5)

$\Delta H^\circ_R(500K) = ?$

La loi de Kirchoff : $\Delta H^\circ_R(T_2) = \Delta H^\circ_R(T_1) + \int_{T_1}^{T_2} \Delta Cp\, dT$ (0,5)

$\Delta H^\circ_R(500K) = \Delta H^\circ_R(298K) + \int_{298}^{500} \Delta Cp\, dT$ (0,5)

avec $\Delta Cp = \sum_{i=1} \nu_i Cp(\text{Produits}) - \sum_{j=1} \nu_j Cp(\text{Réactifs})$ (0,5)

$\Delta Cp = 1\,mol\,Cp(C_2H_2)_g + 3\,mol\,Cp(H_2)_g - 2\,mol\,Cp(CH_4)_g$.

$\boxed{\Delta Cp = 59{,}77\,J\,K^{-1}}$ (0,5)

$\Delta H_R(500K) = \Delta H^\circ_R(298K) + \int_{298}^{500} 81{,}7\,J\,K^{-1}\,dT$ (0,5)

$= 376{,}6\,10^3\,Joul + 59{,}77\,J\,K^{-1}(500K - 298K)$ (0,5)

$\Delta H^\circ_R(500K) = 388673{,}5\,Joul = \boxed{388{,}673\,kJ}$