Corrigé de l'examen de chimie 2

Exercice 1 : (09/09)

1- Calcul : V_A, V_B, P_B et T_C

à l'état (A) : $P_A V_A = nRT_A \Rightarrow V_A = \frac{nRT_A}{P_A}$ (0,25)

$$\boxed{V_A = 3{,}28\ \ell} \quad (0{,}25)$$

- $\boxed{V_B = \frac{V_A}{2} = 1{,}64\ \ell}$ (0,25)

- $P_B = ?$

(A) $\xrightarrow{\Delta T = 0}$ (B)

$PV = \text{cond}^{te} \Rightarrow P_A V_A = P_B V_B \Rightarrow P_B = P_A \frac{V_A}{V_B}$ (0,25) (0,25)

$$\boxed{P_B = 2 P_A = 20\ \text{atm}}$$

ou bien : $P_B V_B = nRT_B \Rightarrow P_B = \frac{nRT_B}{V_B}$.

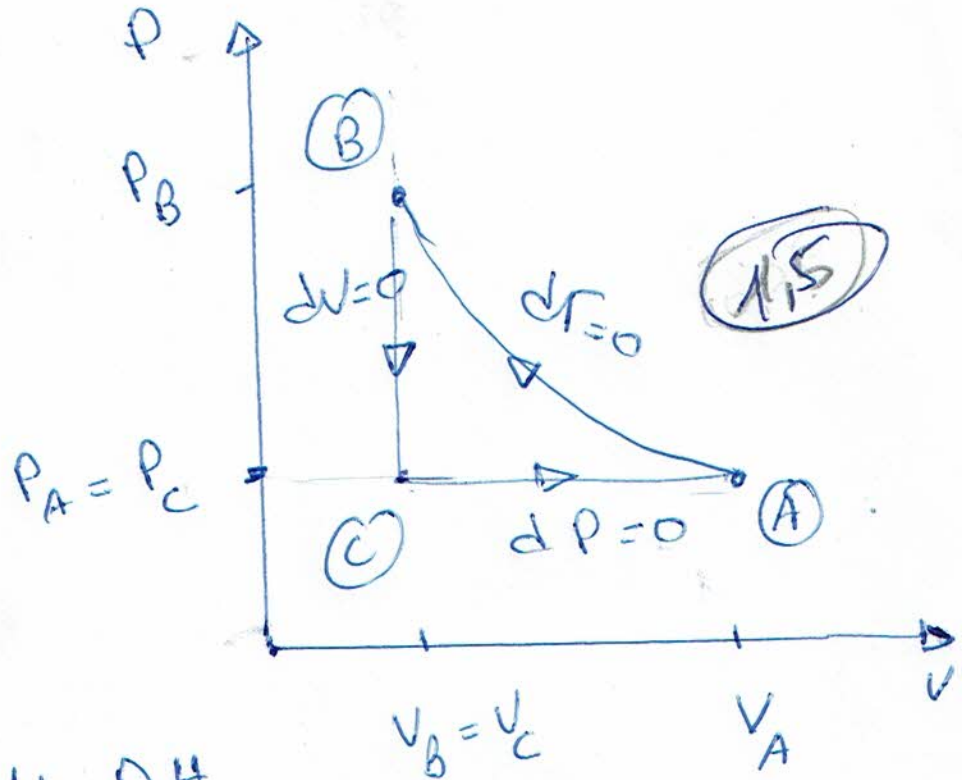
ou bien : (B) $\xrightarrow{\Delta V = 0}$ (C)

$\Delta V = 0 \Rightarrow \frac{P}{T} = \text{cond}^{te}$, $\frac{P_B}{T_B} = \frac{P_C}{T_C}$.

- $T_C = ?$

$$\boxed{T_C = \frac{T_A}{2} = 200\ K} \quad (0{,}25)$$

Diagramme (P,V)



1,5

3- $Q, W, \Delta U, \Delta H$

(A) $\xrightarrow{dT=0}$ (B)

- $\Delta U_{A\to B} = nC_V(T_B - T_A) = 0$ Joul (0,25) (0,25)
- $\Delta H_{A\to B} = nC_p(T_B - T_A) = \gamma \Delta U_{A\to B} = 0$ Joul (0,25) (0,25) (0,25)
- $W_{A\to B} = -\int_{V_A}^{V_B} P\,dV = -nRT_A \ln\frac{V_B}{V_A} = -nRT_B \ln\frac{P_A}{P_B}$ (0,25) (0,25)

$$W_{A\to B} = 2293,56 \text{ Joul}$$ (0,25)

(0,25)

- $\Delta U_{A\to B} = W_{A-B} + Q_{A-B} = 0 \Rightarrow$

$$Q_{A-B} = -W_{A-B} = -2293,56 \text{ Joul}$$ (0,25) (0,25)

(B) $\xrightarrow{V=\text{cst}}$ (C).

$C_V = \frac{R}{\gamma - 1}$ (0,25)

$C_p = \frac{\gamma R}{\gamma - 1}$ (0,25)

- $W_{B-C} = 0$ Joul. ($dV = 0$). (0,25)
- $\Delta U_{B-C} = W_{B-C} + Q_{B-C} = n C_V (T_C - T_B)$

ou

$\Delta U_{B-C} = Q_{B-C} = n \frac{R}{\gamma - 1} (T_C - T_B) = Q_V$ (0,25)

$\boxed{\Delta U_{B-C} = Q_{B-C} = -4155 \text{ Joul}}$ (0,25)

- $\Delta H_{B-C} = n C_p (T_C - T_B) = \gamma \Delta U_{B-C}$

$\boxed{\Delta H_{B-C} = -5817 \text{ Joul}}$ (0,25)

(C) $\xrightarrow{P=\text{cst}}$ (A)

- $\Delta U_{C-A} = n C_V (T_A - T_C) = \boxed{n \frac{R}{\gamma - 1} (T_A - T_C) = 4155 \text{ Joul}}$ (0,25)
- $W_{C-A} = -\int_{V_C}^{V_A} P \, dV = -P_C (V_A - V_C) = -P_A (V_A - V_C)$ (0,25)

$\boxed{W_{C-A} = -1661,36 \text{ Joul}}$ (0,25)

- $Q_{C-A} = Q_P = \Delta H_{C-A} = n C_p (T_A - T_C) = \frac{n R \gamma}{\gamma - 1} (T_A - T_C)$ (0,25)

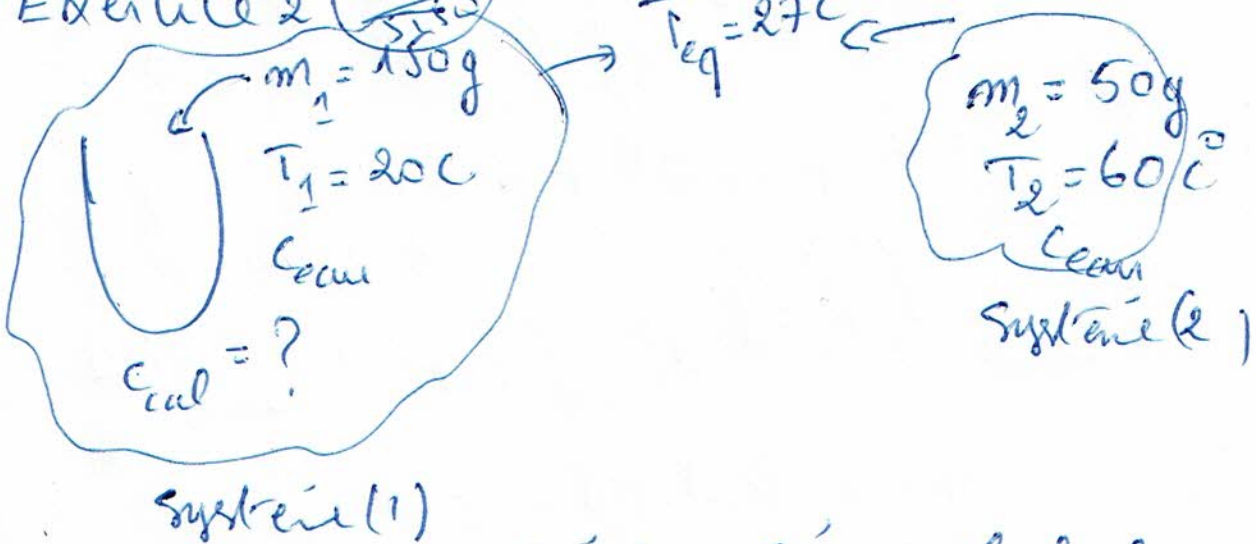
$\boxed{Q_{C-A} = \Delta H_{C-A} = 5817 \text{ Joul}}$ (0,25)

4) W_{cycl} ; Q_{cycl}.

- $W_{cycl} = W_{A-B} + W_{B-C} + W_{C-A} = +632,24$ Joul (0,25)

- $Q_{cycl} = Q_{A-B} + Q_{B-C} + Q_{C-A} = -631,56$ Joul (0,25)

Exercice 2 (5,50 ~~5,00~~)



$T_1 < T_2 \Rightarrow$ le système (2) Cède de la chaleur au système (1)

$Q_{cédée} + Q_{reçue} = 0$ (0,5)

" "

$Q_2 + Q_1 = 0$

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

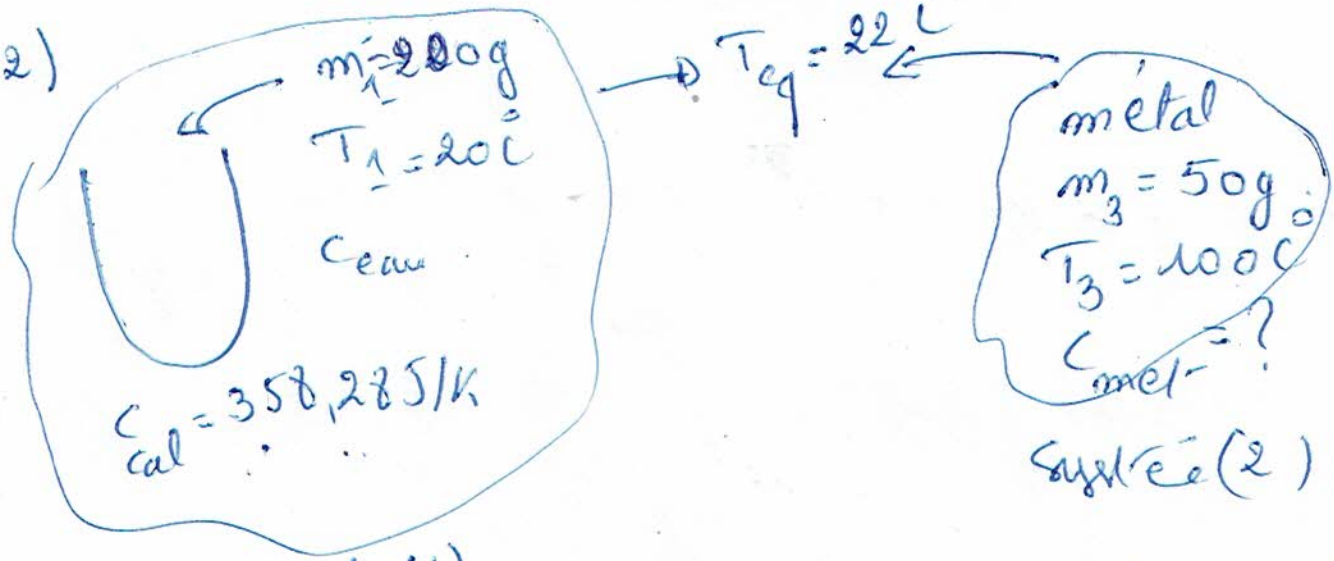
$Q_2 = m_2 C_{eau}(T_{eq} - T_2)$ (0,5)

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

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

$C_{cal} = 358,28$ J/K (0,5)

2)



$T_3 = 100C > T_1 = 20C \Rightarrow$ le système (2) cède de la chaleur au système (1)

$$Q_{cédé} + Q_{reçu} = 0.$$

$$Q_2 + Q_1 = 0.$$

$$Q_1 = (C_{cal} + m'_{Acc} C_{eau})(T_{eq} - T_1) \quad (0,5)$$

$$Q_2 = m_3 C_{mél} (T_{eq} - T_3) \quad (0,5)$$

$$(C_{cal} + m'_1 C_{eau})(T_{eq} - T_1) + m_3 C_{mél} (T_{eq} - T_3) = 0. \quad (0,5)$$

$$C_{mél} = -\frac{(C_{cal} + m'_1 C_{eau})(T_{eq} - T_1)}{m_3 (T_{eq} - T_3)}. \quad (0,5)$$

$$\boxed{C_{mél} = 0,61 \text{ J/gK.}} \quad (0,5)$$

Exercice 3 : (5,5/5,5)

$$C_2H_4(g) + H_2O(g) \xrightarrow{T=298K} C_2H_6O(g)$$

La loi de HESS :

$$\Delta H_R^\circ = \sum_{i=1} \nu_i \Delta H_f^\circ(\text{Produits}) - \sum_{j=1} \nu_j \Delta H_f^\circ(\text{Réactifs}) \quad (0,5)$$

$$= 1\,\text{mol}\,\Delta H_f^\circ(C_2H_6O)_g - [1\,\text{mol}\,\Delta H_f^\circ(C_2H_4)_g + 1\,\text{mol}\,\Delta H_f^\circ(H_2O)_g]$$

(0,5)

$\Delta H_R^\circ = -45,6\,KJ < 0 \Rightarrow$ Réaction exothermique (0,5) (0,5) (0,5)

- $\Delta H_R^\circ(T_2 = 450K) = ?$

La loi de Kirchoff :

$$\Delta H_R^\circ(T_2) = \Delta H_R^\circ(T_1) + \int_{T_1}^{T_2} \Delta C_p\, dT \quad (0,5)$$

$$\Delta H_R^\circ(450K) = \Delta H_R^\circ(298K) + \int_{298}^{450} \Delta C_p\, dT \quad (0,5)$$

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

$$= 1\,\text{mol}\,C_p(C_2H_6O)_g - [1\,\text{mol}\,C_p(C_2H_4)_g + 1\,\text{mol}\,C_p(H_2O)_g] \quad (0,5)$$

$\Delta C_p = -13\,JK$ (0,5)

$$\Delta H_R^\circ(450K) = -45,6\,10^3\,\text{Joule} + \int_{298}^{450} -13\,JK\,dT$$

$\Delta H_R^\circ(450K) = -47576\,\text{Joule} = -47,576\,KJ = \Delta H_R^\circ$ (0,5)