EXERCICE 1

1) La transformation étant isotherme, elle sera ~~supposée~~ quasistatique

$$\Rightarrow \quad W = -\int_{V_1}^{V_2} p\, dV = -\int \frac{nRT}{V-b}\, dV = -nRT \ln \frac{V_2-b}{V_1-b}$$

$$\boxed{W = nRT \ln \frac{V_1-b}{V_2-b}}$$

2) De même $\quad W = -\int p\, dV = -\int \left(\frac{nRT}{V-b} - \frac{a}{V^2}\right) dV$

$$W = -nRT \ln \frac{V_2-b}{V_1-b} - a\left(\frac{1}{V_2} - \frac{1}{V_1}\right)$$

$$\boxed{W = nRT \ln \frac{V_1-b}{V_2-b} + a\left(\frac{1}{V_1} - \frac{1}{V_2}\right)}$$

EXERCICE 2

1-a) p_2 ? On a $p_1 V_1^B = p_2 V_2^B$

$\Rightarrow p_2 = p_1 \left(\frac{V_1}{V_2}\right)^B$ $\boxed{p_2 = 1{,}013 \cdot 10^5 \text{ Pa}}$

$\Delta U(1\to 2) = W(1\to 2) + Q(1\to 2)$ 1er ppe

or $Q(1\to 2) = 0$ adiabatique

La transformation étant quasistatique (diagramme) $W = -\int p\,dV$

donc $\Delta U(1\to 2) = -\int_1^2 p\,dV$ $pV^B = C \Rightarrow p = \frac{C}{V^B}$

$\Delta U(1\to 2) = -C\int_1^2 \frac{dV}{V^B} = -\frac{C}{1-B}\left(V_2^{1-B} - V_1^{1-B}\right)$

soit, en remplaçant C par $p_2V_2^B$ ou $p_1V_1^B$

$\boxed{\Delta U(1\to 2) = \frac{p_2V_2 - p_1V_1}{B-1}}$ A.N. $\boxed{\Delta U(1\to 2) = -3647 \text{ J}}$

1-b) $1\to 3\to 2$

$W(1\to 3\to 2) = W(1\to 3) + W(3\to 2)$ avec $W(1\to 3) = 0$ (V cst)

$= -\int_{V_3}^{V_2} p_2\,dV = p_2(V_1 - V_2)$ $\boxed{W(1\to 3\to 2) = -709 \text{ J}}$

$Q(1\to 3\to 2) = \Delta U(1\to 2) - W(1\to 3\to 2)$ $\boxed{Q(1\to 3\to 2) = -2938 \text{ J}}$

$1\to 4\to 2$

$W(1\to 4\to 2) = W(1\to 4) + W(4\to 2)$ avec $W(4\to 2) = 0$

$= -\int_1^4 p\,dV = -p_1(V_2 - V_1)$ $\boxed{W(1\to 4\to 2) = -22691 \text{ J}}$

$Q(1\to 4\to 2) = \Delta U(1\to 2) - W(1\to 4\to 2)$ $\boxed{Q(1\to 4\to 2) = 19044 \text{ J}}$

2-a) $U = A\,pV \Rightarrow \Delta U(1\to 2) = A\,(p_2V_2 - p_1V_1)$

Or $\Delta U(1\to 2) = \frac{1}{B-1}(p_2V_2 - p_1V_1)$ d'où $A = \frac{1}{B-1}$ $\boxed{A = \frac{3}{2}}$

2-b) $Q(1\to 3) = \Delta U(1\to 3)$ car $1\to 3$ isochore

$= A(p_3V_3 - p_1V_1) = AV_1(p_2 - p_1)$ $\boxed{Q(1\to 3) = -4710 \text{ J}}$

$Q(3\to 2) = \Delta U(3\to 2) - W(3\to 2)$

$\Delta U(3\to 2) = A(p_2V_2 - p_3V_3) = A\,p_2(V_2 - V_1)$

$W(3\to 2) = -709 \text{ J}$ d'où $\boxed{Q(3\to 2) = 1773 \text{ J}}$

Autre méthode : $Q(3\to 2) = Q(1\to 3\to 2) - Q(1\to 3)$

De même $\boxed{Q(1\to 4) = 56728 \text{ J}}$ et $\boxed{Q(4\to 2) = -37684 \text{ J}}$

2-c) $H = U + pV = (A+1)\,pV$

$\Delta H(3\to 2) = (A+1)(p_2V_2 - p_3V_3) = (A+1)\,p_2(V_2 - V_1)$

$\boxed{\Delta H(3\to 2) = 1773 \text{ J}}$

$\Delta H(1\to 4) = (A+1)(p_4V_4 - p_1V_1) = (A+1)\,p_1(V_2 - V_1)$

$\boxed{\Delta H(1\to 4) = 56728 \text{ J}}$

On vérifie que $Q(3\to 2) = \Delta H(3\to 2)$ et $Q(1\to 4) = \Delta H(1\to 4)$

(transformations isobares). Lorsque H est connue, c'est la meilleure méthode.