

Exercice 1 :☞ Calcul de α :

$$V = \frac{nRT}{P} + nb \Rightarrow \left(\frac{\partial V}{\partial T}\right)_P = \frac{nR}{P} \Rightarrow \alpha = \frac{nR}{PV}$$

Calcul de β

$$P = \frac{nRT}{V-nb} \Rightarrow \left(\frac{\partial P}{\partial T}\right)_V = \frac{nR}{V-nb}$$

$$\left(\frac{\partial P}{\partial T}\right)_V = \frac{nR}{V-nb} = \frac{P}{T} \Rightarrow \beta = \frac{1}{T}$$

Calcul de χ_T

$$\left(\frac{\partial V}{\partial P}\right)_T = -\frac{nRT}{P^2} = -\frac{P(V-nb)}{P^2}$$

$$\left(\frac{\partial V}{\partial P}\right)_T = -\frac{V-nb}{P} \Rightarrow \chi_T = \frac{V-nb}{PV}$$

☞ Calcul de α :

Différentions l'équation d'état :

$$\left(dP - \frac{2n^2a}{V^3}dV\right)(V-nb) + dV\left(P + \frac{n^2a}{V^2}\right) = nRdT$$

$$dP(V-nb) + \left(-\frac{n^2a}{V^2} + \frac{2n^3ab}{V^3} + P\right)dV = nRdT$$

Transformation isobare $\Rightarrow dP = 0$

$$\left(P - \frac{n^2a}{V^2} + \frac{2n^3ab}{V^3}\right)dV = nRdT$$

$$\frac{dV}{dT} = \frac{nR}{\left(P - \frac{n^2a}{V^2} + \frac{2n^3ab}{V^3}\right)} \Rightarrow \frac{1}{V} \frac{dV}{dT} = \frac{nR}{\left(PV - \frac{n^2a}{V} + \frac{2n^3ab}{V^2}\right)}$$

$$\alpha = \frac{1}{V} \left(\frac{\partial V}{\partial T}\right)_P = \frac{1}{V} \frac{dV}{dT} \Rightarrow \alpha = \frac{nR}{\left(PV - \frac{n^2a}{V} + \frac{2n^3ab}{V^2}\right)}$$

Calcul de β

$$dP(V-nb) + \left(-\frac{n^2a}{V^2} + \frac{2n^3ab}{V^3} + P\right)dV = nRdT$$

Transformation isochore $\Rightarrow dV = 0$

$$dP(V-nb) = nRdT \Rightarrow \frac{dP}{dT} = \frac{nR}{V-nb}$$

$$\beta = \frac{1}{P} \left(\frac{\partial P}{\partial T}\right)_V = \frac{1}{P} \frac{dP}{dT} \Rightarrow \beta = \frac{nR}{P(V-nb)}$$

Calcul de χ_T

$$dP(V-nb) + \left(-\frac{n^2a}{V^2} + \frac{2n^3ab}{V^3} + P\right)dV = nRdT$$

Transformation isotherme $\Rightarrow dT = 0$

$$dP(V-nb) = -\left(P - \frac{n^2a}{V^2} + \frac{2n^3ab}{V^3}\right)dV$$

$$\frac{dV}{dP} = -\frac{V-nb}{P - \frac{n^2a}{V^2} + \frac{2n^3ab}{V^3}} \Rightarrow -\frac{1}{V} \frac{dV}{dP} = \frac{V-nb}{PV - \frac{n^2a}{V} + \frac{2n^3ab}{V^2}}$$

$$-\frac{1}{V} \left(\frac{\partial V}{\partial P}\right)_T = -\frac{1}{V} \frac{dV}{dP} \Rightarrow \chi_T = \frac{V-nb}{PV - \frac{n^2a}{V} + \frac{2n^3ab}{V^2}}$$

Exercice 2 :

$$1 \text{ a) } v^* = \sqrt{\frac{3PV}{mN}} = \sqrt{\frac{3nRT}{mN}} \Leftrightarrow v^* = \sqrt{\frac{3N}{N_A} \frac{RT}{mN}}$$

$$M = mN_A \Rightarrow v^* = \sqrt{\frac{3RT}{M}}$$

$$b) v^* = 684,1 \text{ m/s}$$

$$2 \text{ a) } U = nC_V T \Rightarrow U = \frac{m}{M} \frac{3}{2} RT \Rightarrow U = \frac{3}{2} \frac{m}{M} RT$$

$$M = mN_A \Rightarrow v^* = \sqrt{\frac{3RT}{M}}$$

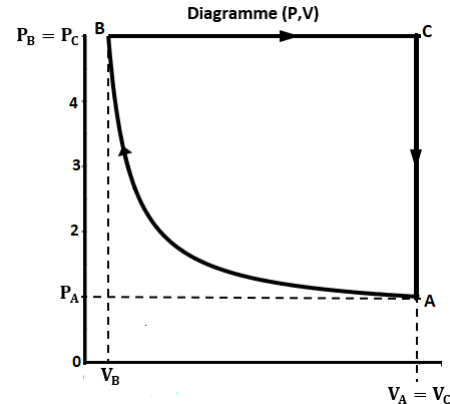
$$b) U = 234 \text{ J}$$

3 a) La détente du gaz se déroulant dans le vide, le

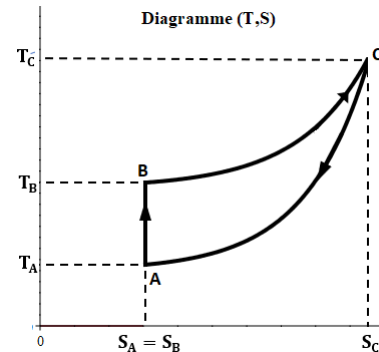
gaz peut-être considéré comme un système isolé.

Ainsi : $W = 0$ b) $\Delta U = 0$ car absence d'échange d'énergie**Exercice 3 :**

1. Le diagramme de Clapeyron donne :

2. a) BC isobare $\Rightarrow dV = 0 \Rightarrow \Delta S_B^C = C_V \ln\left(\frac{T_C}{T_B}\right)$

b) Le diagramme entropique donne :

3. BC : transformation isobare $\Rightarrow P_B = P_C = 5 \text{ atm}$ AB : adiabatique et réversible $\Rightarrow PV^\gamma = \text{cste}$

$$\frac{P_A}{P_B} = \left(\frac{V_B}{V_A}\right)^\gamma \Rightarrow V_B = \left(\frac{P_A}{P_B}\right)^{\frac{1}{\gamma}} V_A = 4,75 \text{ L}$$

$$T_B = \frac{P_B V_B}{nR} \Rightarrow T_B = \frac{P_B V_B}{P_A V_A} T_A = 475 \text{ K}$$

$$BC : \text{détente isobare} \Rightarrow \frac{V_C}{T_C} = \frac{V_B}{T_B}$$

$$CA : \text{transformation isochore} \Rightarrow V_C = V_A$$

$$T_C = \frac{V_C}{V_B} T_B \Rightarrow T_C = \frac{V_A}{V_B} T_B = 1500 \text{ K}$$

$$4. \text{ a) } W_A^B = \frac{1}{\gamma-1} (P_B V_B - P_A V_A) = 22 \text{ kJ}$$

$$W_B^C = -P_B (V_C - V_A) = -5,2 \text{ kJ} \quad W_C^A = 0$$

$$b) Q_B^C = 0 \quad Q_C^A = \frac{\gamma}{\gamma-1} \frac{P_A V_A}{T_A} R (T_C - T_B)$$

$$Q_B^C = 18 \text{ kJ} \quad Q_C^A = \frac{nR}{\gamma-1} (T_A - T_C)$$

$$Q_C^A = \frac{P_A V_A}{(\gamma-1)T_A} R (T_C - T_B) = -15150 \text{ J}$$