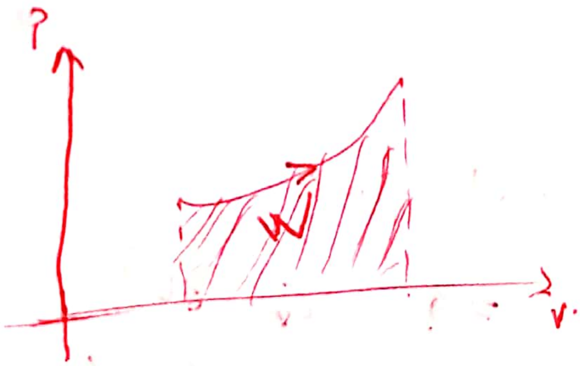
Thermo : 1e principe

- Travail : • élémentaire : $\boxed{\delta W = - P_{ext}\, dV}$
  • $\boxed{W = - \int_A^B P_{ext}\, dV}$

- Transformation polytropique : $\boxed{PV^k = cte}$

- Diagramme de Clapeyron



- Energie interne : $\boxed{U = \sum_i^N e_{c_i} + e_{p_i}}$ N : nbr de particules du ST

- Entalpie : $H = U + PV$

- Capacité calorifique à volume cste : $\boxed{C_v = \frac{\delta Q_v}{dT} = \left(\frac{\partial U}{\partial T}\right)_V}$

- Capacité calorifique à pression cste : $\boxed{C_p = \frac{\delta Q}{dT} = \left(\frac{\partial H}{\partial T}\right)_T}$

1er principe :

$$\boxed{\begin{aligned} \Delta E &= W + Q \\ dE &= \delta W + \delta Q \end{aligned}}$$

Si $\Delta(e_{c_{mac}} + e_{p_{mac}}) = 0$:

$$\boxed{\begin{aligned} \Delta U &= W + Q \\ dU &= \delta W + \delta Q \end{aligned}}$$

- Pour un G.P monoatomique :

$$\boxed{U = \frac{3}{2} nRT} \Rightarrow \boxed{C_v = \left(\frac{\partial U}{\partial T}\right)_V = \frac{3}{2} nR}$$

$$\boxed{H = \frac{5}{2} nRT} \Rightarrow \boxed{C_p = \left(\frac{\partial H}{\partial T}\right)_p = \frac{5}{2} nR}$$

$$\boxed{\gamma = \frac{C_p}{C_v} = \frac{5}{3}}$$

- Pour un G.P diatomique :

$$\boxed{U = \frac{5}{2} nRT} \Rightarrow \boxed{C_v = \frac{5}{2} nR}$$

$$\boxed{H = \frac{7}{2} nRT} \Rightarrow \boxed{C_p = \frac{7}{2} nR}$$

$$\boxed{\gamma = \frac{C_p}{C_v} = \frac{7}{5} = 1{,}4}$$

isochore

Relation de Mayer pour un GP

$$H = U + PV = U + nRT$$

$$\Rightarrow \boxed{\begin{aligned} C_p &= C_v + nR \\ C_p - C_v &= nR \end{aligned}}$$ et $\frac{C_p}{C_v} = \gamma$ donc.

$$\boxed{C_p = \frac{\gamma n R}{\gamma - 1}} \qquad \boxed{C_v = \frac{nR}{\gamma - 1}}$$

- Transformation isotherme: (réversible) pour un GP:

$$W = \int_{V_1}^{V_2} P_{ext}\, dV = \int_{V_1}^{V_2} P\, dV = \int_{V_1}^{V_2} nRT \frac{dV}{V}$$

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

- Transformation adiabatique réversible.

$$dU = \delta W + \delta Q = \delta W = -P\,dV = -\frac{nRT}{V}\, dV.$$

$$dU = C_v\, dT = \frac{nR}{\gamma - 1}\, dT$$

donc. $\frac{nR}{\gamma - 1}\, dT = -\frac{nRT}{V}\, dV.$

donc $\ln T \cdot V^{\gamma - 1} = cte$

$$\Rightarrow \boxed{T \cdot V^{\gamma - 1} = cte}$$

D'après la loi des GP: $\boxed{P V^{\gamma} = cte}$

$$\boxed{T^{\gamma} \cdot P^{1-\gamma} = cte}$$

Lois de Laplace.

- Transf. isochore :

$$W = -\int P_{ext}\, dV = 0.$$

$$\Rightarrow \Delta U = Q_v = C_v \Delta T$$

$$\boxed{Q_v = \frac{nR}{\gamma - 1}(T_f - T_i)}$$

- Transf. isobare :

$$dU = -PdV + \delta Q \Rightarrow \overset{0}{V dp} + p\,dV + dU = \delta Q.$$

$$d(U + PV) = dH = \delta Q.$$

donc

$$\boxed{Q_p = \Delta H = C_p \Delta T = \frac{\gamma n R}{\gamma - 1}(T_f - T_i)}$$