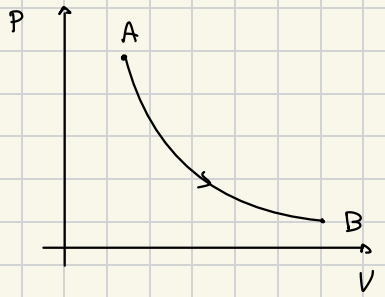
Formule per trasformazioni adiabatiche: No scambio di calore



Def: Definiamo $\gamma = \frac{\ell+2}{\ell}$ con ℓ numero di gradi di libertà (Quel numero esce fuori da una trasformazione su calori molari (c'è nel libro))

Valgono formule sperimentali per le adiabatiche che sono le seguenti:

$$T_B = \left(\frac{V_A}{V_B}\right)^{\gamma-1} T_A \quad , \quad P_B = \left(\frac{V_A}{V_B}\right)^{\gamma} P_A \quad , \quad T_B = \left(\frac{P_B}{P_A}\right)^{\frac{\gamma-1}{\gamma}} T_A$$

Esempio di formula inverse: Voglio trovare P_A dalla III

$$T_B = \left(\frac{P_B}{P_A}\right)^{\frac{\gamma-1}{\gamma}} T_A \quad \rightsquigarrow \text{divido per } T_A \text{ ed elevo alla } \frac{\gamma}{\gamma-1}$$

$$\rightsquigarrow \left(\frac{T_B}{T_A}\right)^{\frac{\gamma}{\gamma-1}} = \frac{P_B}{P_A} \quad \rightsquigarrow \quad \boxed{P_A = \left(\frac{T_A}{T_B}\right)^{\frac{\gamma}{\gamma-1}} P_B}$$

Primo principio della termodinamica: Data una trasformazione reversibile ed ideale vale la seguente formula

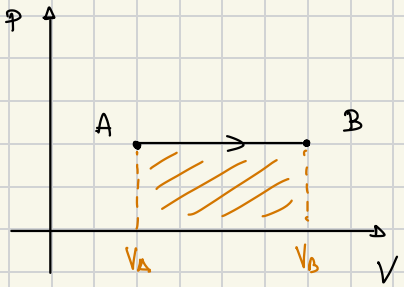
$$\Delta U = Q - W$$

Dove $\Delta U = U_B - U_A$ è la variazione di energia interna
Q = Calore (assorbito o ceduto)
W = Lavoro compiuto o subito del sistema

Significato: Come l'energia si distribuisce durante una trasformazione termodinamica.

Goal: Trovare valore di Q nel caso di trasformazioni famose

Isobara:



$$\Delta U = Q - W$$

$$\Delta U = \frac{\ell}{2} nR\Delta T \qquad PV = nRT$$

$$W = P \cdot \Delta V = nR\Delta T$$

$$Q = \Delta U + W = \frac{\ell}{2} nR\Delta T + nR\Delta T$$

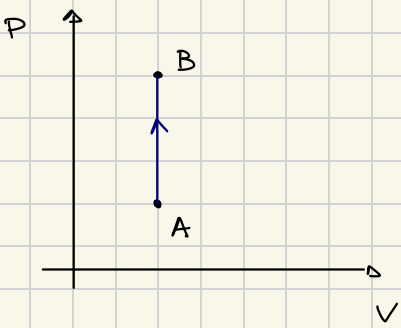
$$\boxed{Q = \frac{\ell+2}{2} nR\Delta T}$$

Isocora

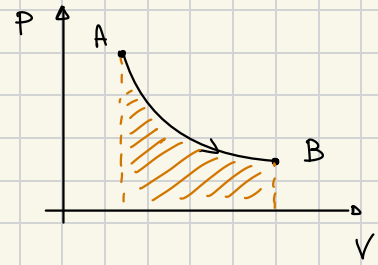
$$\Delta U = Q - W$$

$$\Delta U = \frac{\ell}{2} nR\Delta T \qquad W = 0$$

$$\boxed{Q = \Delta U = \frac{\ell}{2} nR\Delta T}$$



Isoterma



$$\Delta U = Q - W$$

$$\Delta U = \frac{\ell}{2} nR\Delta T = 0 \qquad T_B - T_A \text{ ma } T_A = T_B$$

$$W = nRT \ln\left(\frac{V_B}{V_A}\right) \text{ ovvero } \left(\text{Area del grafico} = \text{Integrale di } \frac{1}{x}\right)$$

$$\boxed{Q = W = nRT \ln\left(\frac{V_B}{V_A}\right)}$$

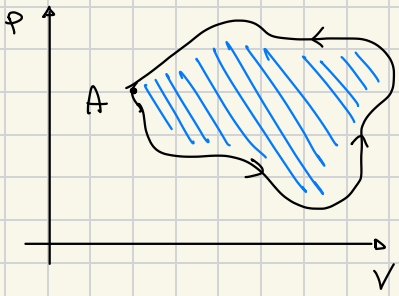
Formule inverse: Voglio trovare V_A:

$\log_a b = x \iff a^x = b$

$$Q = nRT \ln\left(\frac{V_B}{V_A}\right) \rightsquigarrow \frac{Q}{nRT} = \ln\left(\frac{V_B}{V_A}\right) \iff e^{\frac{Q}{nRT}} = \frac{V_B}{V_A}$$

$$\rightsquigarrow \quad V_A = \frac{V_B}{e^{\frac{Q}{nRT}}}$$

Ciclica



$$\Delta U = Q - W$$

$$\Delta U = \frac{f}{2} nR \overbrace{\Delta T}^{T_A - T_A} = 0$$

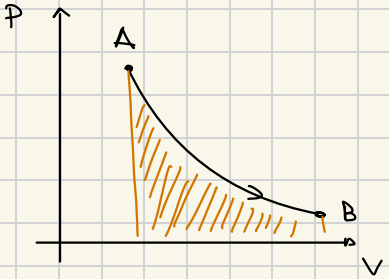
$$\rightsquigarrow \quad \boxed{Q = W}$$

Adiabatica

$$\Delta U = Q - W$$

$$\Delta U = \frac{f}{2} nR\Delta T \qquad Q = 0$$

$$\boxed{-W = \Delta U = \frac{f}{2} nR\Delta T}$$



Pag 452 n 153

$N = 11 \cdot 10^{23}$ neon $\quad N = n \cdot N_A \rightsquigarrow n = \frac{N}{N_A}$

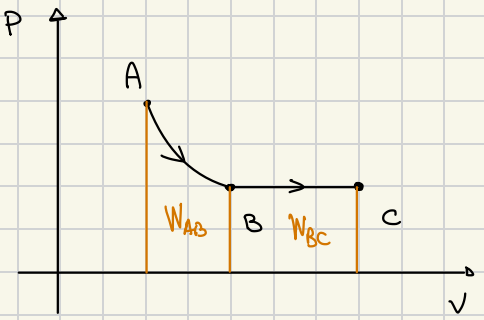
$\ell = 3$

$T_A = 350\ K$

$V_B = 2V_A$

$T_C = T_B + \Delta T = 350\ K + 20\ K = 370\ K$ $\rightarrow T_C - T_B$

$P_B = P_C = 1{,}1\ atm = 1{,}1 \cdot 10^5\ Pa$



$W = ?$ $\quad \Delta U = ?$ $\quad Q = ?$ Durante tutte le trasformazioni

$W = W_{AB} + W_{BC}$

$W_{AB} = nRT \ln\left(\frac{V_B}{V_A}\right) = nRT \ln\left(\frac{2V_A}{V_A}\right)$

$W_{AB} = nRT \ln(2) = \frac{N}{N_A} RT \ln(2)$

$PV = nRT$

$W_{BC} = P_B (V_C - V_B) = nR(T_C - T_B) = \frac{N}{N_A} R \cdot \Delta T$

$$W = W_{AB} + W_{BC} = \frac{N}{N_A} R \left(T_A \ln(2) + \Delta T\right) \approx 4\ kJ$$

---

isoterma

$\Delta U = \frac{\ell}{2} nR\Delta T = \frac{\ell}{2} nR(T_C - T_A) = \frac{\ell}{2} nR(T_C - T_B) = \frac{\ell}{2} \frac{N}{N_A} R\Delta T$

$$\Delta U = \frac{\ell}{2} \frac{N}{N_A} R\Delta T \approx 4{,}6 \cdot 10^2\ J$$

$\Delta U = Q - W \rightsquigarrow$

$$Q = \Delta U + W \approx 4{,}4\ kJ$$