CALORI SPECIFICI

$$dQ = n\, c_t\, dT$$

c_t = calore specifico → dipende dalla trasformazione

$$\begin{cases} \text{ISOTERMA} & c_t = \infty \\ \text{ADIABATICA} & c_t = 0 \end{cases}$$

ISOCORA $\quad dQ = n c_v\, dT = dU$

$$\boxed{c_v = \frac{1}{n} \left.\frac{dU}{dT}\right)_V}$$

ISOBARA

$$\delta Q = p\, dV + dU = n c_p\, dT$$

$$\frac{\delta Q}{dT} = nR \frac{dT}{dT} + n c_v \frac{dT}{dT} = n c_p$$

$$c_p = R + c_v \qquad \text{Relazione di Mayer}$$

$$\begin{cases} c_v = \dfrac{1}{n} \left.\dfrac{dU}{dT}\right)_V = \dfrac{1}{n} N \dfrac{3}{2} k \dfrac{dT}{dT} = \dfrac{3}{2} \dfrac{N}{n} \dfrac{R}{N_A} = \dfrac{3}{2} R & \text{GAS MONOATOMICO} \\ c_v = \dfrac{5}{2} R & \text{GAS BIATOMICO} \end{cases}$$

TRASFORMAZIONI TERMODINAMICHE PARTICOLARI

) TRASFORMAZIONI ADIABATICHE

$$\delta Q = \delta L + dU = 0$$

$$dL = -dU = n c_v\, dT \quad \rightarrow \quad \boxed{L = n c_v (T_B - T_A)}$$

$$\Downarrow$$

$$p\, dV + n c_v\, dT = 0 \qquad p = \frac{nRT}{V}$$

$$nRT \frac{dV}{V} = -n c_v\, dT$$

$$\frac{c_p - c_v}{c_v} \frac{dV}{V} = \frac{dT}{T} \qquad \gamma = \frac{c_p}{c_v}$$

$$\boxed{T V^{\gamma - 1} = \text{cost}}$$

$$T p^{(1-\gamma)/\gamma} = \text{cost}$$

$$p V^{\gamma} = \text{cost}$$

$$\begin{cases} \gamma = \frac{5}{3} = 1.67 & \text{GAS MONOATOMICO} \\ \gamma = \frac{7}{5} = 1.40 & \text{GAS BIATOMICO} \end{cases}$$

In generale:

$$p V^{\alpha} = \text{cost}$$ TRASFORMAZIONI POLITROPICHE

$\alpha = 1$ ISOTERMA
$\alpha = 0$ ISOBARA
$\alpha = \gamma$ ADIABATICA

b) TRASFORMAZIONI ISOTERME $T = \text{cost}$

$$\delta Q = \delta L + dU \qquad dU = 0$$

$$\Delta Q = L = \int_A^B p\, dV = n R T \lg \frac{V_B}{V_A}$$

c) TRASFORMAZIONI ISOCORE $V = \text{cost}$

$$\delta Q = \delta L + dU \qquad \delta L = 0$$

$$\Delta Q = \Delta U = n c_v (T_B - T_A)$$

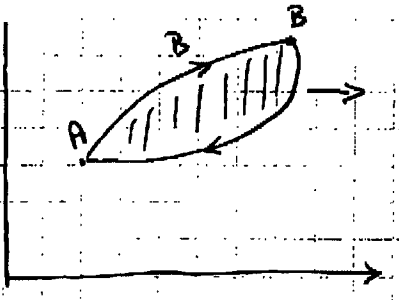
d) TRASFORMAZIONI ISOBARE $p = \text{cost}$

$$\delta Q = \delta L + dU$$

$$\Delta Q = n c_p \Delta T$$

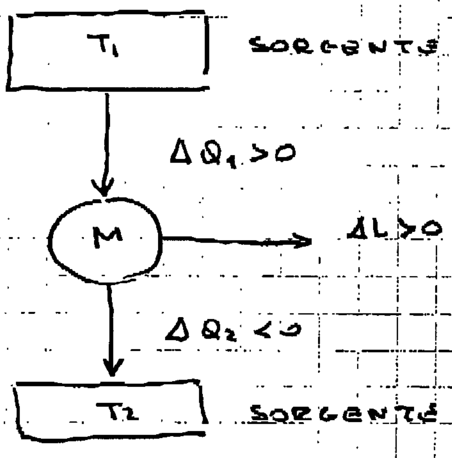
$$\Delta L = n R \Delta T$$

TRASFORMAZIONI CICLICHE



Assorbe ΔQ
Produce $\Delta L > 0$
CICLO TERMICO

Assorbe $\Delta L < 0$
Produce $\Delta Q < 0$
CICLO FRIGORIFERO



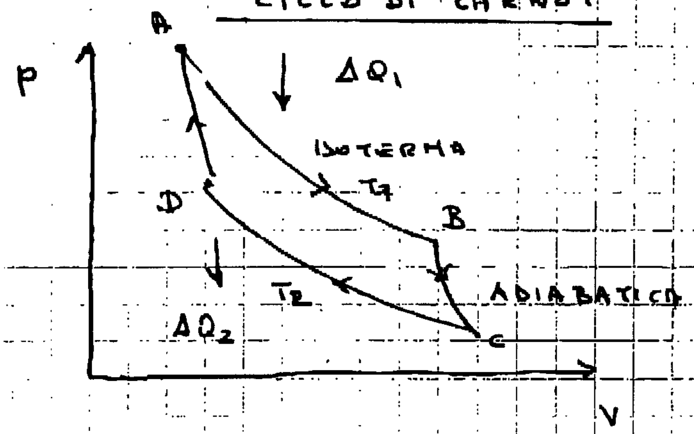
$T_1 > T_2$

$$\Delta Q = \Delta Q_1 + \Delta Q_2 = \Delta L$$

RENDIMENTO

$$\eta = \frac{\Delta Q_1 + \Delta Q_2}{\Delta Q_1} = \frac{\Delta L}{\Delta Q_1} = 1 - \frac{|\Delta Q_2|}{\Delta Q_1}$$

CICLO DI CARNOT



a) ISOTERMA AB (Espansione)

$$\Delta Q_1 = \Delta L_{AB} = n R T_1 \lg \frac{V_B}{V_A}$$

b) ADIABATICA BC (Espansione)

$$\Delta L_{BC} = - \Delta U = n c_v (T_1 - T_2)$$

con $T_1 V_B^{\gamma - 1} = T_2 V_C^{\gamma - 1}$

c) ISOTERMA CD (Compressione)

$$- \Delta Q_2 = - \Delta L_{CD} = n R T_2 \frac{V_D}{V_C}$$

d) ADIABATICA DA (Compressione)

$$- \Delta L_{DA} = \Delta U = n c_v (T_2 - T_1)$$

$$T_2 V_D^{\gamma - 1} = T_1 V_A^{\gamma - 1}$$

$$\Delta Q = \Delta Q_1 - |\Delta Q_2| = \Delta L$$

$$\eta_c = \frac{\Delta Q_1 - \Delta Q_2}{\Delta Q_1} = 1 - \frac{\Delta Q_2}{\Delta Q_1}$$

$$\eta_c = 1 - \frac{nRT_1}{nRT_2} \frac{\lg V_B/V_D}{\lg V_B/V_A}$$

$$\begin{cases} T_1 V_B^{\gamma-1} = T_2 V_C^{\gamma-1} \\ T_2 V_A^{\gamma-1} = T_2 V_D^{\gamma-1} \end{cases} \Rightarrow \frac{V_B}{V_A} = \frac{V_C}{V_A}$$

$$\boxed{\eta_c = 1 - \frac{T_1}{T_2}}$$