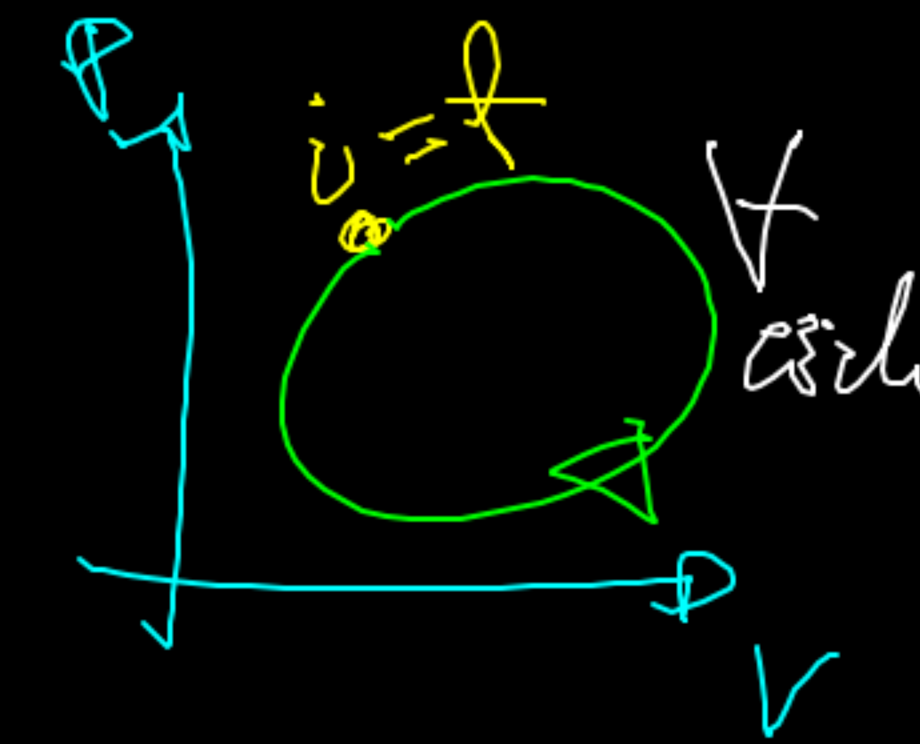
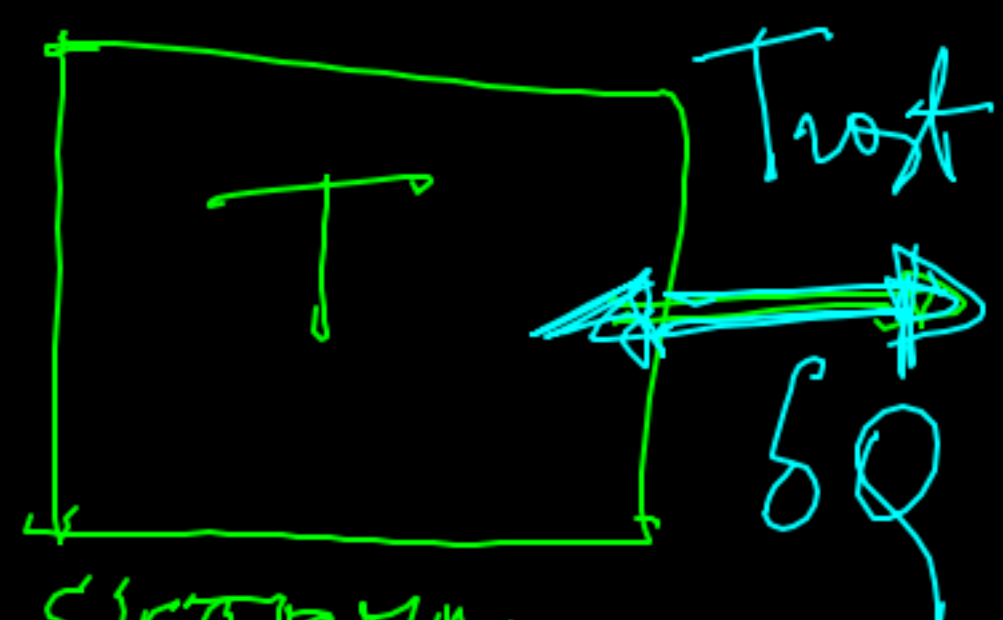
ENTROPIA

→ Variabili di stato $(p, V, T, U \ldots) \Longleftrightarrow \forall$ ciclo $i \to f$

$\Delta p = 0$
$\Delta U = 0$
$\Delta T = 0$
$\Delta V = 0$



Trasf. REV.



$$\boxed{dS = \frac{\delta Q}{T}}$$

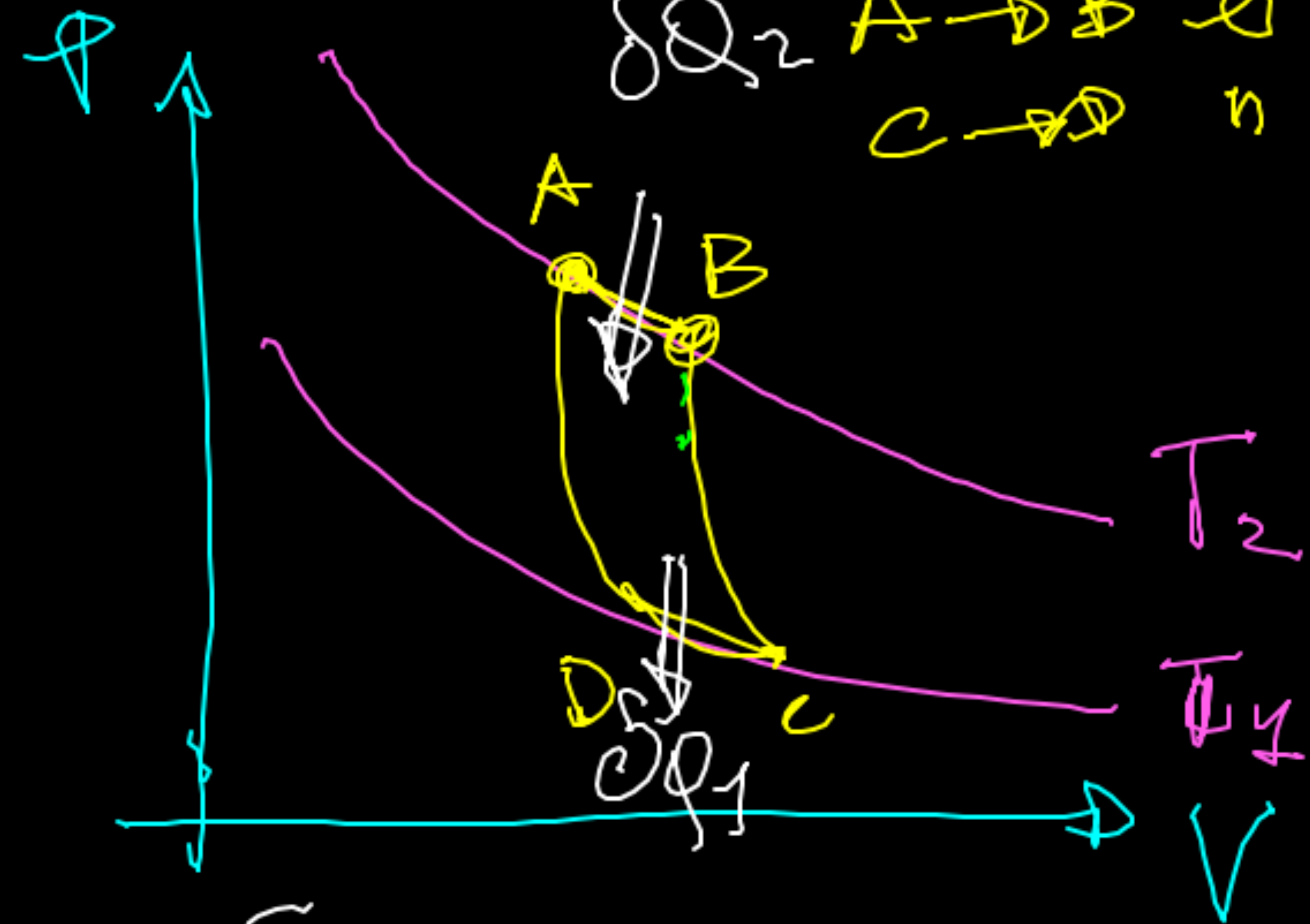
VARIAZIONE DI ENTROPIA

$\Delta S = 0$ SU UN CICLO?

PER UNA TRASF. FINITA REV.

$$\Delta S = \int_i^f \frac{\delta Q}{T} = S_f - S_i$$

δQ_2 $A \to B$ è infinit.
$C \to D$ " "



$\delta Q_1 < 0$
$\delta Q_2 > 0$

$dS_{AD} = 0$

perché $\delta Q = 0$

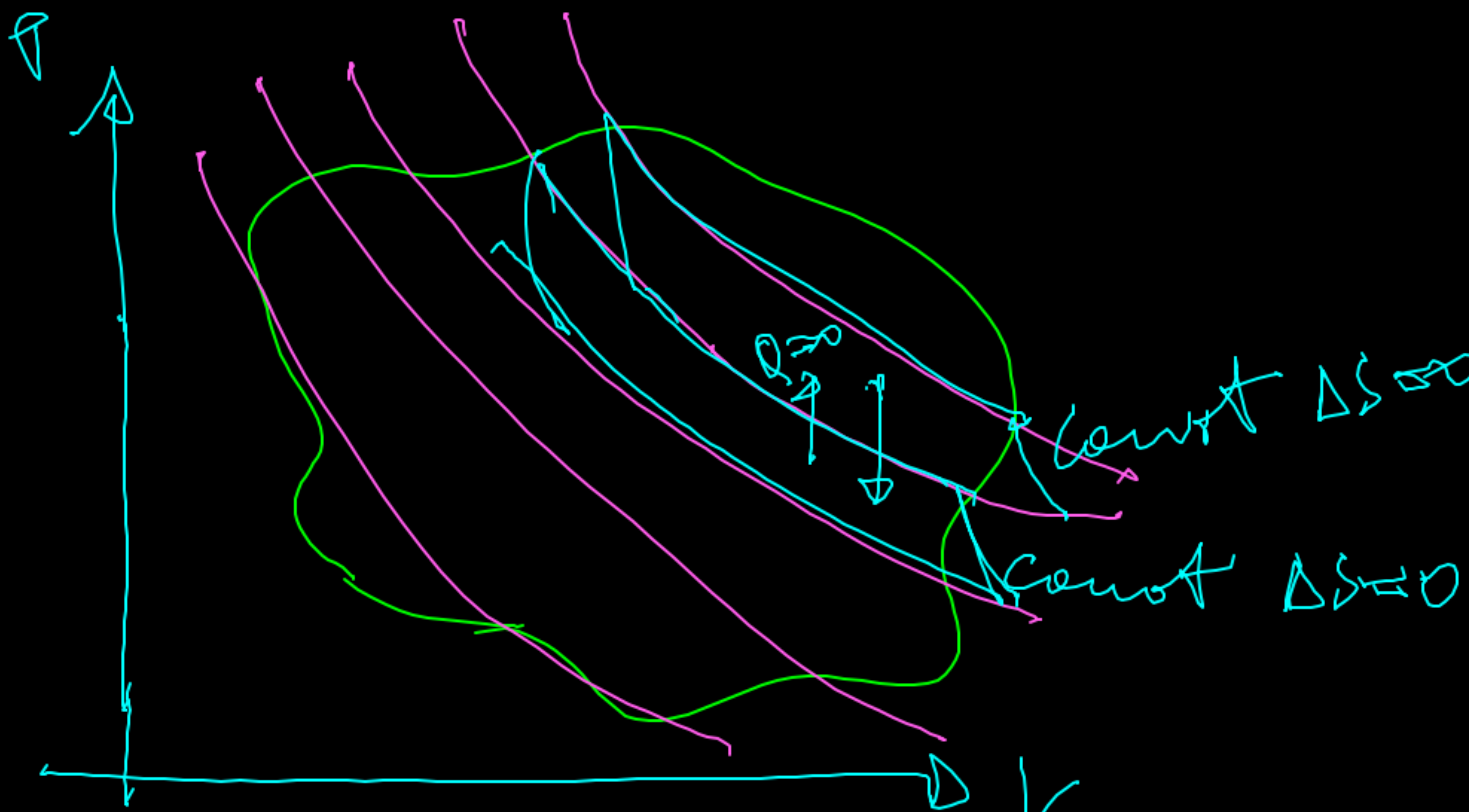
$$\frac{\delta Q_2}{|\delta Q_1|} = \frac{T_2}{T_1} \Rightarrow \frac{\delta Q_2}{T_2} = \frac{|\delta Q_1|}{T_1}$$

$$\frac{\delta Q_2}{T_2} - \frac{|\delta Q_1|}{T_1} = \boxed{0 = \underbrace{\frac{\delta Q_2}{T_2}}_{dS_2} + \underbrace{\frac{\delta Q_1}{T_1}}_{dS_1}}$$

PER UN CICLO DI CARNOT REV.

$$\boxed{0 = dS_2 + dS_1}$$

$$\Delta S = 0$$



L'ENTROPIA È UNA FUNZIONE DI STATO

∀ CICLO REV. → SOMMA DI CICLI DI CARNOT REV.

ΔS=0

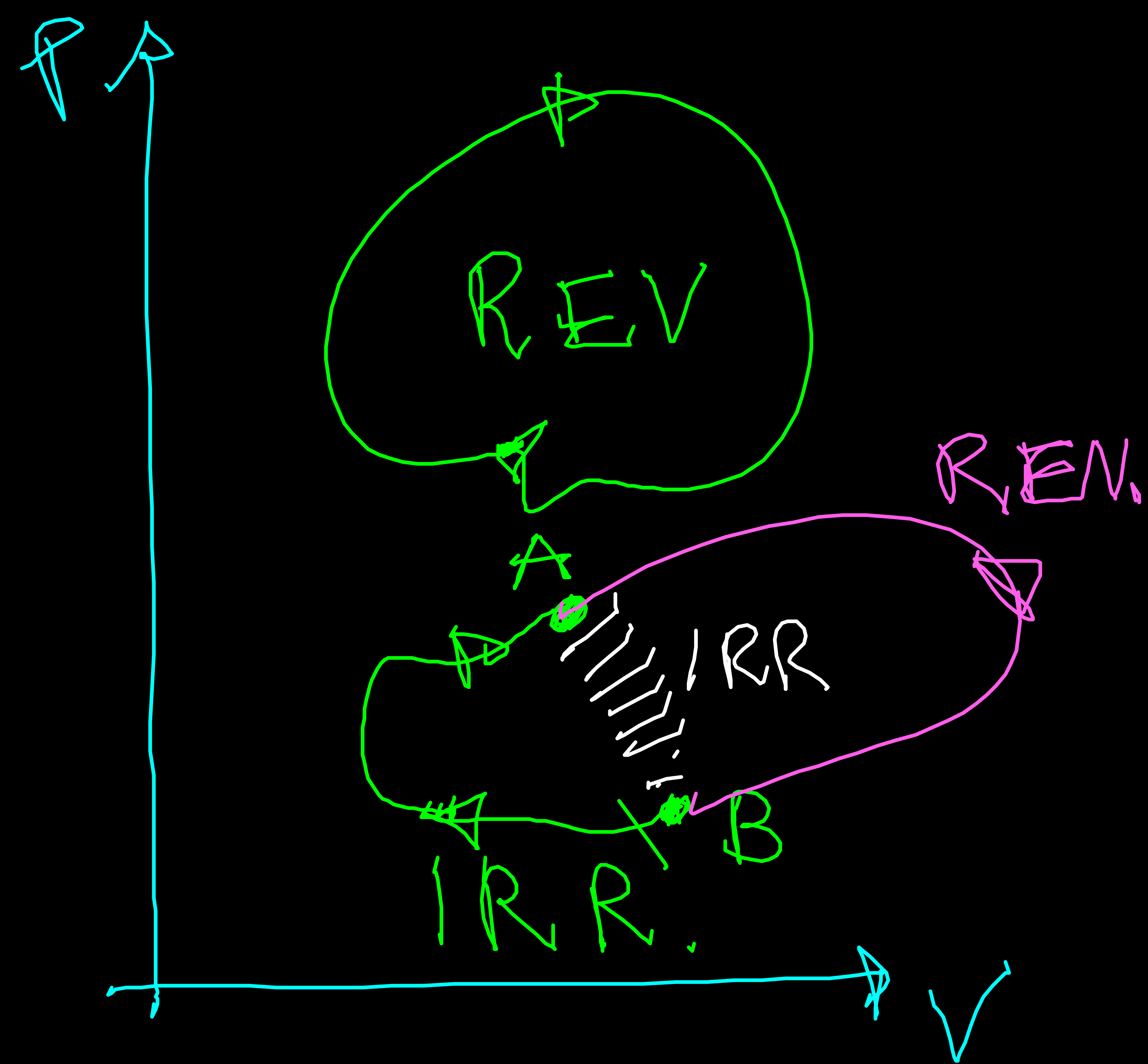
ΔS=0 —

$$\Delta S_{ciclo} = 0 \qquad \text{(ciclo qualsiasi)}$$

$$\Delta S_{ciclo} = \int_{\text{CICLO REV.}} \frac{\delta Q}{T} = \boxed{\oint_{REV.} \frac{\delta Q}{T} = 0}$$

S è una funzione di stato

Variabili di stato: $p, V, n, T, U, S \ldots$



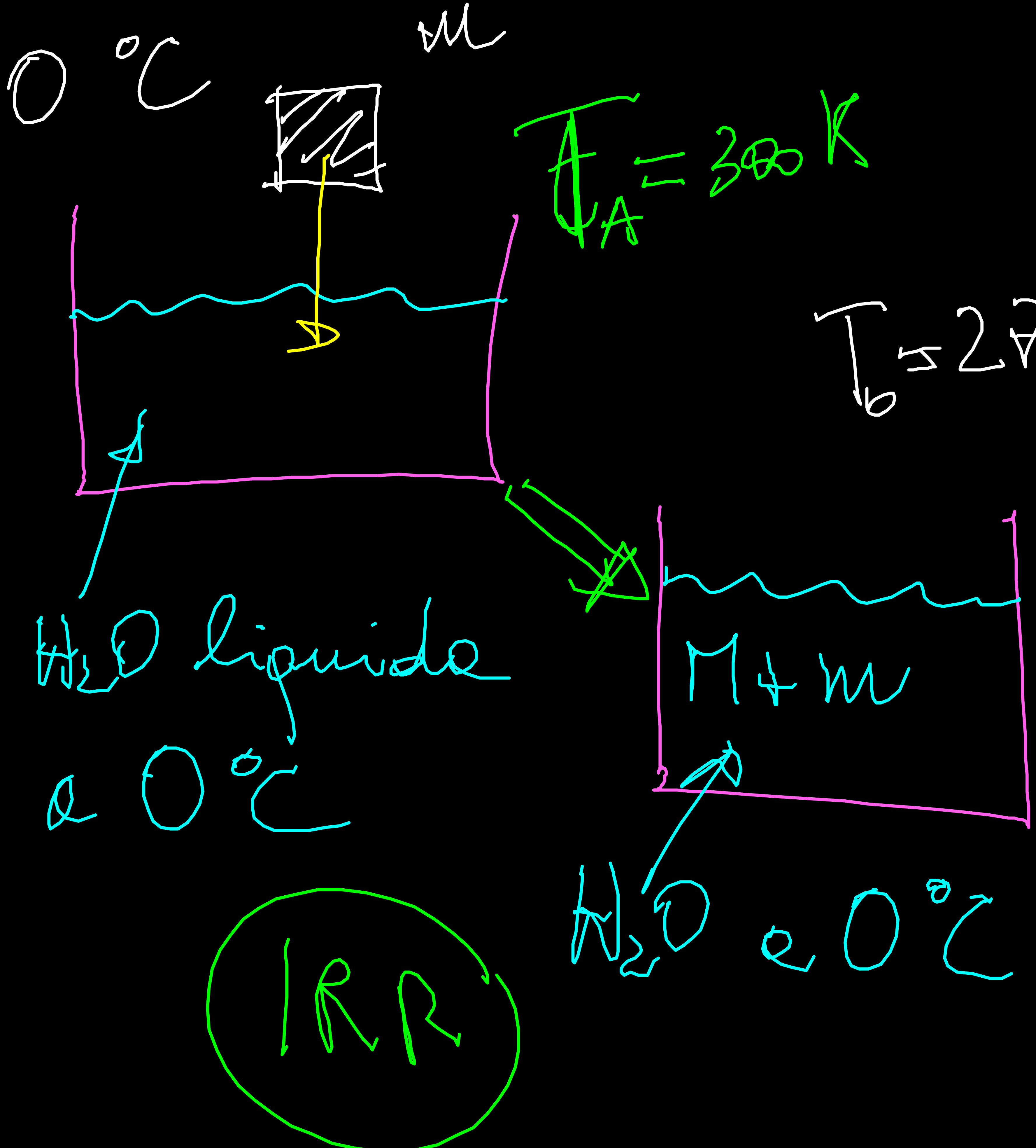
$$\oint \frac{\delta Q}{T} \begin{cases} = 0 & \text{REV.} \\ < 0 & \text{IRR.} \end{cases}$$

INTEGRALE DI CLAUSIUS

$A \to B$ TRASF. REALE IRR, si può comunque calcolare $\Delta S_{AB} = S_B - S_A$ usando una qualunque trasformazione REV. da $A \to B$

ESEMPI DI CALCOLO DI ΔS

• Cambiamento di fase

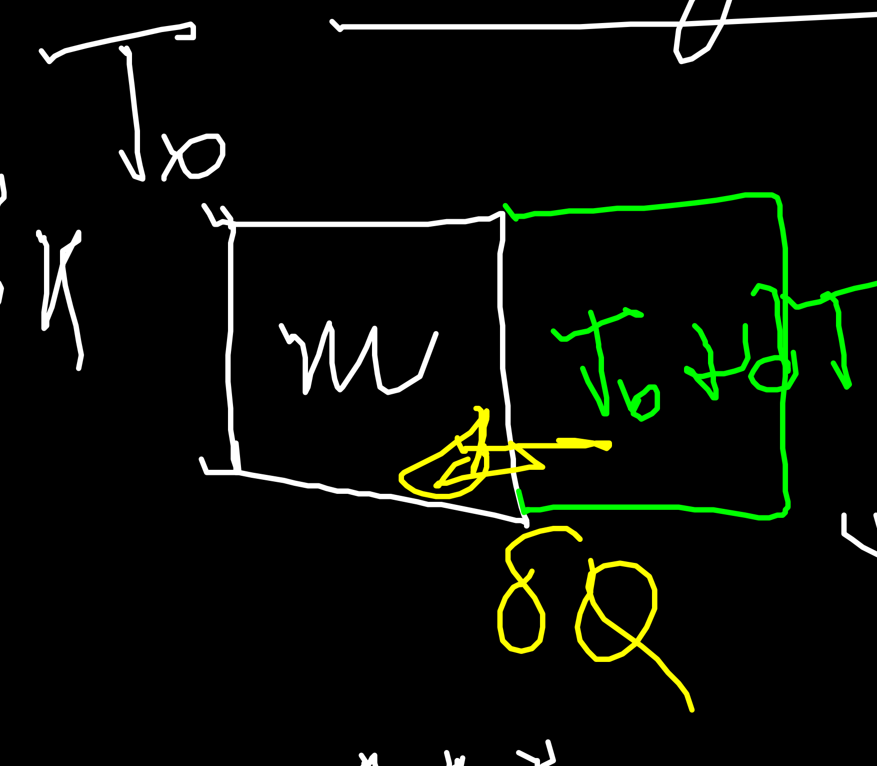


$T_0 = 273.16\,K$

Per calcolare $\Delta S_{fusione}$

immagino una trasf. rev.

INFINITE QUASI-STATICHE REV.

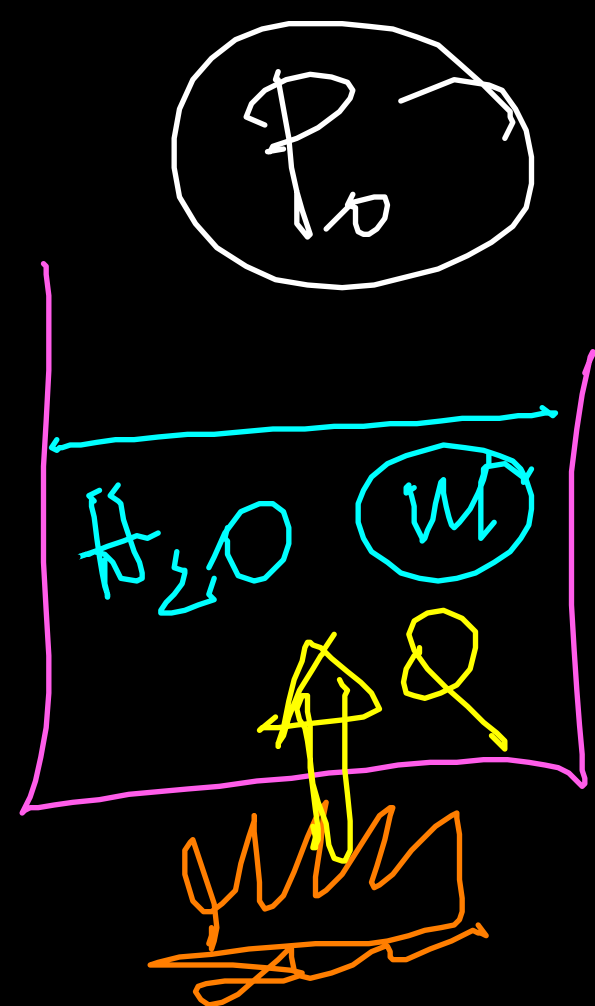


$$Q_{TOT} = m \lambda_f$$

$$\Delta S_{fusione} = S_{LIQ} - S_{SOLIDO} = \int_i^f \frac{\delta Q}{T} = \frac{1}{T_0} \int_i^f \delta Q = \frac{Q_{TOT}}{T_0}$$

$$\Delta S_{fus} = \frac{Q_{TOT}}{T_0} = \frac{m \lambda_f}{T_0} > 0 \quad \left[\frac{J}{K}\right]$$

• riscaldamento



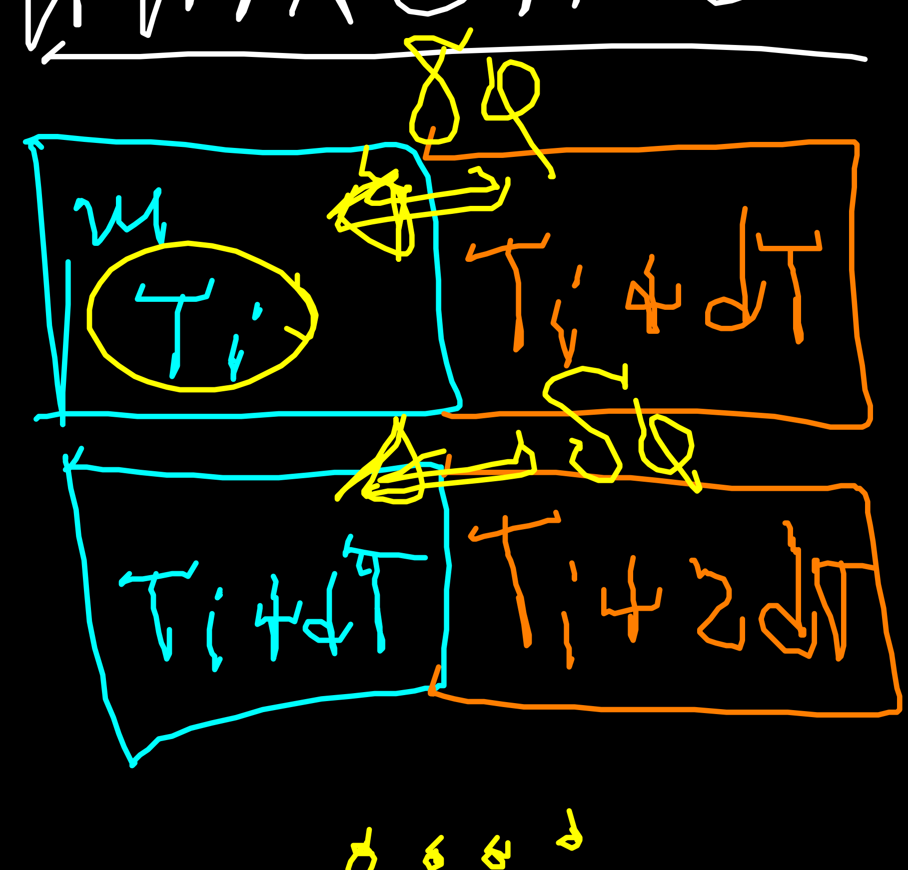
H_2O

$t_i \to t_f < 100°C$

$T_i \to T_f < 373.16\ K$

IRR.

IMMAGINO



quasi-statica rev.

T_f

$$\Delta S = \int_{T_i}^{T_f} \frac{\delta Q}{T} = \int_{T_i}^{T_f} \frac{\overbrace{m c_p\, dT}^{\delta Q}}{T} = m c_p \int_{T_i}^{T_f} \frac{dT}{T} = m c_p \ln \frac{T_f}{T_i} > 0$$

$T_f > T_i$