$$\Delta S = S_B - S_A = \int_A^B \left(\frac{\delta Q}{T}\right)_{rev} \Rightarrow dS = \left(\frac{\delta Q}{T}\right)_{rev}$$

$A\ (p_A, V_A, T_A)$ $\qquad$ $B\ (p_B, V_B, T_B)$

$$\delta Q = dU + \delta W \overset{\text{gas}}{=} m c_v dT + \delta W \overset{\text{rev.}}{=} m c_v dT + p dV =$$

$$= m c_v dT + m R T \frac{dV}{V}$$

$$S_B - S_A = \int_A^B \left(\frac{\delta Q}{T}\right)_{rev} = \int_{T_A}^{T_B} m c_v \frac{dT}{T} + \int_{V_A}^{V_B} m R \frac{dV}{V} =$$

$$= \underbrace{m c_v \ln \frac{T_B}{T_A} + m R \ln \frac{V_B}{V_A}}$$

$$T = \frac{pV}{mR} \Rightarrow S_B - S_A = m c_v \ln \frac{p_B V_B}{p_A V_A} + m R \ln \frac{V_B}{V_A} =$$

$$= m c_v \ln \frac{p_B}{p_A} + m c_v \ln \frac{V_B}{V_A} + m R \ln \frac{V_B}{V_A} =$$

$$R = c_p - c_v \Rightarrow \qquad = \underbrace{m c_v \ln \frac{p_B}{p_A} + m c_p \ln \frac{V_B}{V_A}}$$

$$S_B - S_A = mc_v \ln \frac{T_B}{T_A} + mR \ln \frac{V_B}{V_A} = \qquad *$$

$$V = \frac{mRT}{p} \Rightarrow \qquad = mc_v \ln \frac{T_B}{T_A} + mR \ln \frac{T_B}{p_B} \frac{p_A}{T_A} =$$

$$= mc_v \ln \frac{T_B}{T_A} + mR \ln \frac{T_B}{T_A} - mR \ln \frac{p_B}{p_A} = \qquad R = c_p - c_v$$

$$\underbrace{= mc_p \ln \frac{T_B}{T_A} - mR \ln \frac{p_B}{p_A}}$$

$$S_B - S_A = mc_v \ln \frac{T_B}{T_A} + mR \ln \frac{V_B}{V_A} =$$

$$= mc_v \left(\ln \frac{T_B}{T_A} + \frac{c_p - c_v}{c_v} \ln \frac{V_B}{V_A} \right) =$$

$$= mc_v \left[\ln \frac{T_B}{T_A} + \ln \left(\frac{V_B}{V_A} \right)^{\gamma-1} \right] = \underbrace{mc_v \ln \frac{T_B V_B^{\gamma-1}}{T_A V_A^{\gamma-1}}}$$

$$S_B - S_A = m c_v \ln \frac{p_B V_B^{\gamma}}{p_A V_A^{\gamma}}$$

$$= m c_p \ln \frac{T_B \, p_B^{\frac{1-\gamma}{\gamma}}}{T_A \, p_A^{\frac{1-\gamma}{\gamma}}}$$

Isoterma : $S_B - S_A = mR \ln \frac{V_B}{V_A} = -mR \ln \frac{p_B}{p_A}$

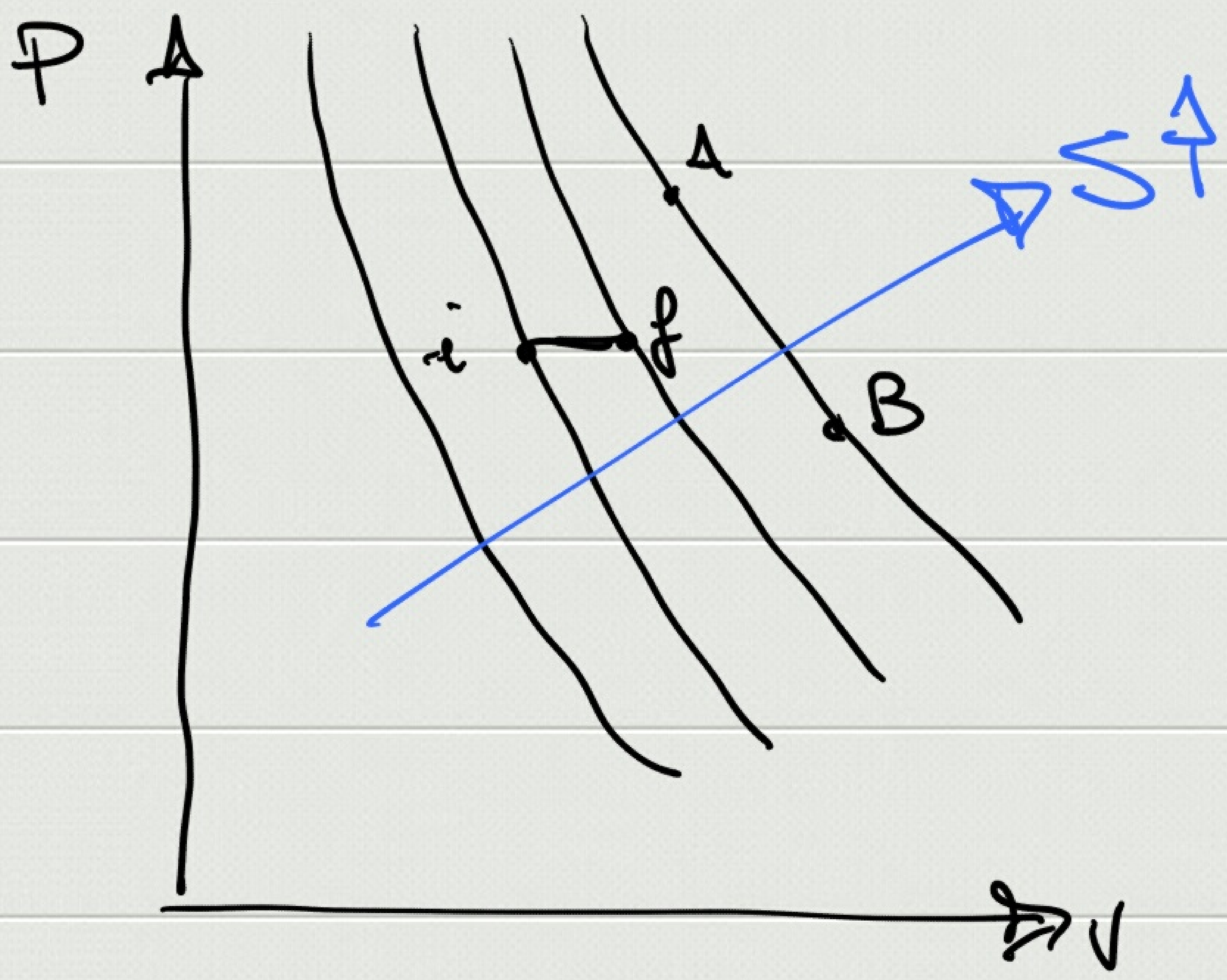
Isocora : $S_B - S_A = m c_v \ln \frac{T_B}{T_A} = m c_v \ln \frac{p_B}{p_A}$

Isobara : $S_B - S_A = m c_p \ln \frac{T_B}{T_A} = m c_p \ln \frac{V_B}{V_A}$

Adiabatiche $\left(pV^{\gamma} = \text{cost} \quad TV^{\gamma-1} = \text{cost} \quad T p^{\frac{1-\gamma}{\gamma}} = \text{cost} \right)$

reversibili

rev. $\Rightarrow \Delta S = 0$ $\boxed{S_B = S_A}$



$pV^\gamma = \text{cost}$

$S_B = S_A$

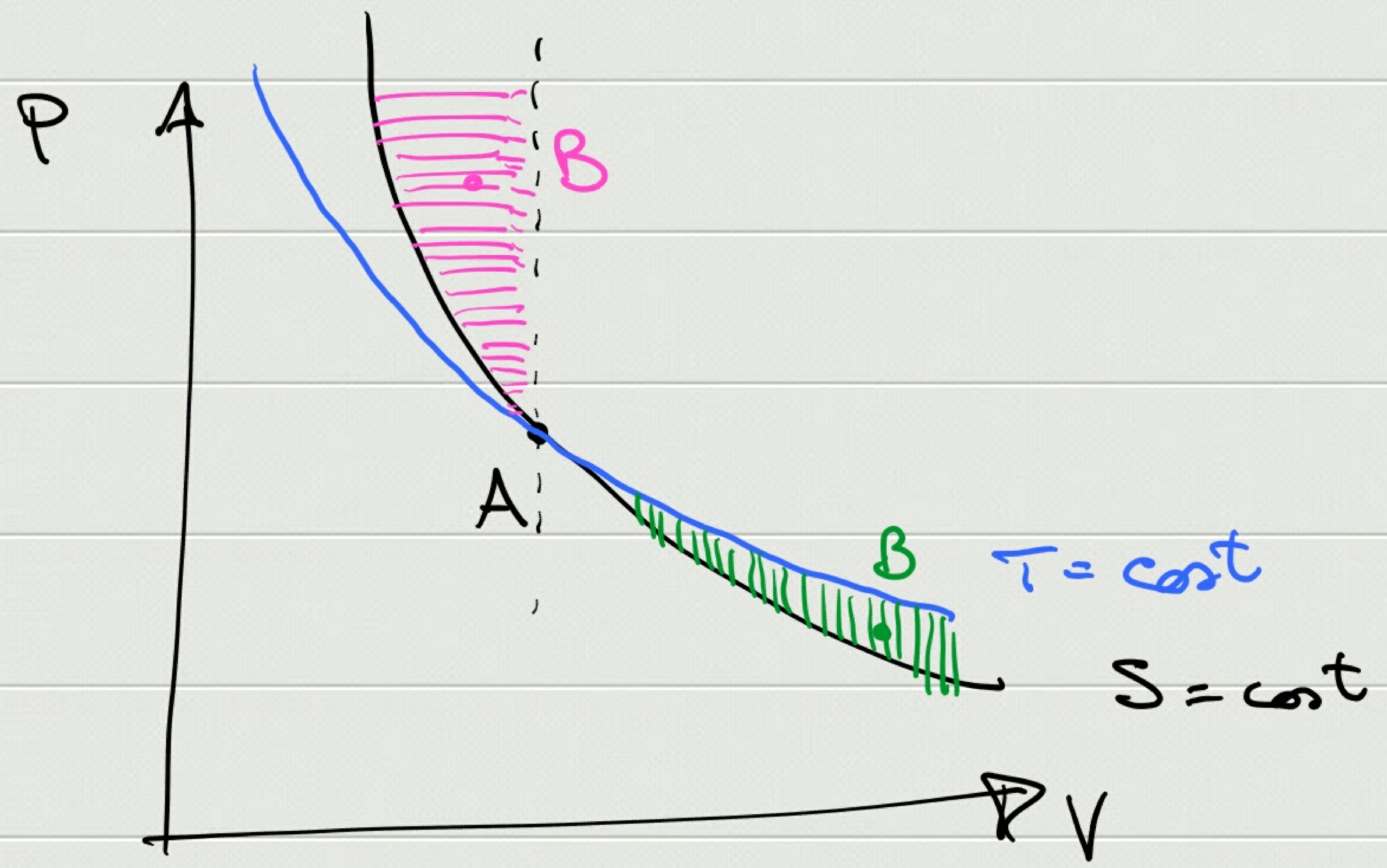
← curve isoentropiche

$$\Delta S = S_f - S_i = n c_p \ln \frac{V_f}{V_i} > 0 \implies S_f > S_i$$

Adiab. irreversibili $\quad dS = \left(\frac{\delta Q}{T}\right)_{rev} > \left(\frac{\delta Q}{T}\right)_{irr} = 0$

$(\delta Q)_{irr} = 0$

$$\implies \boxed{dS > 0}$$



espansione adiab. irrev. $\Delta S > 0$

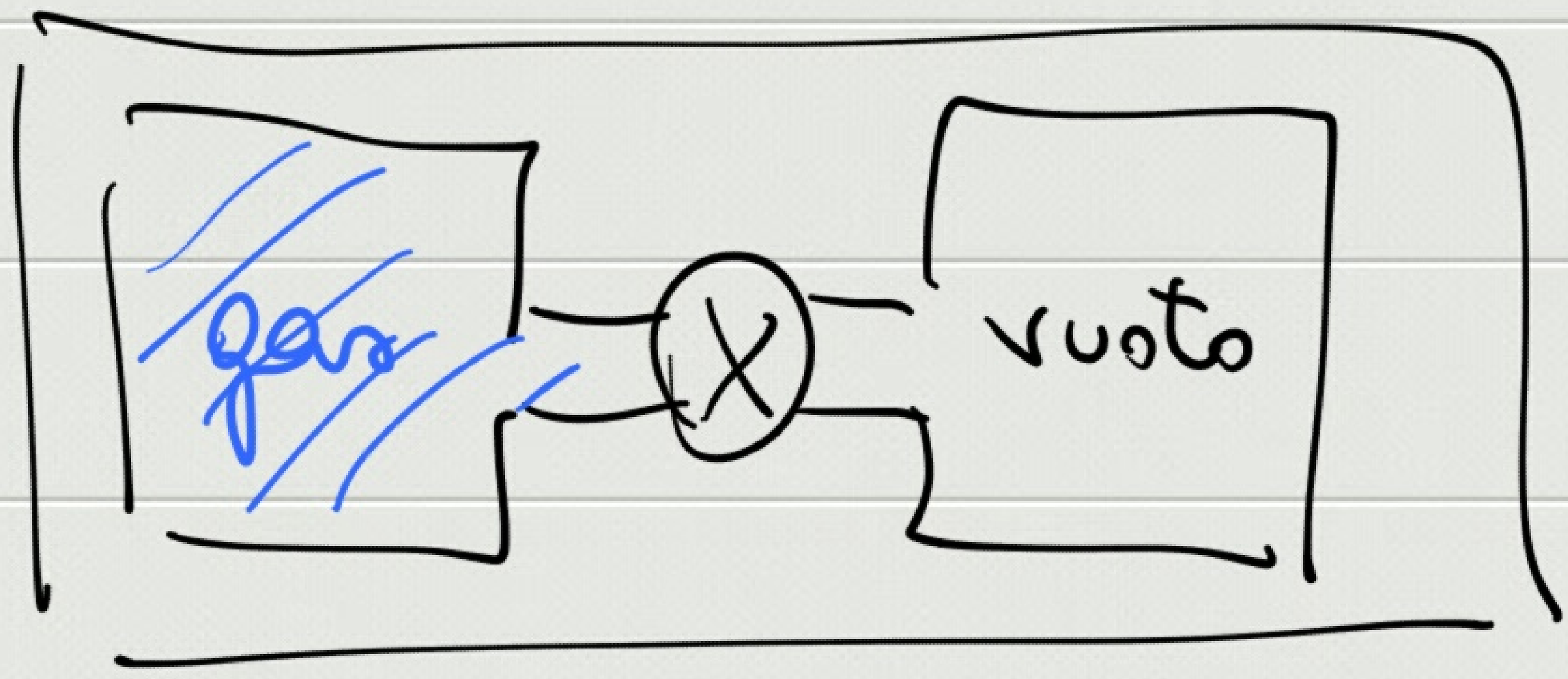
$$\left.\begin{array}{l} Q = 0 \Rightarrow W = -\Delta U = -n c_V \Delta T \\ W > 0 \end{array}\right\} \Rightarrow \Delta T < 0$$

$T_B < T_A$

compressione adiab. irrev. $\Delta S > 0$

$V_B < V_A$

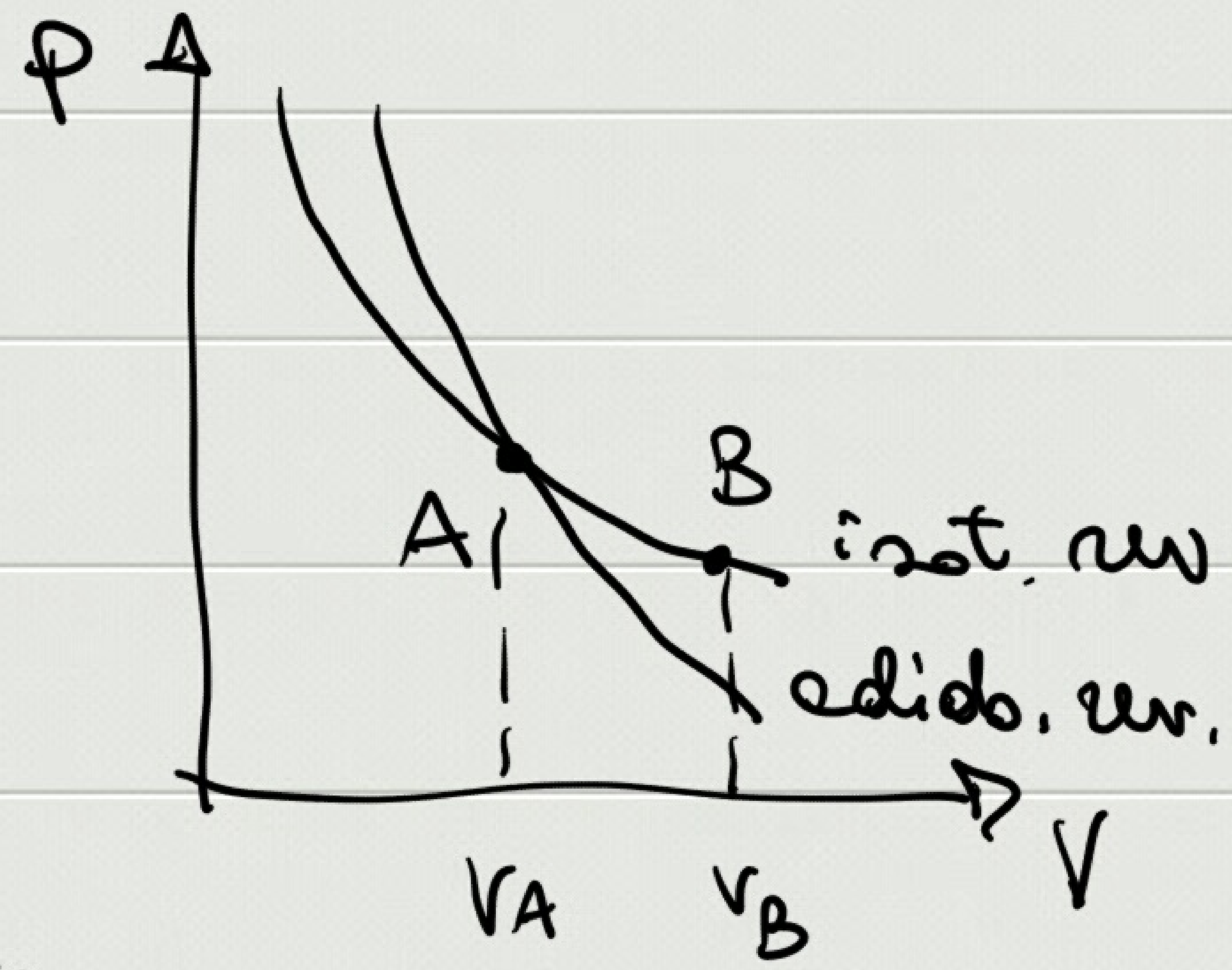
Espansione libera di un gas



$\Delta U = 0 \qquad W = 0 \qquad Q = 0 \qquad \Rightarrow T = \text{cost}$

Trasf. irreversibile (adiabatica)

$\Delta S = ?$



$T_B = T_A \Rightarrow$ trasf. rev. isoterma

$$\boxed{\Delta S_{BA} = nR \ln \frac{V_B}{V_A}}$$