

Entropy

$$dS = \frac{dq_{rev}}{T}$$

↑
state function

Carnot Cycle

$$\Delta S = S_f - S_i$$

$$= \int \left(\frac{dq_{rev}}{T} \right)$$

Reversible process

$$S = k_B \ln W$$

particles

↑
"ways" a system
can exist

- # states accessible
to system

$$S = -k_B \sum_{\substack{\text{states} \\ i}}^W [p_i \ln(p_i)]$$

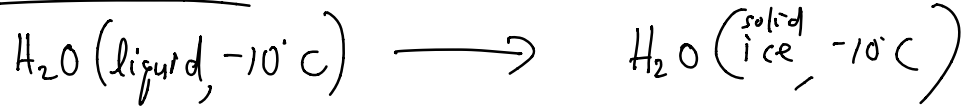
$$-k_B [p_1 \ln p_1 + p_2 \ln p_2 + p_3 \ln p_3]$$

↔ $W=3$

2 states: $p_1 \neq p_2$ $p_2 + p_1 = 1$

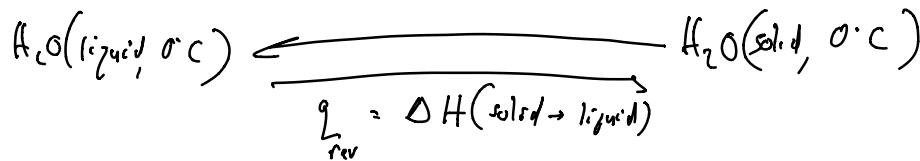
Example: Irreversible process

Constant $P = 2 \text{ atm}$ $\Delta S = ?$



$$\uparrow \quad d\bar{q} = C_p^{\text{liquid}}(T) dT$$

$$\downarrow \quad \begin{array}{l} \text{Heat solid Ice} \\ \text{to } 0^\circ\text{C} \\ \boxed{d\bar{q} = C_p^{\text{solid}}(T) dT} \end{array}$$



Construct a Reversible Path / Process

$$\Delta S_1 = \int \left(\frac{d\bar{q}_{\text{rev}}}{T} \right) = \int_{T=-10^\circ\text{C}}^{T=0^\circ\text{C}} C_p^{\text{solid}}(T) \frac{dT}{T} = \int_{T=-10^\circ\text{C}}^{T=0^\circ\text{C}} C_p^{\text{solid}}(T) d(\ln T)$$

$$\Delta S_2 = \int \frac{d\bar{q}_{\text{rev}}}{T} = \frac{1}{T} \int d\bar{q}_{\text{rev}} = \frac{\bar{q}_{\text{rev}}}{T} = \frac{\Delta H}{T}$$

$$\Delta S_3 = \int \frac{d\bar{q}_{\text{rev}}}{T} = \int_{T=0^\circ\text{C}}^{T=-10^\circ\text{C}} C_p^{\text{liquid}}(T) \frac{dT}{T} = \int_{T=0^\circ\text{C}}^{T=-10^\circ\text{C}} C_p^{\text{liquid}}(T) d(\ln T)$$