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Entropy and the Second Law of Thermodynamics

• Like mass and energy, every system has entropy. Entropy is a measure of the degree of microscopic disorder and it represents uncertainty about the microscopic state.

• Entropy is extensive; the entropy of a system is the sum of the entropies of its parts.

• Unlike mass and energy, entropy can be produced, but it can never be destroyed. The entropy of a system and its surroundings (an isolated system) can never decrease (Second Law of Thermodynamics).

$$\Delta S \geq 0 \qquad \text{isolated system}$$

• In general $\Delta S > 0$ will be true, and the processes inside the isolated system will produce entropy. The limiting case $\Delta S = 0$ corresponds to an idealized process in which entropy is conserved.

$$(\Delta S)_{\text{isolated system}} = (\Delta S)_{\text{system}} + (\Delta S)_{\text{surroundings}} \geq 0$$

where $\Delta \equiv \text{final} - \text{initial}$.

• Reversible process is a process that produces no entropy.

• Irreversible process is a process that produces entropy.

• Entropy is zero ($S = 0$) when a perfect crystal of a pure substance when its temperature is at absolute zero ($T = 0\,K$). The molecules are perfectly arranged and motionless. There is no uncertainty about the microscopic state.