

STATISTICAL MECHANICS SUMMARY

Boltzmann's Entropy

Relates thermodynamic entropy to microscopic multiplicity.

$$S = k_B \ln \hat{\Omega}$$

Partition Function (Canonical)

The sum over all possible states of the system.

$$Z = \sum_i e^{-\beta E_i}$$

Gibbs Entropy

Generalization for any probability distribution.

$$S = -k_B \sum_i p_i \ln p_i$$

Equipartition Theorem

Mean energy per quadratic degree of freedom.

$$\langle E \rangle = \frac{1}{2} k_B T$$

ENSEMBLE	CONSTANT VARIABLES	PROBABILITY DISTRIBUTION
Microcanonical	N, V, E	$p_i = 1/\hat{\Omega}$
Canonical	N, V, T	$p_i = e^{-\beta E_i} / Z$
Grand Canonical	μ, V, T	$p_i = e^{-\beta(E_i - \mu N_i)} / \hat{\mathcal{Z}}$

$$\beta = 1 / (k_B T) \cdot k_B \approx 1.38 \text{ \AA}^{-1} \cdot 10^{-23} \text{ J/K}$$