

**Entropy and Probability:  $S = -k \sum p_i \ln p_i$**

$$\ln W = \ln \mathcal{N}! - \sum_i \ln n_i!$$

$S = -k (1 \ln 1) = 0$

$S = -k(9/15 \ln 9/15 + 4/15 \ln 4/15 + 2/15 \ln 2/15)$

Sterling's formula:

$$N! = \left(\frac{N}{e}\right)^N \quad \text{and} \quad \ln N! = N \ln N - N \quad (N \rightarrow \infty)$$

$$\ln W = \mathcal{N} \ln \mathcal{N} - \mathcal{N} - \sum_i (n_i \ln n_i - n_i)$$

summations are associative,  $\Sigma(a_i + b_i) = \Sigma a_i + \Sigma b_i$

$$\ln W = \mathcal{N} \ln \mathcal{N} - \mathcal{N} - \sum_i n_i \ln n_i + \sum_i n_i$$

$$\ln W = \mathcal{N} \ln \mathcal{N} - \sum_i n_i \ln n_i = \sum_i n_i \ln \mathcal{N} - \sum_i n_i \ln n_i$$

$\Sigma a_i b_i + \Sigma a_i c_i = \Sigma a_i (b_i + c_i)$ :

$$\ln W = - \sum_i n_i (\ln n_i - \ln \mathcal{N})$$

$\ln a - \ln b = \ln(a/b)$ :

$$\ln W = - \sum_i n_i \ln \frac{n_i}{\mathcal{N}}$$

$$S = -k \sum_i \frac{n_i}{\mathcal{N}} \ln \frac{n_i}{\mathcal{N}}$$

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

C≡O	C≡O	C≡O	C≡O
C≡O	C≡O	C≡O	C≡O
C≡O	C≡O	C≡O	C≡O

perfect crystal

C≡O	O≡C	C≡O	O≡C	C≡O
C≡O	C≡O	O≡C	O≡C	C≡O
O≡C	C≡O	O≡C	C≡O	O≡C

orientational randomness

$$p(\text{C}\equiv\text{O}) = p(\text{O}\equiv\text{C}) = 1/2$$

$$S_o = -R \sum_i p_i \ln p_i = -R (1/2 \ln 1/2 + 1/2 \ln 1/2) = R \ln 2 = 5.76 \text{ J K}^{-1} \text{ mol}^{-1}$$