Key points lecture 01/31/2022:

- $S = S(E, V, N)$

$\Rightarrow$ slow variation of E and V

$$dS(E,V,N) = \left(\frac{\partial S}{\partial E}\right)_{V,N} dE + \left(\frac{\partial S}{\partial V}\right)_{E} dV$$

$\left(\frac{\partial S}{\partial E}\right)_{V,N}$: by def. $= \frac{1}{T}$

$\left(\frac{\partial S}{\partial V}\right)_{E}$: define: $\frac{P}{T}$

our definitions within statistical mechanics give us the "correct" thermodynamics

$$= \frac{1}{T}(dE + P\,dV)$$

first law of thermodynamics

- Once we know $T(E, V, N)$, we know $S(E, V, N)$ (can get)

From the entropy, we can calculate other thermodynamic quantities.

- Equipartition theorem:

$$\left\langle x_i \frac{\partial \mathcal{H}}{\partial x_j} \right\rangle = \delta_{ij}\, kT$$

$$\left\langle \sum_{i=1}^{3N} q_i \dot{p}_i \right\rangle = -3NkT$$

} any Hamiltonian $\mathcal{H}$

For $\mathcal{H}$ quadratic: $\langle \mathcal{H} \rangle = \frac{1}{2} f\, kT$; # of degrees of freedom