

Problem #1: Statistical Mechanics

- (a) In the canonical ensemble, show that the fluctuations in energy $\Delta E^2 = \langle E^2 \rangle - \langle E \rangle^2$ are proportional to the heat capacity.
- (b) Show that in the canonical ensemble, the Gibbs entropy can be written as

$$S = k_B \frac{\partial}{\partial T} (T \log Z)$$

Problem #2: Entropy of a two-state system

- 1) What is the statistical (Boltzmann's) definition of entropy?
- 2) Using the two-state system as an example, explain why negative temperatures should be hotter than positive ones. You may use diagrams to help with the explanation.