Physics 112 - Intro to Statistical and Thermal Physics - Spring 2023
Spoiler Set 07

Problem 7.1 - The Canonical Two-State Paramagnet

(a) We already did this using the *micro-canonical* approach in Problem 6.1. You should get the same answer here but the derivation itself should be much more straightforward.

We can consider "just the first spin" as a closed sub-system.

(b) We learned in Problem 6.3 that the canonical particion function of a combined system is the product of the canonical partition functions of the individual elements. You can break up the N-spin paramagnet into N individual close systems and use this result.

(c) There are actually two consistent but distinct ways of finding σ_E using Z!

Problem 7.2 - Canonizing the Ideal Gas

(a) The "sum over microstates" will become a 3D volume integral $\iiint d^3\vec{x}$ over positions, a 3D momentum integral $\iiint d^3\vec{p}$ over the momenta, and a discrete sum $\sum_{\mathscr{I}_{\text{int}}}$ over the internal microstates.

$Z_1 = Vn_Q Z_{\text{int},1} = VZ_{\text{int},1}/\lambda_{th}^3$.

(e) There are *three* different possible $j = 1$ states (corresponding to $m_j = -1, 0, +1$), so you wlil have to take this multiplicity into account.

(g) The results are given in Figure 6.7 of Schroeder.

Problem 7.3 - Probability Distributions

(b) An intermediate result should be $\rho_v(\vec{v}_1) = m^3\rho_p(m\vec{v}_1)$.

Not for Credit - Problem X.1 - The Entropy of Mixing

(a) Don't overthink the first part! You will use Eq. **??** and the result from Problem 7.2(a).

The most important feature here is that $Z_1 \propto V$.

To get the entropy first find the Helmholtz free energy.

(b) You will need to use the factor of $\sqrt{2\pi N}$ in Stirling's approximation to get a non-zero result.

After removal, all $2N$ particles are now indistinguishable.

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