1. Consider a system of two noninteracting particles. Each particle may occupy one of two energy levels, $E_0 = 0$ and $E_1 = \varepsilon$.

   (a) Assume the particles are *distinguishable*. Determine the number of available configurations, then using direct enumeration, write down the partition function.

   (b) Now assume the particles are *indistinguishable*. Determine the number of available configurations, then using direct enumeration, write down the partition function.

2. A bare proton in a magnetic field B_z has energy $E_{\pm\frac{1}{2}} = \mp\frac{1}{2}\hbar\gamma B_z$, where γ is the gyromagnetic ratio. Show that the partition function can be written as $Q(\beta, B_z) = 2\cosh\left(\frac{\beta\hbar\gamma B_z}{2}\right)$, where $\cosh(x) = \frac{e^x+e^{-x}}{2}$

3. Consider a system at temperature $T = 298$ K with three energy states $E = 0, 100, 500 \ \frac{\text{J}}{\text{mol}}$. Using the Boltzmann distribution:

   (a) Evaluate the partition function Q

   (b) What is the probability of occupying the highest energy level at 298 K?

   (c) What is the average energy at 298 K?

Homework Problem 3

1. A system has four energy levels given by:

$$\tilde{E}_0 = 0 \qquad \tilde{E}_1 = 25 \text{ cm}^{-1} \qquad \tilde{E}_2 = 50 \text{ cm}^{-1} \qquad \tilde{E}_3 = 100 \text{ cm}^{-1}$$

Calculate the probability of being in an excited state at 300K. Use $k_B = 0.695 \frac{\text{cm}^{-1}}{\text{K}}$