Statistical Physics

March 20, 2025

12-1 Suppose that you flip 50 "honest" coins.

(a) How many microstates are there? Give your answer as a factor of the order of unity times an integral power of 10.

(b) How many microstates are there corresponding to the most probable macrostate?

(c) What is the true probability of achieving the most probable macrostate?

Note: Use a calculator that gives you $n!$ or a table of gamma functions ($\Gamma(n+1) = n!$). Stirling's approximation will not give you sufficient accuracy.

12-6 Consider a model thermodynamic assembly in which the allowed (nondegenerate) states have energies 0, ε, 2ε, 3ε, 4ε, 5ε, 6ε. The assembly has *four distinguishable* (localized) particles and a total energy $U = 6\varepsilon$.

(a) Tabulate the nine possible distributions of the four particles among the energy levels $n\varepsilon$, where $n = 0, 1, \ldots$.

(b) Evaluate ω_k for each of the macrostates and calculate $\Omega = \sum_k \omega_k$.

(c) Calculate the *average* occupation numbers

$$\overline{N}_j = \sum_k N_{jk}\omega_k/\Omega$$

of the four particles in the energy states.

12-12 Consider a gas consisting of one kilomole of helium atoms at standard temperature and pressure. Calculate the degeneracy $g(\varepsilon)$ for the energy level $\varepsilon = (3/2)k_B T$ (take $\gamma_s = 1$). What is the approximate ratio of $g(\varepsilon)$ to the number of atoms N