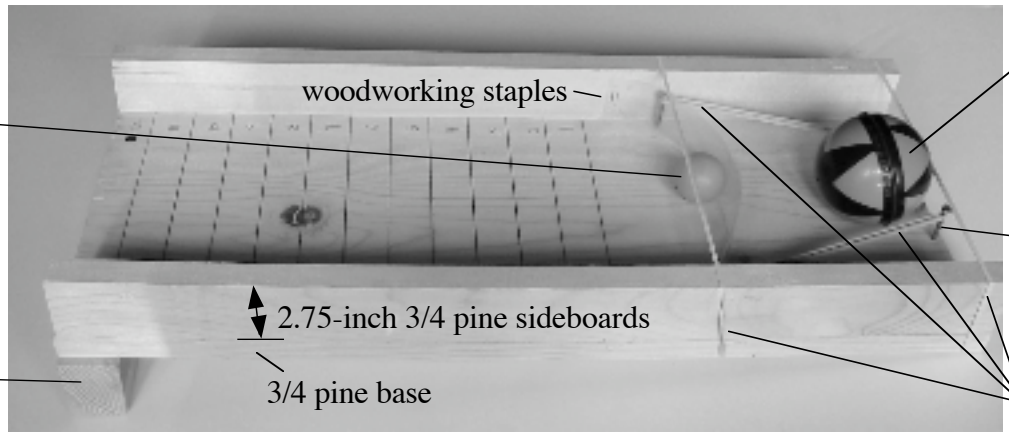
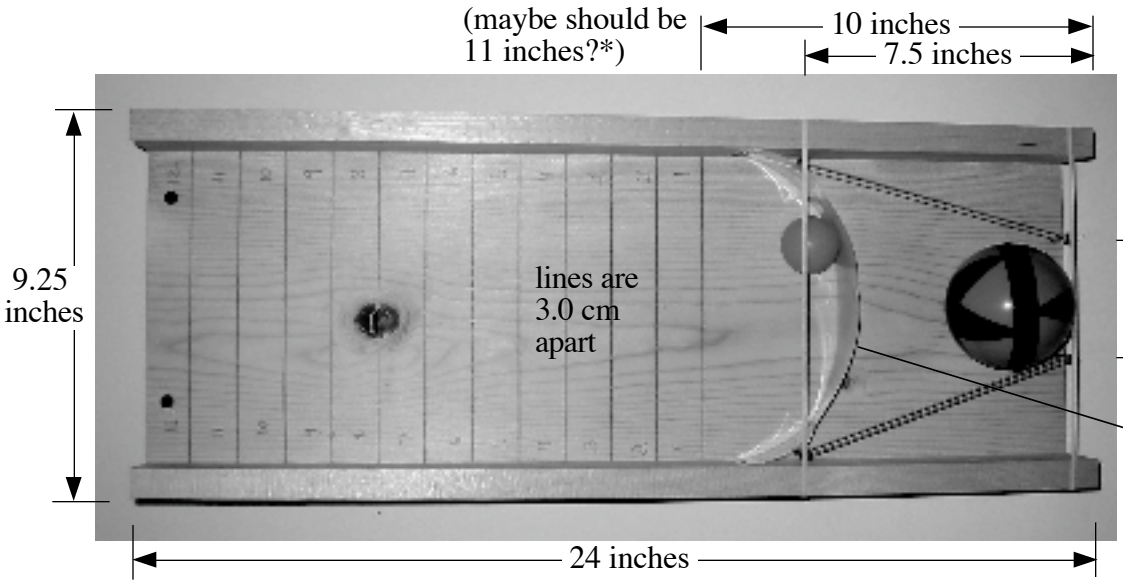
BOLTZMANN-FACTOR EXPERIMENT

Created by Thomas Moore (with help from David Haley and Glenn Flohr)





*With the 10-inch distance, if one does not use the ball's trailing edge to define levels, the level-1 counts come out too small. Making this distance 11 inches may yield better results for other methods.

When the battery-powered Squiggle Ball™ is turned on, it randomly moves around the area caged in by rubber bands, serving as a model of a constant-temperature "reservoir". Mechanical energy can flow across the flexible boundary to or from the ping-pong ball, so it remains in "thermal equilibrium" with the Squiggle Ball™. If one tallies the number of times the ping-pong ball makes it to a given gravitational "energy level" on the inclined plane during a given period of time and then plots the tally versus energy level, one finds an exponential relationship (see the graph to the right), as predicted by Boltzmann statistics.

The data to the right was for a 25-minute run (I called out numbers and Dave marked tallies). I counted the ball as making it to a certain level if its trailing edge was over the line. The uncertainty bars are 95% confidence intervals ≈ 2×sqrt(counts). Data points for which the uncertainty was larger than the value were not plotted. The line is a least-squares fit, and the uncertainty of the slope is determined by a Monte-Carlo method based on the uncertainties of the data. One can use the slope to calculate the effective "temperature" of the Squiggle Ball™ (≈ 10^{19} K).