Macroscopic States and Microscopic States

Apparatus

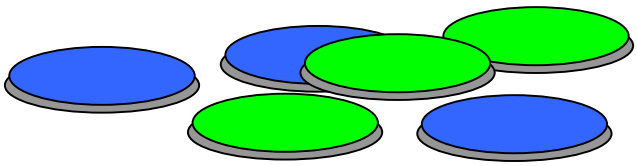
10 or 20 plastic discs with a different colour on each side, for example the game pieces from an Othello set or even coins
(Note that in the workshop sheets we refer to green and blue.)

Action

The students examine the discs and experiment with the number of possible microstates they can produce with 2 or more discs. They should relate the number of microstates to the entropy of the system. Beginning with two discs, they count the number of microstates possible, and how many ways they can produce a given macrostate – half blue, half green facing up. They then repeat this with four discs, and consider the general case of increasing the number of discs.

The Physics

With two discs there are four possible microstates. B is blue side up, G is green side up. The possible states are BB, BG, GB, GG.
The macroscopic state of half of the discs facing up to be blue and the other half to be green has a probability of ½, as two of the four possible microstates give this macrostate.
With four discs there are 2×2×2×2 = 16 possible microstates. These are BBBB, BBBG, BBGB, BBGG, BGBB, BGBG, BGGB, BGGG, GBBB, GBBG, GBGB, GBGG, GGBB, GGBG, GGGB, GGGG. The probability of half the discs green add half blue is now 6/16 = 3/8. The probability has decreased.
In general, the more possible microstates there are, the less probable a given macrostate becomes. As the number of components increases, so does the possible number of microstates, and so does the entropy of the system.



Accompanying sheet

Macroscopic States and Microscopic States

Take two discs from the container.
How many microstates are possible? List the microstates.
Consider the macroscopic state (also called simply a state)
of half of the discs facing up to be blue and the other half to be green.
What is the probability of this state?

Now take 4 discs instead of 2. How many microstates are possible now?
What is the probability of half of the discs facing up
to be blue and the other half to be green now?