Multiplicity

Apparatus

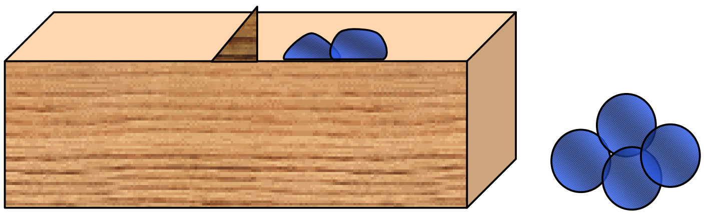
six or more balls or molecular models, box with two or more compartments

Action

The students experiment with the different possible microstates of this system. They should try to find how many ways each macrostate is possible, defining as they go what a microstate is and what a macrostate is. They should recognise that the greater the possible number of microstates, the higher the probability of that macrostate, and the greater the entropy of the system.

The Physics

There are 6 identical "molecules" and a box with two parts.
The possible states, written (X,Y) where X is the number in one side and Y is the number in the other are: (6,0) (5,1) (4,2) (3,3) (2,4) (1,5)(0,6). The multiplicity, W, of a state is the number of different ways in which that state can be achieved. It is equal to $W=N!/n_1!n_2!$. So in this case the multiplicities are: 1, 6, 15, 20, 15, 6, 1. There are 1 + 6 + 15 + 20 + 15 + 6 + 1 = 64 possible states in total.
The equilibrium condition is the most probable state – in this case the state with 3 molecules in each half of the box. This is also the most disordered state, and hence it has the greatest entropy.



Accompanying sheet

Multiplicity

You have 6 identical "molecules" and a box with two parts.
What are the possible states
(i.e. combinations of number of molecules in each half of the box)?

What is the multiplicity of each state?
How many possible microstates are there altogether?

Which of these states would be the equilibrium condition?
What can say about the order and entropy of this state?