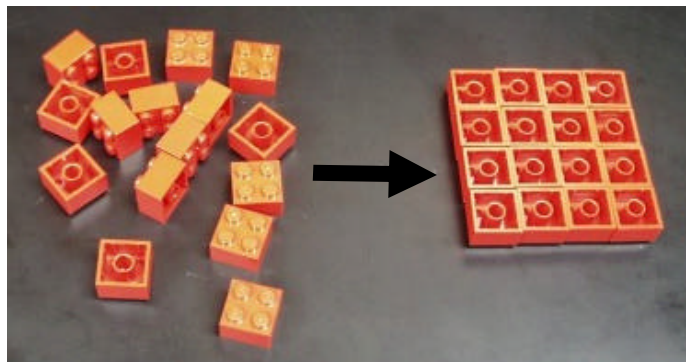


Self-Assembly: Building Structures at the Nanoscale

Materials needed:

- at least 16 2 peg x 2 peg LEGO bricks
- 500 -1000 mL beaker half-filled with water
- table salt and toothpicks

How can you make a square pattern of LEGO bricks like that shown?



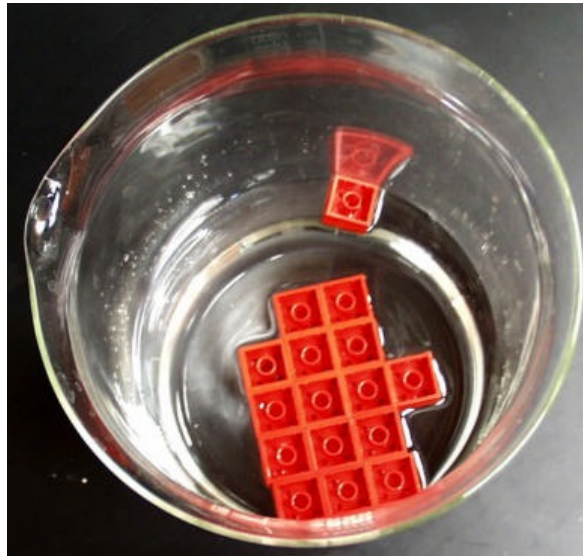
There are really two ways to do this. One is called the top-down approach, where a big structure is cut down in size until the desired shape is achieved. This is similar to carving a piece of wood down into a sculpture. For our LEGO pattern we could take a big arrangement of bricks and remove the bricks we do not want until we get the pattern. This can be a bit wasteful and sometimes the patterns we want are still very difficult to make, especially very small patterns.



The other method is called the bottom-up approach, where a big structure is built up from smaller pieces. For objects you can see, feel, and pick up this method can be easy. The LEGO pattern above is easily put together by hand. But what if the objects to be placed into a pattern were molecule-sized – in the realm of the nanoscale? To get an idea of the difficulty involved, try arranging grains of table salt into the same square pattern. You will probably find that your fingers are too big for the task. Try again using smaller manipulators such as toothpicks or tweezers to arrange the grains. This is still difficult. You will also find that it takes quite a while to make a sizable pattern.



Imagine then, how much more difficult and time-consuming a nanoscale pattern takes to make. It would be even better if the objects were designed so that they could arrange themselves into the patterns. This type of fabrication is called “self-assembly”. Place several of the square LEGO bricks peg side down in a large beaker filled with water. Do not flood the bricks with water. The bricks will interact with the surface tension of the water and each other to assemble into a square pattern. Gently tapping the beaker with your hand might help the structure to assemble.



Researchers are exploring methods of self-assembly of small electronic components to produce useful circuits. Some are using surface tension methods of assembly similar to those used in the activity above. Other researchers use self-assembly of molecules at the nanoscale level to produce very complex, very small structures.

An alternative method of showing self-assembly involves magnetic LEGO bricks. Each assembling unit in the figure below (one is outlined with a black line) is made by placing a magnetic LEGO brick over four 1 peg x 2 peg bricks. Two of these units have their magnetic north poles facing upward, and the other two units have their magnetic south poles facing upward. When these units are placed into a flat-bottomed container and shaken, they tend to aggregate together to form larger organized patterns comprised of many individual units.

Materials needed for magnetic assembly:

- at least 4 magnetic LEGO bricks
- at least 16 1 peg x 2 peg LEGO bricks
- a flat smooth-bottomed tray

