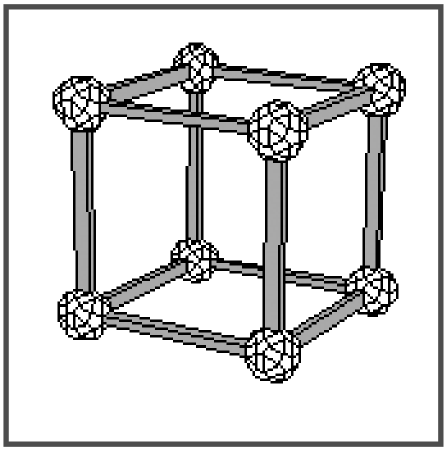
Beginning Bubbles

Physics
Basic Concept

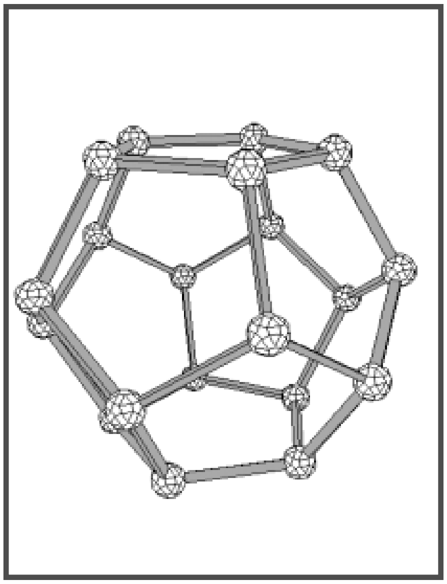
Lesson Objective:
Students start exploring bubble making with Zome System. They will establish that bubbles have 3-fold symmetry.

Prerequisite Skills:
Students should have some background in relating geometric shapes to numbers (“Shape and Number”), as well as the ability to identify a line of symmetry (“What is Reflection Symmetry?”). It is also good if they have experimented with, or discussed, surface tension in the past.



Time Needed:
One class period of 45-60 minutes.

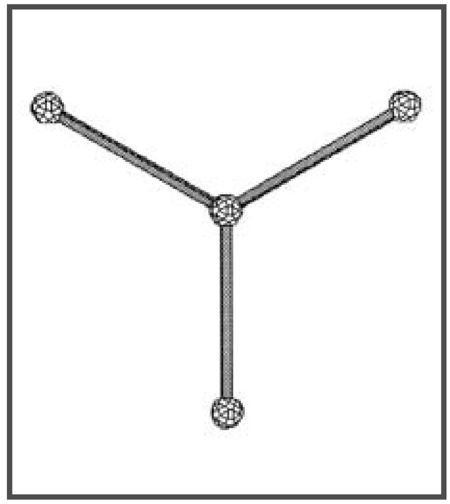
Materials Needed:
• Two Zome System Creator Kits for 25-30 students
• Five or six buckets of water with approx. 1/3 cup of liquid dish soap in each (Dawn works well)
• A few drinking straws
• Overhead projector



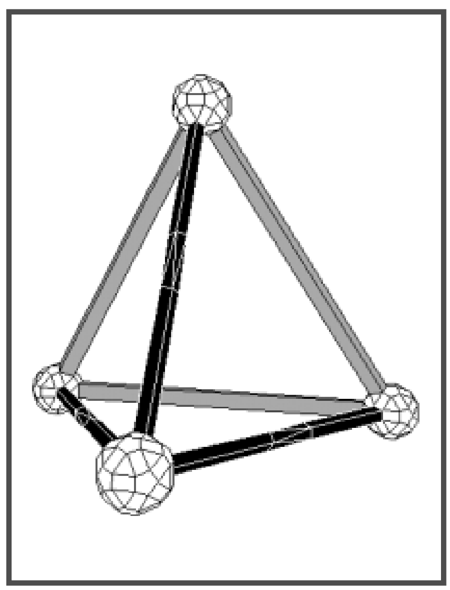
Procedure:
Prepare by reading the section on bubbles (pages 5-7) in Zome System Manual 2.0, the color brochure that came with the Zome System kit. Mix the bubble solution the day before the class for better lasting bubbles. A few drops of glycerin may also be added. Test that the solution is strong enough to make bubbles. Place the buckets in your class room so the students have space to work around them. Place newspapers on the floor and workspace to absorb the drips.

Divide your class into teams of 3-5 students, and assign each team to one of the buckets. Ask the students if they know how soap bubbles work. *Are bubbles always round?*

How can we find out to be sure? Lead the discussion until the students have established that we must do experiments to learn certain things. Tell the students that they are going to make the bubbles by making Zome System structures and dipping them in the solution. To avoid a big mess, discourage the students from blowing bubbles. During the first 20 minutes they may experiment freely, but must take notes of their findings.



Walk around and assist as needed as the students experiment. Use examples from the students' structures to point out interesting features to the other ones using the same bucket. *Which is best, a flat polygon, or a 3-D structure? Why? Why does a dry finger pop the bubble, while a wet finger does not?* Students will eventually notice that a simple structure such as a cube or a tetrahedron gives cleaner, more interesting, combination of bubble surfaces than a complex piece with a large number of struts. Also, guide the students if they do not realize that they can trap air inside the structures by first dipping an entire structure, and then submerging it only partially into the solution. A "double-dipped" cube will have a cube-shaped bubble suspended inside, and a tetrahedron can contain a tetrahedron-shaped bubble, and so on, with increasingly complex shapes. Change the size of a bubble by blowing in or sucking out air with the aid of a drinking straw (which must be wet, as a dry straw will pop the bubble).



As a whole class, collect students' findings on the board or on flip chart paper. *Why do the bubbles connect and pull in towards the center of the Zome System structures, instead of staying on the outside* (the bubbles are striving for a minimal surface. Younger students will understand the concept of a bubble being "lazy"; it takes less bubble, less energy, to create a shared bubble surface in the center of the structure)*? Did anyone notice how many bubbles can touch each other at the same time? (Either spherical bubbles in the bucket, or bubble films inside the structures.)*

Place a transparency sheet on the projector and pour a very small amount of bubble solution on it. With your straw, blow a number of bubbles on the transparency to show how bubbles always will meet in threes. The shadow cast by the projector will show a perfect 3-fold symmetry wherever the bubbles meet. *What is the angle between the bubbles? Can we build a Zome System structure that shows the same 3-fold symmetry?*

Go back to the simple Zome System structures that made the best bubbles earlier. *How many bubble films meet to form the lines in the bubble structures?* The students will find that the most striking bubbles were made by structures with no more than 3 struts in each node. Hold a short discussion about the consistency of the number 3 in the bubbles.

There are several more Zome System classes that use bubbles. The solution can be saved for these classes.

Assessment:

Observe students as they work and questions the groups about their findings. Ask a few students to demonstrate the 3-fold symmetries to others in their group. Older students should write up their findings in their math journals. To meet the standard the students must verbalize which type of structures make bubbles effectively. To exceed the standard they must make a connection between bubbles, the Zome System structures, and the number 3.

Standards Addressed:

* Science standards addressing consistency of natural laws, particularly benchmarks on surface tension and energy use in nature.

Transfer Possibilities:

More advanced work with bubbles (“Bubbles II - Surface Tension & Minimal Surface”). Physics classes dealing with surface tension, and minimum energy use in nature.