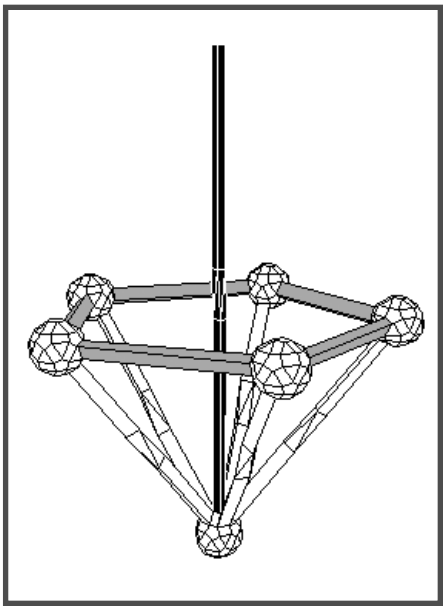
Spinners

Physics / Mathematics
Basic Concept

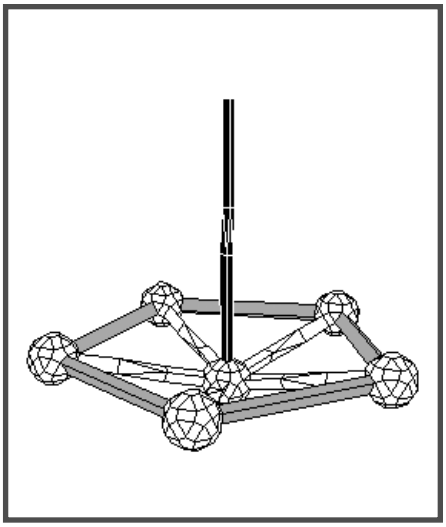


Lesson Objective:
Students will use symmetry to learn about balance, center of gravity and centripetal acceleration.

Prerequisite Skills:
Basic understanding of symmetry and numbers in geometry ("Shape and Number," "What is Reflection Symmetry?" "Multiple Reflection Symmetry," and "Rotation Symmetry").

Time Needed:
One or two class periods of 45-60 minutes.

Materials Needed:
- One or two Zome System Creator Kits for a class of 25-30 students
- Stopwatch or timer calibrated in seconds



Procedure:
Divide the class into teams of 4 students, and distribute the Zome System elements evenly. The challenge for the teams is to build the "spinner" which can rotate longest without falling over. Demonstrate with a small spinner (as shown in graphic). While this small model will probably only stay spinning for a few seconds, a larger, more intricate spinners can stay spinning for up to 30 seconds. It's best to use a smooth wooden or formica surface for the spinner time trials because these surfaces offer less drag and don't wear on the Zome System nodes. Let the teams know that inter-team trading of parts is allowed.

Circulate and assist the teams as necessary while they experiment. Models can be spun only if one node touches the table and so balance is very important. Every spinner needs a "rotor," the strut along the symmetry axis of the spinner, which is used to set the model in motion. The

teams are likely to discover on their own that a low center of gravity helps models to balance and spin easier. Ask a few leading questions if a team becomes especially frustrated with a design that isn't working. The teams should make careful notes of their findings as they experiment.

When each team has finished building and testing their spinner, begin the time trials. The teams should introduce their model and explain which of its features will help it spin longer. Each team should be allowed the best of 4 times; that way, each team member gets a chance to set the spinner in motion. Duration is from the time the team member lets go of the spinner until the time a second node touches the table top. It is probably best for the teacher to operate the stopwatch during the time trials.

When a winner has been declared, lead a discussion of student discoveries: *Why did the winning spinner win? Which tend to spin longer, small spinners or large ones? Why? Do larger spinners go faster or slower than smaller ones? Why? Can a spinner be balanced on one node? Is it easier to keep the spinner balanced when it's spinning or when it's at rest? Why? Is there a relationship between the shape of a spinner and the shape of the "rotor" strut that's used to spin it? What do all spinners have in common? What are some differences between various spinners built during this exploration? What are examples of every day spinner-like objects* (windmills, propellers, waterwheels, etc.)*?*

Items the students may point out include that a low center of gravity gives more stability and therefore longer spin time. A model that is not symmetrical will not spin. Expand the discussion to include the forces involved in a rotation. Compare this to a discus or hammer thrower at the Olympics. *Which forces are acting on the Zome System spinner? Which force is preventing the outer parts of the spinner from flying away like a discus? Why does the spinner eventually slow down and topple over?*

Assessment:

Observe the teams as they experiment, take notes of their discussion, and review their notes in their math/science journal. To meet the standard students must understand the importance of a symmetrical structure with a low center of gravity. To exceed the standard they must attempt to explain which forces are involved in the rotation of the model, and where the energy has gone when the spinning stops.

Standards Addressed:

* Physical Science standards requiring students to know and understand common properties, forms, and changes in matter and energy.
* Mathematics standards addressing geometry and spatial sense (NCTM Standard 9).
* Mathematics standards addressing measurement (NCTM Standard 10).

Transfer Possibilities:

This lesson is a good lead-in to other physics experiments of forces and accelerations. Also good for explorations of gravity forces and stresses ("Tallest Tower in the World," and "Bridge Building Unit")