

Zome System

Builds Genius!

Cubes - III

Mathematics / Physics / Art Basic Concept

Lesson Objective:

Students will deepen their understanding of the relationship between 2, and 3 dimensional objects by working with the shadows of the cube.

Prerequisite skills:

Ability to define the difference between 2-dimensional and 3-dimensional objects ("2-D and 3-D Shapes," "3-D Triangles," and "Speed Lines!"). Ability to build and describe the properties of the cube ("Cubes - I").

Time Needed:

One class period of 45-60 minutes.

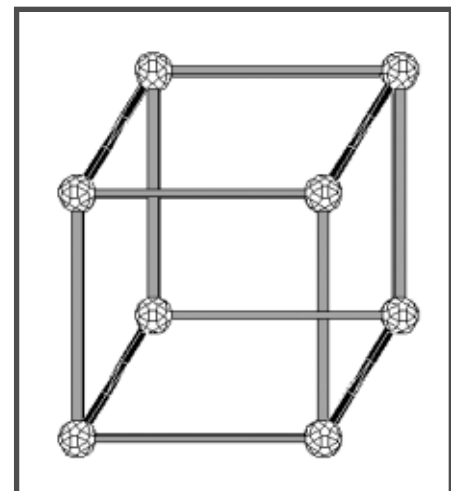
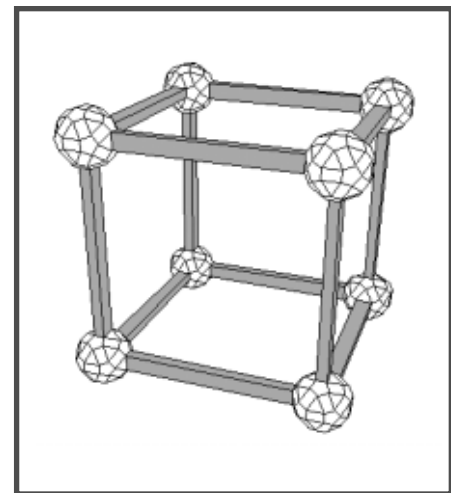
Materials Needed:

- Two Zome System Creator Kits for 25-30 students
- One 9"x12" sheet of blueprint paper per team of 3 students (see "Resources" section)
- One piece of 12"x 15" cardboard per team, to cast shadows on
- One cardboard box per team, large enough to fit over Zome System model and sheet of blueprint paper
- Household ammonia solution
- One 9x12 plastic tub or cake pan (not aluminum)
- Masking tape

Procedure:

Prepare the supplies needed by following the instructions in the "Resources" document. The required ammonia solution can be harmful, the "Caution" and "First Aid" notices should be taken very seriously. Cut the large sheets of blueprint paper into the required 9"x12" sheets.

Since students will be working with a photosensitive material, the work area should be set up in an area out of direct sunlight. The paper will be exposed by direct sun-



light in a few seconds, fluorescent light in less than an hour, incandescent light will take several hours.

Regroup the class into the teams from the “Cubes - I” and “Cubes - II” explorations. Each team member should have a cube model (one small, one medium and one large cube per team) built during those lessons.

The challenge for the teams is create a “permanent shadow” of one of their cubes, using sunlight and blueprint paper. They must take notes of all their findings as they work. First they are to attach their sheet of blueprint paper to a piece of cardboard using masking tape. A cube model should be placed on the blueprint paper (can be anchored with pins if desired). *Where on the paper should the cube be placed in order to center the shadow on the paper? Which size cube should be used? Where in the sky will the sun be?*

Place cardboard boxes over the cube and blueprint paper, and carry the whole assembly into direct sunlight. Remove the boxes and let the paper fade from yellow into white (apx. 3-5 seconds). Re-place the box over the model and paper, and remove from sunlight. “Develop” the images following instructions in the “Resources” document.

When all teams have successfully produced cube shadows they can be posted in the class room for viewing and discussion. *Are all the shadows the same? Why, or why not? Do all the shadow have something in common? What do they have in common with the cube model? How can all the cubes be the same, and their shadows be different? How many squares are in every shadow? How many diamonds are in the shadows? Do squares count as diamonds too? How many lines are in each shadow? How many points? Is it possible to build a Zome System model other than the cube that would line up with the shadow created today?* The answer to the last question will be found in the “Cubes - IV” lesson.

Assessment:

Take notes during discussions and while the students experiment, Review the created “shadows” and notes taken by the teams. To meet the standard, students must create and analyze permanent 2-D images of a cube.

Standards Addressed:

- * Mathematics standards addressing **mathematical connections** (NCTM Standard 4)
- * Mathematics standards addressing **geometry and spatial sense** (NCTM Standard 9)
- * Physical Science standards requiring students to **know and understand common properties, forms, and changes in matter and energy**
- * Fine Art standards addressing **perspective and projection drawing**

Transfer Possibilities:

More work on shadows and perspective drawing.