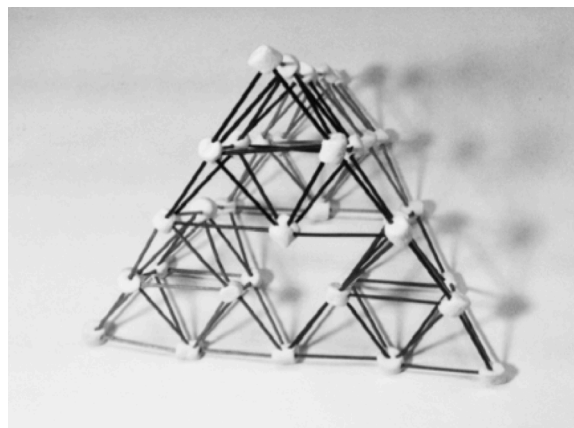# Fractal Tetrahedrons

Overview

In this lesson, students will cooperate to create a large, complex fractal tetrahedron. A tetrahedron is a three-dimentional solid made of four triangles. Each student will create their own fractal tetrahedron out of toothpicks and mini-marshmallows. Students will then group together in teams of four and combine their tetrahedrons into a larger version of the same shape. To continue, four groups of four will join their tetrahedrons into an even larger version, and so on.

Appropriate for: grades K – 12, college and adults

Objectives

- To create a complex pattern by repeating a simple process over and over again
- To analyze and compose shapes according to properties of their lines and angles
- To use operations to explain patterns in arithmetic
- To observe mathematical trends and create models to make predictions
- To attend to precision
- To draw, construct and describe geometrical figures and describe the relationships between them
- To exhibit teamwork when using each student's individual tetrahedron to make a larger product

Materials

- Toothpicks (500 for class of 16 to 20 students)
- Mini-marshmallows, set out to dry out at least 24 hours before activity to ensure firmness (1 bag for class of 16 to 20 students)
- Protractors
- Tetrahedron worksheet

Brief the students that these are **construction materials** and NOT food or candy! These stale marshmallows are for an educational project… not a snack! Toothpicks are sharp, and must be handled carefully by children. Let students know that the resources are limited. If students break their toothpicks or eat marshmallows, they may not be able to complete their part of the project.

Fractal Tetrahedrons

Common Core Standards for Mathematics

Code	Standard	Grade	Code	Standard	Grade
CC	Counting and Cardinality	K	NS	Number System	6, 7
NBT	Number and Operations in Base Ten	K, 1	RP	Ratios and Proportional Relationships	6, 7
OA	Operations and Algebraic Thinking	K – 5	SP	Statistics and Probability	6
MD	Measurement and Data	K – 5	EE	Expressions and Equations	6, 7
G	Geometry	K – 7	F	Functions	8
NF	Number and Operations – Fractions	4			

Common Core Standards for English Language Arts

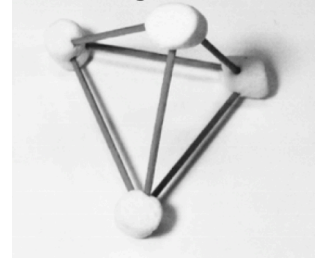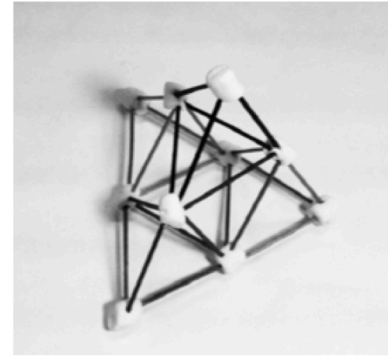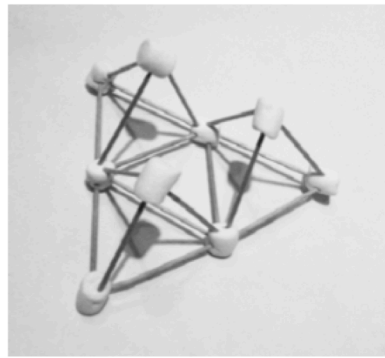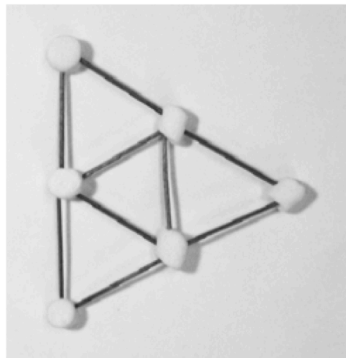| Code	Standard	Grades K – 5	Grades 6 – 8	Grades 9 – 12
RL	Reading: Literature	1, 4, 7, 10	1, 4, 7, 10	1, 4, 10
RI	Reading: Informational Text	1, 3, 4, 7, 10	1, 3, 4, 7, 10	1, 3, 4, 10
FS	Foundational Skills	1, 2, 3 for grades K – 1; 3 and 4 for grades 2 – 5	None available	None available
W	Writing	2, 3, 8; 4 for grades 3 – 5	2, 3, 4	2, 3, 4, 9
SL	Speaking and Listening	1, 2, 3, 4, 5, 6	1, 2, 3, 4, 5, 6	1, 2, 3, 4, 5, 6
L	Language	1, 4, 6; 3 for grades 2 – 5	1, 3, 4, 6	1, 3, 4, 6
RST	Science and Technical Subjects	None available	1, 3, 4, 6, 7, 10	2, 3, 4, 6, 7, 10

Fractal Tetrahedrons

Instructions

A tetrahedron is a simple three-dimensional shape made of four equilateral triangles. The basic building block of the fractal tetrahedron is made with four marshmallows and six toothpicks.
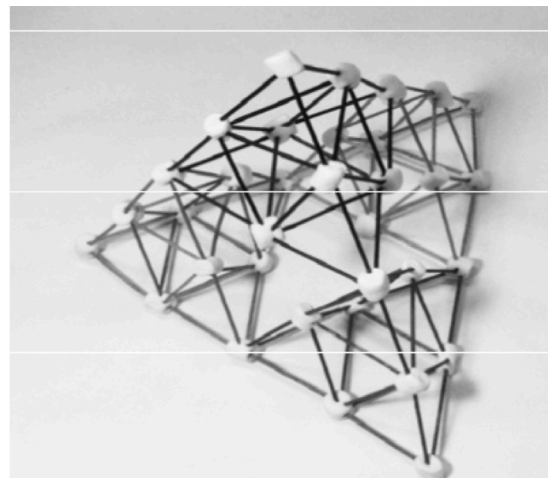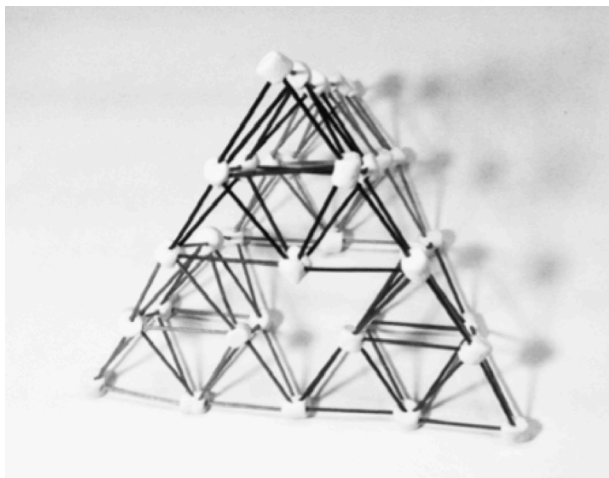
To make a second-order tetrahedron, rather than building four of the building blocks and joining them, it is easier for students to build the base of triangles, as shown here, and then extend the outer three triangles into tetrahedrons. Add a single building block to the top to complete their second-order tetrahedron.

When a group of students has finished their tetrahedrons, they can assemble all four of them into a larger creation containing 16 of the building blocks. Students can do so by arranging three of them into a base and then adding the final one on top. This will require team work as they must remove one marshmallow each from the corner of their individual tetrahedrons in order to carefully join them together.

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Fractal Tetrahedrons

Fractals are never ending patterns, the next step is to take the output of four groups of four students, and combine them into a bigger tetrahedron comprised of 16 by 4 or 64 building blocks.

If possible, merge a few classes so that you have 64 participants, which will allow them to reach the next level, a giant tetrahedron made of 256 building blocks.

Children love the expansive possibilities of this sort of fractal engineering. Challenge them to figure out the arithmetic of their creations at each level.

Elementary-aged students from Albuquerque, NM building tetrahedrons

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