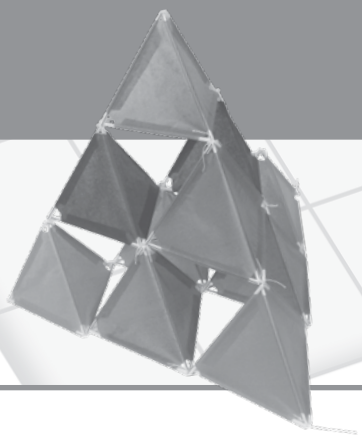
10-Cell KaZoon Kite Kit
Teacher Procedure



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Overview

The 10-cell KaZoon Kite activity gives students a real-life connection to solid geometry. Using simple materials, students build 10 individual tetrahedrons (cells) with two adjacent faces covered with tissue paper. When tethered with a kite string, these individual cells fly, but they will fly even better when combined into larger tetrahedral configurations.

Construction will take approximately 60 to 90 minutes. An additional 45 to 60 minutes is recommended for flying time, extension activities, and discussion of the math connections.

Math Connections

The individual tetrahedron cell is composed of four equilateral triangles. Each of these triangles is one face of the tetrahedron. The area of each triangle can be found, and the surface area of the tetrahedron can be calculated. The volume of the tetrahedron can also be calculated.

When four cells are arranged and connected to make a larger tetrahedron (four-cell), the surface area and volume can be calculated. With additional materials, four of the larger tetrahedrons can be arranged and connected to make a 16-cell tetrahedron. Students can predict the number of cells that would be required for the next in the sequence, a 64-cell tetrahedron.

Area of a triangle = ½ (base x height) or $\frac{\sqrt{3}}{4} s$

Surface area (tetrahedron) = 4 x area of one triangle or $\sqrt{3}\, s^2$

Volume (tetrahedron) = $\frac{\sqrt{2}}{12} s^3$

Materials

Included:

- 60 straws – six for each cell
- 3 sheets of tissue paper – one sheet per four cells
- 1 kite string roll
- 1 Lifting Surface Template
- 1 – 10-Cell KaZoon Kite User Guide

Required (not included):

- Glue stick
- Scissors
- Paper clips

Construction Details

Students will follow the detailed instructions found in the user guide.

Kite Flying Tips

Important: The kite string on the roll is *not* attached to the core. As the string is let out, students must take care that their kite does not escape by pulling the end of the string off the roll.

- When flying, the kites will fly inverted from the position the kite is shown after the final build. It will help to have the kite in the inverted position as students are attempting to get their kites in the air.
- Launching the kites is best done with a team of two students – one holding the kite in the inverted position while the other holds the roll of string about 20 to 30 feet away. The line should be somewhat tight as the student with the kite tosses it gently into the air. Depending on the wind velocity, the student holding the string may have to run a small distance to get the kite up and into the higher winds.
- The tetrahedron kites fly well in straight winds blowing 5 to 8 miles per hour (mph).
- Kites made from a single cell are the least stable but will fly. A four-cell tetrahedron kite (basically, a kite made like the top two levels of the 10-cell kite) flies very well. If desired, students can construct and fly a four-cell kite and compare it to the flight characteristics of the 10-cell kite (amount of pull, height gained, amount of wind velocity required for flight, and so forth).
- If winds are faster than 8 mph or are turbulent, the kites will be difficult to control and will tend to take sudden dives. Taping a tissue paper tail to the back of the kite (when it is in the inverted flying position) can offset this. The tail should be about two inches wide and can be from one to three feet long – the best length for the conditions may be determined by trial and error.
- Be sure to fly in open areas and away from power lines, trees, and buildings.
- Do not fly these kites in damp conditions. Any moisture on the tissue paper will ruin it.

Extensions

- Students can design a variety of tetrahedron kites. Many different designs are available by searching the Internet.
- Have students fill in a chart of the number of vertices, sides, faces, and cells for the one-cell, four-cell, and 20-cell kites. Have them try to predict the number of vertices, sides, and faces in a 35-cell kite.
- Have students determine the quantities of materials needed for a 35-cell kite.
- As the students are flying kites, have them determine the altitude of the kite by using similar triangles.
- Show how the formulas for surface area and volume are derived, or let students try to come up with their own formulas for these values.

Glossary

area – size of an enclosed region

face – a planar surface of a geometric solid

sequence – an ordered list of mathematical events

surface area – the total of the area of all surfaces of a three-dimensional object

tetrahedron – a polyhedron with four triangular faces

volume – the amount of space occupied by a three-dimensional object

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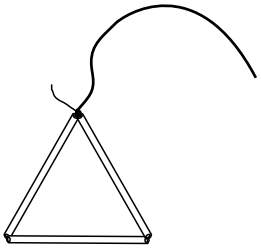
Making Triangular Straw Frameworks

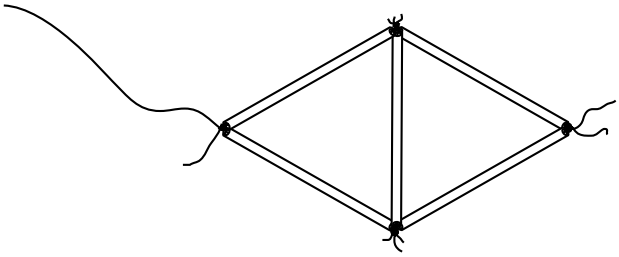
1. Locate the String Measurement Guide on the Lifting Surface Template.
2. Locate the spool of kite string.
3. Measure and cut 10 strings 40" long. Refer to the String Measurement Guide printed on the Lifting Surface Template. The String Measurement Guide is 10" long. You must measure four continuous segments of the string to achieve a piece of string 40" long.
4. Measure and cut 20 strings 14" long. Find the 7" mark on the String Measurement Guide. Measure two continuous segments of string to make a piece of string 14" long.
5. Using one of the 40" pieces of string, thread it through three plastic straws.
6. Tie the two ends of the string together. Leave 2" of string on one side of the knot and about 12" of string on the other side. The straws should form a triangular shape.



7. Make an extra knot in the string to strengthen the original knot. Set this straw triangle aside.
8. Repeat Steps 5 through 7 nine more times to make nine more straw triangles like the first one.

Expanding Frameworks

1. Take a straw triangle and tie one of the 14" strings to one of the triangle's vertices opposite the vertex with the 2" and 12" string hanging from it. Tie it so it has 2" on one side of the knot and 12" on the other.
2. Take another 14" string and tie it in the same manner to the third vertex of the straw triangle.
3. Thread the long string from one of the straw triangle's vertices through an unattached straw.
4. Thread the long string from a second vertex of the straw triangle through another unattached straw.
5. Take the two strings just threaded and tie them together. A diamond shape is the result.



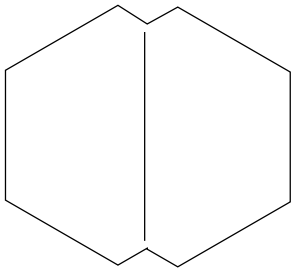
6. Repeat Steps 1 through 5 with the nine remaining straw frameworks so that you have 10 diamond-shaped pieces.

Attaching the Wing Surface

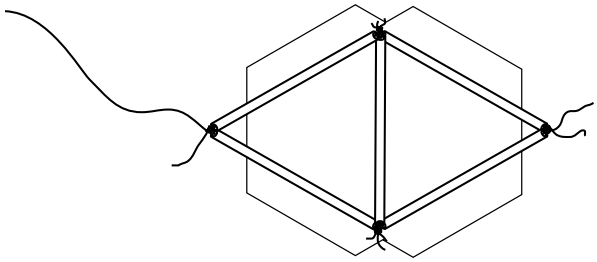
1. Locate the Lifting Surface Template (LST) and cut out the template.
2. Stack the three pieces of 20" x 30" tissue paper on top of each other. Fold the stacked sheets as shown on the LST.
3. Locate two paper clips. Attach the LST to the tissue paper by placing the clips on the long folded edge. **Important:** Place the dotted side along the long fold of the tissue paper.

4. Use sharp scissors to cut around five sides of the LST. Do not cut along the long fold where the clips are attached.

5. Unfold one of the four pieces of tissue paper. The shape it makes should closely resemble this drawing:



6. Place the diamond-shaped straw figure on the unfolded piece of tissue. Place the center straw (between the two triangular shapes) at the center of the unfolded tissue paper as shown in this drawing:



Important: The tissue paper should extend equally in all directions from under the diamond shape.

7. Use the glue stick to place a strip of glue along one of the edges of the tissue paper.

8. Fold the glued edge of the tissue paper over the straw and press it smoothly to the tissue surface.

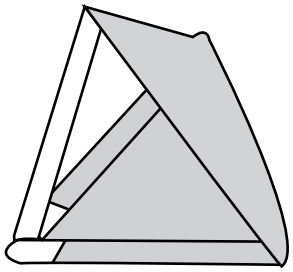
9. Repeat Steps 7 and 8 until all four edges have been glued to the tissue surfaces.

10. Repeat Steps 5 through 9 for each diamond-shaped piece.

Forming the Kite Wings

1. Locate the 12″ string remaining on the diamond object and thread it through another unattached straw.

2. Tie the end of the string threaded in Step 1 to the opposite vertex. Use one of the 2" strings at this vertex to tie to the string threaded in Step 1. You have now formed one of the kite's wings.

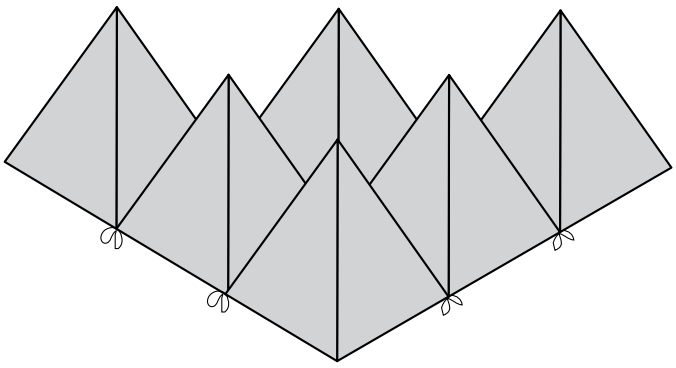


3. Repeat Steps 1 and 2 until you have 10 kite wings.

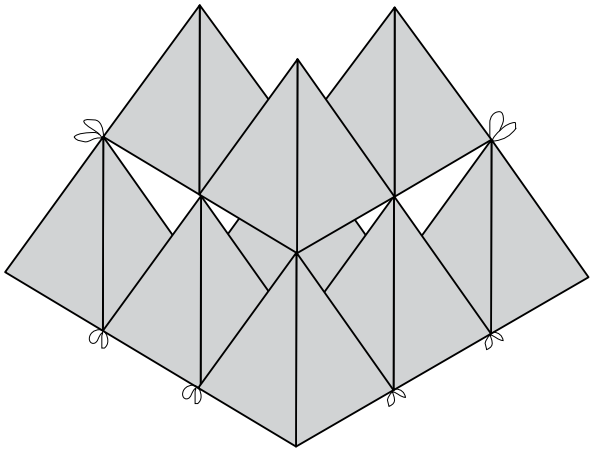
Tying It All Together

1. Place an uncovered side of each of six kite wings on a flat surface so that they form a triangular shape (see below). **Important:** Tissue-covered faces of all wings should point toward the front point of the kite. These will form the kite base.

2. Using the strings at the vertices, tie the corners of the six wings together where they touch at their bases as shown below.

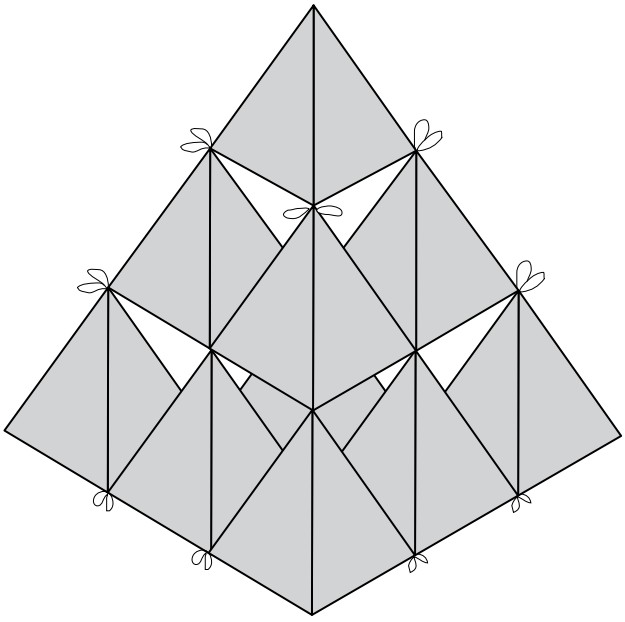


3. One at a time, place three kite wings on top of the base wings. Using the strings at the top vertices of the base wings, tie the three mid wings as shown.



4. Place the 10th and final kite wing on top of the three mid wings. **Important:** Ensure that all tissue-covered surfaces face toward the front of the kite.

5. Using the strings at the top vertices of the three mid wings, tie the top kite wing to the three mid wings as shown.



Finishing Up

1. Trim the excess strings from each vertex. Make sure you don't trim so closely that the knot is weakened.

2. Locate the front of your kite. When viewed from the front, all surfaces are covered.

3. Attach the end of the kite string on the spool through the front bottom vertex of the base wing. Tie it tightly. A second knot should be used to ensure that the kite does not come loose in flight.

Your tetrahedral kite is now ready for flight!

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