- Activity Name: **Tetrahedron Kites**

- Objectives:

  During the making of the kites, the students will learn about the tetrahedon, networks, 3-dimensional models and geometric vocabulary. After the kite is built, they will explore the relationships of length, area, surface area, and volume. The students will also explore some of the patterns in the tetrahedral kite including the packing of space with the basic units involved in the kite.

- EALR/Standards:

  1.3 understand and apply concepts and procedures from geometric sense
  2.1 investigate situations
  2.3 construct solutions
  3.1 analyze information
  3.3 draw conclusions and verify results
  4.1 gather information
  4.2 organize and interpret information

- Materials:

  Straws (24 per group to build two levels, 60 per group to build three levels)
  Ribbon or yarn (4 or 10 pieces per group each approximately 6 feet long)
  Tissue paper (4 or 10 pieces of 10" by 15" per group)
  Scissors
  Tape (24 inches is plenty per group)

- Teacher Notes
  - Prerequisites for the learner:

    Depends on the use of the project. See teacher hints for more information.

  - Teacher hints for the activity:

    This is an activity that can be used as an introduction to the school year for vocabulary building, review, and an introduction to Geometry. It can also be used later in the year or with advanced classes to teach relationships between linear, area, and volume calculations, or for regression models and finite differences.
    Before starting this project, the instructor needs to build a tetrahedral, an octahedral, and a tetrahedron that is sheared.

- ## Introductory questions: For the building of the kites

Holding up a tetrahedron model:

What is this made of material wise and piece wise?

What will you need to build one of these?

Can one of these be built by putting the ribbon/string through each straw only once.

- ## Solutions:

Introductory questions: Straws and ribbons, 6 straws, approximately 4 feet ribbon

The straws and ribbon.

No – there are 4 odd nodes. (Do not give this answer until the end of the building)

- ## Assessment suggestions:

Does it fly (checking for team work and direction following)

Given a model of cubes build in the same fashion, redo the worksheets.

The Activity:

Begin by showing the students a tetrahedron. Explain that they each need to build one. Do not give a lot of instructions on the how, just let them experiment and try. It is important that they help each other in their groups.

If you want to teach **networks** and traversability, introduce this by asking students to try to go through each straw only once with the ribbon. It is also important that they do not cut the ribbon. (They will hopefully discover that this is impossible.)

Once the group has produced four tetrahedrons, have them brainstorm **vocabulary** words that they can see on the tetrahedron. (Examples: face, edge, segment, circle, dihedral angle.) Groups should be able to find at least 25 words. After brainstorming in groups, have the class build a vocabulary list on the board. Have students show where the words can be seen on their tetrahedrons, especially those words that are questionable.

To finish the kites, have students place three of the tetrahedrons together so that their bases form a large triangle. Use short pieces of ribbon to tie these three tetrahedral together. Place the fourth tetrahedron on top of the bottom three to form a large tetrahedron. Use ribbon to tie this in place. While two students are tying these together, the other two should be cutting the tissue paper according to the pattern. When the cutting is complete, the students need to tape the tissue paper onto the kite according to the diagram. Finally, they need to attach the bridal.

For homework or for those students who finish early, each group needs to build an addition 6 tetrahedra and one octahedral. For extra credit or as an optional, have each student take 12 straws, place them on a string with the end straws taped to the ribbon end, and then fold the line of straws into an octahedron. This shows students that octahedra are traversable networks.

After the kites are completed, begin working through the worksheets and questions on the student pages.

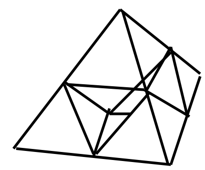
Assessment material:

Worksheet pages can be used to check the student's work.

- <u>Extensions:</u>

    Why does the kite fly?
    Can an octahedron be made to fly?
    Is there a relationship between the area and volume of tetrahedral or cubes?

Two level kite: Four tetrahedra



TETRAHEDRON WORKSHEET

After completing the building of your two level tetrahedron kite, answer the following question.

1) Fill in the chart using the given information:

	First level tetrahedron	Second level tetrahedron
Edge length	One Unit	______Unit(s)
Area of one Face	One Square Unit	______Square Unit(s)

***Are the units of the edge length and the face area the same? (i.e. Inches for both or Centimeters for both) Answer with complete sentences and give an explanation. A picture might be helpful.

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Total surface area	______Square Units	______Square Units
Volume	One Cubic Unit	______Cubic Unit(s)

Build a third level tetrahedron

2) Give the dimension for each of the following: (i.e. 1,2 or 3 dimensional)

a) Length ______________ b) Area ___________ c) Volume ______________

3) Using the chart and the information from question 2, imagine placing a fourth and fifth tier on your tetrahedron. Fill in the following chart.

	One Tetrahedron	Third Tier	Fourth Tier	Fifth Tier
Edge Length	One Unit	_____Unit(s)	_____Unit(s)	_____Unit(s)
Area of One Face	One Sq. Unit	_____Sq. U(s)	_____Sq. U(s)	_____Sq. U(s)
Surface Area	_____Sq. U(s)	_____Sq. U(s)	_____Sq. U(s)	_____Sq. U(s)
Volume	One Cubic Unit	_____Cu. Unit(s)	_____Cu. U(s)	_____Cu. U(s)

4) Describe a pattern for comparing areas and volumes of different tetrahedron tiers.

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5) What is the volume relationship between your second tiered tetrahedron and the octahedron built with the same straws? How about the single tetrahedron and a square pyramid built with the same straws?

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6) Fill in the following chart

Level	Up Tetrahedra	Octahedra	Down Tetrahedra
0	0	0	0
1	1	____	____
2	4	____	____
3	_____	____	____
4	_____	____	____
5	_____	____	____

7) What is the volume for each level tetrahedral kite?

Level	Volume
0	0
1	1
2	_____
3	_____
4	_____
5	_____
n	_____

8) What is the ratio of one level tetrahedral to octahedral in a n-level tetrahedron kite?

9) If n goes to infinity, what happens to the ratio found in 8)? What does this mean for the tiling of space with tetrahedral and octahedral?

Extra Thoughts and Extensions

1) If you had several squares which grew in size by taking the smallest edge length and doubling it for the second square, tripling it for the third and so on, would you find a pattern in the areas and volumes? Explain why or why not. Give the pattern if you think yes.

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***Draw a set of six squares on graph paper following the idea presented in question 6.

2) Using your graph paper squares, make and fill in a chart that shows edge lengths, area, and volume*.

*For volume, Use the square as one side of a cube

3) Was your answer to question 1) correct? ________ . Do you think this pattern will work for other shapes? Give an explanation and possibly examples.

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****More thoughts and questions:

Do the shapes have to be identical except for edge length?

What happens if you consider the fourth dimension or even higher dimensions?

Can you draw or build models of shapes that fit the pattern and ones that do not fit the pattern?

Why does the kite fly?

Could you get an octahedron to fly?

Can you find relationships in the areas and volumes of cubes and tetrahedrons?