DISCOVER

4-H ART OF MATH CLUBS

EXTENSION
UtahStateUniversity

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Aris Biederman | Rebecca Mills | Stacey MacArthur
Utah State University Extension

Description

The Discover 4-H Clubs series guides new 4-H volunteer leaders through the process of starting a 4-H club or provides a guideline for seasoned volunteer leaders to try a new project area. Each guide outlines everything needed to organize a club and hold the first six club meetings related to a specific project area.

Purpose

The purpose is to create an environment for families to come together and participate in learning activities that can engage the whole family, while spending time together as a multi-family club. Members will experiment with new 4-H project areas.

What is 4-H?

4-H is one of the largest youth development organizations in the United States. 4-H is found in almost every county across the nation and enjoys a partnership between the U. S. Department of Agriculture (USDA), the state land-grant universities (e.g., Utah State University), and local county governments.

4-H is about youth and adults working together as partners in designing and implementing club and individual plans for activities and events. Positive youth development is the primary goal of 4-H. The project area serves as the vehicle for members to learn and master project-specific skills while developing basic life skills. All projects support the ultimate goal for the 4-H member to develop positive personal assets needed to live successfully in a diverse and changing world.

Participation in 4-H has shown many positive outcomes for youth. Specifically, 4-H participants have higher participation in civic contribution, higher grades, increased healthy habits, and higher participation in science than other youth (Learner et al., 2005).

Updated February 2015

Utah 4-H

4-H is the youth development program of Utah State University Extension and has more than 90,000 youth participants and 8,600 adult volunteers. Each county (Daggett is covered by Uintah County) has a Utah State University Extension office that administers the 4-H program.

The 4-H Motto

"To Make the Best Better!"

The 4-H Pledge

I pledge: My HEAD to clearer thinking, My HEART to greater loyalty, My HANDS to larger service and My HEALTH to better living, For my Club, my Community, my Country, and my world.

4-H Clubs

What is a 4-H Club? The club is the basic unit and foundation of 4-H. An organized club meets regularly (once a month, twice a month, weekly, etc.) under the guidance of one or more volunteer leaders, elects its own officers, plans its own program, and participates in a variety of activities. Clubs may choose to meet during the school year, only for the summer, or both.

Club Enrollment

Enroll your club with your local Extension office. Each member will need to complete a Club/member Enrollment form, Medical History form, and a Code of Conduct/Photo Release form (print these from the www.utah4h.org website or get them from the county Extension office).

Elect Club Officers

Elect club officers during one of your first club meetings. Depending on how many youth you have in your club, you can decide how many officers you would like. Typical officers will include a president, vice president, pledge leader, and secretary. Other possible officers or committees are: song leader, activity facilitator, clean-up supervisor, recreation chair, scrapbook coordinator, contact committee (email, phone, etc.), field trip committee, club photographer, etc. Pairing older members with younger members as Sr. and Jr. officers may be an effective strategy to involve a greater number of youth in leadership roles and reinforce the leadership experience for both ages. Your club may decide the duration of officers–six months, one year, etc.

A Typical Club Meeting

Follow this outline for each club meeting:

- ☐ Call to order–President
- ☐ Pledge of Allegiance and 4-H Pledge–Pledge Leader (arranges for club members to give pledges)
- ☐ Song–Song Leader (leads or arranges for club member to lead)
- ☐ Roll call–Secretary (may use an icebreaker or get acquainted type of roll call to get the meeting started)
- ☐ Minutes of the last meeting–Secretary
- ☐ Business/Announcements–Vice President
- ☐ Club Activity–arranged by Activity Facilitator and includes project, lesson, service, etc. These are outlined by project area in the following pages.
- ☐ Refreshments–arranged by Refreshment Coordinator
- ☐ Clean Up–led by Clean-up Supervisor

Essential Elements of 4-H Youth Development

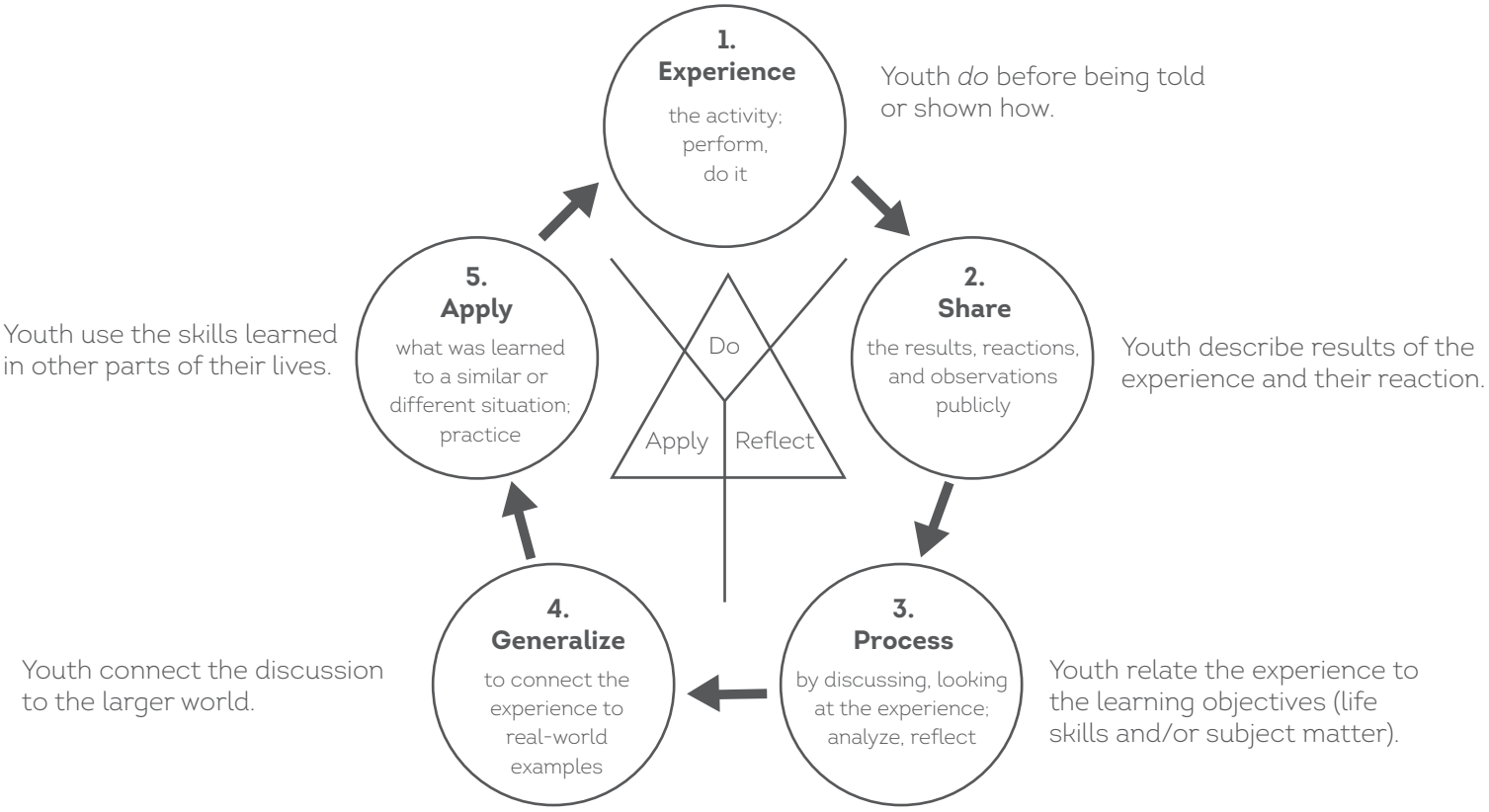
The essential elements are about healthy environments. Regardless of the project area, youth need to be in environments where the following elements are present in order to foster youth development.

1. **Belonging**: a positive relationship with a caring adult; an inclusive and safe environment.
2. **Mastery:** engagement in learning; opportunity for mastery.
3. **Independence:** opportunity to see oneself as an active participant in the future; opportunity to make choices.
4. **Generosity:** opportunity to value and practice service to others.

(Information retrieved from: http://www.4-h.org/resource-library/professional-development-learning/4-h-youth-development/youth-development/essential-elements/)

4-H "Learning by Doing" Learning Approach

The Do, Reflect, Apply learning approach allows youth to experience the learning process with minimal guidance from adults. This allows for discovery by youth that may not take place with exact instructions.



4-H Mission Mandates

The mission of 4-H is to provide meaningful opportunities for youth and adults to work together to create sustainable community change. This is accomplished within three primary content areas, or mission mandates, - citizenship, healthy living, and science. These mandates reiterate the founding purposes of Extension (e.g., community leadership, quality of life, and technology transfer) in the context of 21st century challenges and opportunities. (Information retrieved from: http://www.csrees.usda.gov/nea/family/res/pdfs/Mission_Mandates.pdf)

1. **Citizenship:** connecting youth to their community, community leaders, and their role in civic affairs. This may include: civic engagement, service, civic education, and leadership.
2. **Healthy Living:** promoting healthy living to youth and their families. This includes: nutrition, fitness, social-emotional health, injury prevention, and prevention of tobacco, alcohol, and other drug use.
3. **Science:** preparing youth for science, engineering, and technology education. The core areas include: animal science and agriculture, applied mathematics, consumer science, engineering, environmental science and natural resources, life science, and technology.

Getting Started

1. Recruit one to three other families to form a club with you.
    a. Send 4-H registration form and medical/photo release form to each family (available at utah4h.org)
    b. Distribute the Discover 4-H Clubs curriculum to each family
    c. Decide on a club name
    d. Choose how often your club will meet (e.g., monthly, bi-monthly, etc.)
2. Enroll as a 4-H volunteer at the local county Extension office (invite other parents to do the same)
3. Enroll your club at the local county Extension office
    a. Sign up to receive the county 4-H newsletter from your county Extension office to stay informed about 4-H-related opportunities.
4. Identify which family/adult leader will be in charge of the first club meeting.
    a. Set a date for your first club meeting and invite the other participants.
5. Hold the first club meeting (if this is a newly formed club).
    a. See *A Typical Club Meeting* section above for a general outline.
        i. Your activity for this first club meeting will be to elect club officers and to schedule the six project area club meetings outlined in the remainder of this guide. You may also complete a-d under #1 above.
    b. At the end of the first club meeting, make a calendar outlining the adult leader in charge (in partnership with the club president) of each club meeting along with the dates, locations, and times of the remaining club meetings.
6. Hold the six project-specific club meetings outlined in this guide.
7. Continue with the same project area with the 4-H curriculum of your choice (can be obtained from the County Extension Office) OR try another Discover 4-H Club project area.

Other Resources

Utah 4-H website: www.Utah4-h.org
National 4-H website: www.4-h.org
4-H volunteer training:
To set up login:
http://utah4h.org/htm/volunteers/get-involved/new-volunteer-training
To start modules: http://4h.wsu.edu/volunteertraining/course.html
(password = volunteer)

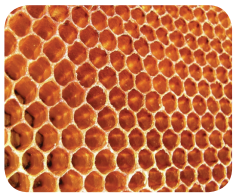
References

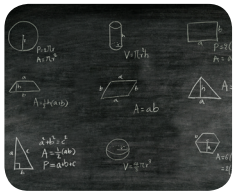
Information was taken from the Utah 4-H website (utah4h.org), the National 4-H Website (4h.org), the Utah Volunteer Handbook, or as otherwise noted.

Lerner, R., M. et al., (2005). Positive youth development, participation in community youth development programs, and community contributions of fifth grade adolescents: Findings from the first wave of the 4-H Study of Positive Youth Development. Journal of Early Adolescence, 25(1), 17-71.

We would love feedback or suggestions on this guide; please go to the following link to take a short survey:
http://tinyurl.com/lb9tnad

4-H ART OF MATH CLUB *Meetings*





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4-H Club Meeting 1
Patterns and the Fibonacci Sequence

Supplies

- Graphing paper
- Pencil OR pen
- (optional) Crayons, markers, and other coloring materials
- (optional) Calculator

Activity #1

THE FIBONACCI SEQUENCE

Fibo-what? In the 13th century, Signore Leonardo Pisano Bogollo created a special sequence of numbers named after his nickname, "Fibonacci," which roughly translates to "son of Bonacci" (Knott 1996). Thus, we have a beautiful mathematical way to help make sense of the patterns in this world: the Fibonacci sequence.

But what is the Fibonacci sequence? Quite simply, the Fibonacci sequence is a list of numbers that form a naturally occurring pattern. That's right, this order of numbers exists in nature. For example, you can find them in pinecones, conch shells, and flowers, to name a few.

(Belmont, p. 12)

So, how does it work? The Fibonacci sequence can be found quite simply. You start with the first two numbers, 0 and 1. Then you add them together to get the next number. So, 0 + 1=1. Now your sequence is 0, 1, 1. Then you look at the last two numbers and add them together. So, 1+1=2. Now your sequence is 0, 1, 1, 2. See the pattern? In mathematical notation, this is described as Xn = Xn-1 + Xn-2, which is just a fancy way of saying that your next number in the sequence can be found by taking the last two numbers and adding them together.

THE FIBONACCI SEQUENCE CONTINUED

Your turn. Now that you have the first four numbers in the Fibonacci sequence, find the next ten and add them to the sequence. [Answer: 0, 1, 1, 2, 3, 5, 8, 13, 21, 34, 55, 89, 144, 233]

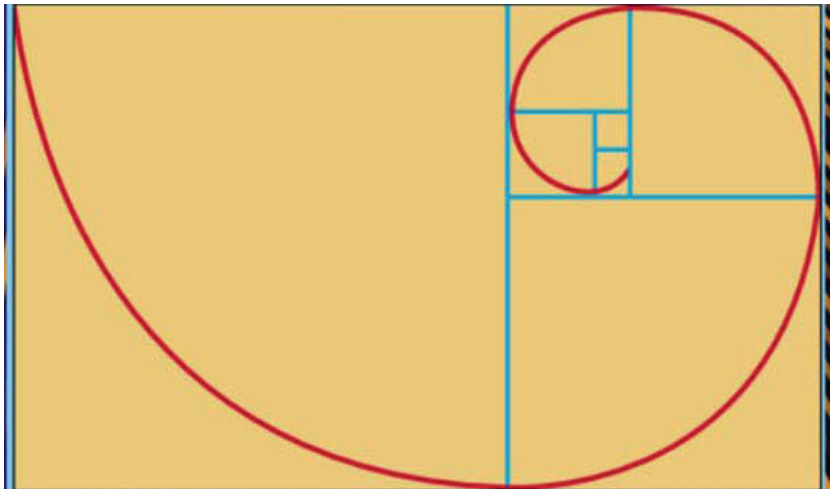
Discussion Options: What kinds of patterns naturally occur in the world around us? What kind of man-made patterns can be found in the world around us?

Activity #2

A SEQUENCE, A SPIRAL

Now that you've learned how to create the Fibonacci sequence, let's talk about how it is applied. In art and nature, the Fibonacci sequence appears as a spiral, beginning quite small, and getting larger and larger as it turns. This spiral is created by placing squares of equal base and height (in order of Fibonacci's sequence) close to one another. Here's how:

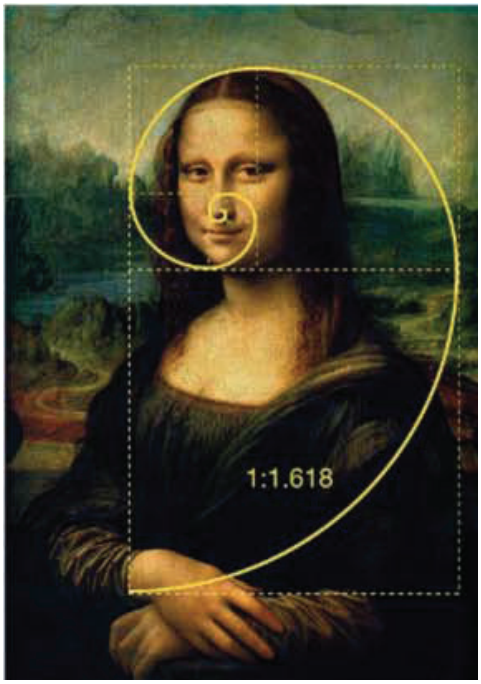
1. In the very center of your graphing paper, trace a one by one square. Next to that one, trace another one by one square (should be touching). This takes care of the first three numbers of Fibonacci's sequence (0, 1, and 1).
2. Next, trace a two by two square that shares the bottom edge of the previous two squares.
3. To the right of these, trace a three by three square.
4. On the top, trace a five by five square.
5. Continue creating squares in a counterclockwise direction according to the Fibonacci sequence until your graphing paper can't hold anymore squares.
6. Finally, create your spiral by connecting the points of your squares at a diagonal. Starting with the one by one squares in the middle, draw a half circle in the first one toward the second. Then continue at the point the last square ended, drawing another half circle from that point to the two by two. Continue until the spiral is connected through all of the traced squares.
7. (optional) Now that you have a spiral, why not spice it up with some color? Use coloring materials to turn your Fibonacci sequence into an eye-catching wonder.



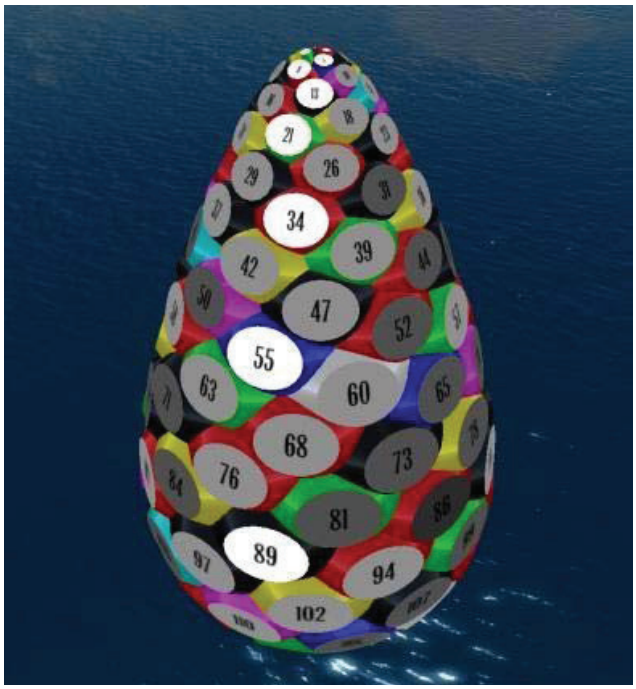
(Belmont, p. 10)

A SEQUENCE, A SPIRAL CONTINUED

Where can you find a spiral like this? Since this sequence is all about natural patterns, many artists use the sequence (and others like it) to create art without even knowing that they are using it. Remember Leonardo Da Vinci's famous painting, the Mona Lisa? Her body is aligned according to the Fibonacci sequence, sitting quite comfortably in a spiral exactly like the one you just created.



(Belmont, p. 14)



(Belmont, p. 9)

As mentioned briefly in the previous activity, the sequence is also found in natural objects, like pinecones, as well. To find it, simply count how many spirals exist on the pinecone going in one direction. Not surprisingly, the number of spirals will always be a number in the Fibonacci sequence.

If you would like to learn more about the Fibonacci sequence, look up the golden ratio.

Activity #3

MAKE YOUR OWN PATTERNS

The Fibonacci sequence does not apply to everything, but it is a great example of how it is possible to find patterns in the world around you. Once you find a pattern, it is also possible to describe the "rule" of the pattern by describing how you get from one part to the next.

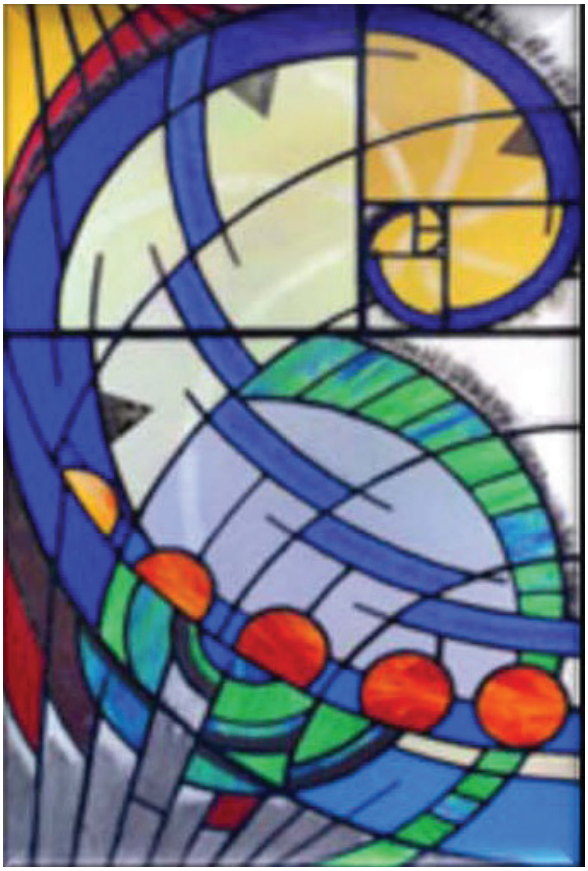
MAKE YOUR OWN PATTERNS CONTINUED

What's the "rule?" The rule of a pattern is simply a description of how it works. Let's use Fibonacci's sequence as an example. 0, 1, 1, 2, 3, 5, 8... The rule for this pattern was looking back at the last two numbers and adding them together. Patterns of objects in our world have rules like this that mathematicians try to find in order to explain and recreate those patterns. Thus, we can use addition, subtraction, multiplication, and division to describe what's going on in the world around us.

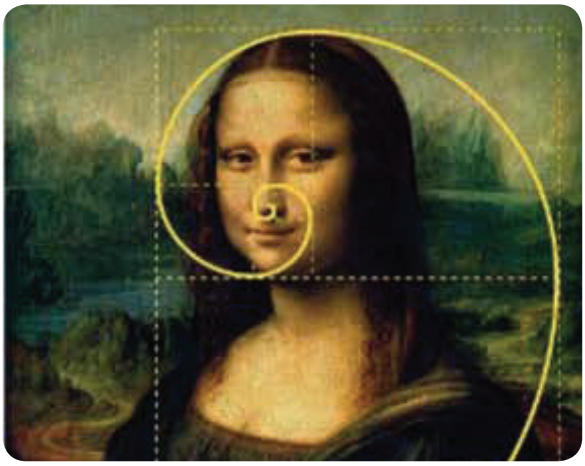
Let's try an example. Look at these numbers: 2, 4, 8, 16, 32, 64... Can you figure out what the pattern is? [Answer: 2 times the number]. That pattern only used multiplication, but it is possible to use more than one operation (like multiplication and subtraction]. Let's try a harder one: 1, 5, 21, 85, 341, 1365... What rule will give us this sequence of numbers? [Answer: 4 times the number plus 1]. And just like that, we have found the rule for a pattern.

Your turn. Make up your own pattern. Remember, you can use one or more operations (don't use division if you're not ready for fractions). When you've created one, share it with a partner and see if they can guess your pattern's rule.

Optional: Line up the numbers in your pattern by the ones, tens, and hundreds place and see if you can find any other patterns.



(Belmont, p. 21)



Reflect

- What is a pattern?
- Who was Fibonacci and what was his connection to patterns?
- In what ways do you see patterns in the world around you?

Apply

- How are patterns related to art? How can artists use them to their advantage?
- What is it about a spiral that is visually appealing?
- Why do you think patterns (such as the Fibonacci sequence) are so important to mathematics?

Belonging

A caring adult can set the tone for a positive experience for 4-H members. At the first club meeting, this can be accomplished by setting up club rules or acceptable behaviors and boundaries. When youth have completed their spirals, take time to showcase and encourage the accomplishment, either individually or as a group.

Mastery

This lesson highlights principles that youth might know, but they also might not know they know it. We see patterns around us all the time, and when we help youth to recognize the patterns, they are gaining skills that this club will build on through the six lessons. Be sure to reflect along the way, to engage them in the learning, and to gauge their progress.

Independence

While teamwork is important, it is also important for youth to gain the confidence in their ability to move forward in life independently. Balance the development of this skill with group and individual activities – perhaps completing the spiral individually but working together to make and solve patterns.

Citizenship

Encourage youth to take leadership roles in the club, from leading pledges to handing out supplies or calling the meeting to order.

Science

This lesson sets the foundation for applied mathematics and the following lessons will build on the concepts of patterns.

Supplies

- Colored paper
- Pencil OR pen
- Scissors
- Elmer's glue or glue sticks
- (optional) Crayons, markers, and other coloring materials
- (optional) Old magazines

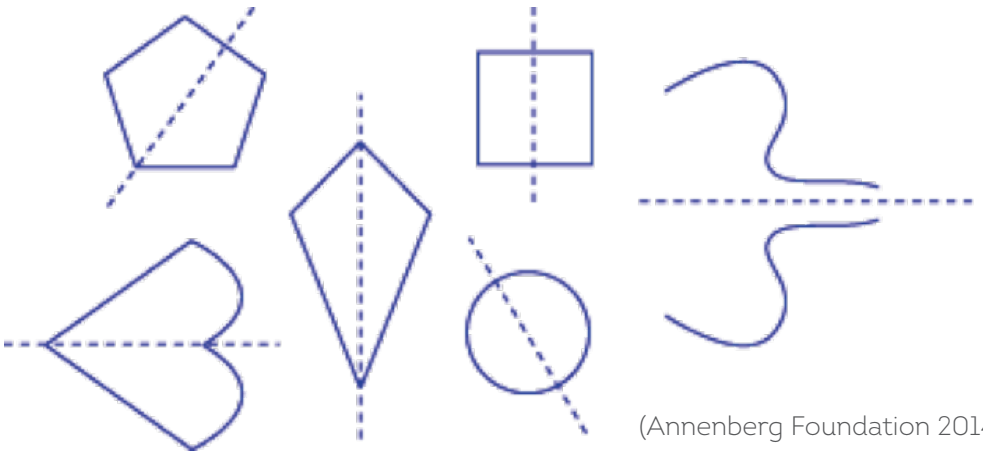
Activity #1

SYMMETRY

Last time, we learned that mathematics is full of patterns, which we try to understand through numbers. These patterns can be represented in numbers, squares, spirals, or any variety of other shapes and symbols. For mathematicians, these representations are extremely important to help visually understand complex and abstract concepts.

So, let's talk shapes. Let's say I have a square and I rotate it 360 degrees (that's one full circle). Does its position change? No. Let's think of that another way. A square table is a square object. If you close your eyes and I turn the square table around in a full circle, and then you opened your eyes again, could you tell that I had moved the table? No. That's because the square has some symmetry. If it is moved and its position does not appear to have changed, then we call that symmetry. The number of ways it can move and not appear to change position is its number of symmetries (Frenkel 2013).

With that in mind, which has more symmetry, a circle or a square? [The correct answer is a circle, because a square only has 4 symmetries and a circle has an infinite number of symmetries]. No matter how many times you turn that circle, its position will not appear to change. However, the square can only not appear to change at 90, 180, 270, and 360 degrees. It appears to change in all the other rotations in between.



(Annenberg Foundation 2014)

SYMMETRY CONTINUED

Here's another way to think of symmetry: If you were to draw a line from top to bottom through the very center point of a circle, would both sides look exactly the same? If yes, then that's symmetry. Can you do the same thing with a square? That's some more symmetry. Many objects in nature have symmetry.

Think of a butterfly. If you were to imagine a line straight down the center of a butterfly and fold it in half, you would find symmetry. That imaginary line is called the line of symmetry. We represent it by a dashed line. On either side of that dashed line, you should have a mirror image. Mathematicians love discovering these sorts of natural symmetries of shapes because it helps to map out the patterns of objects we see every day.

Your turn. Let's create some symmetry [You can choose to do either Activity 1 or 2, or double the fun and do both of them].

Pre-made Practice

1. Use the "Cat Shape" and a sheet of colored paper that matches the size of the "Cat Shape" page.
2. Fold the cat shape in half along the dotted line, creating a line of symmetry. Cut along the outside of the cat (be sure not to cut the fold). Set the outer edges aside.
3. Cut out the triangle nose. Set the nose aside.
4. Fold the diamond eye along the dotted line (creating a line of symmetry) and cut out the eye. Set the eye aside.
5. Follow the same steps (in step 4) for the triangle eyelashes. Set the eyelashes aside.
6. Unfold your shape and see the symmetry you've created. Is everything symmetrical? [If done correctly, then yes]
7. Now cut the cat shape in half, down the line of symmetry.
8. Cut the outer edges you have set aside in half along the line of symmetry.
9. Paste one of the halves of the outer edges to the left or right side of your colored paper.
10. Take half of the cat face and match it up to the opposite side of your outer edges, creating a full cat face again. Paste it in place.
11. Find the nose and eye that you set aside. Cut the nose in half. Inside the outer edge half, match these pieces to the other side so they are symmetrical, paste into place.
12. For the eyelashes, you can choose whether to make them symmetrical or not. If you want them to be symmetrical, paste them like a mirror object to the ones on the other side. If not, paste them somewhere else (like maybe below the eye instead of on top of the eye).
13. Enjoy your symmetrical creation.

(optional) Create your own shape.

1. Pick two sheets of colored paper.
2. Fold one of the papers in half. The fold is now your line of symmetry.
3. Along the fold, use a pencil to draw the outline of half of any shape you want to draw (examples: butterfly, cat, dog, or any object).
4. Cut along the outside of the shape (be sure not to cut the fold).
5. Ta da! You now have a symmetrical shape.

CREATE YOUR OWN SHAPE CONTINUED

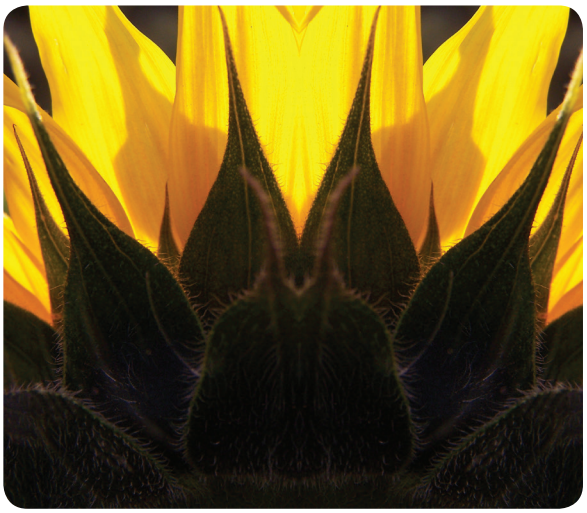
6. If you would like to make eyes or other shapes that do not involve cutting by your fold, you will have to make your own line of symmetry. Do this by drawing a symmetrical shape and then drawing a dashed line where you want your line of symmetry to be.
7. Fold along your new line of symmetry and cut out the shape without cutting through your fold.
8. Enjoy!

Activity #2 (optional)

MORE SYMMETRY

Here is another symmetry exercise you can try:

1. Take out the old magazines (or find some faces of people/animals/other objects you like on the Internet).
2. Cut the face/object in half and paste it to a regular sheet of paper.
3. On the blank side, try to draw in the other side of the face/object to match the pre-drawn side.
4. Ta da! You now have a symmetrical face/object. Use the coloring materials to make it really shine.



Reflect

- What kind of shapes can you create that have symmetry?
- How did folding the object help to see the symmetry?
- Can you find symmetry without folding?

Apply

- Why might artists choose to use symmetry (e.g. drawing)?
- What other objects in your day-to-day life have symmetry?
- Do you have symmetry in you?
- When might it be a good idea to create something with symmetry?
- When might it be a good idea to create something without symmetry?

Belonging

Adults should give positive and encouraging feedback to youth as they work to understand new concepts. This activity may help youth to understand how they are connected to the world around them as they look for symmetry in their own bodies as well as objects in the world around them.

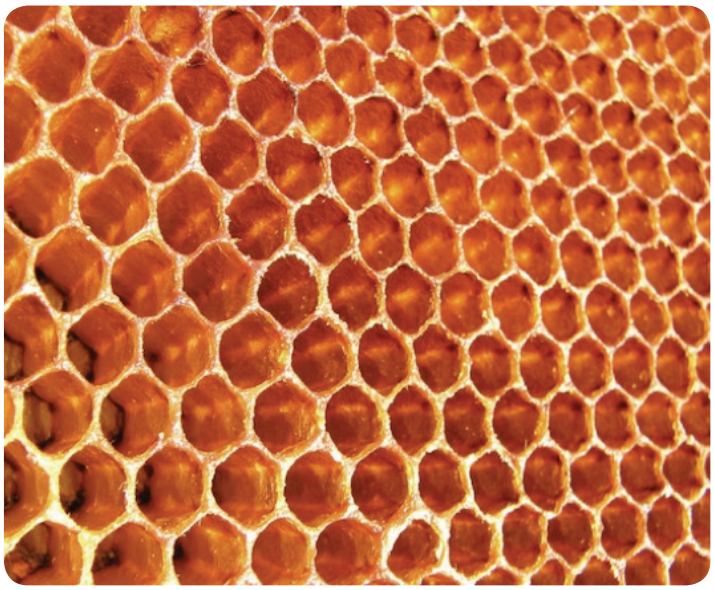
Mastery

Help the youth connect with the material and engage with the subject area. Encourage them to look for other ways to apply the concepts even beyond what is shared in the lesson.

Independence

Encourage the youth through the activities to help them gain positive self-confidence and self-esteem. Younger youth might have difficulty cutting or drawing straight lines which may affect the results of symmetry in the activities of this lesson. Think outside the box to help them find success. Or problem-solve to accomplish the task, then celebrate that success.

4-H Club Meeting 3
Shapes and Tessellations



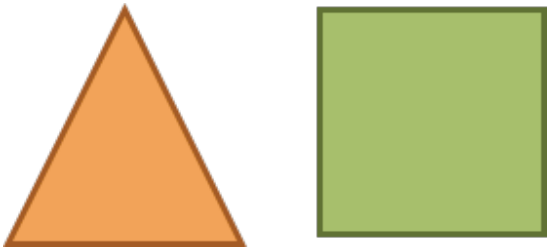
Supplies

- Elmer's glue or glue sticks
- Scissors
- Toothpicks
- Marshmallows
- Computer with Internet access
- Tape
- Paper
- (optional) Paint/paintbrushes and canvas
- (optional) Crayons, markers, and other coloring materials
- (optional) Origami books or printouts from the Internet

Activity #1

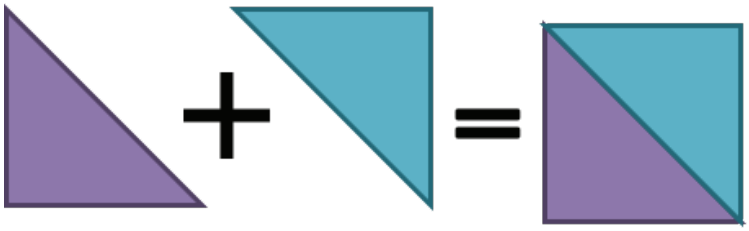
A SHAPE WITHIN A SHAPE

So far, we've talked about patterns and symmetry; now let's talk a little more about shapes. Off the top of your head, what are some basic shapes? [Answers vary, from circles to stars]. For the purposes of this activity, let's talk about triangles and squares.



A triangle has three sides and a square has four, but there are many other shapes out there with many different numbers of sides. We call a shape that has many sides (more than four) a polygon. How many sides does a stop sign have? [Answer: 8] Is it a polygon? [Answer: Yes, because it has many sides]. These many-sided shapes are everywhere, but they aren't as different as they seem. In reality, they are simply just large shapes that have smaller shapes inside them. That means we can use basic shapes to create complex shapes.

A SHAPE WITHIN A SHAPE CONTINUED



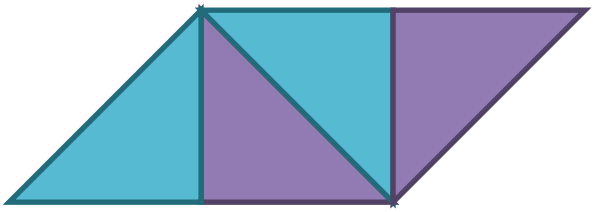
For example, a triangle is a pretty simple shape, but when we put two triangles together, we can build a square. When you combine two triangles with a square, you can build a trapezoid or if you flip one of the triangles upside down, you can build a parallelogram.

Trapezoid

Parallelogram

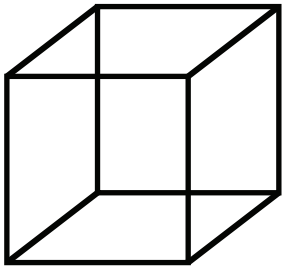
If you combine basic shapes together, you can create more complex shapes of all kinds and sizes. In 2-D, we create polygons. In 3-D, we do the same but call them polyhedrons instead.

POLYGON



VS

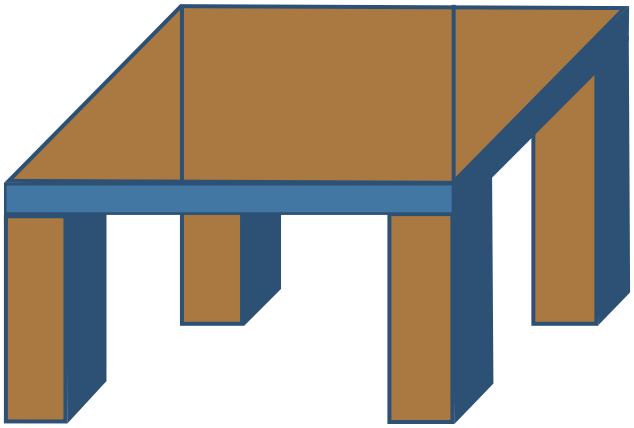
POLYHEDRON



A SHAPE WITHIN A SHAPE CONTINUED

Why combine shapes? We put different shapes together all the time to fit our daily needs. Look around you. These include tables, chairs, playgrounds, houses. Every 2-D and 3-D object is made of a combination of shapes.

How many shapes do you see?



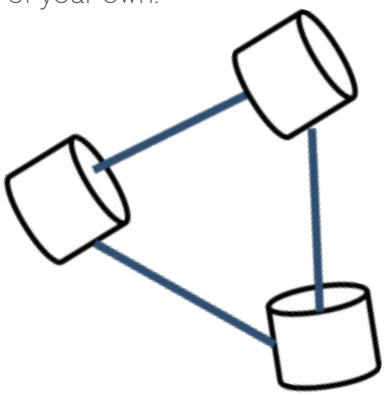
Your turn. Let's build a complex shape.

1. Take out one of the polyhedron papers (cube, pyramid, soccer-ball, etc.). [It may be easier if you are able to print these on a larger sized paper than 8 ½"x11"]
2. (optional) Use crayons, markers and other coloring materials to give your soon-to-be polyhedron some color. Glitter works great, too.
3. Cut along the outside of the shape.
4. Fold at creases (you may need to fold it all the way into the shape to see what should be pasted to what.
5. Put glue on the tabs and paste your shape together until it becomes a full polyhedron.
6. (Optional) Take out an origami book or online template and fold to your heart's content. Be sure to point out all the different shapes that make up each polyhedron you create.

Activity #2

SHAPING THE WORLD

Now that you've made complex polyhedrons based off of someone else's design, it's time to make some polyhedrons of your own.

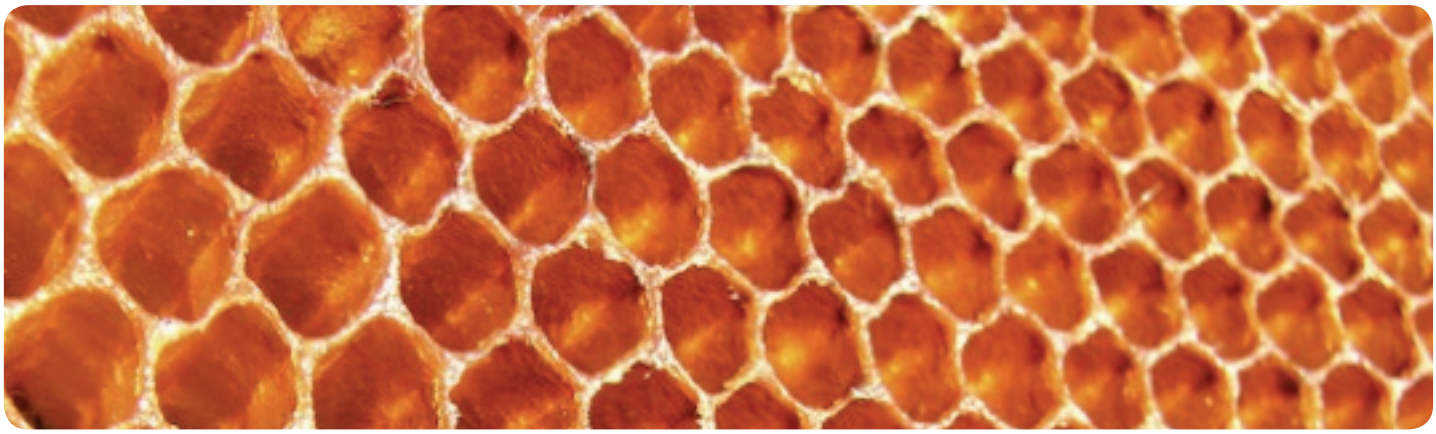


1. Pull out the toothpicks and marshmallows.
2. Stick a toothpick into a marshmallow; now you have one side.
3. Can you make a triangle?
4. How about a pyramid?
5. Can you make a cube?
6. Keep experimenting with polyhedrons as long as you'd like!

Activity #3

TESSELLATIONS

Since polygons and polyhedrons are simply basic shapes added together, you should be able to create an endless amount of shapes. A very unique and appealing group of shapes is called a tessellation.



(Kids Revolution 2012)

What is a tessellation? A tessellation is a pattern that sort of looks like a puzzle. It is created by taking a shape and moving it (without rotating it) using translation symmetry. It is important to note that this shape touches all of the other translated versions of that shape.

There are plenty of tessellations that exist all around us; the most common one that occurs in nature is a beehive, which has a bunch of hexagons translated up, down, left and right. If you Google "tessellation," you are bound to find a whole bunch of interesting patterns created using this symmetry technique. So, let's create a tessellation:

1. Go to https://www.youtube.com/watch?v=Lc4LGZwlcvs (Artc1kar 2011).
2. Follow the instructions on the video; you may need to pause as you follow each instruction carefully.
3. When you have created your shape, you can choose to trace it on paper or canvas.
4. Color and/or paint your creation; enjoy your tessellation!

Reflect

- How many shapes is it possible to make?
- What kind of shapes do you use every day?
- Why are basic shapes, polygons, and polyhedrons important?

Apply

- What tessellations are in the world around you?
- How do artists use shapes?
- What shapes do you use or need every day?

Belonging

As youth build their shapes and design their tessellations, take opportunities to provide feedback and praise. Creating a positive, caring, encouraging environment will help youth to achieve.

Mastery

Connecting the conversation about shapes back to what they build with marshmallows and toothpicks or to their tessellation can be a great way to help the youth master the concept of how the patterns, shapes, math, and art are connected.

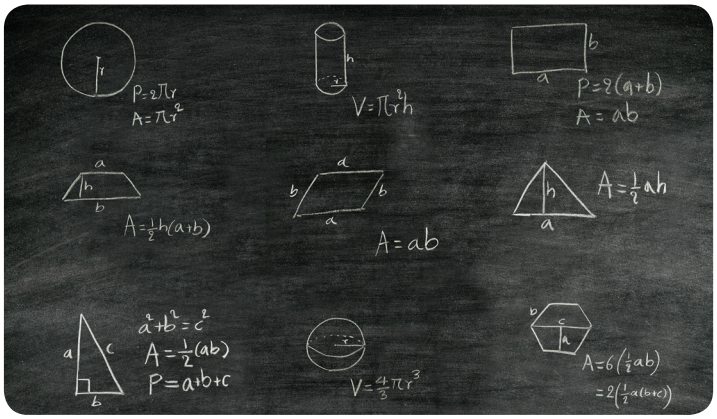
Independence

Allow adequate time for youth to explore building and using shapes, and recognize efforts of persistence, creativity, and determination.

Generosity

Consider taking the tessellation project a step further and doing some artwork and donating it to a local care center or hospital facility. Helping the youth to see that the learning they are doing can contribute to an enjoyable visual for others is one way to teach generosity.

4-H Club Meeting 4
Area, Perimeter, and Volume



Supplies

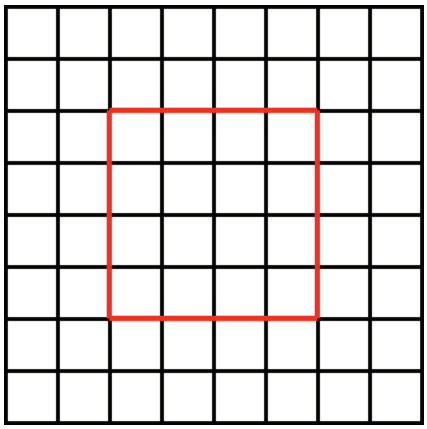
- Paper (plain – 8½"x11" or larger, colored, and graphing)
- Ruler
- Calculator
- Scissors
- Crayons, markers, and other coloring materials

Activity #1

AREA, PERIMETER, AND VOLUME

Area is simply the size of any given surface (Math is Fun 2014). We calculate area using formulas that other people have already created, but let's look at why some of these work.

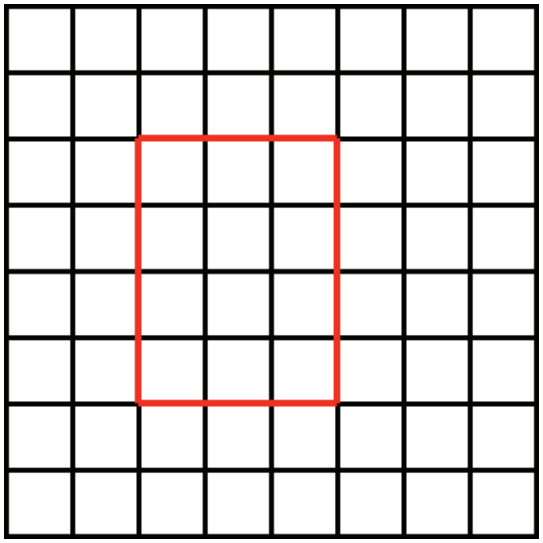
1. Take out a sheet of graphing paper and a pencil.
2. Somewhere on the graphing paper, trace a square that is four boxes tall and four boxes wide.



3. Count how many boxes make up the square [Answer: 16]
4. Now count up the left side. How many boxes make up just that left side? [Answer: 4]
5. Do the same for the top side. How many boxes make up the top side? [Answer: 4]
6. Hmmm… Do you see the pattern? [If not, try another square like a 3x3 or 2x2 OR try a rectangle like a 3x4 or 6x7…]

7. The pattern is a sequence. Since it's a sequence, we need a rule. So, what is the rule? If you multiply the length by the width (or top by left or bottom by right], then you have the total number of boxes inside the larger box. You have the area!
8. Now let's try a few other shapes, and this time, the rule will already be written for you. Do the practice on the Area Worksheet with a partner.
9. If you really want to show off your skills, use a ruler to measure out some triangles or rectangles and use your measurements to find area. Feeling really confident? Measure out a polygon made up of triangles and squares and then find the area by using the rule for each small shape, then adding the areas of the smaller shapes together to find the area of the large polygon.

So area tells you what's inside the lines, but what about the actual lines? Well, that's where perimeter comes in.

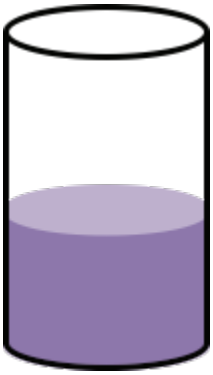


Perimeter is simply the total sum of the edges. Thus, looking at the above 3x4 box, if you count up the boxes that take up each side, you have the perimeter [Answer: 14]. Remember, even though you will sometimes get the same number for perimeter and area, perimeter is not the same as area. Try to find the perimeter for the other boxes you have drawn.

Now let's say you are using units (like cm, inches, or feet) instead of the number of boxes. For perimeter, you would simply add your units after the number you calculated. For example, the perimeter of the 3x4 square would be 14 inches. When you find area, you add the word "square" before your units. So the area of the 3x4 would be 12 square inches.

AREA, PERIMETER, AND VOLUME CONTINUED

What if the shape that I'm using isn't 2-D (flat)? How do I find the area of a 3-D shape like a polyhedron? Never fear; volume is here.



Volume doesn't actually measure area because area is a flat measurement, and 3-D is definitely not flat. Instead, volume is a measurement of how much some 3-D object can hold (like how much water a cup can hold). Flat surfaces (like polygons) only have two sides to compare—the length and the width (Or bottom to side versus top to side). 3-D objects (like polyhedrons) measure the length, the width, and a third side which we call depth (Pipe 2013).

As for units, when you calculate volume, you add the word "cubic" before your units. Let's say the 4x4 square has a depth of 4 inches. Since we already know the area (16 square inches), all we have to do is multiply that by the depth (4 inches) to find the volume. So, what is the volume? [Answer: 64 cubic inches]

Let's practice finding a few volumes. Again, this time the rule will be given to you, but the pattern is there if you are curious and want to find it.

1) Do the practice on the Volume Worksheet with a partner. [Notice that the volume of anything with a sphere is a little different because it includes a new symbol, π, which we call pi (pronounced like "pie"). In later math classes, you will learn more about the many, many numbers and uses of pi, but for now, let's just call it 3.14 and use a calculator to figure it out.]

Activity *#2*

WASTE NOT, WANT NOT

Finding areas and volumes help to limit how much we waste. For example, if you want to build a garden with a pretty picket fence around it, you can decide how large you want it to be (7 feet by 4 feet maybe) and calculate the area. The area of the rectangle will tell you how much space you will have inside the rectangle to plant your garden and the length of the sides will tell you how much fencing to buy (perimeter). Volume works quite the same.

It is important to find these calculations so that you do not waste money, space, energy, or time trying to, say, create the perfect picture frame or fill a Mason jar with a new recipe without making it overflow or look too empty. Waste not, want not.

So, let's practice being resourceful, not wasting the materials we are given.

I have a job for you. The tiny town of Mathematica has lots of people but not a lot to do, so I bought a 12 inch by 8 inch plot of land so that I can build a tiny zoo for them. Please help me create this zoo so that the tiny folks of Mathematica can have a good time (21st Century Math Projects 2014).

1. There are a few things that you should know before you start. First, the tiny folks need at least an inch and a half of room to walk about between cages so they can get to all the animal cages to see them. Second, I will need to know your calculation just in case I want to recreate your zoo somewhere else, so please include the perimeter and area calculations you found.

2. This project can be done in 2-D or 3-D, but if you choose to make it 3-D, I would also like to know the volume of your creation.
3. Get creative. Use everything we've learned about patterns, shapes, symmetry, and visual appeal to make your zoo really shine.

Reflect

- What information do you need to calculate area, perimeter, and volume?
- What are the different rules for calculating area, perimeter, and volume for different shapes?

Apply

- Where else might you use area, perimeter, and/or volume equations? How does wasting the materials we have hurt us? How does not wasting help us?
- What kind of patterns and shapes are helpful when looking at perimeter, area, and volume?

Belonging

By this time, your group should be feeling comfortable working with one another. You might think about ways to incorporate group activities into the club meeting so that the youth can get to know each other better and get to know you – the adult volunteer – better. In this lesson an idea could be to talk about "if you were a zoo animal, which animal would you be?" Simple activities that get youth talking about who they are and what they are interested in can create connections with others and create a sense of belonging.

Mastery

Encourage the youth to be neat and exact with their measuring and designing of the zoo project. Help them see that you can do a rough draft first and then create a neat final project or make notes on a separate piece of paper of what to include, then do the math and get the different shapes to fit into the space allotted. All of these skills help a youth gain mastery of the subject.

Independence

Understanding principles of area, perimeter, and volume can help a youth be more independent in their actions. When they understand how much a shape can hold, they can practice things like measuring and pouring with more accuracy – skills easily transferable to other things like cooking and baking or building.

Science

This lesson provides a glimpse into engineering and helps youth connect the idea of shapes, patterns, and measurements into real world structures and examples like the zoo building activity.

4-H Club Meeting 5
How strong are your shapes?

Supplies

- Computer with Internet access
- Toilet paper rolls
- Duct tape
- Scissors
- Sand/salt
- Beads
- Rectangular pan, tray, or cardboard (or something else that is flat and will catch sand/salt/beads/filler material)
- A chair (for balance and safety)
- Other filler materials like marbles, small rocks, etc. (optional)

Activity #1

THE STRENGTH TEST

Last time we talked about not wasting materials by finding out how best to use the space we have. Now let's talk about how we might use shapes and patterns to build in the space we are given, making sure that what we build is strong, sturdy enough to last, and will carry a fair amount of weight.

So, which basic shapes do you think are the strongest? Which basic shapes do you think are the weakest?

1. Go to http://www.pbs.org/wgbh/buildingbig/lab/shapes.html (WGBH Educational Foundation) and read the Shapes Lab [if you are interested in learning more after this meeting, that website is a great tool to learn about building]. Be sure to click on each of the shapes first before stacking elephants on the shapes.

What did you learn? Which shapes are strong and which shapes are weak?

Let's put that knowledge to the test.

1. Take out four toilet paper rolls and hold them up for all to see.
2. Do you think I can stand on these without breaking them? Discuss why or why not.
3. Set a flat square of cardboard (or other flat surface) on the ground.
4. Place the four toilet paper rolls on the cardboard with the holes facing the ceiling.
5. Give the students tape, scissors, sand/salt, beads, and other filler materials and have them work together to figure out how to make those toilet paper rolls strong enough to hold smaller objects (like books and water bottles) first.
6. When they think they have something strong enough, use a chair for support and have someone test it by standing on the filled toilet paper rolls (you can even put another sheet of cardboard over them for more balance; just be sure to stand where the rolls are and not in the space surrounding them).

Reflect

- How does symmetry relate to your strength test?
- Did you notice any patterns or shapes that helped you build a sturdier object?
- Why do you think the filled shape supported more than the unfilled shape?
- What do you think would happen if you combined more shapes than one?

Apply

- How can you use this knowledge in your daily life?
- What filled shapes make up the world around you?

Healthy Living

One way to relate this concept to healthy living is to talk briefly about nutrient density of our food – some foods have more nutrition in them than others and can help our bodies be stronger. For example, consider eating an apple, a cup of applesauce, or an apple pastry. The apple would be the most nutrient dense item as the others may have added sugar, salt, and fat. When our food has excess sugar, salt, or fat these are often referred to as "empty calories," or calories that don't provide our body the nutrition we need. When we eat things that are packed with good nutrition (whole grains, fruits, vegetables, etc.), our bodies become strong. When we eat things that don't have as much nutrition (less nutrient dense/"empty calories"), our bodies become weak. Just like the shapes; a shape is stronger when it has more shapes inside, than when it is "empty." This concept is somewhat abstract for younger audiences to understand but may be relatable for older youth.

Science

This lesson continues along the engineering lines as youth now take the concepts they've been learning into a real-world example and see how and why an object has strength.

4-H Club Meeting 6

The Ultimate Test – Bridge and House Building

Supplies

- Toothpicks
- Straws
- Duct tape
- String
- Scissors
- (optional) Spray paint – to make the finished product all one color
- (optional) Popsicle sticks
- (optional) Marshmallows
- (optional) Other crafting/building materials

Activity #1

BUILD A BRIDGE

Now that you know which shapes are stronger than others and how to combine shapes and materials to make a sturdy object, let's talk about people who use this knowledge all the time.

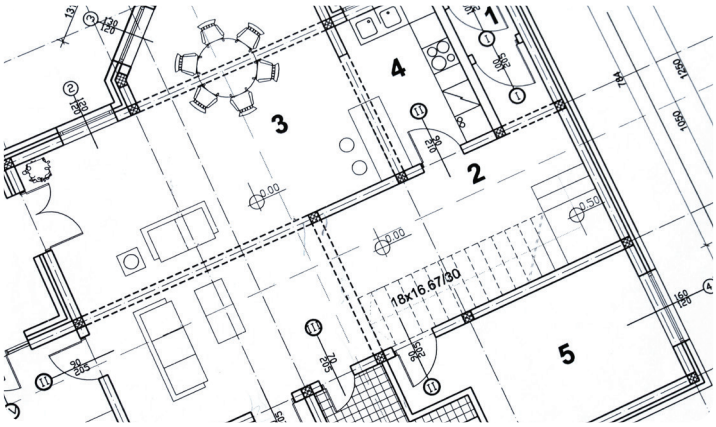
What do you think? Who uses shapes, patterns, and strong objects in their everyday life? Anybody who builds uses the math we've learned to do so far. Architects and engineers are the most common careers that directly relate to building. Of course, they took quite a few more math classes to help them, but the basic concepts are rooted in what we've discussed so far: patterns, symmetry, shapes, perimeter, area, volume, and of course, strength tests.

For today, let's put all of our new knowledge to the test by building a bridge that passes all of these tests (TeachEngineering 2014).

1. Take out all of the building materials.
2. Have the students design what they will build first, deciding on the perimeter and area of their bridge.
3. Then set them free to build as they choose, using the given materials.
4. When they finish, test the bridge using various objects weighing all sorts of different weights. [DO NOT attempt to stand on it unless you have provided building materials that they can fill with other given materials]
5. Allow students to build other buildings if they would like (skyscrapers, houses, etc.), and use the strength test to determine how successful they were at building.

BUILD A HOUSE (OPTIONAL)

This project's materials are listed separately because there are quite a few of them and you may decide to skip this activity entirely.



Supplies

- Modge podge
- Tissue paper
- Cardboard
- Box cutter
- Tape
- Paper
- Ruler
- Calculator
- Pencil/pen
- Paint
- Paintbrushes
- Hot glue gun
- Hot glue sticks
- Other building materials

This project tests all the skills you have learned so far. It is a great activity to utilize all of this knowledge plus your creativity.

1. Tell your club members that they each get 144 square inches to create the building of their choice (that means they need a square that is 12 inches by 12 inches).
2. Tape four pieces of paper together to form a square.
3. Use a ruler to trace a 12 inch by 12 inch square.
4. Encourage them to create rooms (don't forget to measure them with straight lines). They can make bedrooms, bathrooms, or other imaginative rooms they decide. You may need to remind them to create hallways and mark where their doorways will be.
5. Once all rooms are created and labeled, have them measure them and create a table of their calculations like this:

Room Name	Dimensions	Area	Perimeter

They can use a calculator to complete this section if they need one.

6. When they have finished all of their calculations, tell them that you are the inspector who must approve their design before they may build. Be sure to ask them about what they have learned so far. Are their calculations correct? Will their building have symmetry? How will they ensure a strong building? What kinds of shapes will they use to build it? How high will it be? What colors? (And any other questions you can think of. We created an inspector sheet that had to be signed before they could build).
7. Now they are free to build. Have them start by cutting out the square of land using cardboard and a box cutter. Then have them build up walls by cutting out a rectangle. This rectangle will be the length of one drawn side by the height of the building.
8. Use hot glue to stick the pieces of the building together.
9. Once all of the walls and the roof are glued together, tear a piece of tissue paper and line it up against the cardboard. Dip a paintbrush in modge podge and brush it against the tissue paper until it stays down on its own. Cover all of the cardboard (including the edges) this way.
10. After the modge podge has dried, paint the house using any colors of your choice.
11. Add windows, doors, front yard, and any other pieces you choose using the building materials you have available.
12. Enjoy your designs!

Reflect

- What concepts did you use to create your bridge (or other building)?
- Why was your bridge successful or why did it not succeed as well as you wanted it to?
- How could you have improved your design?
- Did your design turn out as you imagined? Why or why not?

Apply

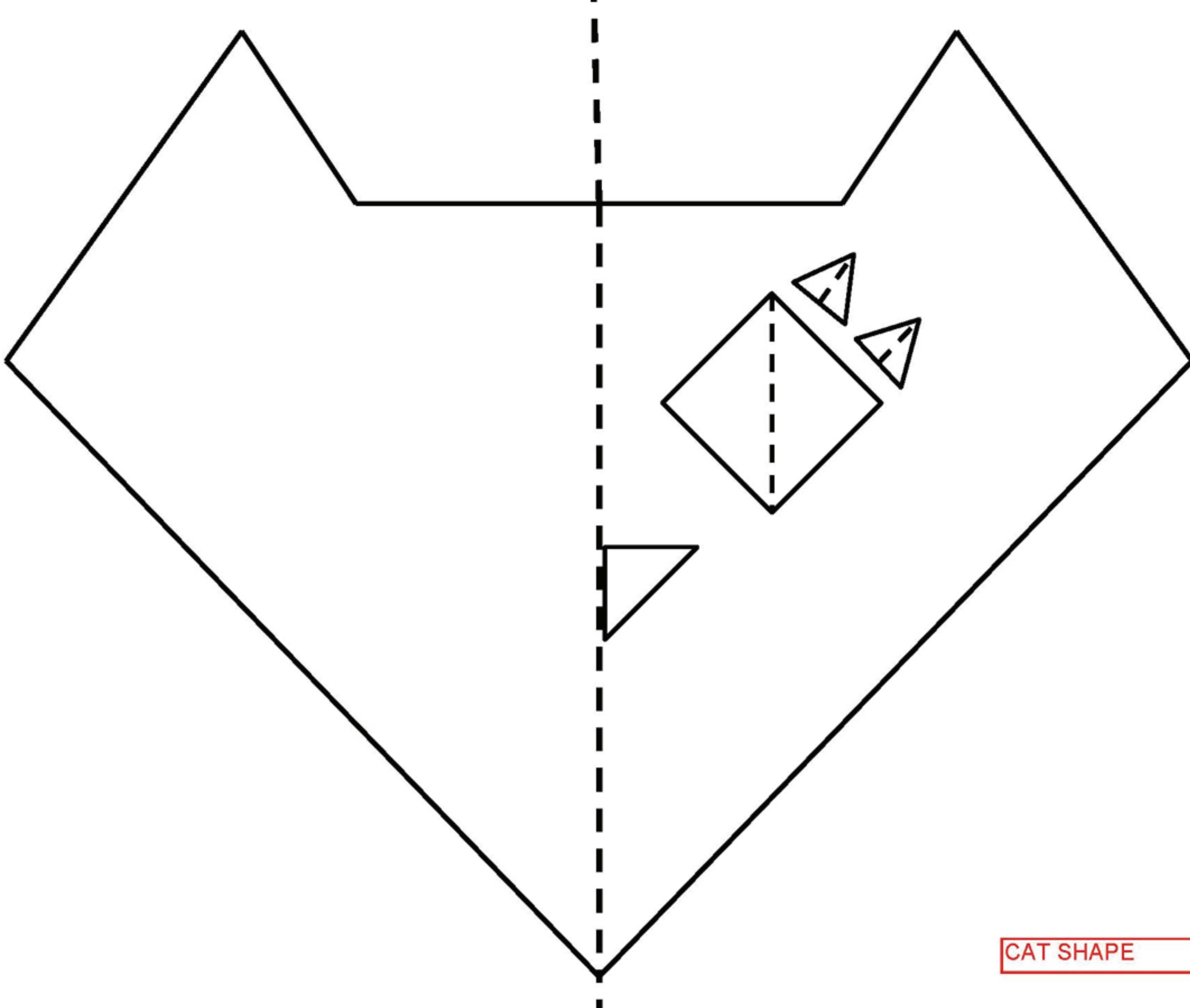
- What other objects could you build with these same materials?
- Does all of this have to do with math? Why or why not?

Healthy Living

With the final project of your club, you could consider making a 4-H Town or, in other words, have each youth build a building in a make-believe town. This culminating project would bring all the youth together in a common goal and could be a possible club exhibit in the county fair. If you choose to build bridges, you could also have a display of all the different designs and how much weight each bridge could handle.

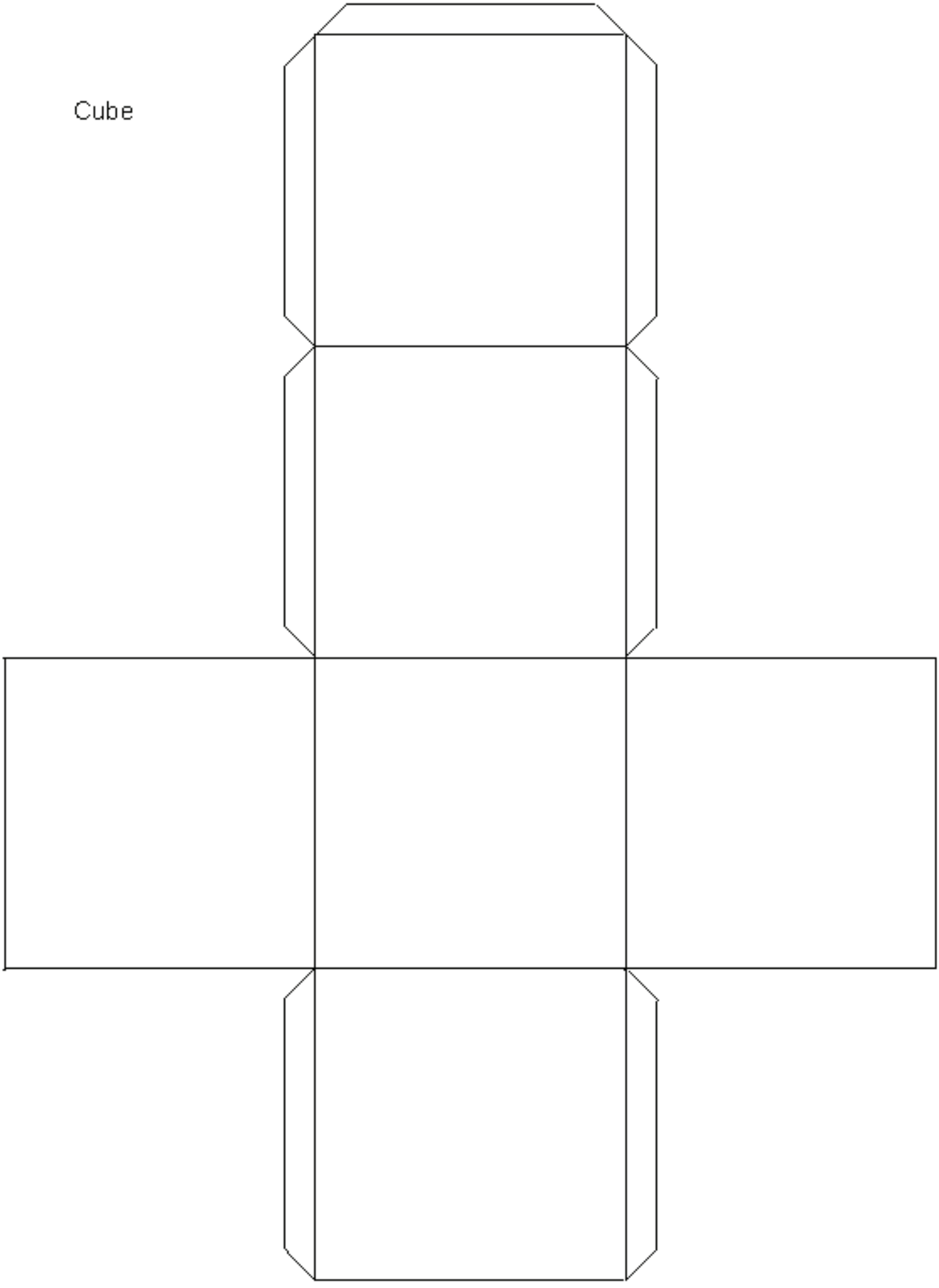
Mastery

Having something tangible to show for the knowledge a youth has gained is a way to exhibit mastery. Encourage the youth to complete a project they can share with others and teach the skills and knowledge gained along the way. One way to do this is to incorporate mini-demonstrations into your club meetings. A mini-demonstration would be having a youth stand in front of their peers and re-teach a topic learned in the club. Another example would be putting an exhibit (bridge, house, tessellation, etc.) in the county fair.

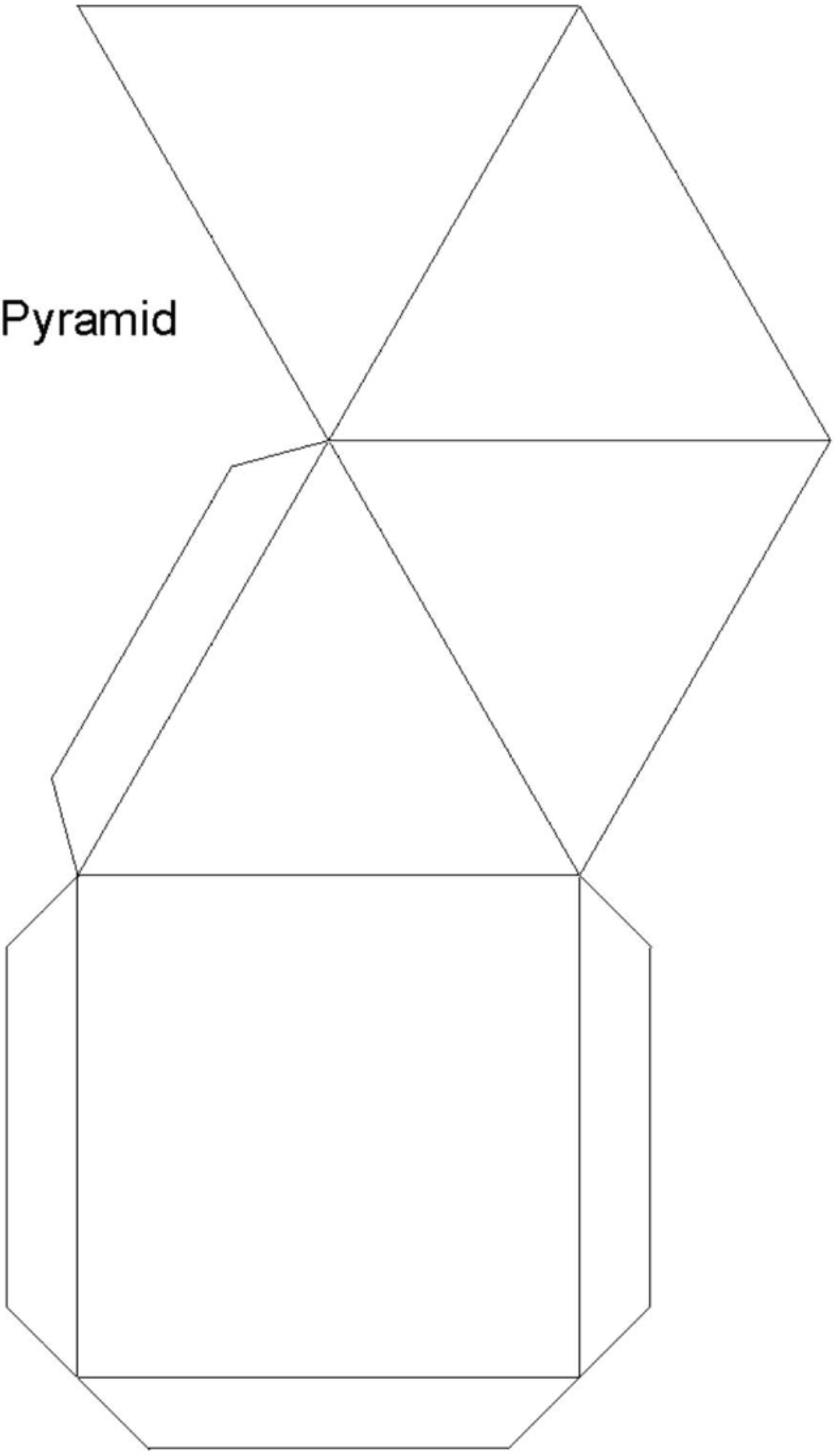


CAT SHAPE

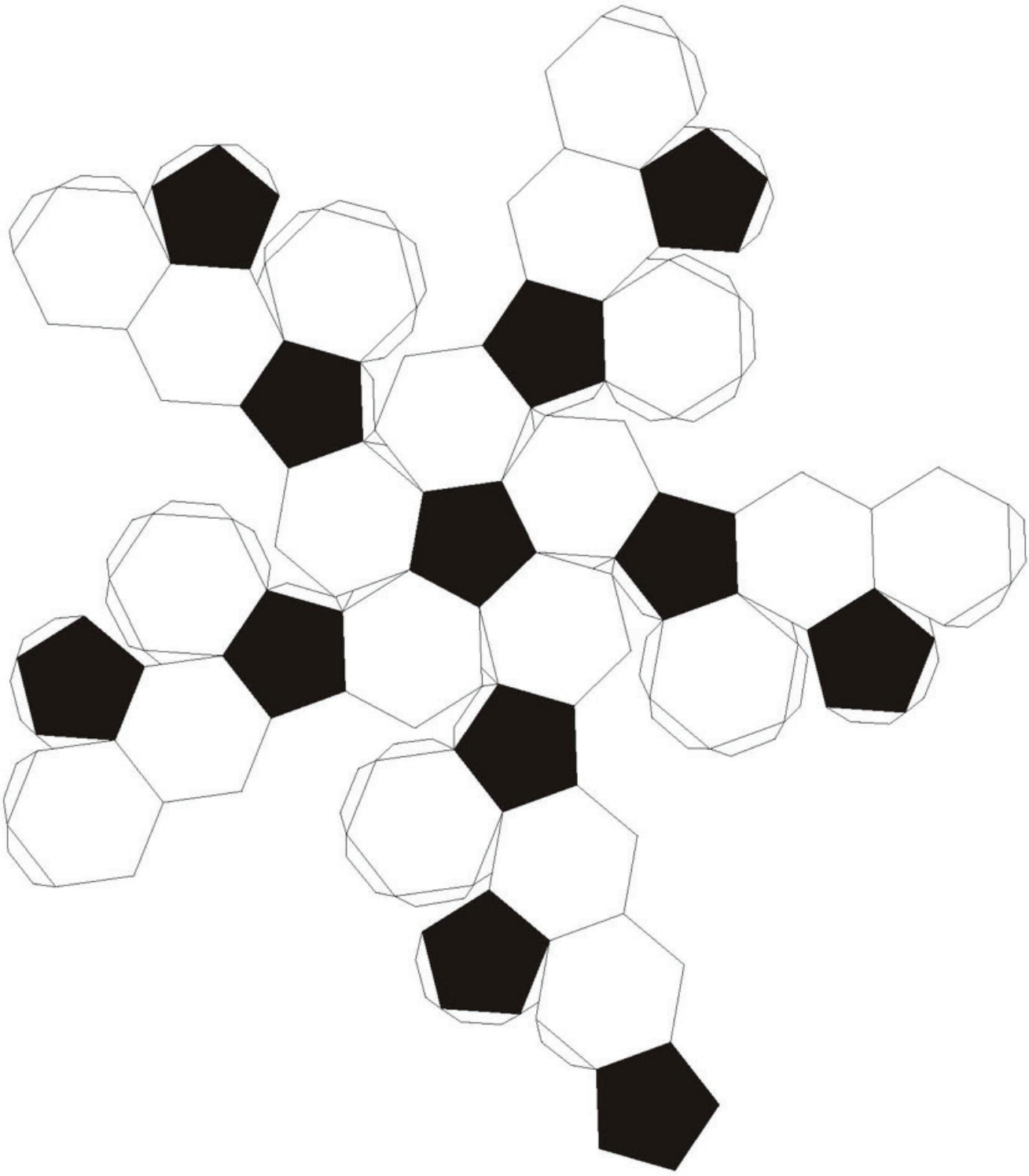
Cube



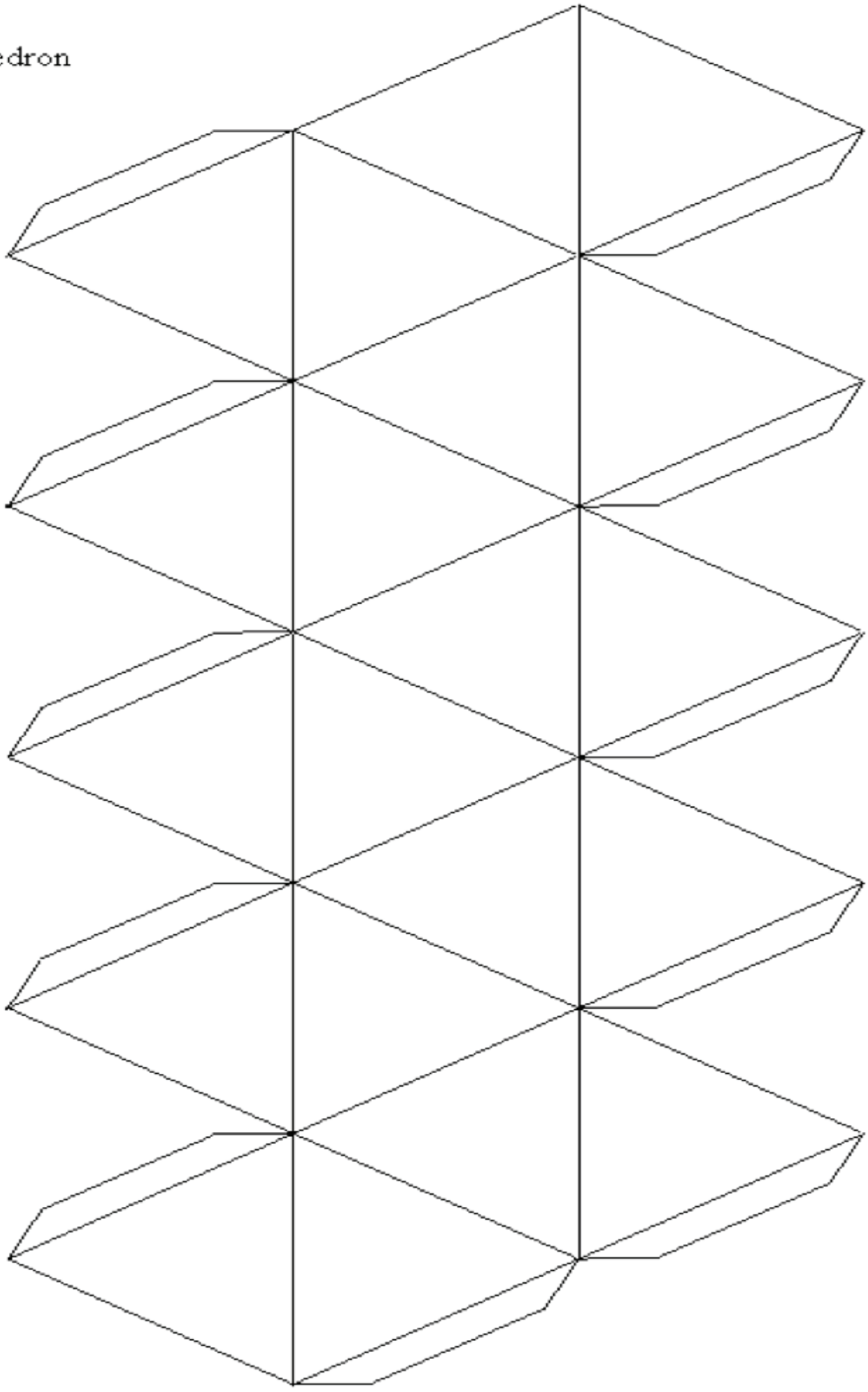
Pyramid



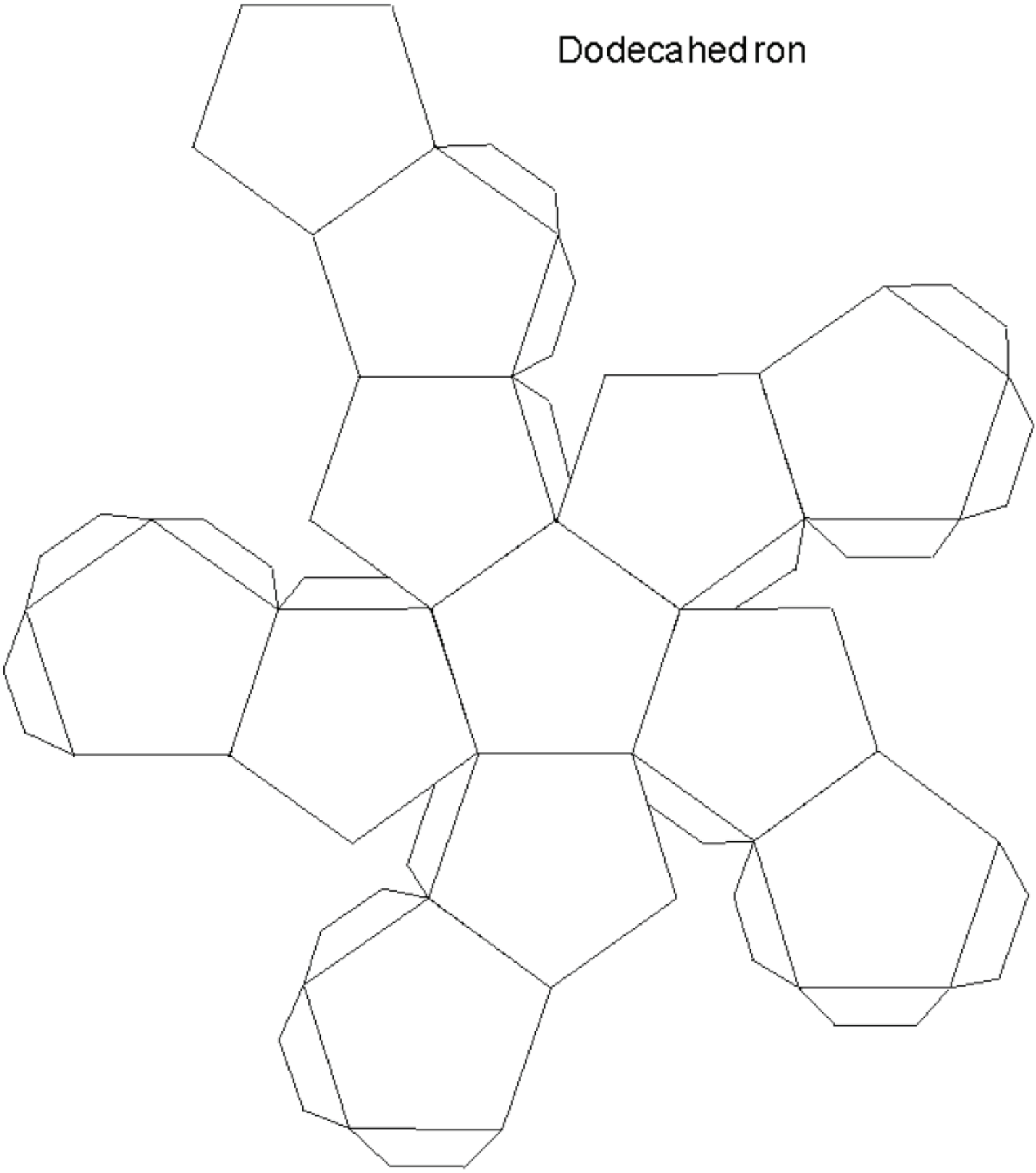
Soccerball (football)
(small version)

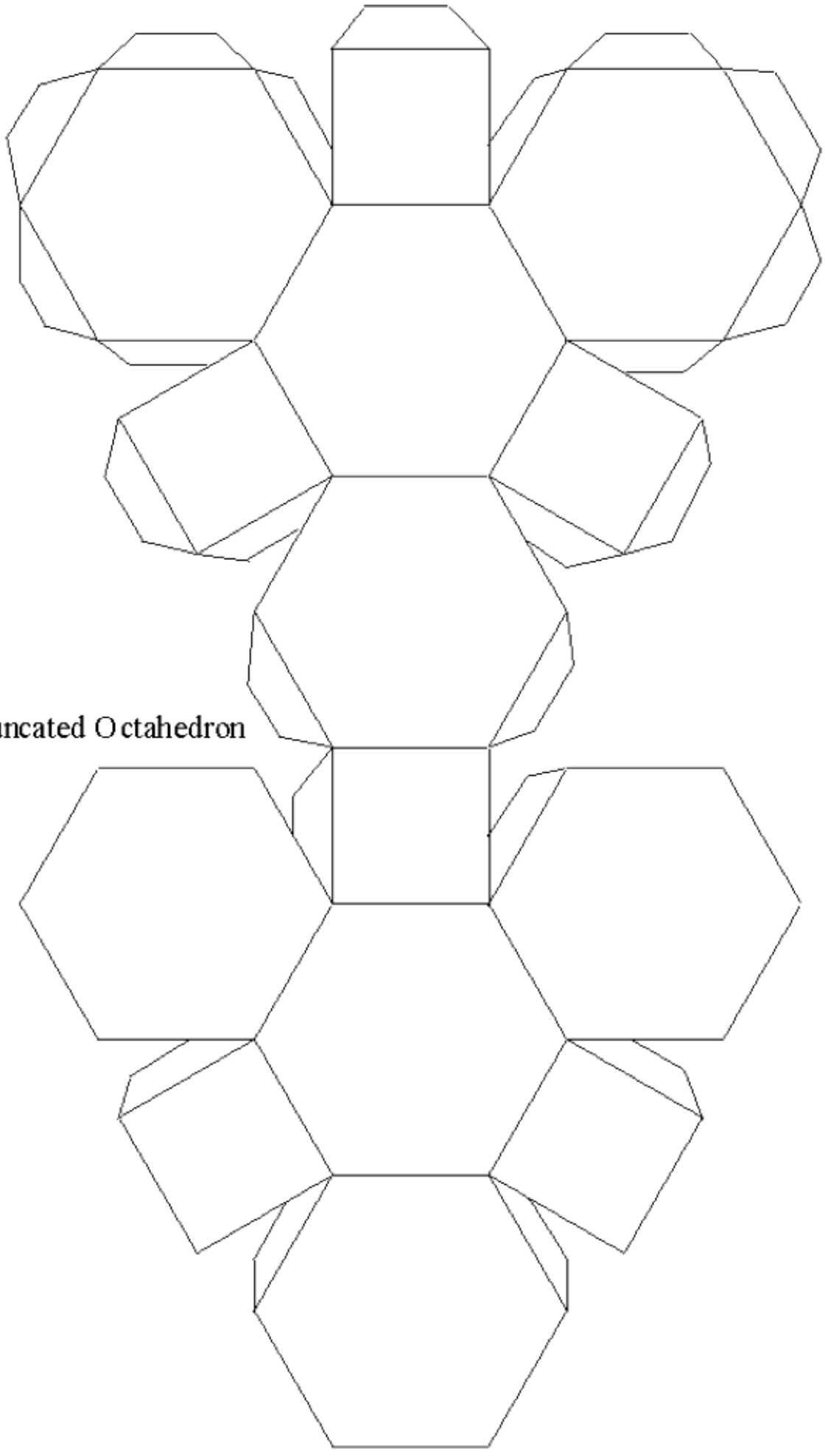


Icos ahedron



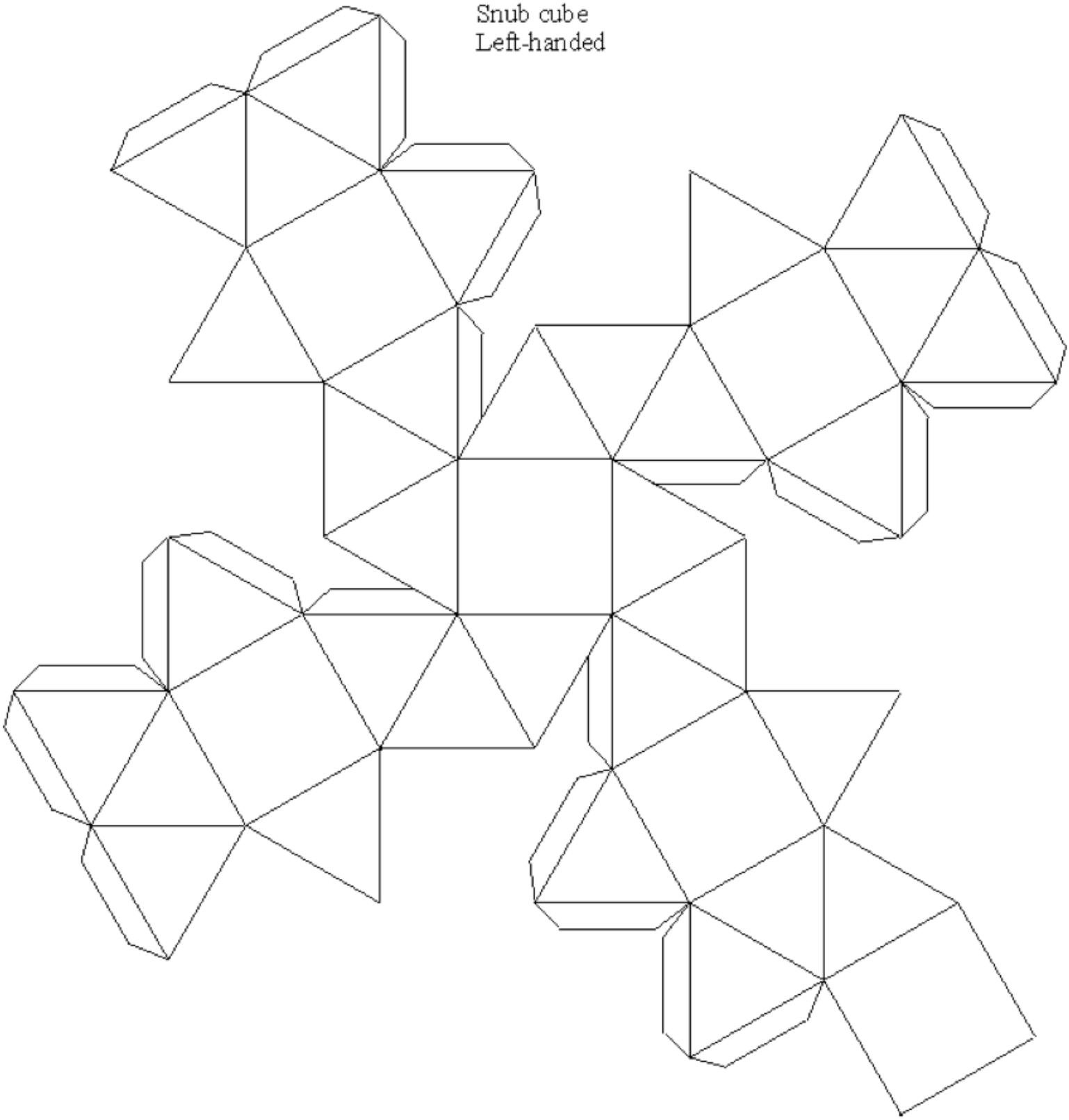
Dodecahedron





Truncated Octahedron

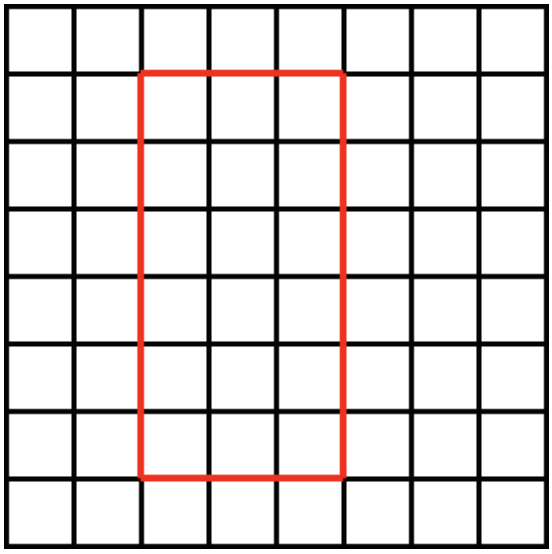
Snub cube
Left-handed



Area *Worksheet*

Note: The rule (or formula) for area of a square/rectangle is A = lw which means Area equals length times width. With that rule in mind, find the area for the next two problems.

1. What is the area of the traced rectangle?

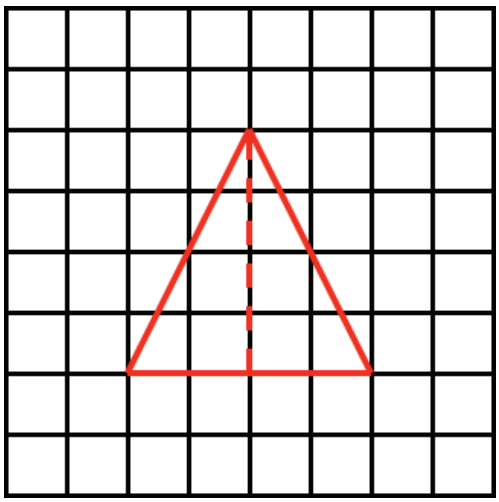


2. Find the area.

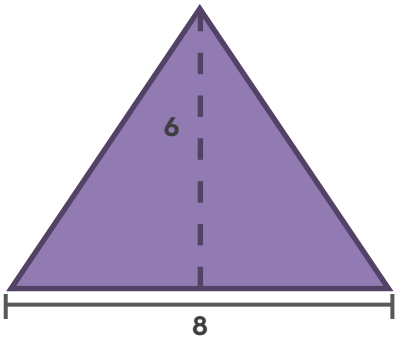
AREA WORKSHEET CONTINUED

Note: The rule (or formula) for the area of a triangle is a little different. A= bh/2, which means Area equals base times height all divided by 2. This is sometimes written as ½ times base times height. If fractions are not your favorite, you can also do 0.5 times base times height. With that rule in mind, find the area for the next two problems.

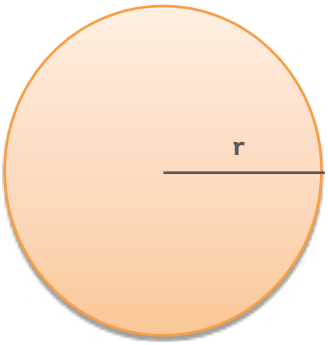
3. What is the area of the traced triangle?



4. Find the area.

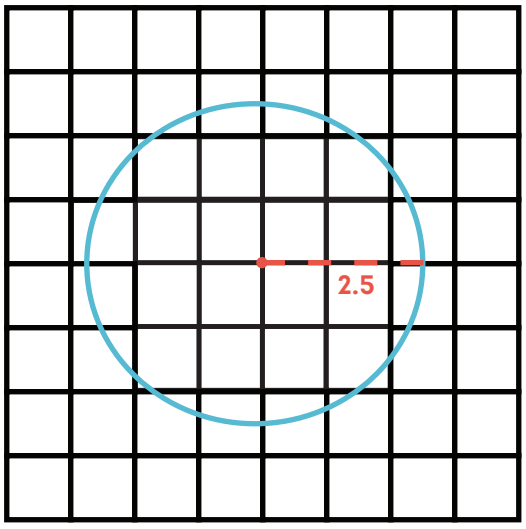


Note: Even circles have their own rule. The rule (or formula) for a circle is A=πr^2. This is quite a bit different. The π symbol is something you will see quite a bit later in math class, but for now, we are going to say that π = 3.14. As for r, it stands for "radius," which is the line that goes from the very center of the circle to any point directly across on the edges of the circle.



And that little 2 above the r means that r is "squared." For now, let's just say that you will have to multiply that r number times itself (will be explained more in later math classes). So, for now, the area of the circle equals 3.14 times (π) times r times r. With that rule in mind, try the following problem.

5. What is the area of the traced circle?

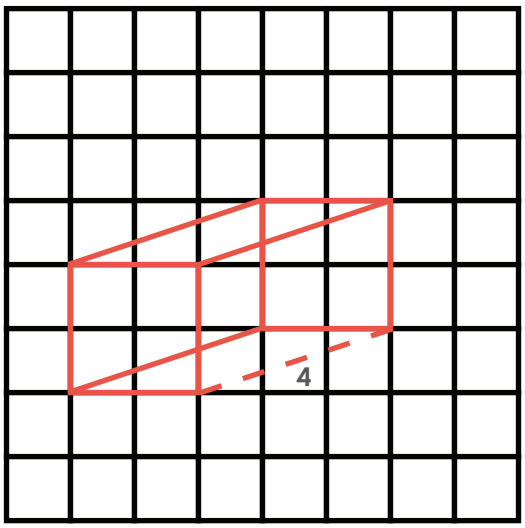


Answers: 1) 18 2) 36 3) 8 4) 24 5) 19.625

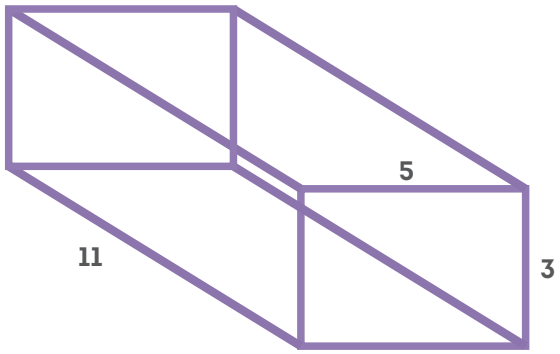
Volume *Worksheet*

Note: The rule (or formula) for the volume of a 3-D rectangle (called a rectangular prism) is V = lwh which means volume equals length times width times height (which is sometimes referred to as depth). With that rule in mind, find the volume for the next two problems.

1. What is the area of the traced rectangle?



2. Find the volume. Use centimeters as the unit in your answer.



Note: Since there are many, many other 3-D shapes, there are many, many other volume formulas, but lucky for you, these rules have already been created. So, for the most part, you can look up volume formulas for the shapes you need and then you will just need to follow the rule to find your volume. [The same goes for area and perimeter.]

Answers: 1) 16 2) 165 cubic centimeters

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More to Discover

Congratulations on completing your Discover 4-H club meetings! Continue with additional curriculum in your current project area, or discover other 4-H project areas. Check out the following links for additional 4-H curriculum.

1. http://utah4h.org/htm/discover4hclubs
2. http://www.4-h.org/resource-library/curriculum/
3. http://utah4h.org/htm/resource-library/view-all-curriculum

Become a 4-H Member or Volunteer

To **register** your Utah club or individuals in your club visit:

http://www.utah-4.org/htm/staff-resources/4-h-online-support

http://utah4h.org/htm/about-4-h/newto4h/

Non-Utah residents please contact your local 4-H office:

http://www.4-h.org/get-involved/find-4-h-clubs-camps-programs/

Stay Connected

Visit Your County Extension Office

Stay connected with 4-H activities and news through your county Extension office. Ask about volunteer opportunities and don't forget to register for your county newsletter. Find contact information for counties in Utah here:

http://extension.usu.edu/htm/counties

Enjoy the Fair!

Enter your project or create a new project for the county fair. Learn about your county fair and fair judging here:

http://utah4h.org/htm/events-registration/county-fairs

Participate in Local or State 4-H Activities, Programs, Contests or Camps

For Utah state events and programs visit:

http://utah4h.org/htm/events-registration

http://www.utah4h.org/htm/featured-programs

For local Utah 4-H events and programs, visit your county Extension office.

http://extension.usu.edu/htm/counties

Non-Utah residents, please contact your local 4-H office.

http://www.4-h.org/get-involved/find-4-h-clubs-camps-programs/

Discover *Service*

Become a 4-H Volunteer!

http://www.youtube.com/watch?v=UBemO5VSyK0

http://www.youtube.com/watch?v=U8n4o9gHvAA

To become a 4-H volunteer in Utah, visit us at:

http://utah4h.org/htm/about-4-h/newto4h/

Serve Together as a 4-H Club or as an Individual 4-H Member

Use your skills, passions, and 4-H to better your community and world. You are needed! Look for opportunities to help in your area or participate in service programs that reach places throughout the world (religious groups, Red Cross, etc.).

Hold a Club Service Project

USU Collegiate 4-H Club hosted "The Gift of Giving" as a club activity. Club members assembled Christmas stockings filled with needed items for CAPSA (Community Abuse Prevention Services Agency).

http://tinyurl.com/lu5n2nc

Donate 4-H Projects

Look for hospitals, nursing homes, or other nonprofit organizations that will benefit from 4-H projects. Such projects include making quilts for CAPSA or Primary Children's Hospital, or making beanies for newborns. During Utah 4-H State Contests, 40 "smile bags" were sewn and donated to Operation Smile.

Partner with Local Businesses

92,000 pounds of processed lamb, beef, and pork were donated to the Utah Food Bank in 2013 by multiple companies.

http://tinyurl.com/pu7lxyw

Donate Money

Clubs or individuals can donate money gained from a 4-H project to a worthy cause. A nine-year-old 4-H member from Davis County donated her project money to help a three-year-old battle cancer.

http://tinyurl.com/mqtfwxo

Give Us Your *Feedback*

Help us improve Discover 4-H curriculum. We would love feedback or suggestions on this guide; please go to the following link to take a short survey:

http://tinyurl.com/lb9tnad