HONORS GEOMETRY

QUARTERLY PROJECTS 2012-2013

PROJECT RULES: (QUARTERS 1-4)

1. STUDENTS WILL RANDOMLY CHOOSE A PROJECT NUMBER AT THE BEGINNING OF EACH QUARTER.

2. STUDENTS MAY VOLUNTARILY TRADE NUMBERS BEFORE HANDING IN THEIR FINAL CHOICE.

3. PROJECTS ARE DUE NO LATTER THAN THE DATE POSTED.

4. A STUDENT CAN DO A PARTICULAR PROJECT NUMBER ONLY ONCE.

5. PROJECTS WILL BE GRADED BASED ON A MAXIMUM OF 50 POINTS.
   a. 10 POINTS FOR HANDING THE PROJECT IN ON TIME. THERE WILL BE A 10 DEDUCTION FOR EACH DAY LATE PAST THE DUE DATE.
   b. 10 POINTS FOR NEATNESS AND USING THE PROPER MATERIALS. (WHEN **POSTERBOARD** IS INDICATED, **IT MUST BE A FULL SHEET WHICH MEASURES APPROXIMATELY 22" BY 28"**).
   c. 20 POINTS FOR FOLLOWING INSTRUCTIONS AND REACHING THE PROPER CONCLUSIONS.
   d. 10 POINTS FOR ORAL PRESENTATION TO THE CLASS.

Some of the vocabulary discussed in the project instructions may be unfamiliar. You will have to research the words to fully understand your assignment.

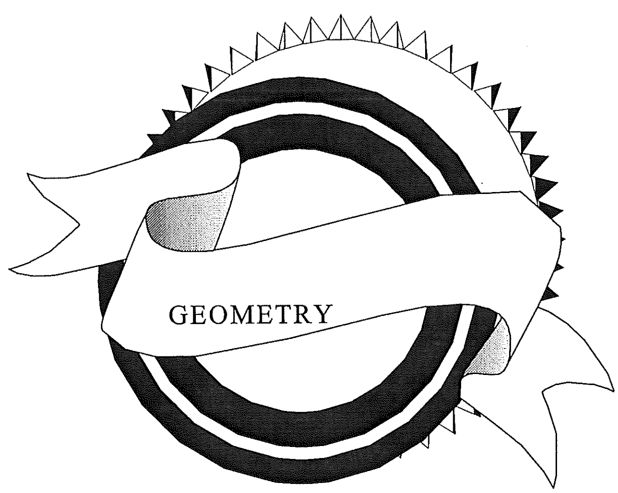
A research project on mathematicians will be assigned during Quarter 3.

A string art project will be assigned during quarter 4. The string art instructions will be handed out at the time that the project is assigned.

PROJECT #1

Line and Rotational Symmetry

A commercial logo is an important part of a company's advertising. The logo of a company is clearly marked in the mind of a consumer. The logo of a company such as Nike or Chevrolet is important to the success of the product.



Many commercial logos are symmetric in their design, with either one or more lines of symmetry or with rotational symmetry. Your project is to produce a poster(using poster paper) or a PowerPoint which demonstrates how important symmetry is in commercial logos. The poster must contain at least ten (10) commercial logos. Your poster or PowerPoint should demonstrate the lines of symmetry or rotational symmetry for each logo you have selected. Be sure you have some examples of rotational symmetry. See Chapters 0 and 8 in your text for examples of symmetry.

PROJECT #2

Geometry Scrapbook

For this project you will create a geometry scrapbook. The scrapbook will contain specific items as described below. The items will be pictures cut from magazines, newspapers, advertisements, commercial packaging. Items should be taped or glued neatly, and labeled as requested. Your scrapbook should be stapled together or placed in a report binder.

Cover: Your name, a title, and a geometric design that you construct.

Page 1: **A Triangle** Measure and record the length of all 3 sides and the degree measure of each angle of the triangle.

A Rectangle Measure and record the length of all four sides and the length of a diagonal of the rectangle.

Page 2: **Parallel Lines** Find parallel lines that demonstrate function versus design. For example, railroad tracks must be parallel. Explain the function of the parallel lines in your photo.

Page 3: **Congruent Shapes** Find congruent shapes that are not triangular. For example, a pair of socks. Explain what would happen if the shapes were similar instead of congruent.

Page 4: **Symmetric Logos** Find 3 different logos which contain rotational or line symmetry. Describe the symmetry of each.

Page 5: **Solids** Find and label a sphere, cylinder, pyramid, cone, and prism.

Page 6: **Geometric Sample** Find a photo of something that you think relates to geometry. Explain what you think the connection is to geometry.

PROJECT #3

History of Mathematics-Vocabulary

The vocabulary of mathematics developed over many centuries. Some words such as *cone* and *circle* are thousands of years old, while other words such as *fractal* are only about 20 years old. Many common vocabulary words were translated from other languages and interesting backgrounds. The word *rhombus*, for example, is taken from the Greek meaning 'spinning wheel' or 'top'. The reason for such an unusual origin is that the ancient Greeks used a spinning top shaped like a rhombus to foretell the future. Another term, *cevian* (a segment from the vertex of a triangle to the opposite side), is derived from Italian mathematician Giovanni Ceva(1648-1734), who first wrote about such segments.

Your assignment is to produce a poster or PowerPoint which shows the derivation of at least twenty (20) vocabulary words. Drawings or photos must be included to illustrate each word.

The poster should be on a standard-sized posterboard and be colorful and eye-catching.

PROJECT #4

Figuring the
Circumference of Earth

Was anyone really worried that Columbus would sail off the edge of the Earth? Not really. By Columbus' time only the uneducated and superstitious believed Earth is flat. In fact, the ancient Greeks not only knew Earth was round but they knew its circumference.

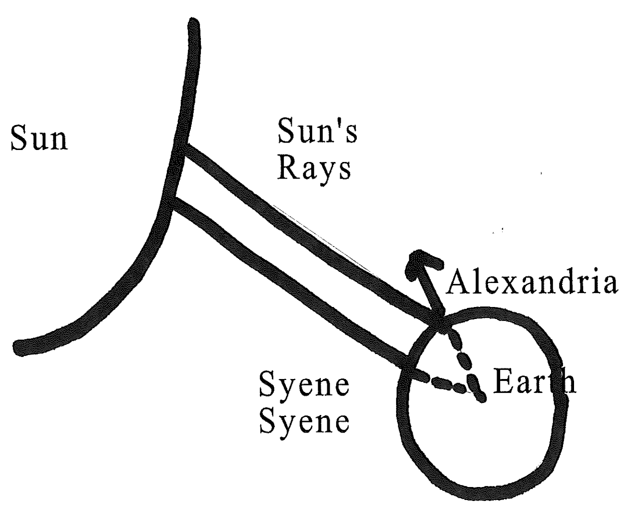
It was a Greek mathematician named Eratosthenes who first calculated the circumference. How did he do it?

Eratosthenes lived in the city of Alexandria, Egypt. He heard reports of an unusual well in the city of Syene, directly to the south. This well was very deep, and on the longest day of the year the reflection of the sun could be seen on the water surface.

Eratosthenes reasoned that this meant that the sun was directly over the well. On the same day, 5000 stadia (One stadium was equal to 500 feet) to the north in Alexandria, the sun made an angle of 7.2^{o}.

With only this information, and the same knowledge of geometry you have, Eratosthenes was able to determine the circumference of Earth.

<u>Your assignment is to use the diagram below to help determine the circumference of Earth and to use your knowledge of parallel lines to explain why your calculations are correct.
The project should be on standard -sized posterboard or PowerPoint. Illustrate and explain on the posterboard or in the PowerPoint how you reached your conclusion.</u>



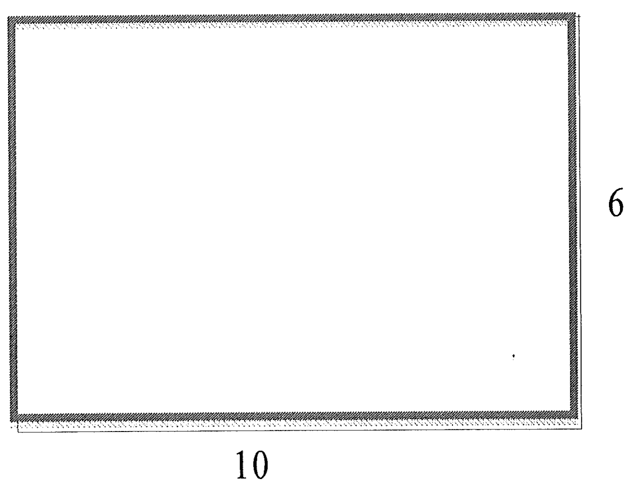
PROJECT #5

The Golden Ratio and The Golden Rectangle

The Golden Rectangle is a rectangle whose ratio of width to length is the most pleasing to the human eye. The ratio, about 0.618:1, is an irrational number and is called the Golden Ratio. Artists, architects, and even advertisers have taken advantage of this most pleasing rectangle and have incorporated it into their work.

Your project is to find fifteen (15) objects in your home which display the Golden Rectangle. In order to be the Golden Rectangle, a rectangle must show the Golden Ratio of its width to its length.

On posterboard , display photos of the objects. State the length and width of each object and find the ratio of width to length.



PROJECT #6

The Golden Ratio-
Found in Living Things

The Golden Rectangle shows the Golden Ratio in its ratio of width to length. The approximate value of this irrational number is 0.618:1. This ratio is found throughout nature. The way branches are arranged on a stem, the curve of an elephant's tusk, and the nodules on the spirals of pineapple are some examples of how the Golden Ratio is present in all life.

The human body also demonstrates the Golden Ratio in several ways. For this project, use an adult subject to make the measurements described below. Once the measurements have been made, find the ratio of M_1 to M_2. Display each measurement on posterboard or in a PowerPoint and display the resulting ratio.

M_1	M_2
1. Top of head to mid neck	Mid neck to navel
2. Top of head to navel	Navel to floor
3. Knee to floor	Knee to navel
4. Bottom of nose to mid-mouth	Bottom of nose to mid-eyes
5. Mid-eyes to bottom of nose	Bottom of nose to bottom of chin
6. End joint of any finger	Middle joint of the same finger
7. Middle joint of any finger	Base joint of the same finger

How close to the Golden Ratio did you come? The ratios of persons not fully grown will not be as close to the Golden Ratio as the ratios of grown persons. Once growing has stopped, the majority of people show ratios very close to the Golden Ratio for all of the above data.

PROJECT #7

The Golden Ratio and
The Fibonacci Sequence

In 1202 the Italian mathematician Leonardo of Pisa, better known as Fibonacci, wrote the first book in Europe that used our modern number system, including zero. Until that time all mathematics books used Roman numerals. Even after this book was published and widely circulated, there was a great deal of resistance to the new number system. The city of Florence, Italy, even passed a law outlawing the new numbers because they were too easy for counterfeiters to change!

One problem in Fibonacci's book is called the Rabbit Problem, and its solution is a sequence of numbers which has been named the Fibonacci Sequence. The quotient of two consecutive numbers in the Fibonacci Sequence approaches the Golden Ratio as explained in **PROJECT #6** and **PROJECT #7**.

Your assignment is to work to discover the Fibonacci Sequence. As part of the solution, display a chart on posterboard or in a PowerPoint that shows the number of pairs of rabbits there are each month. These numbers are part of the Fibonacci Sequence. Also show how these numbers relate to the Golden Ratio.

The Rabbit Problem reads as follows:

> A man put a **pair** of just-born rabbits in a certain place entirely surrounded by a wall. How many pairs of rabbits will there be in a year if the nature of these rabbits is such that two months after each pair is born the pair bears a new pair?

PROJECT #8

Pi Explorations-
Buffon's Experiment

Sometimes mathematics appears in the most unlikely of places. For example, a French aristocrat,

Louis LeClerc, the Compte de Buffon, conjectured that the value of π could be found by dropping needles onto a piece of paper covered with a series of parallel lines. He claimed the ratio of the number of needles tossed to the number of needles resting on the lines could be predicted using the number π.

You will replicate Buffon's experiment to experimentally verify his conjecture, which was eventually proven by a member of the French Academy some years later.

1. Fill a standard piece of 8½" by 11" unlined paper with parallel lines 1" apart.

2. Cut the tops of five flat toothpicks to 1" lengths.

3. Hold the five sticks over the paper and drop them. Keep track of how many sticks come to rest on one of the parallel lines.

4. Do Step 3 twenty times, which is equivalent to dropping one shortened toothpick 100 times.

5. Evaluate the following expression: $\frac{\text{number of tosses}}{\text{number of hits}} \cdot 2$

Buffon conjectured this number would be equal to π. How close did you come?
Using posterboard or in a PowerPoint, make a chart showing the results of each drop and the resulting value of the expression. Demonstrate the experiment to the class.

PROJECT #9

Calendar Vocabulary

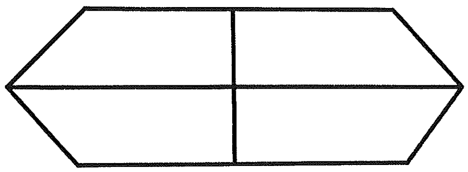
Some of the familiar names for polygons such as octagon and decagon have prefixes which have become part of the English language. An octopus has eight arms, just as an octagon has eight sides. The words decade and decimal are closely identified with the number 10, just as a decagon has ten sides. October and December offer a troubling fact, however. October is not the eighth month, but the tenth month. Likewise, December is not the tenth month, but the twelfth month. Even September and November have prefixes that mean seven and nine, respectively, but they are the ninth and eleventh months. What has happened?

Your project assignment is to do reasearch and find out why the names of the months do not match up with the meaning of the prefixes. A two-page report, doublespaced, explaining how our present-day calendar evolved to what we use today, is to be turned in by the due date. Be sure to list your sources at the bottom of the report.

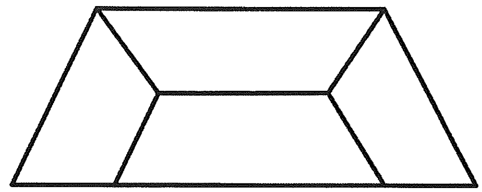
PROJECT #10

Rep-Tiles

Any polygon that can be divided into congruent parts, each similar to the original, is called a replicating polygon or a REP-TILE. Study the examples given.



This hexagon is divided in four congruent parts, but they are not similar to the original figure.



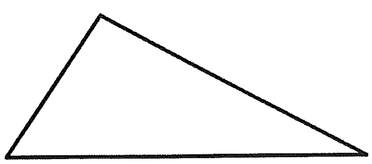
This trapezoid is divided into 4 congruent parts, each similar to the original figure.

The subdivision in the trapezoid could be continued within each smaller trapezoid, or 4 of the original trapezoids could be used to make a larger trapezoid. The replication can occur in either direction.

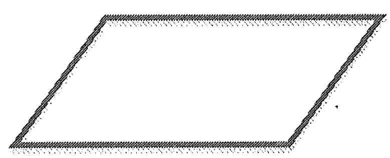
A REP-TILE has order n if it can be divided into n replicas congruent to one another and similar to the original. The trapezoid shown has order 4, abbreviated rep-4.

Part 1: On a posterboard or in a PowerPoint, for at least four of the REP-TILES shown, subdivide the figure into congruent parts according to the order given.

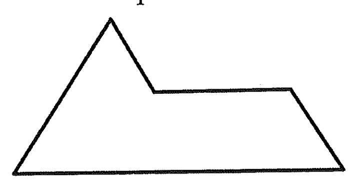
1. Rep-4



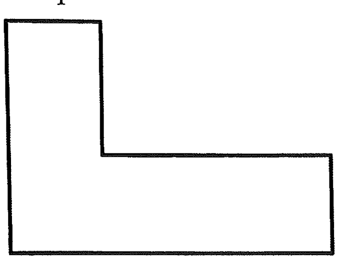
2. Rep-2



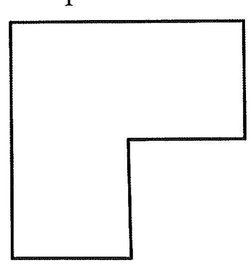
3. Rep-4



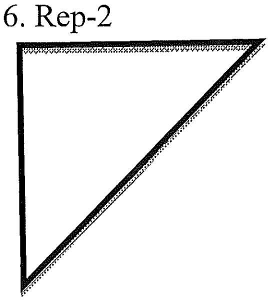
4. Rep-4



5. Rep-4



6. Rep-2



Part 2: Design a REP-TILE of order 2, 3, or 4. On your posterboard or in a PowerPoint, show how the REP-TILE can be subdivided into the given number of parts.

PROJECT #11

Construction-
Mystery Quadrilateral

A recent discovery in geometry was made be a high school sophomore in 1990. He found that by following the construction steps below, the result is always the same quadrilateral. Follow the construction steps on posterboard, and identify the mystery quadrilateral .

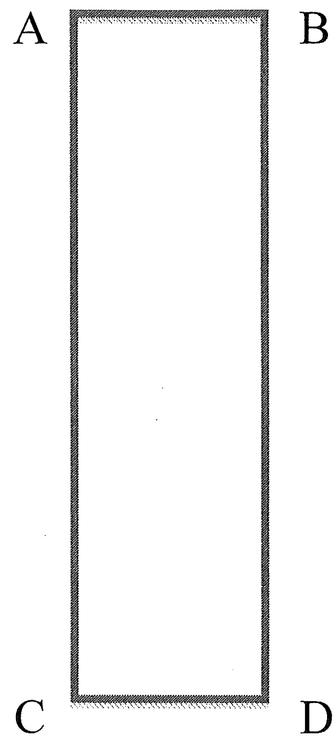
1. Construct a circle on a piece of posterboard.
2. Inscribe random quadrilateral ABCD inside the circle.
3. Bisect $\angle A$ and label the intersection of the bisector with the circle as point Q.
4. Construct the bisectors of $\angle B$, $\angle C$, and $\angle D$, respectively, and label their intersection with the circle as points R, S, and T, respectively.
5. In a different color draw quadrilateral QRST, and make a conjecture about what kind of quadrilateral QRST is.

Your completed construction should be clearly constructed, with all the points easily identified. Be sure to leave in all your construction marks.

PROJECT #12

Construction-
The Mobius Strip

A German mathematician called Augustus Mobius discovered an interesting object that has only one surface. It is called *Mobius Strip* in his honor.



<u>Your project is to make the mobius strips using the instructions below. Answer the questions on a separate piece of paper.</u>

To make a Mobius strip, cut out a strip of paper measuring 1 inch by 12 inches similar to the illustration. After giving the strip a half twist, tape the ends. Match A with D and B with C.

1. A sheet of paper has two surfaces. Start coloring the Mobius strip you just made. What happens?

2. Construct a second strip. Draw a line down the middle of the Mobius strip, then cut along this line. What happens?

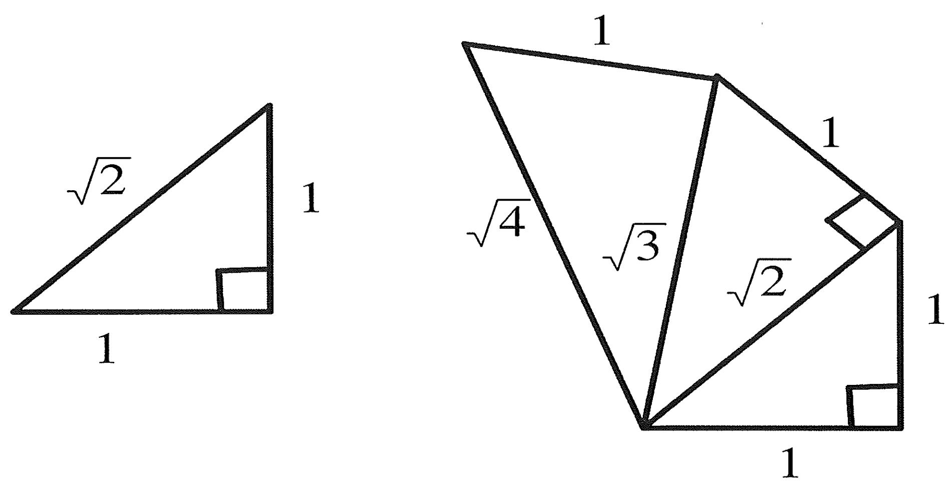
3. Make a third strip. This time make the cut near the edge. What happens this time?

PROJECT #13

Wheel of Theodorus

Theodorus was a Greek philosopher who lived about 425 B.C. He is said to have discovered the following method for constructing segments with lengths 1, $\sqrt{2}$, $\sqrt{3}$, $\sqrt{4}$, and so on. The technique is referred to as the *"Wheel of Theodorus."*

Consider a right isosceles triangle. If the length of each leg is 1, then the length of the hypotenuse is $\sqrt{2}$. If another right triangle is constructed as shown, it has legs $\sqrt{2}$ and 1. The hypotenuse of the new triangle is $\sqrt{3}$. If you continue the process a "wheel" is formed.



1. On posterboard, construct a "wheel of Theodorus" of your own. Use a unit segment of one inch for the original triangle. Position the original triangle near the center of your posterboard. Continue until you obtain a segment of length $\sqrt{17}$. Show the lengths of all sides of the triangles.

2. When does the wheel overlap?

PROJECT #14

Platonic Solids

A geometric solid bounded by planes is called a polyhedron. If the polyhedron has congruent regular polygons as faces and the same number of faces meet at each vertex in exactly the same way, then it is a regular polyhedron. There are only five such regular polyhedrons. Plato knew that the number of convex regular polyhedrons was limited to five, and we therefore refer to them as the Platonic solids. The following table summarizes information about the Platonic solids.

Name of Solid	Polygons used as faces	#vertices	#edges	#faces
Tetrahedron	equilateral triangles	4	6	4
Cube	squares	8	12	6
Octahedron	equilateral triangles	6	12	8
Dodecahedron	regular pentagons	20	30	12
Isoshadedron	equilateral triangles	12	30	20

<u>Your project is to make at least three of the Platonic solids. Use poster board or cardboard for the models. The sides of the polygons used in the solids should measure at least 6 inches.</u>

<u>Carefully cut out the polygons and carefully align them before taping or gluing. Tape from the inside as much as possible. A neat finished model is the goal.</u>

PROJECT #15

Geometry Awareness-
Scavenger Hunt

Your project is to scavenge for items related to geometric concepts, vocabulary, and shapes. The items foster the idea that geometry is in the world we live in, and not just in the classroom that we sit in. All items relate to some aspect of geometry studied in Geometry. Items and/or descriptions should be placed on posterboard or in a PowerPoint.

Find at least ten of the items from the following list:

1. A classified ad for a surveyor or cartographer.
2. UPC code from three different sizes of the same brand of a product.
3. A piece of mail (envelope or letterhead) with a "geometric" logo.
4. A picture of a quilt which uses congruent shapes.
5. A piece of wallpaper that contains at least one transformation.
6. The number of "books" in Euclid's **Elements.**
7. The names of two Non-Euclidean Geometries.
8. A right circular cone of diameter approximately 10 cm; student made or commercially made.
9. A dodecahedron; student made or commercially produced.
10. A rectangular prism whose volume in cubic units is ≥ its surface area in square units.
11. A square nut, hexagonal nut, and pentagonal nut.
12. An advertisment for a specific item which shows vertical angles.
13. A list of five geometry words that begin with the same letter.
14. A picture of concentric circles.
15. The brand name of a photographic enlarger.
16. A photograph showing parallel, perpendicular, and skew lines.
17. The name of a local business that duplicates keys.
18. The names of three devices used to measure angles.
19. A sphere whose volume, in cubic centimeters, is $400 \leq V \leq 600$.

PROJECT #16

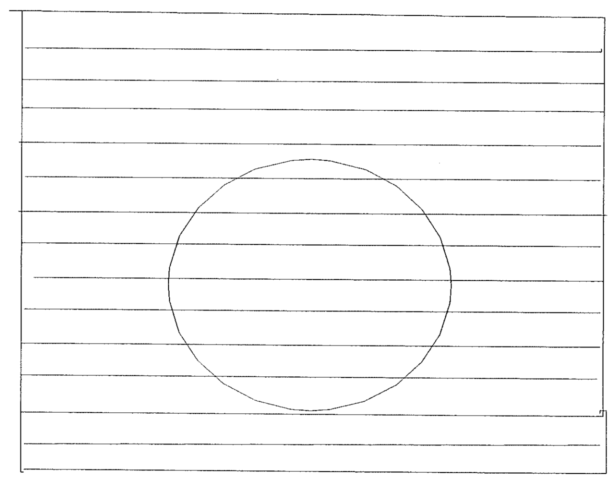
Indirect Measurement-
The Stadiascope

The clinometer and the hypsometer are instruments that may be used to indirectly measure the height of an object. Another such instrument that may be used is the stadiascope. The stadiascope is easy to build and has no moving parts.

<u>Your assignment is to build a stadiascope, following the directions below, and use it to indirectly measure an object in the classroom during your presentation.</u>

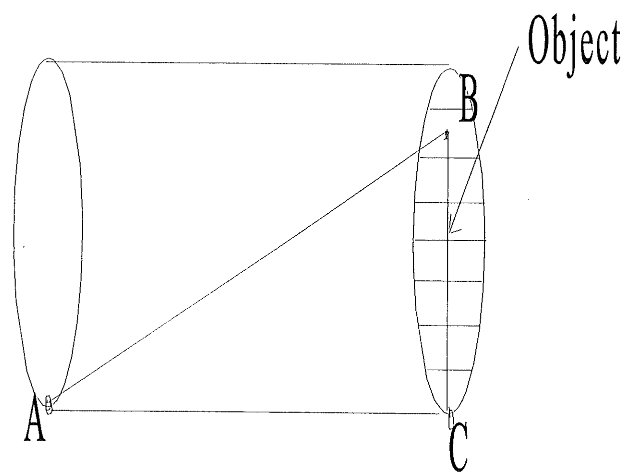
Directions for building a stadiascope:

1. Find a long tube from a roll of paper towels, from a Pringle's Potato Snack canister, or from a similar object.
2. Take a piece of mylar, clear plastic, or clear food wrap and mark off a series of parallel lines evenly spaced apart at intervals of 1 or 2 centimeters.
3. Fit the clear sheet over one end of the tube so that one of the parallel lines is exactly even with the bottom as shown at the right. Tape the sheet to the tube.



The stadiascope uses similar triangles to indirectly measure the height of objects. This side view of the stadiascope shows how.

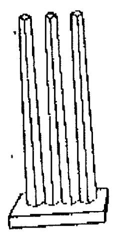
The viewer looks through the stadiascope at point A, making sure that the bottom of the object is even with the bottom line on the stadiascope. This will form a triangle as shown at the right. Triangle ABC is similar to the triangle formed by the top and bottom points of the object and point A.



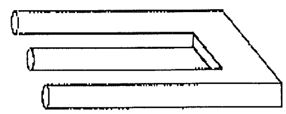
Since triangle ABC is similar to triangle AB'C', a proportion may be set up to find the length of B'C'.

PROJECT #17

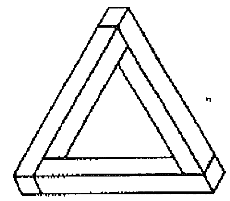
Optical Illusions



Three towers from four?



Three prongs from two?



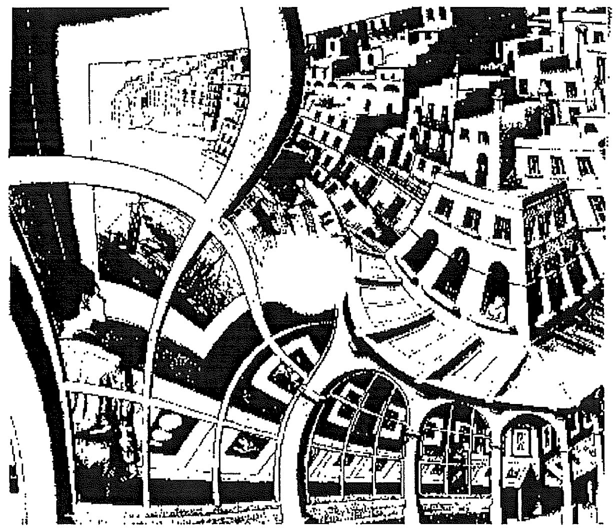
Penrose triangle

You've seen many kinds of optical illusions. Some at first appear to be drawings of real objects, but actually they are impossible to make, except on paper. Your first task in this project is to draw on <u>posterboard</u> the three objects seen above.

You now shall create at least four optical illusions of your own on the <u>posterboard</u>.
See page 16 in your book for instructions on drawing the illusions shown above.

PROJECT #18

Geometry in Sculpture



M. C. Escher is famous for his geometric art and sculptures. He used geometry in creative ways to make his sometimes strange and always interesting works of art.

Your project is to create a geometric sculpture of your own. You can use simple materials like clay, cardboard, styrofoam, and wire to make cubes, cylinders, or other shapes. You might choose to carve a simple geometric design and its complement into two surfaces you can use to make pressed paper sculptures.

Write a short report about your sculpture, describing what makes your sculpture geometric, including any symmetry it has and any geometric tools you used to construct it.

PROJECT #19

Three-Peg Puzzle

The three-peg puzzle first appeared as a toy in 1883 in France. Shortly after it was introduced, this story, as told by W. W. R. Ball in *Mathematical Recreations and Essays,* was associated with **it.** The game became known as the Tower of Brahma or as the Tower of Hanoi.

> In the great temple at Benares, beneath the dome which marks the center of the world, rests a brass plate in which are fixed three diamond needles, each a cubit high and as thick as the body of a bee.
> On one of these needles, sixty-four disks of pure gold were placed. The largest disk resting on the brass plate, and the others getting smaller and smaller up to the top one. This is the Tower of Brahma. Day and night unceasingly the men transfer the disks from one diamond needle to another according to the fixed and immutable laws of Brahma, which require that the man on duty must not move more than one disk at a time and that he must place this disk on a needle so that there is no smaller disk beneath it. When the sixty-four disks shall have been thus transferred from the needle on which they started to one of the other needles, tower, temple, and Brahmins alike will crumble into dust, and with a thunderclap the world will vanish.

What is the smallest number of moves by which the men can successfully transfer all 64 rings from one needle to another according to the given rules? Remember, in solving big problems, it is often useful to solve smaller, similar problems to discover a pattern that will make your difficult problem an easy one.

1. Copy the table below. Then cut out six circular disks of different sizes from a sturdy piece of cardboard and physically solve this problem for zero through six rings.

Rings	1	2	3	4	5	6	...	*n*	...	64
Necessary Moves	—?—	—?—	—?—	—?—	—?—	—?—	...	—?—	...	—?—

2. When you have completed the table for zero through six rings, find a pattern and make a conjecture about the number of moves necessary for *n* rings. What is the number of moves necessary for *n* rings?

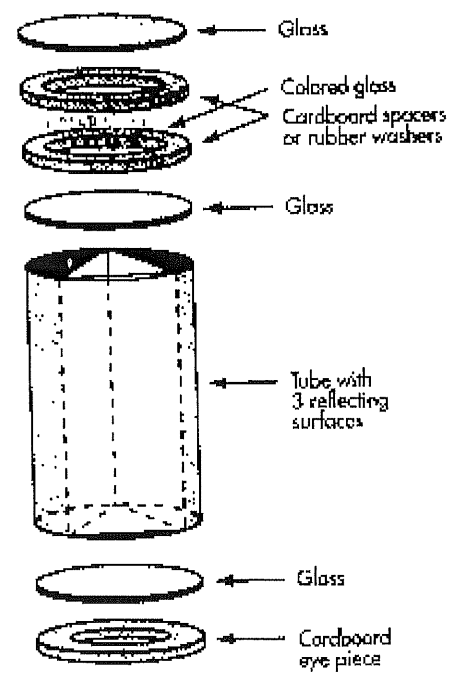
3. Use your conjecture to find how many moves it will take the men to transfer all 64 rings. You may express your answer using exponents.

Your project is to create a working replica of the three-peg puzzle using only three disks to demonstrate to the class. Use this to find the smallest number of moves possible in which to successfully transfer all 64-rings of the original puzzle. Carefully follow and complete all three steps above.

PROJECT #20

Kaleidoscopes II

Many people have looked through kaleidoscopes. The tube-shaped kaleidoscope was invented by physicist Sir David Brewster in 1816. There are many varieties of tube kaleidoscopes. Some have colored glass or plastic that tumbles. Some have nothing in the end chamber but a lens, and the designs created depend on the objects at which the kaleidoscope is aimed. Some have a marble at the end.



Your project is to design and build your own kaleidoscope.

1. Make a diagram that show your kaleidoscope plan.
2. Collect the materials and tools necessary to create your kaleidoscope.
3. Write a report that includes diagrams describing what you did, and a list of the materials used.

The figure above is an exploded view of a typical kaleidoscope. This entire scope must be rotated in order for the colored pieces to tumble into the diferent designs. The materials used can vary.

The tube can be cardboard or plastic. The round clear pieces can be glass, a lens, clear plastic, or clear acetate. The three reflecting surfaces can be mirror glass, glass painted black on one side, or clear vinyl painted black on one side. The colored pieces that go into the end chamber can be almost anything translucent. Don't put too many colored pieces between the spacers! If you use too many, they won't tumble well and they may block out too much light.

PROJECT #21

Patterns in Pascal's Triangle

In this project you will look for patterns in a special triangular arrangement of numbers. This arrangement was known by Persian poet and mathematician Omar Khayyam. The triangle is commonly known as **Pascal's Triangle**, named after French mathematician Blaise Pascal. A partial recreation of the triangle appears below.

				1					Row 0
			1		1				Row 1
		1		2		1			Row 2
	1		3		3		1		Row 3
1		4		6		4		1	Row 4

On **<u>posterboard or in a PowerPoint</u>**, recreate at least 11 rows of Pascal's Triangle and answer the following questions.

1. If the sequence in the <u>first diagonal</u> is 1,1,1,1,... what is the formula for the ***nth*** term in that diagonal?

2. The sequence in the <u>second diagonal</u> is 1,2,3,4,.... What is the formula for the ***nth*** term in that diagonal?

3. Find a formula for the ***nth*** term in the <u>third diagonal</u>.

4. Look for a pattern in the <u>sum of each row</u>. What is the sum of the numbers in the ***nth*** row?

5. Demonstate how the triangle can be used in raising a binomial to a power, such as

   $$(a + b)^{10}$$

6. Describe at least one other pattern that can be found in Pascal's triangle.

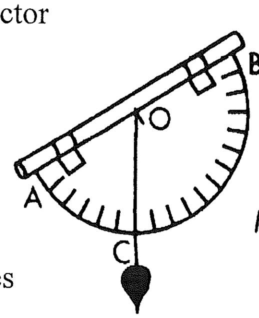
PROJECT #22

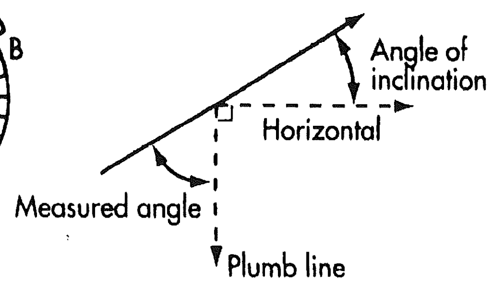
Making a Clinometer

One of the most important applications of angle measurement comes from navigation by way of astronomy. Sailors at sea, where there are no visible landmarks, depend on the location of stars or the sun to indicate where they are. A clinometer is related to early tools used to measure the location of stars. It is a protractor-like tool used to measure the angle of inclination, the angle at which an object or a slope rises above the horizontal.

In this project, you'll make a clinometer and use it to measure angles of inclination.

One type of clinometer uses a protractor with a viewing tube. The tube is attached to the zero-edge (AB) and a plumb line is attached to the vertex point (O). Hold the device in such a way that when the top of the object is sighted through the viewing tube, the plumb lines crosses the angle measurements on the protractor (C), forming an acute angle (∠AOC). This angle is the complement of the desired angle.





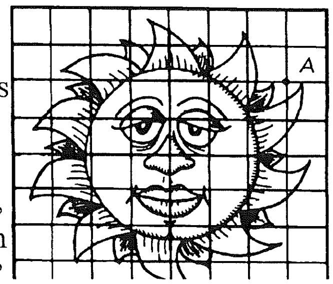
Be prepared to demonstrate to the class how the clinometer works.

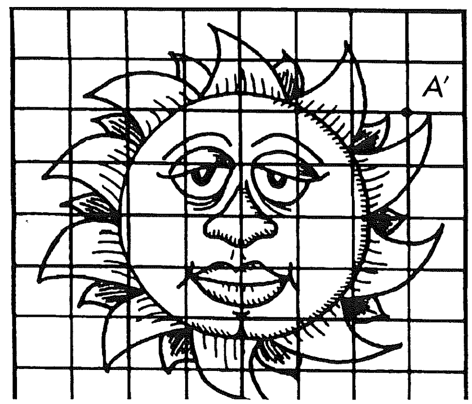
PROJECT #23

Making a Mural

Mural artists use similarity to help them create their large artwork. Muralist begin creating a mural by drawing a small picture with a grid of squares drawn over it. They then divide the surface on which the mural will be painted into a similar but larger group of squares. Proceeding square by square, they draw the lines and shapes of the original drawing into the corresponding positions of the mural surface's large squares.

The design in the small grid at the right is similar to the design in the larger grid of squares. The enlargement was made by matching points in the original drawing to the corresponding points in the larger grid. For example, point A in the small grid is in the same position as point A' in the larger grid.





Using <u>posterboard</u>, your project to to **create a mural of your own**.

1. Select a small drawing of your choice to reproduce.
2. Begin by constructing lightly in pencil a grid of squares on a photocopy of the drawing you will reproduce.
3. On your posterboard, divide a portion at least one foot by one foot into a similar group of larger squares.
4. To create your mural, carefully draw the lines and curves of the drawing in the small squares into their corresponding large squares.
5. Be sure your original drawing is attached to the posterboard for comparison.

PROJECT #24

Map Coloring

This project consist of two parts, each to be displayed on a posterboard and presented to the class.

Part I

Coloring the Map of the United States

A cartographer is someone who makes maps. Your job is to color a map of all the states in the continental United States. To make each state easy to distinguish from the others, states that share a border cannot be the same color, but states that just touch at a corner point can be the same color. Your project to to color the map with the least number of colors possible. What is the least number of colors needed to color the map of the United States?

Part II

Coloring Two Special Kinds of Maps

The least number of colors needed to color a map is called the **chromatic number** of the map. In this section you will invent two types of maps and find their chromatic numbers.

1. On an unlined sheet of paper, to be attached to your posterboard, randomly draw 10 to 15 intersecting lines that go entirely across the paper. Assume the different regions are countries on a map. Color the map with the least number of colors possible. Record the chromatic number on the map.

2. Tie a 1 meter length of string into a single loop. Drop it onto a piece of plain paper. Use just enough cellophane tape to hold the string in place. Again, think of the different regions as countries on a map. Your map consists of only those regions enclosed by string. Color the map with the least number of colors possible. Record the chromatic number on the map and attach it to your posterboard.

What is the least number of colors you need to color any map on the earth?

PROJECT #25

The Geometry of Baseball

Select a baseball stadium of your choice. On posterboard, make a **scale drawing** of the field illustrating all of its dimensions.

Laying Out the Bases

According th the 1992 official handbook, when laying out the field, "when the location of home plate is determined, use a steel tape to measure 127 feet, 3-_ inches in the desired direction to establish second base. From home plate measure 90 feet towards first base. From second base measure 90 feet towards first base. The intersection of these lines locates first base."

Display answers to the following questions:

1. Is the official method used to locate first base correct?
2. Is it reasonable?
3. Why do you think the rules specify the distances as they do?
4. Are the lines connecting first to second and first to home perpendicular?

Pitching Speed

1. Is the pitchers position in front of, on, or behind the line from first to third base? Use geometry to justify the answer
2. If a pitcher throws a ball at 90 mph, how long does it take to reach home plate? How long for a 60 mph pitch?

Where to Stand in the Batter's Box

The batter's box extends 3 ft behind and 3 ft in front of the center of the rubber for home plate. Sometimess coaches advise batter to stand at the back of the batter's box when facing exceptionally fast pitchers. Why?

1. For a 90 mph pitch, how much longer does it take the ball to get to the batter standing at the back of the batter's box than it does to get to a batter standing in from of the the box?

All questions and responses are to be displayed on your poster.

PROJECT #26

Calculating Area in Ancient Egypt

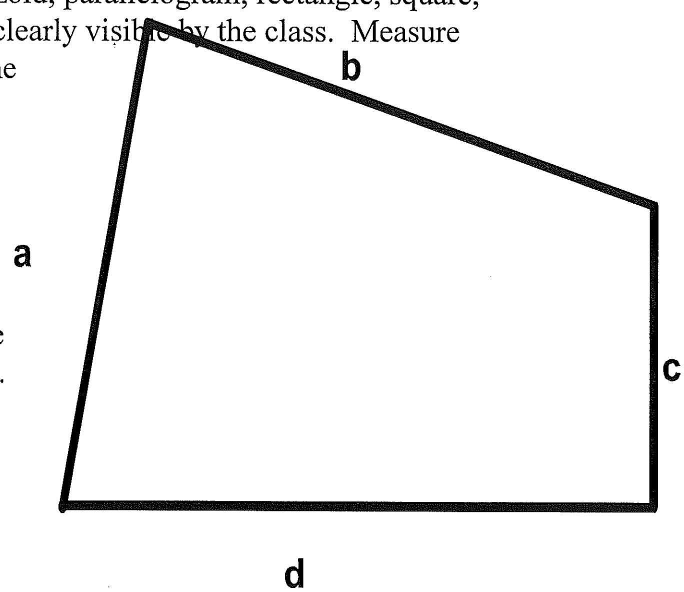
Egyptians developed some of the earliest mathematics, partly to keep track of land and finances. For example, the Egyptian government taxed land and thus needed methods of measuring the area of people's property. Much of the fertile land in Egypt is along the Nile, which flooded regularly. When the river receded it often followed a different course, so the shape and size of fields could change from year to year.

After deciphering ancient records, historians believe that Egyptian tax collectors used this formula to find the area of an arbitrary quadrilateral:

$$A = \tfrac{1}{2}(a + c) \times \tfrac{1}{2}(b + d)$$

where a, b, c, and d are the lengths, in order, of the figure's four sides.

On **posterboard or in a PowerPoint**, draw a trapezoid, parallelogram, rectangle, square, rhombus, and kite. Make them large enough to be clearly visible by the class. Measure each of the sides of the quadrilaterals and display the measures on your poster.



Step 1: Find the area of each quadrilateral using the traditional formulas presented in your textbook.

Step 2: Find the area of each quadrilateral using the formula developed by the ancient Egyptians.

Step 3: Clearly display all areas adjacent to each quadrilateral.

Investigate and answer the following.

1. Is the ancient Egyptian formula correct? How does the area given by the formula compare to the actual area?
2. Does the Egyptian formula always favor either the tax collector or the land owner, or does it favor one in some cases and the other in other cases? Explain.
3. Describe the quadrilaterals for which the formula does work.
4. Describe a correct way of calculating the area of an arbitrary quadrilateral.

PROJECT #27

Polygonal Pickup

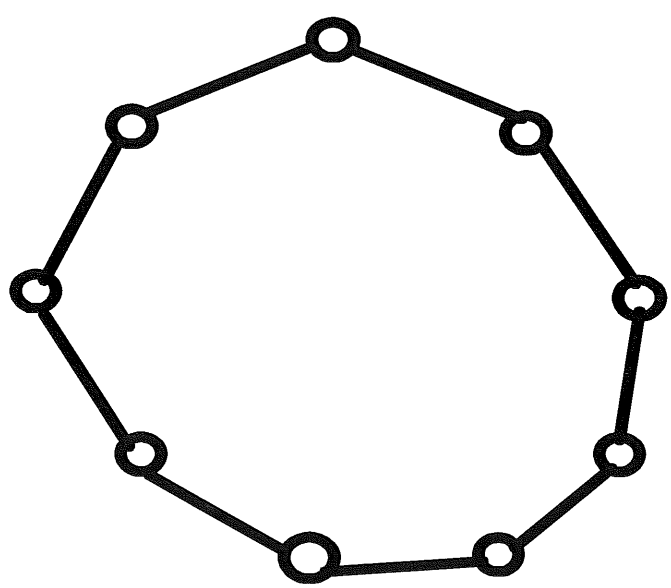
Place a checker or other counter on each vertex of a regular polygon. Take turns removing either one counter or two adjacent counter. The player who picks up the last counter is the loser.

On **posterboard**, draw the regular polygon. Make it large enough to be clearly visible to the class. Choose a second player and demonstrate the game.

1. Find a strategy that will enable you to always win.

2. Will the strategy you found work if the game is played on any regular polygon with an odd number of vertices? Draw another polygon on your posterboard and illustrate.

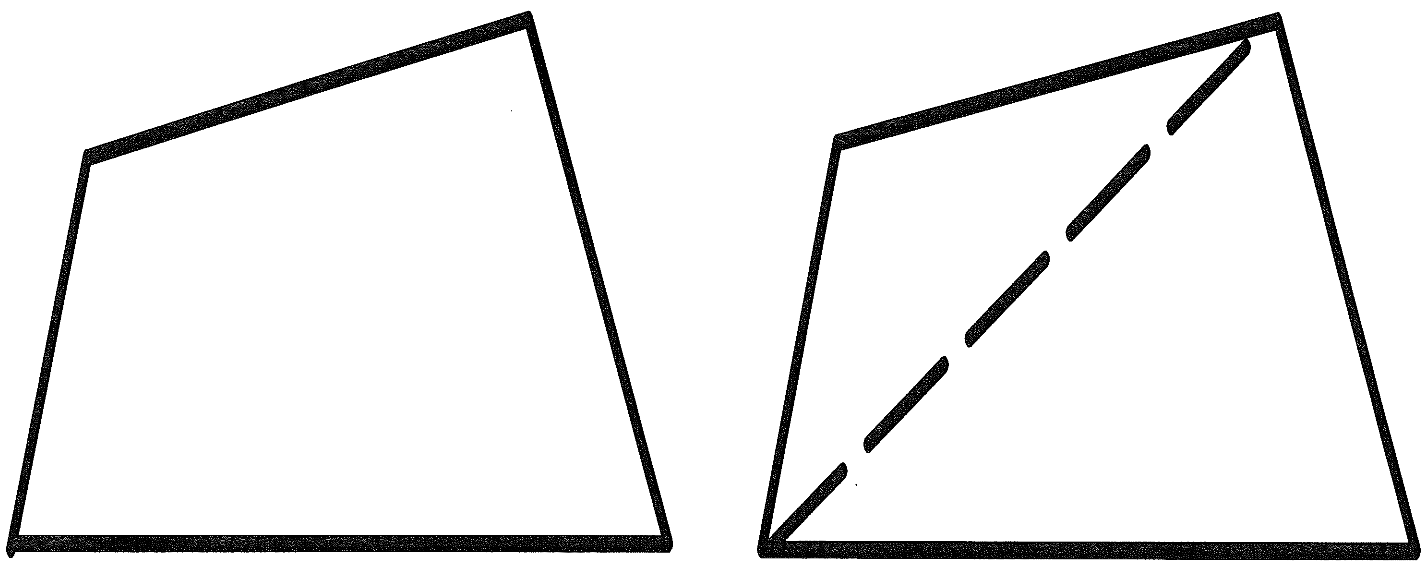
3. Suppose the game is played on a regular polygon with an even number of vertices. Can you find a strategy that will guarantee that you will win? Illustrate.



PROJECT #28

Surveying in Triangles

When surveyors determine the area of a plot of land, they often use a method called ***triangulation***. For example, even though no area formula exists for the first quadrilateral below, the quadrilateral's area is composed of two triangular areas. You could draw a different diagonal, but the area remains the same.



Heron's Theorem enables us to find the area of a triangle if we know the lengths of the sides.

Your project, to be displayed on **posterboard or in a PowerPoint**, is to find Heron's Theorem and use it to find the area of a triangle you have drawn (large enough to be viewed by the class) and measured.
Compare the area you found with the area given by using the traditional formula.

Does this theorem work for all triangles?

Use the triangulation method to find the area of a non-special quadrilateral illustrated on your poster or in the PowerPoint.

PROJECT #29

Origami

Origami is the Japanese art of paper folding. Thousands of designs are possible, and some are very simple, while others are quite complex.

Your project is to research the art of origami and construct at least three designs using this ancient method. Attach them to a **posterboard**, carefully labeling and detailing each design.

During you presentation be prepared to make a simple design to illustrate to the class.

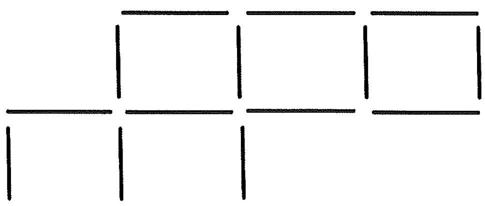
PROJECT #30

Toothpick Puzzles

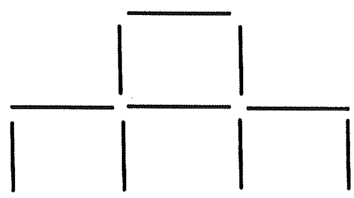
You have seen puzzles like the following in books of recreational mathematics. Some are fairly simple, but others can be quite challenging. Use any convenient objects such as toothpicks, straws, or pencils to help you find solutions.

On **<u>posterboard or in a PowerPoint</u>**, draw and list the instructions to each of the following puzzles. Adjacent to each puzzle, draw the solution. Use a piece of construction paper to hide the result of each puzzle from the class until your demonstration.

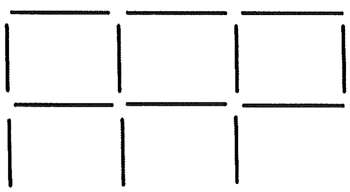
1. Move toothpicks to form four squares of the same size.



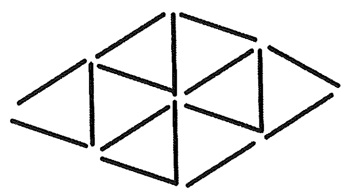
2. Make six squares with these thirteen toothpicks.



3. Remove three toothpicks so that three squares are left.

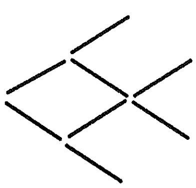


4. Remove the least number of toothpicks to leave four triangles

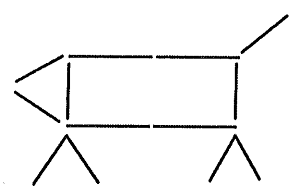


the same size as the eight shown.

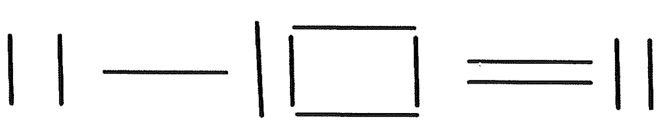
5. Move the least number of toothpicks to make the fish swim in the opposite direction.



6. Move the least number of toothpicks to make the pig face the opposite direction.



7. Move one toothpick to make a correct equation. More than one solution is possible.

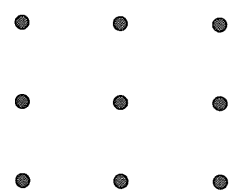


PROJECT #31

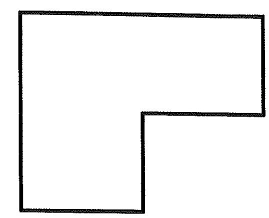
A Few Puzzles

Geometry puzzles can be both interesting and challenging. Diagrams often make solving a puzzle easier. Your project is to illustrate each of the following puzzles on **posterboard (large enough for the class to view) or in a PowerPoint.** Next to each puzzle illustrate the solution. Cover each solution with construction paper so they are not visible to the class. The solutions will be viewed during your presentation.

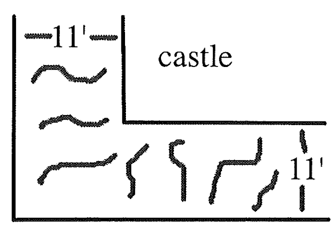
1. Without lifting your pencil, draw four line segments that pass through all nine points.



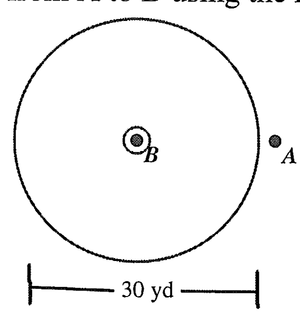
2. A woman wants to split a piece of land with her four children so that each child gets a piece equal in shape and area. How How can she do it?



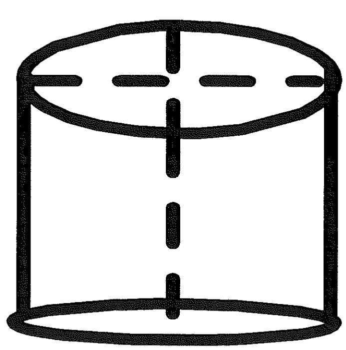
3. A square castle is surrounded by an 11-foot wide moat. A knight wants to cross the moat, but the drawbridge is closed. If he has two boards, each 10 feet long, how can he cross the moat?



4. A circular pond has a small island in the center. Points A and B represent trees. A woman who cannot swim has a rope a few yards longer than 30 yards. How can she get from A to B using the rope?



5. A grocer can cut a wheel of cheese into four equal pieces by making two slices. How can the grocer make one more slice to form eight equal pieces?

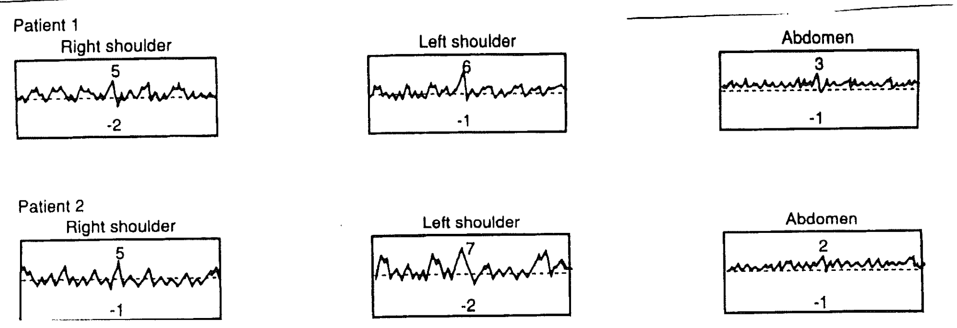


6. How can ten trees be planted so that each tree is in two rows of four trees?

PROJECT #32

Einthoven's Triangle

A device called an electrocardiograph measures the electrical activity of a person's heart at three equidistant points of the body. The device gives a readout called an electrocardiogram. The strength of the electrical impulses at each point can be read from the electrocardiogram.

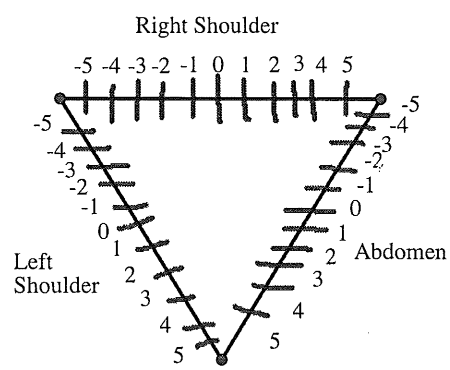


The angle of the heart within the body cavity can be determined by plotting the readouts on the equilateral triangle below. This triangle is called ***Einthoven's Triangle***, after the German cardiologist who invented the electrocardiograph.

Your project is to draw Einthoven's Triangle on a **posterboard (large enough for everyone to see) or in a PowerPoint** and follow the instructions below to find the angle of the heart. Use patient 1 information.

1. Find the net deflection of each readout. The net deflection is the sum of the two extreme values given. For example, the net deflection in the right shoulder of Patient I is 5 + (-2) or 3.

2. Graph each net deflection on the corresponding side of Einthoven's triangle.



3. **Construct** a line perpendicular to the side of the triangle at each of these points. Label the point of intersection of the perpendiculars E.

 Construct the medians of the triangle. Label the point of intersection A. Draw line EA, called the *electrical axis* of the heart. Through A, draw line b parallel to the side of the triangle corresponding to the right-shoulder node. Line b is called the *base line.*

4. Measure the angle between b and line EA. This is the angle of the person's heart.

PROJECT #33

House Plans

Your project is to design a house. Your house must meet the following requirements:

- House must be between 1800 and 2400 square feet.
- 2 - 3 bedrooms
- At least one bathroom
- A kitchen
- A dining area
- At least one living area
- The lot is to measure 75 feet by 100 feet.

Your task will be the following:

- You must first come up with a rough sketch of your house. This sketch must include measurements but does not need to be drawn to scale and rooms must be clearly labeled.
- You will then create from your rough sketch a well planned, scaled and labeled drawing on your posterboard. The scale will be 1 cm = 2 feet.
- Finally, you will be required to price your house using the fact that its costs $100 a square foot to build a house. When finding the cost of your house you must include detailed calculations.

PROJECT #34

Children's Books

As a writer and Senior executive at a well-known educational publishing company, you have recently been put in charge of the children's book division. The current trend is to teach young children advanced mathematical topics in a way that they will be able to understand the basic concepts. Your first assignment is to choose a topic from a high school geometry course and write a children's book that will serve as a model for the other writers in your department.

Below is a list of suggested topics. You may choose a specific topic in one of these general categories or write about the general category:

Parallel lines	Pythagorean Theorem	Circles
Congruent figures	Transformational Geometry	Quadrilaterals
Similar figures	Area of figures	Coordinate Geometry
Perimeter of figures	Trigonometry	Volume & Surface Area

<u>The book must be at least ten pages long and include a cover. There should be written text and illustrations (hand-drawn or computer generated).</u>

HONORS GEOMETRY 3RD QUARTER PROJECT

For this project you will be doing some research about a mathematician chosen from the list below. In order to share your findings with the entire class, you will produce a full-sized posterboard or a PowerPoint which highlights the mathematician's life and accomplishments. The poster or PowerPoint shall contain the mathematician's name with dates of birth and death prominently displayed. Include a portrait or photocopy of what the mathematician looked like. Items to be included are achievements in mathematics with a brief explanation of what the mathematician accomplished, such as the Pythagorean Theorem, complete with a diagram and/or formula. Accomplishments outside the field of mathematics such as Einstein's winning the Nobel Prize, should also be used. List at least two references you used for your research, visible on the posterboard or PowerPoint.

Be sure your poster or PowerPoint is easily read and eye-appealing.

The following is a list of mathematicians for the mathematics history project.

1. THALES
2. PYTHAGORAS
3. JOHN NAPIER
4. JOHANN KEPLER
5. LEONHARD EULER
6. ALBERT EINSTEIN
7. RENE DESCARTES
8. BLAISE PASCAL
9. ERATOSTHENES
10. GALILEO GALILEI
11. EMILIE DU CHATELET
12. APPOLONIUS OF PERGA
13. CHARLES BABBAGE
14. GRACE MURRAY HOPPER
15. EUCLID
16. BHASKARA
17. HYPATIA
18. SOPHIE GERMAIN
19. ADA LOVELACE
20. JANOS BOLYAI
21. NICCOLO TARTAGLIA
22. PIERRE DE FERMAT
23. GEORGE BOOLE
24. C.F. GAUSS
25. EVARISTE GALOIS
26. EVANGELISTA TORRICELLI
27. N.I. LOBACHEVSKI
28. ARCHIMEDES
29. G.W. LEIBNITZ
30. OMAR KAYYAM
31. MARY FAIRFAX SOMERVILLE
32. ISAAC NEWTON
33. LEWIS CARROLL
34. FIBONACCI
35. SONYA KOVALEVSKY
36. EMMY NOETHER
37. AL-KHWARIZMI
38. WITCH OF AGNESI
39. GOROLAMO CARDANO
40. SRINIVASA RAMANUJAN
41. FRANCOIS VIETE
42. HERON

The following set of books may serve as resources for any of the mathematicians listed.

Bell, T.E. (1937). *Men in Mathematics.*

Boyer, C. (1968). *The History of Mathematics.*

Burton, D. (1985). *The History of Mathematics: An Introduction.*

Cajori, F. (1928). *A History of Mathematics Notation.*

Dunham, W. (1990). *Journey Through Genius - The Great Theorems of Mathematics.*

Eves, H. (1983). *An Intoduction to the History of Mathematics.*

Eves, H. (1969). *In Mathematical Circles.*

Hollingsdale, S. (1989). *Makers of Mathematics.*

Johnson, Art. (1994). *Classic Math: History Topics for the Classroom.*

National Council of Teachers of Mathematics. (1969). *History Topics for the Mathematics Classroom.*

Osen, Lynn M. (1974). *Women in Mathematics.*

Information on mathematicans can be found on the internet. Use a search engine to find information on your choice.