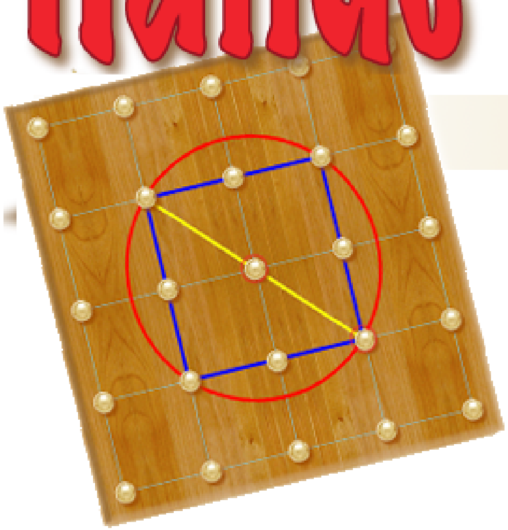
Tools for Active Teaching and Active Learning

# Hands-On Math

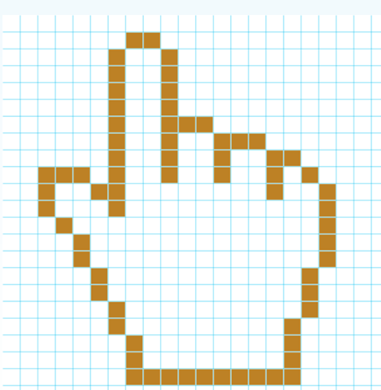
## Geoboard



Explore and Discover

- ✔ Basic Geometry
- ✔ Area and Perimeter
- ✔ Symmetry

## Instructor's Guide



Ventura Educational Systems

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## Credits

| | |
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| **Instructional Technology and Programming** | Fred Ventura, Ph.D.<br>Ben Ventura<br>Jon Ventura |
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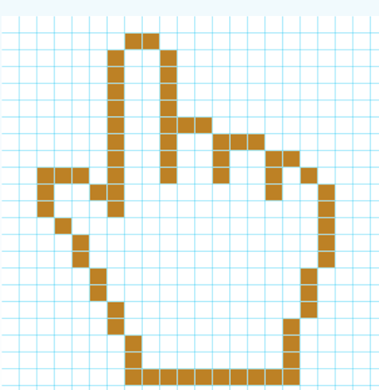
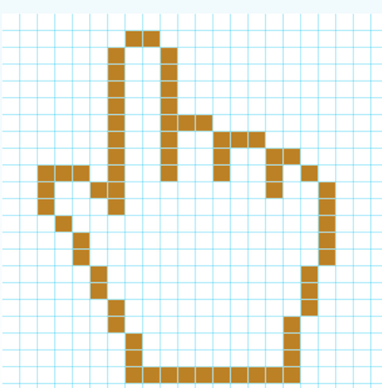


# Table of Contents





# Overview

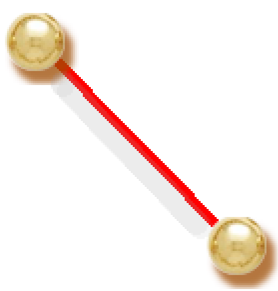
The use of a Geoboard is one of the best ways to give students an insight into basic geometry. The formal study of geometry is often attributed to the Greeks where simple drawing tools, a straight line, and an arc were used to explore the properties of a variety of figures. Descartes furthered the study of geometry with his development of Cartesian or analytic geometry. Descartes used algebra to describe geometry. He invented the convention of representing positions using x, y, and z. The Hands-On Math Geoboard is designed to help children develop an understanding of these concepts and more. In order for a child to develop a meaningful understanding of mathematics it is essential that the child know the underlying concepts of basic geometry. After a student has developed clear understanding of of these ideas problem solving related to geometry can be introduced.

Learning basic geometry involves the study of lines, line segements, shapes and symmetry. The introductory study of geometry includes learning that some figures are open and others are closed. Children learn that shapes have properties. Shapes can be described in a variety of ways .

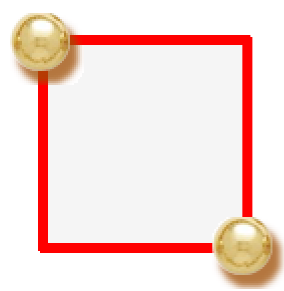
The Hands-On Math Geoboard app turns your iPad into a interactive tabletop surface that we call a Playground. The Playground provides the child with an opportunity to freely explore the basic concepts of geometry. The Playground provides three types of drawing tools.

*Visualizing mathematical concepts is the key to understanding. Models help significantly in cognitive development.*

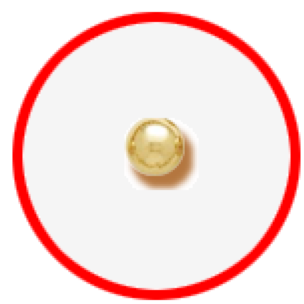
**Line Segment**



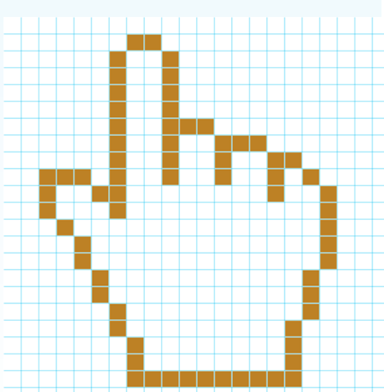
**Rectangle**



**Circle**



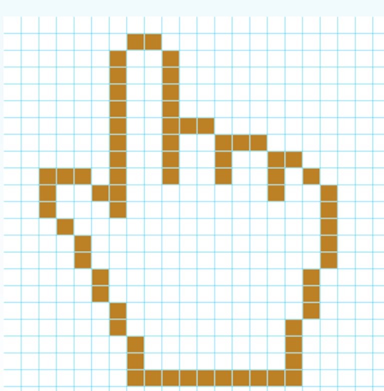
Research has shown that children learn best through active involvement in the learning process. Hands-On Math: Geoboard is designed to be a tool that teachers can use for active teaching and active learning. Math manipulative devices can be a rich source of teaching strategies for problem solving and can be very helpful in developing an intuitive understanding of mathematical concepts. The Hands-On Math series suggests ways in which concrete learning experiences can be extended to a representational level and still remain manipulative and interactive.



This guide consists of two sections. The first part is written for the teacher and explains the functions of the app and options available. It presents ideas for instructional strategies that can be implemented with each simulated manipulative device.  The second section of the manual is a set of curriculum-based activities that are designed to help the teacher in using the Hands-On Math app.  These activities have been developed for elementary and middle school age children and are arranged by order of grade level where the concepts are typically introduced.  Teachers will want to decide what is the best sequence for using the materials with their particular group of students.  Each lesson is aimed at specific mathematical objectives including counting, representing numbers using the place value system, addition and subtraction with regrouping.  Each activity is meant to be a beginning.  Teachers will want to encourage the children to explore extensions of each activity with different examples.  Orally discussing each activity will help to foster higher level thinking.

Hands-On Math: Geoboard is a starting point.  Learning should be fun and as students work with the app, it is my intention that they will begin discussing, sharing and creatively exploring mathematics.

-- Fred Ventura, Ph.D.



# Introduction to Hands-On Math: Geoboard

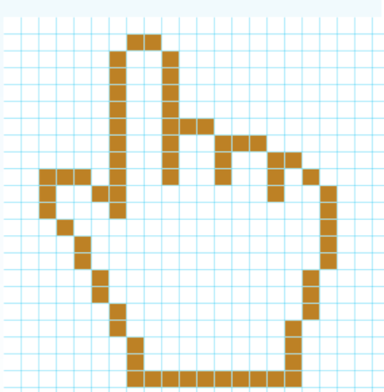
Approaches to the teaching of mathematics that rely heavily on one methodology are inherently weak and unlikely to produce optimal results. Educators have found that teaching strategies must adapt to accomodate new discoveries which expand our understanding of the learning process and new technologies which expand our delivery systems.

According to learning theory, children learn best when they are actively involved in the learning process. There are many ways to do this but one example is having children work in small groups in a laboratory/discovery situation. Small group instruction encourages variation in teaching methodology. Variation in the way in which material is presented serves the instructional process since one particular methodology may not be best for all children. Different children respond differently to a particular educational approach. The same methodology that is appropriate for one content area or developmental stage may not be appropriate in a different content area or with children who are at a different developmental stage.

For learning mathematics an active teaching and active learning situation is a very desirable educational environment. To create it the teacher must be aware of the behavioral characteristics of the students with regard to mathematics, must be knowledgeable in the particular skills which are being taught and must be able to draw upon diverse strategies in order to decide which is the most appropriate for fostering the development of the targeted mathematical concepts.

*Piaget's theory of cognitive development is a comprehensive theory about the nature and development of human intelligence.*

In general, educational psychologists believe that the ability of children to learn passes through developmental stages. Each stage is characterized by particular behaviors. In the early stages learning is tied to perceptual responses. As the child matures, abstract reasoning becomes possible and concrete models are useful for laying the conceptual groundwork for new ideas, but once a concept has been internalized the concrete models are no longer necessary. The work of Swiss psychologist, Jean Piaget, has contributed a great deal to support this theory, and to foster the development of educational strategies which are consistent with the theory.



# Using an iPad in a Manipulative Approach to Math

Hands-On Math: Geoboard combines and extends the use of concrete materials for teaching mathematics to the touch-based interactive enviroment of the Apple® iPad™. When used in conjunction with actual manipulative devices the app offers a unique set of strategies for active learning. While using the app students can draw upon concepts developed from concrete experiences that were gained using manipulative devices and will work with the same concepts in a more representational manner using the app. In this way the child's <u>concrete</u> mathematical knowledge is used to help make a transition to a <u>representational</u> stage and serves as a foundation for the development of <u>abstract</u> mathematical thinking skills.

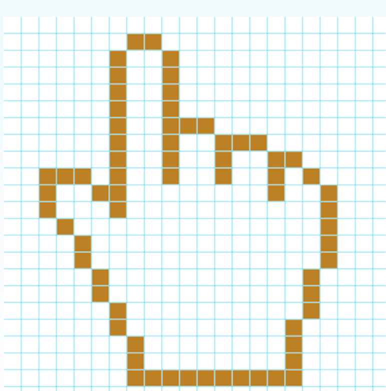
Once mathematical concepts have been internalized by the child in a concrete way, the stage is set for a deeper understanding of the more formal, abstract axioms of higher mathematics.

Hands-On Math: Geoboard simulates the use of three basic drawing tools, a line, a rectangle and a circle. Using these three tools a great deal of geometry can be learned. The concepts studied in this curriculum are the foundations of geometry. The app simulates the use of a 5x5 peg board with elastic bands, however the opportunities for learning are augmented by the artificially intelligent feedback provided by the software. The instructional approaches that result from creating an open-ended area for free exloration and discover are exciting. On the Geoboard Playground students manipulate a supply of virtual elastic bands to represent geometric figures and learn about the properties of shapes.

*We use the term "playground" to convey the open-ended, discovery approach to learning that this tool was designed to support.*

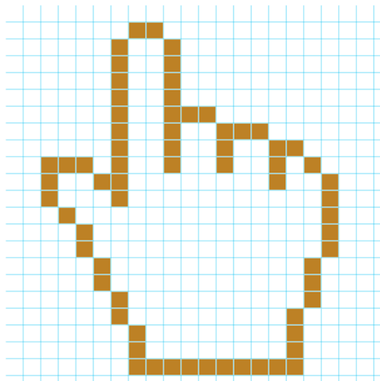
Using the Geoboard Playground students can use gestures to draw lines, rectangles and circles. The author and designer coined the term, "artificially intelligent math manipulative" to describe how using the Hands-On Math Geoboard differs from the concrete manipulative devices traditionally used in classrooms. The Hands-On Math Geoboard Playground provides intelligent mathematical feedback as the student manipulates the Geoboard.

The Hands-On Math Geoboard Playground can also be effectively used with lessons that present mathematical concepts in a structured way. Initially teachers may want to provide ample free exploration time and then after the students have become familiar with the product, direct students into more structured investigations. Students will make discoveries and when they do teachers should encourage them to share their discoveries with others in their group.

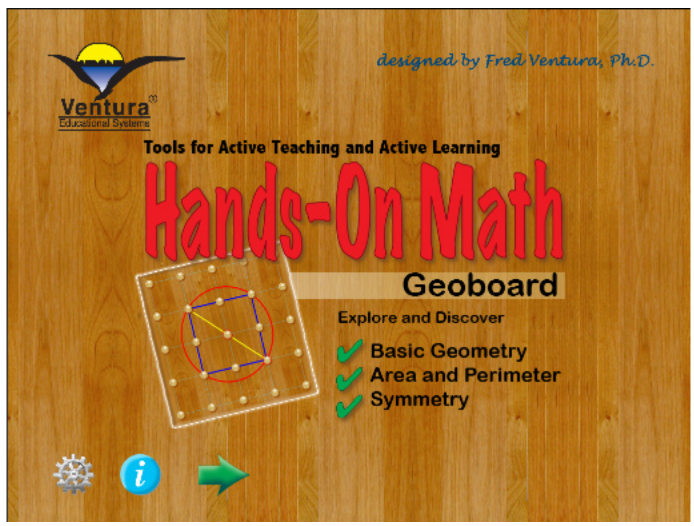


# Getting Started

Hands-On Math: Geoboard helps student develop an understanding of basic geometry. The program is designed in such a way that the physical operation of the app does not interfere with the learning activity. Icons are used to provide the user with complete control over the interaction with the software features.



Tap the Hands-On Math Geoboard icon to launch the app.

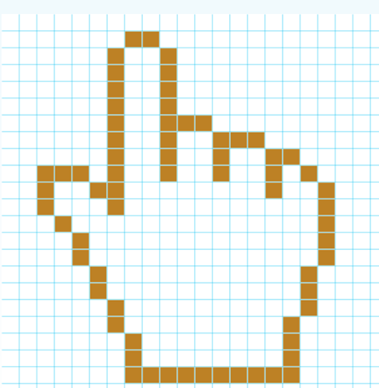



The opening view presents the title page with three options:

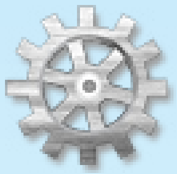
Settings - Tap this icon to control the sound, speech and view options of the app.

Info - Tap this icon to access the User's Guide where an overview of the app is presented.

Begin - Tap the green arrow to start using the Hands-On Math: Geoboard Playground.

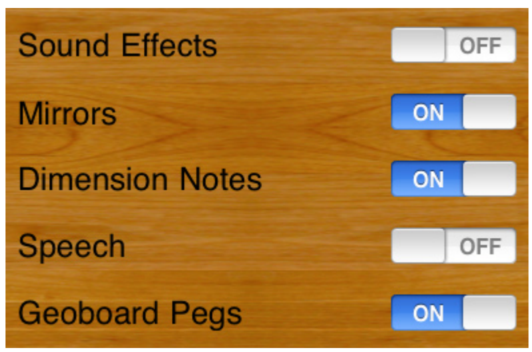


# Settings



The Settings option provides control of some of the basic features of the app.  Options include control for sound effects and speech.


Mild sound effects are used through out the app and add a level of interest for students.  When using the app with very young students teachers may wish to have the Speech option on.  When Speech is on the name of each color is pronounced when a color splash is tapped.




Use the on/off switch to activate or deactivate the sound effects, and the speech or the writing of numbers.

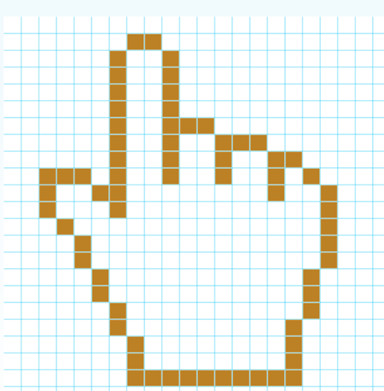
The mirror option can be slid to 'Off' for a more simplified Geoboard.

When studying measurement, length, area, perimeter, and circumference, teachers may want to activate the Dimension Notes where dimensions are reported.

When speech is 'On' color names are pronounced as they are selected.

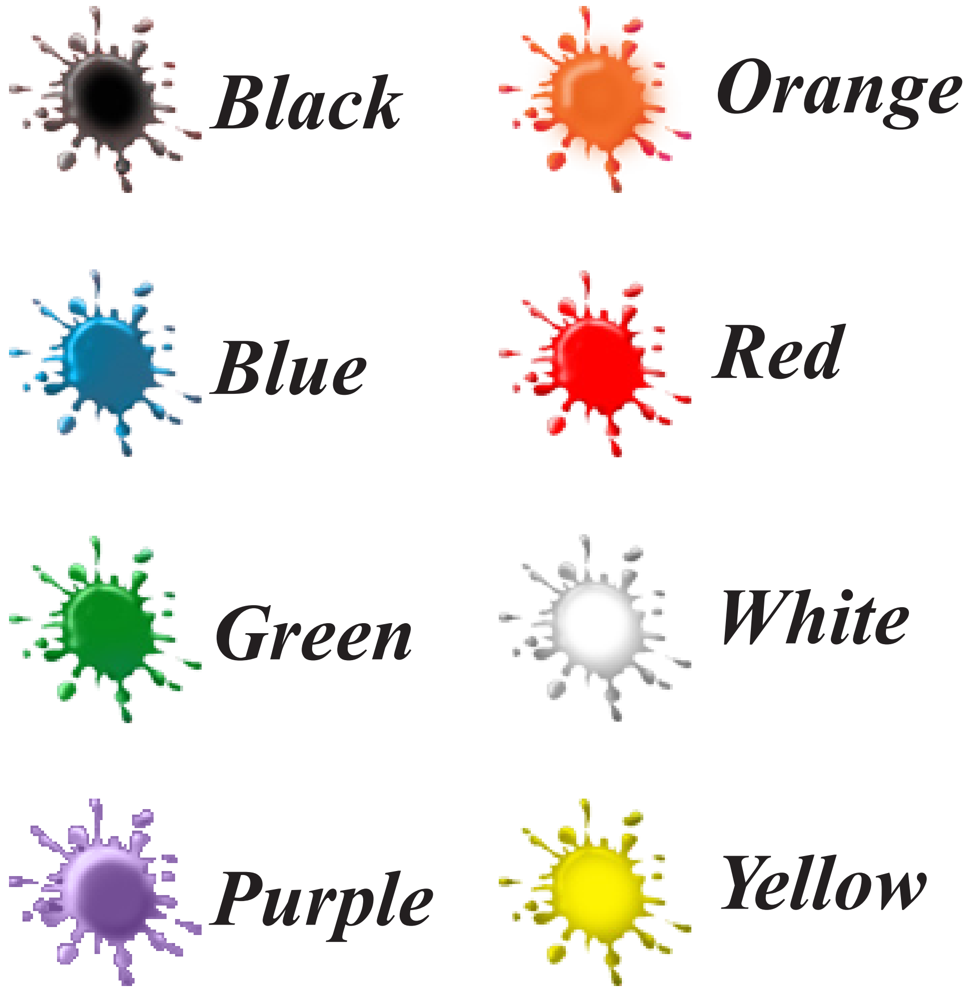
The Geoboard pegs can be hidden to use just a simple grid.

*Use Speech effects with very young children to help them learn the names of colors.*



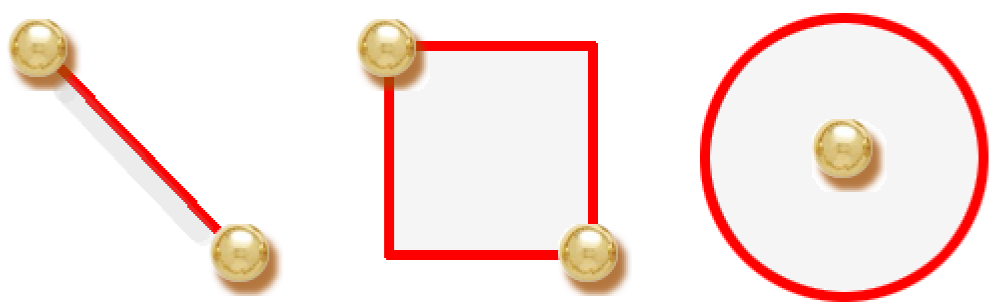
## Drawing Tools

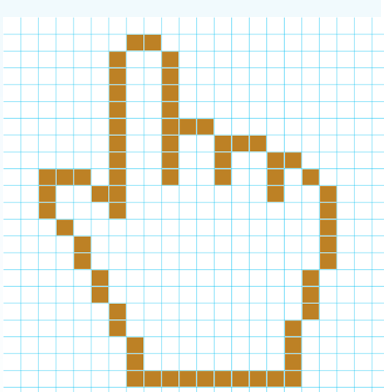
Tap a color splash to select a color.




Tap a drawing tool to select a shape.  Repeatedly tap a drawing tool icon to set the opacity of the fill for the rectangle and circle.

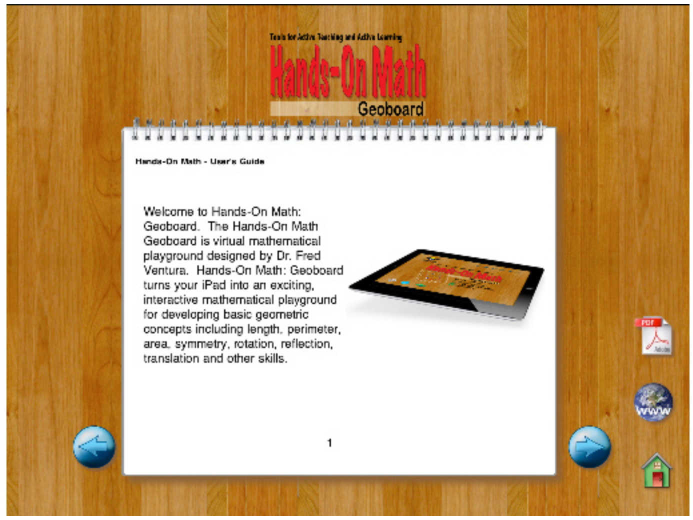
**Line Segment** **Rectangle** **Circle**





# In App User's Guide

Tapping the Info icon brings up the Hands-On Math User's Guide. The guide provides a quick overview to the features of the app. It serves as a quick reference to the use of the product.




Users can navigate by tapping either the right or left arrows. Swiping right or left can also be used to move to the next page or previous page.

Exit the user's guide by tapping the home icon.

*Swipe right or left to change pages or use the buttons.*

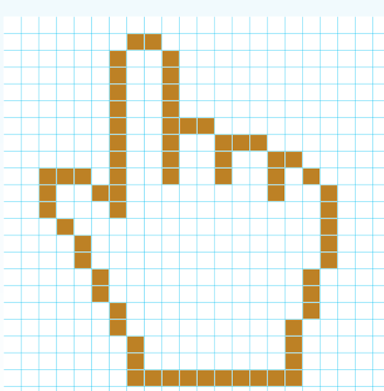
Next Page - Tap this icon to move to the next page.

Previous Page - Tap this icon to move to the next page.

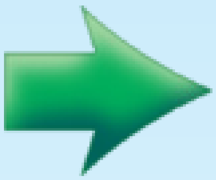

Instructor's Guide - Tap to automatically begin downloading the PDF of the Instructor's Guide from www.venturaes.com. We recommend you install the Instructor's Guide in iBooks for convenient reference.


Tap the World Wide Web icon to launch your iPad browser and view the Ventura Educational Systems website.

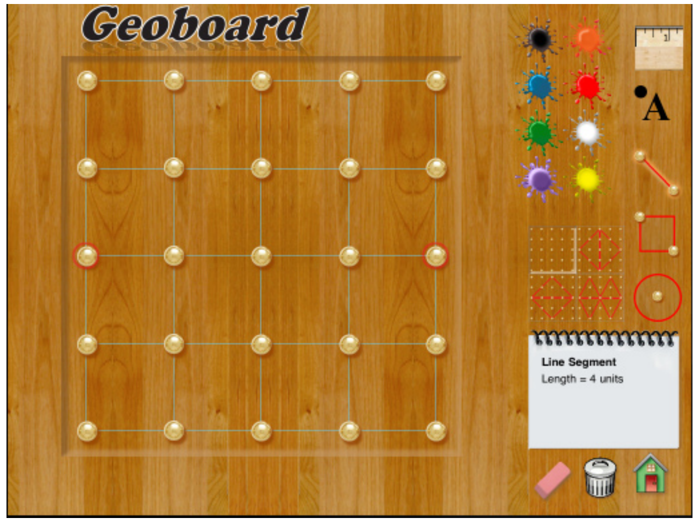
Home - Tap this icon to exit from the User's Guide.



# Geoboard Playground

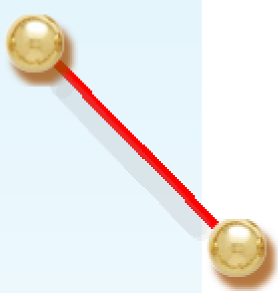


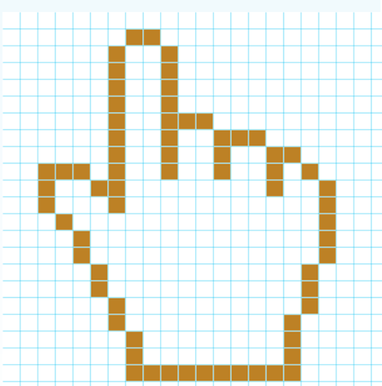
The Geoboard Playground is where the fun begins. Tap the green arrow to get started. You will notice that in addition to the Geoboard there are eight color splashes, an eraser, a ruler icon, three drawing tool icons, mirror icons, a trash can and a note card.

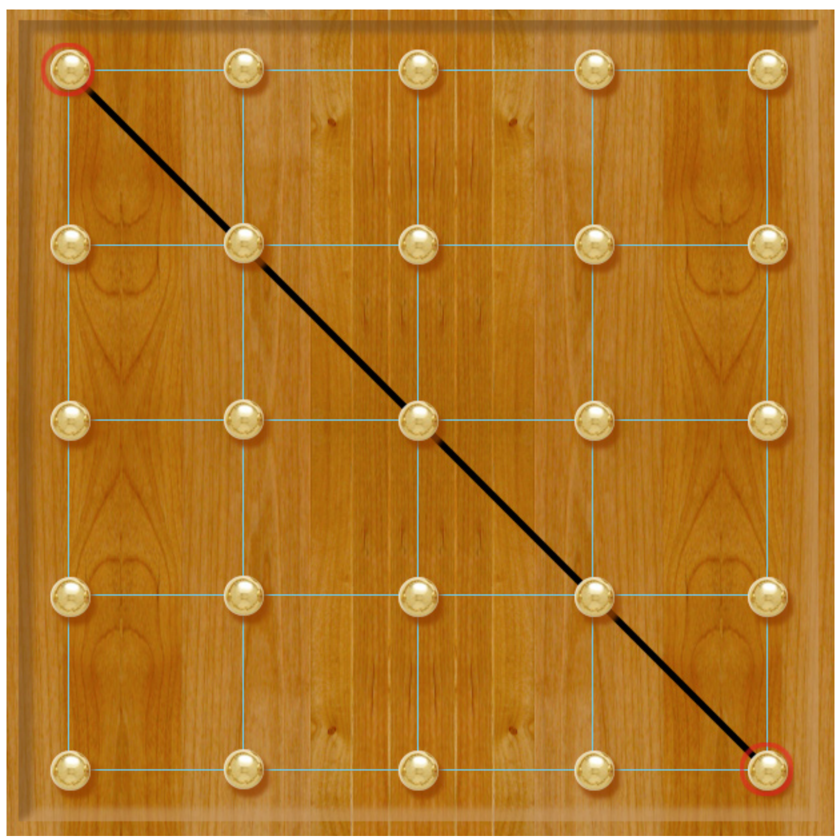



Drawing Gesture: Tap black and then tap the line segment tool. Touch the top left peg on the Geoboard and slide your figure to the bottom right peg.

Line Segment



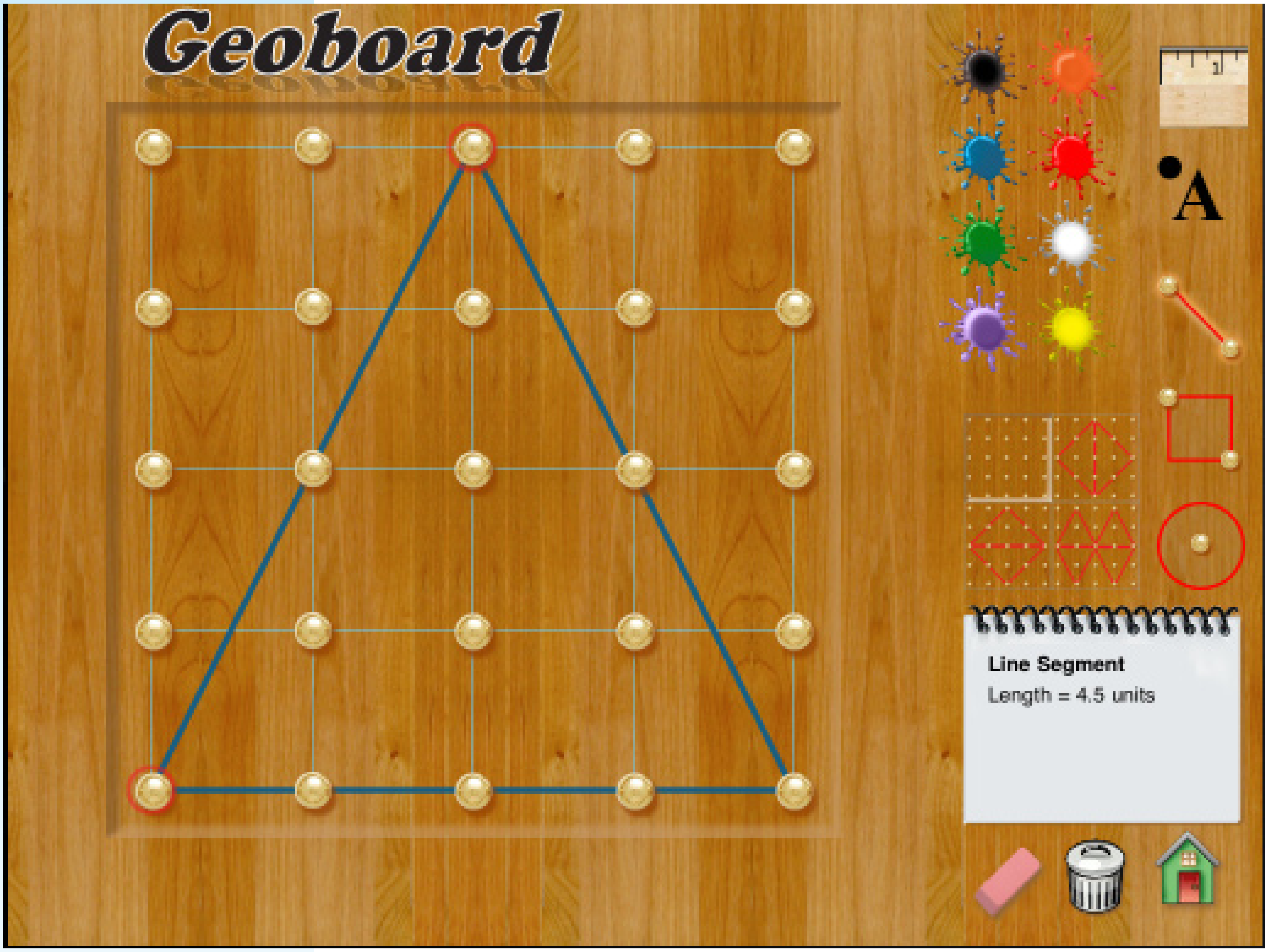




When you release your finger a diagonal line will appear as shown above. Experiment with the rectangle and circle tools to learn how these tools work.

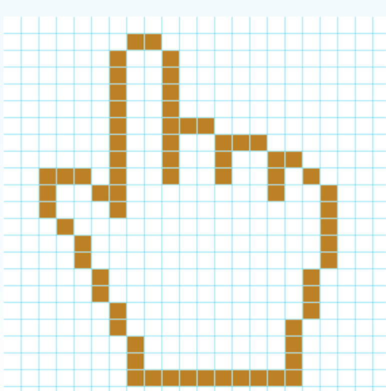
# Drawing a Triangle on the Geoboard Playground

To draw a geometric figure on the Geoboard, select a color and appropriate drawing tool then use simple gestures to make the figure.  Draw a triangle using three line segments as shown below.



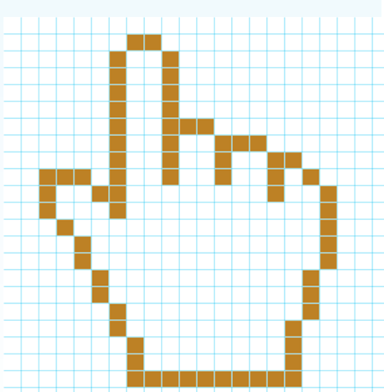

Tap the eraser icon to remove a line.

Tap the trash can icon to clear the Geoboard.



# Activities





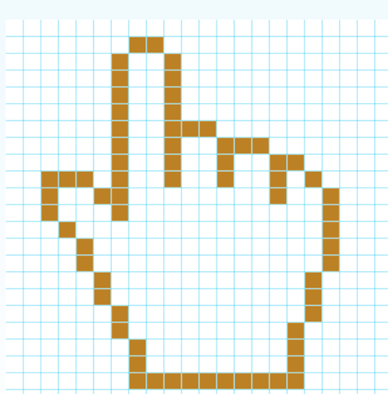
## Basic Figures

Settings


Sound Effects


Speech

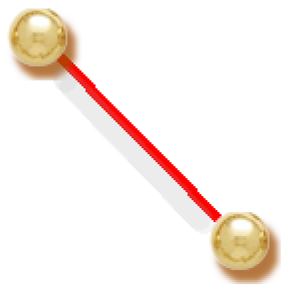
Eraser

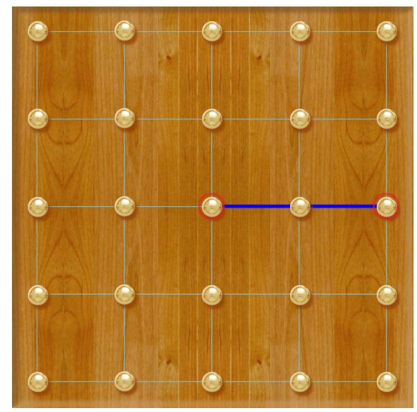


Let’s begin exploring the Hands-On Math: Geoboard Playground by drawing three basic figures, a line segement, a square and a circle.  Tap the blue color splash to choose blue for your drawing.

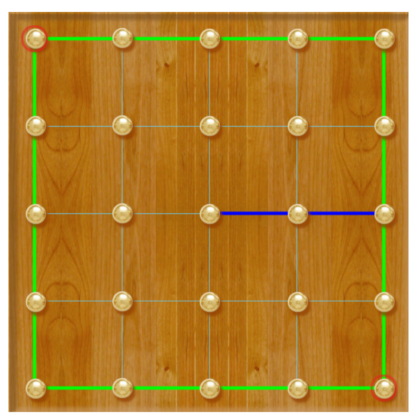
First choose the line segment tool and using the drawing gesture draw a horizontal line from the center peg to the right edge as shown below

**Line Segment**

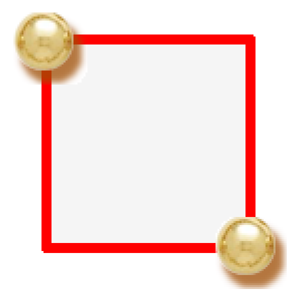




Next, choose green and then the rectangle tool.  Draw a square from the top left corner to the bottom right corner.

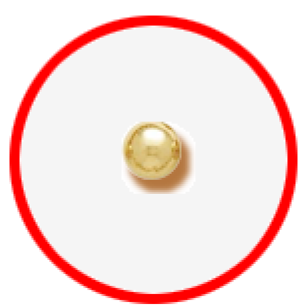


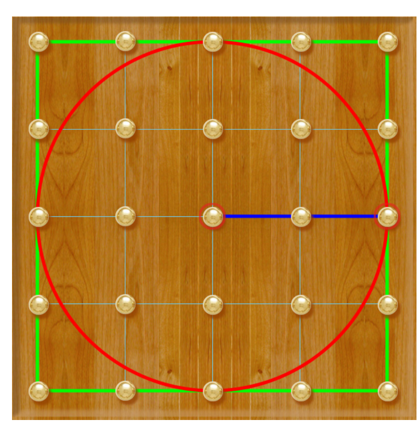
**Rectangle**



Finally, choose red and then the circle tool.  By touching the center peg and dragging to the right edge, draw a circle inscribed in the square.

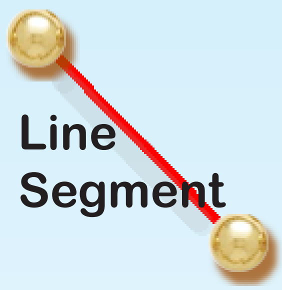
**Circle**

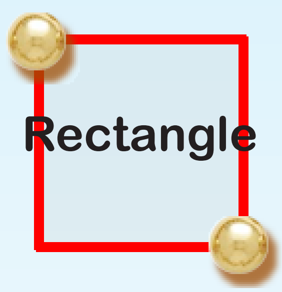


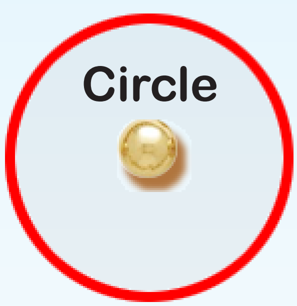


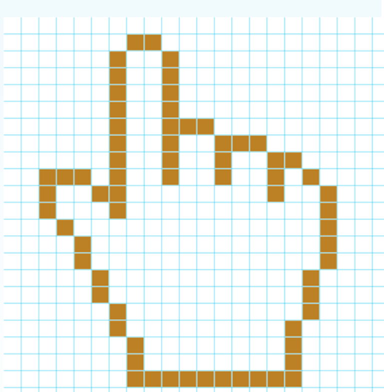
## Exploring Line Segments and Shapes

Trash Can



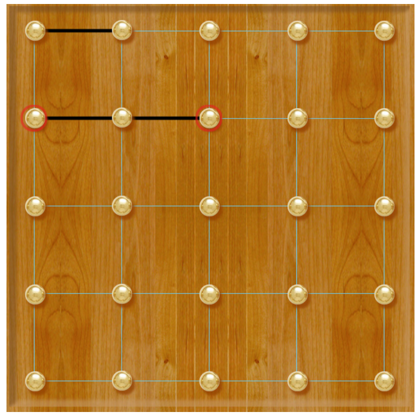



Use the Geoboard to complete these activities.

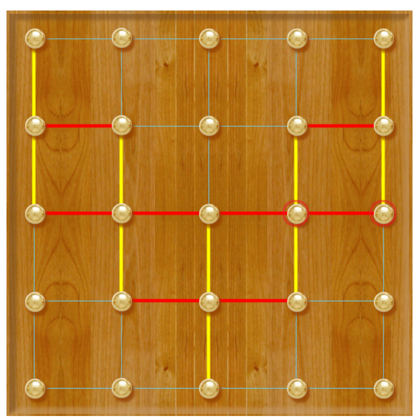
1. Draw two horizontal line segments on the Geoboard as shown below.



2. The first line segment is 1 unit long. The second line segment is 2 units long. Draw line segments for each length given below:

**3 units** **4 units**

3. Clear the Geoboard by tapping the trash can icon. Make a colorful design using only horizontal and vertical line segments



In this design the yellow line segments are horizontal and the red line segments are vertical.

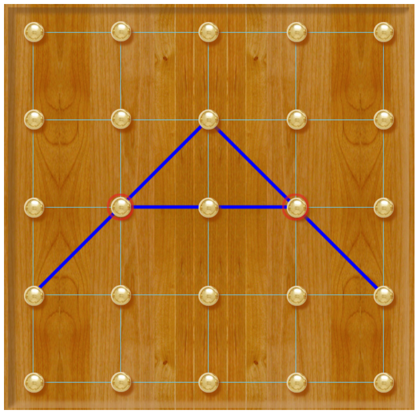
4. Clear the Geoboard. Draw line segments to make each of these figures:

| | | |
|---|---|---|
| **Triangle** | **Rectangle** | **Trapezoid** |
| **Square** | **Parallelogram** | **Hexagon** |

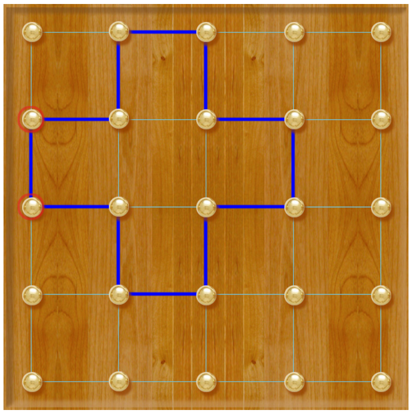
5. Clear the Geoboard. Use the rectangle and circle tools to make a square with a circle inside of it.

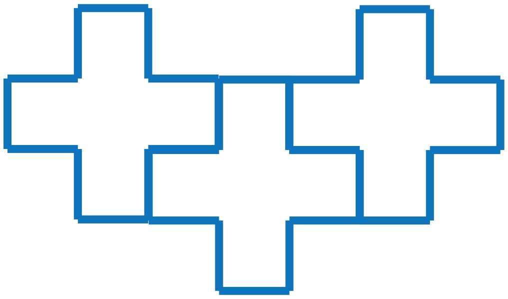
# Fun with Line Segments

1. This Geoboard shows one way to make the letter A using line segments. How many letters of the alphabet can you make?



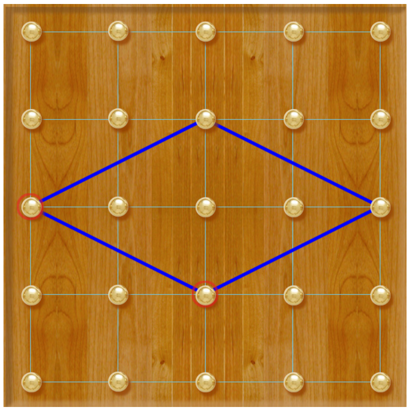
2. Copy this shape on to your Geoboard. This shape would fit together to make a pattern.



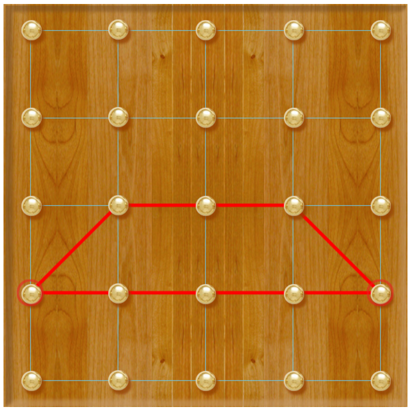


3. Draw another shape that will fit together to make a similar pattern.

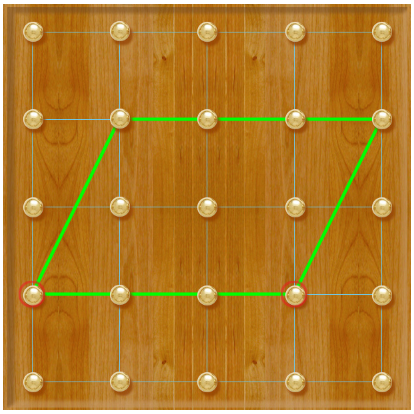
4. Each shape shown on these Geoboards is a quadrilateral. A quadrilateral is a figure with four sides. Certain quadrilaterals have special names. Draw these quadrilaterals on your Geoboard.



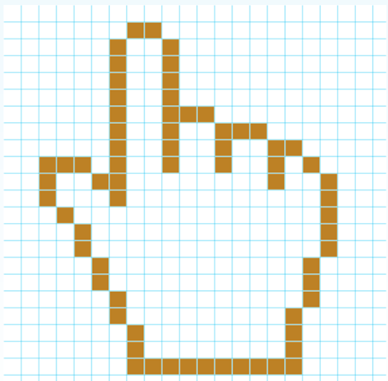
*rhombus*



*trapezoid*



*parallelogram*

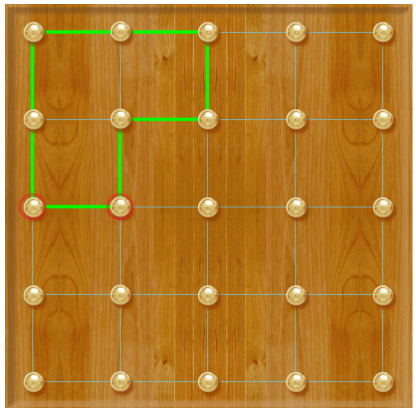


# Congruency

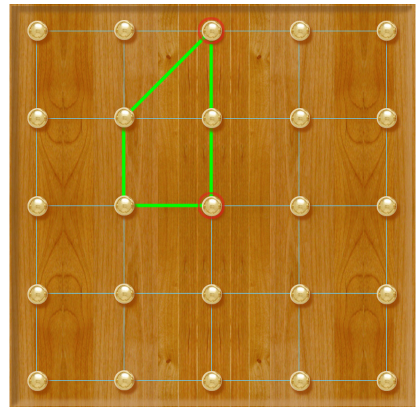
***Figures that are the same size and shape are congruent.***

1. Use the Geoboard to copy the shapes shown on each Geoboard. Draw the green shape on your Geoboard. Use blue to draw a congruent shape.

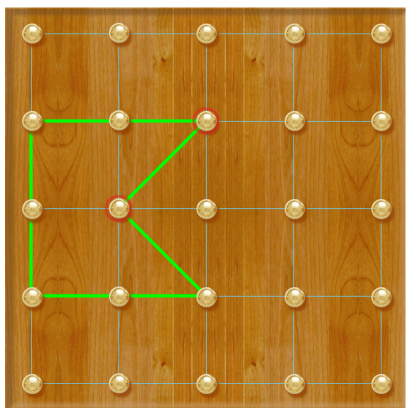
A



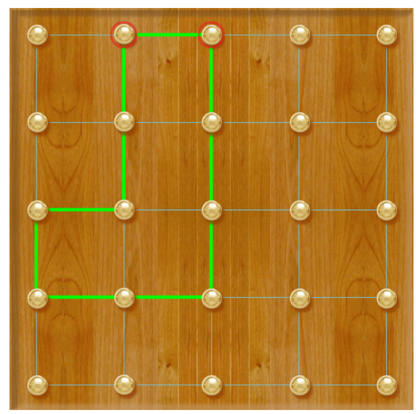
B



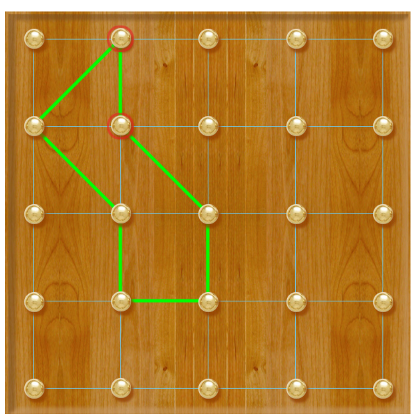
C



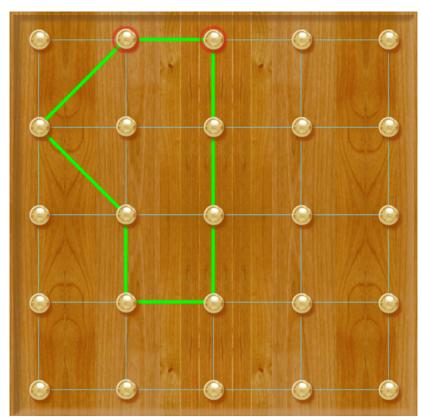
D

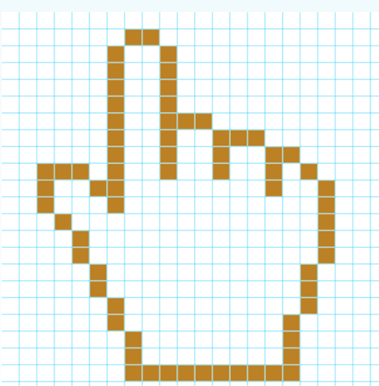


E

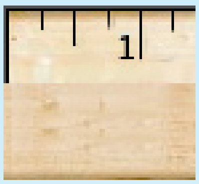


F

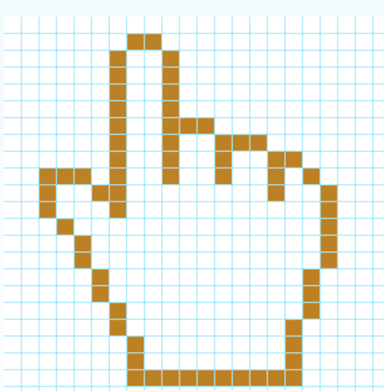




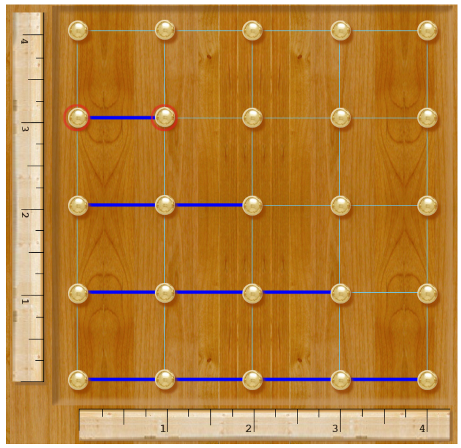
## Measuring Length



Ruler Icon



For this activity tap the ruler icon until rulers appear on the sides of the Geoboard.



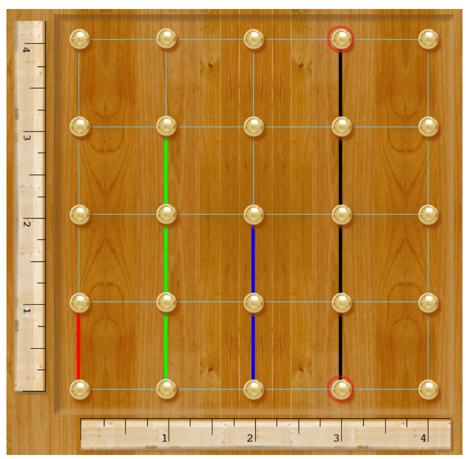
1. Draw four horizontal line segments with the these lengths:

   4 inches

   3 inches

   2 inches

   1 inch



2. Study this Geoboard. Tell the length of these line segments:

   red ______________

   green _____________

   blue ______________

   black ______________

3. Use the line segments in question 2 to solve these arithmetic probems.

**red + black = 5**

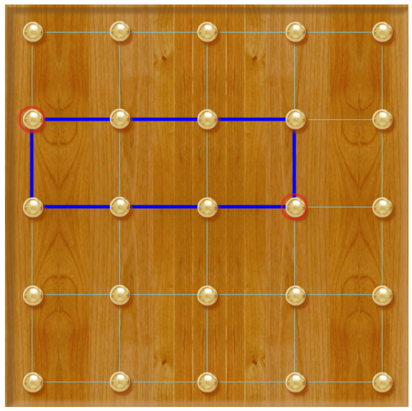
**blue + black = _____**

**green + blue = _____**

**black - red = _____**

# Perimeter

The total length of the sides of a figure is the perimeter. When you draw a rectangle the perimeter of the figure is shown on the Note Card. Draw this figure using the rectangle tool.



The Note Card reports that the perimeter of this figure is 8 units.

Notice that two of the sides are 3 units long and two of the sides are 1 unit long.

The sum of the sides can be found using addition:

$$3 + 1 + 3 + 1 = 8$$

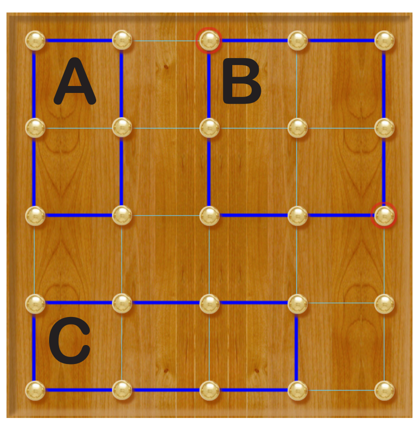
Often in geometry a formula is used to calculate perimeter. This formula works for rectangles:

$$P = 2(l + w)$$

where:

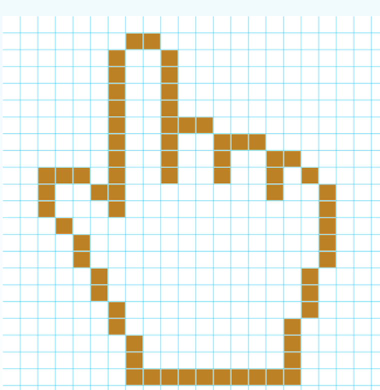
P = perimeter
l = length
w = width

Study these figures. Write the perimeter of each figure in your notebook. Copy the figures to your Geoboard to check your answers.




## Perimeter

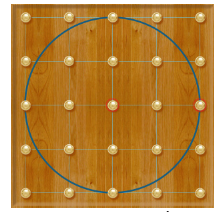
| |
|---|
| A |
| B |
| C |



# Naming Shapes

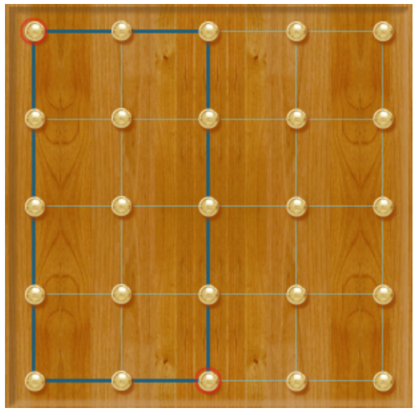
Draw each of these shapes on your Geoboard. Write the names of the shapes in your notebook.

Example:

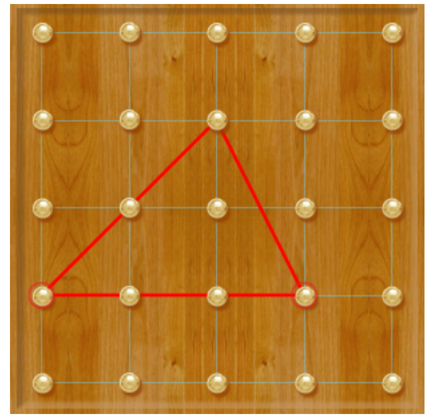


Circle

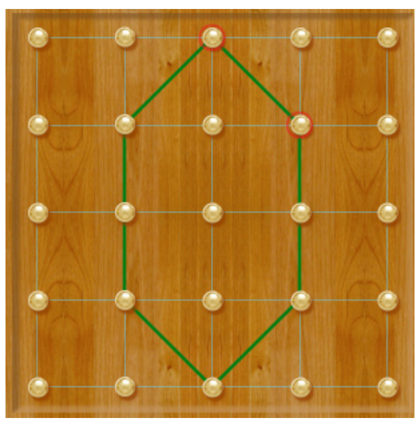
1.



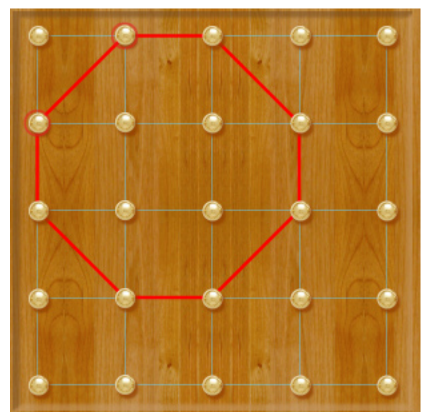
2.



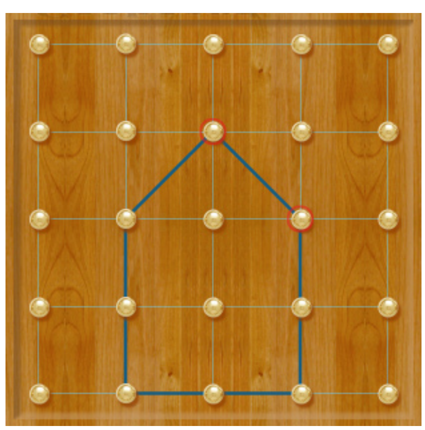
3.



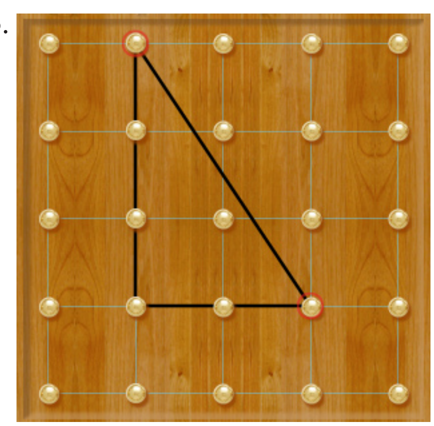
4.

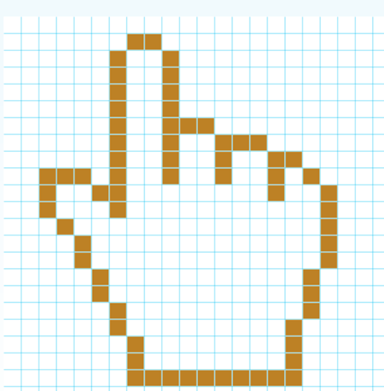


5.



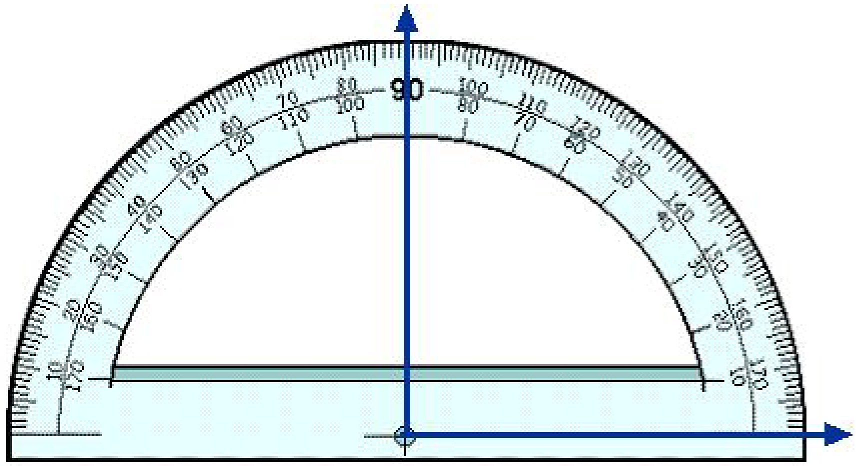
6.



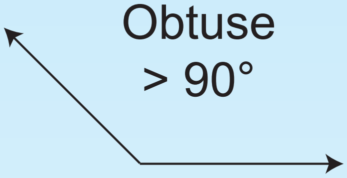


# Classifying Angles

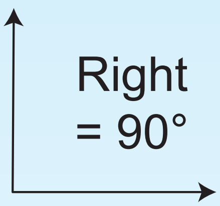
Angles can be classified by size. Angles that are 90° are right angles, angles that are greater than 90° are obtuse angles and angles less than 90°.



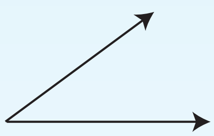
Obtuse
> 90°

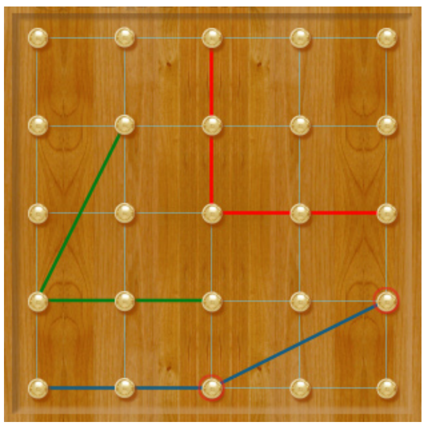


Right
= 90°



Acute
< 90°





1. Copy these angles on your Geoboard. In your note book write ***obtuse***, ***right*** or ***acute*** for the angles shown.

**Red** ____________

**Green** ____________

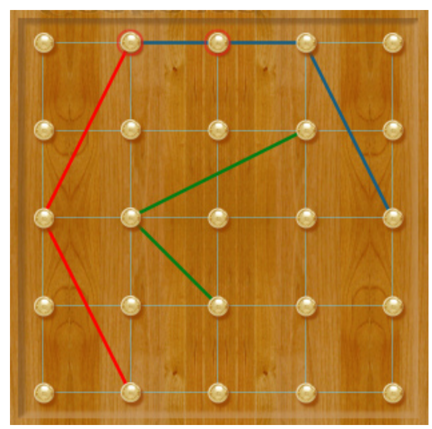
**Blue** ____________

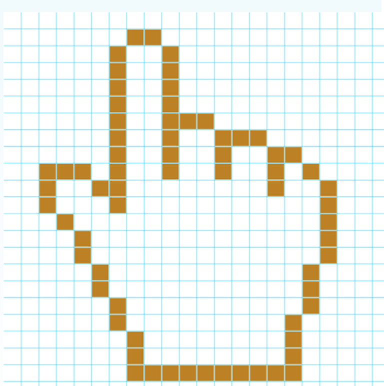
2.

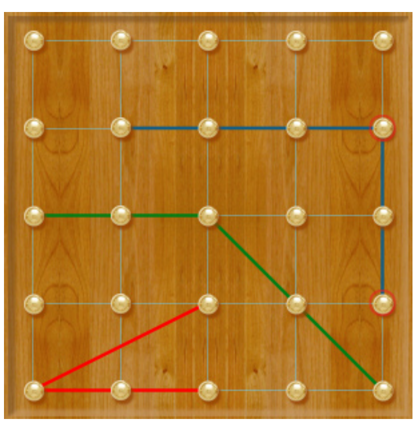
**Red** ____________

**Green** ____________

**Blue** ____________







3.

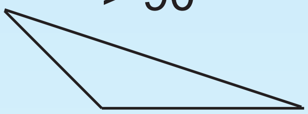
**Red** ____________

**Green** ____________

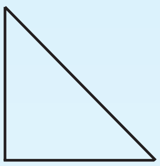
**Blue** ____________

# Classifying Triangles

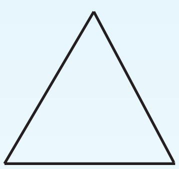
Obtuse
> 90°

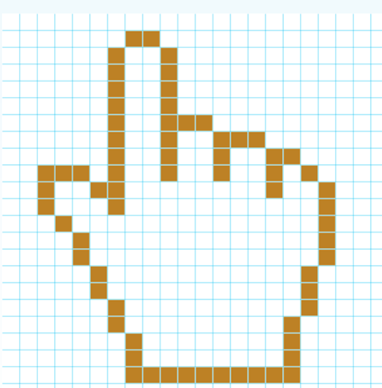


Right
= 90°

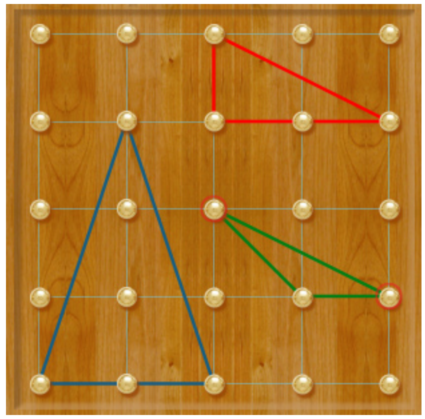


Acute
< 90°





Triangles can be classified by the sizes of the angles. Triangles with an angle that is equal to 90° are ***right triangles***, triangles with an angle greater than 90° are ***obtuse triangles*** and triangles with all three angles less than 90° are ***acute triangles***.

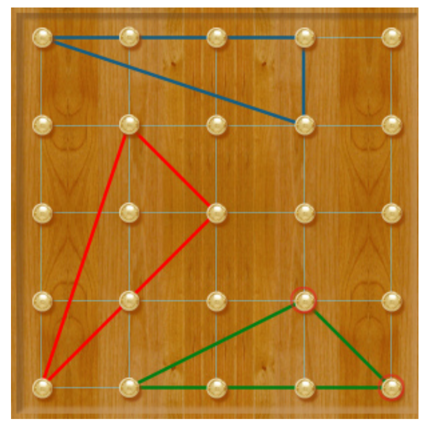


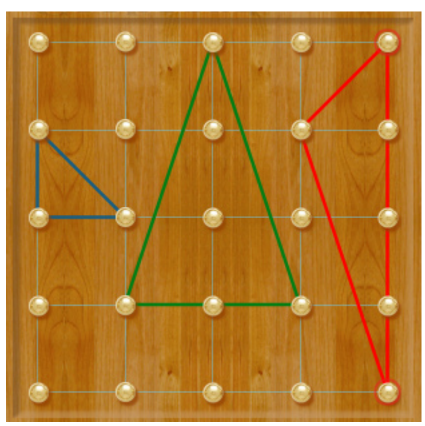
1. Copy these triangles on your Geoboard. In your notebook write ***obtuse***, ***right*** or ***acute*** to describe the triangles shown.

**Red** ____________
**Green** ____________
**Blue** ____________

2.

**Red** ____________
**Green** ____________
**Blue** ____________



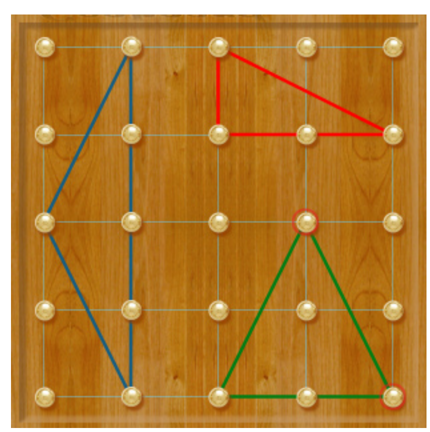


3.

**Red** ____________
**Green** ____________
**Blue** ____________

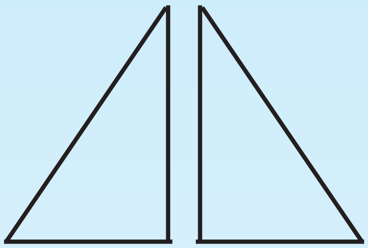
4.

**Red** ____________
**Green** ____________
**Blue** ____________

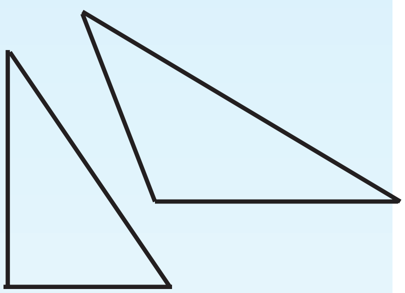


# Congruent Triangles

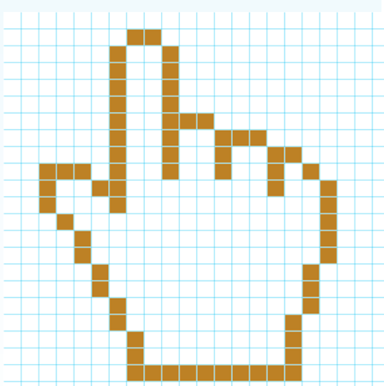
Triangles are ***congruent*** if all ***corresponding sides*** and ***interior angles*** are congruent. ***Congruent*** triangles have the same shape and size.



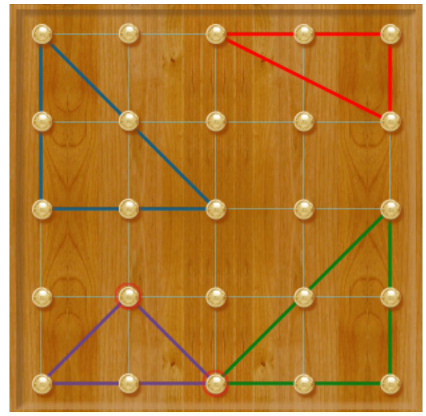
Congruent Triangles



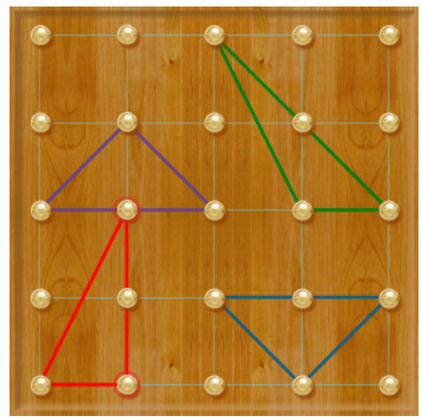
Not Congruent



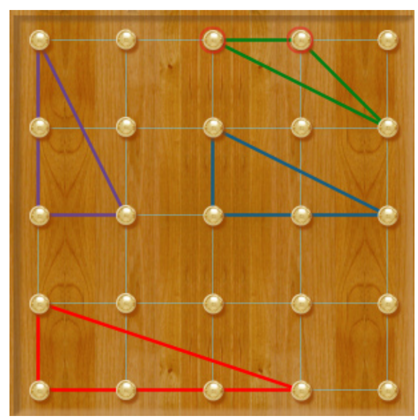
For each example, copy the triangle on the Line Design Playground. Draw a congruent triangle using a different color.



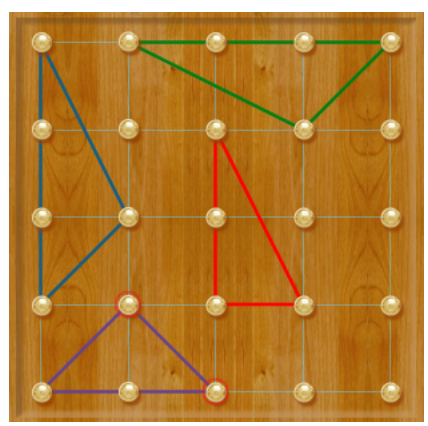
2.



3.



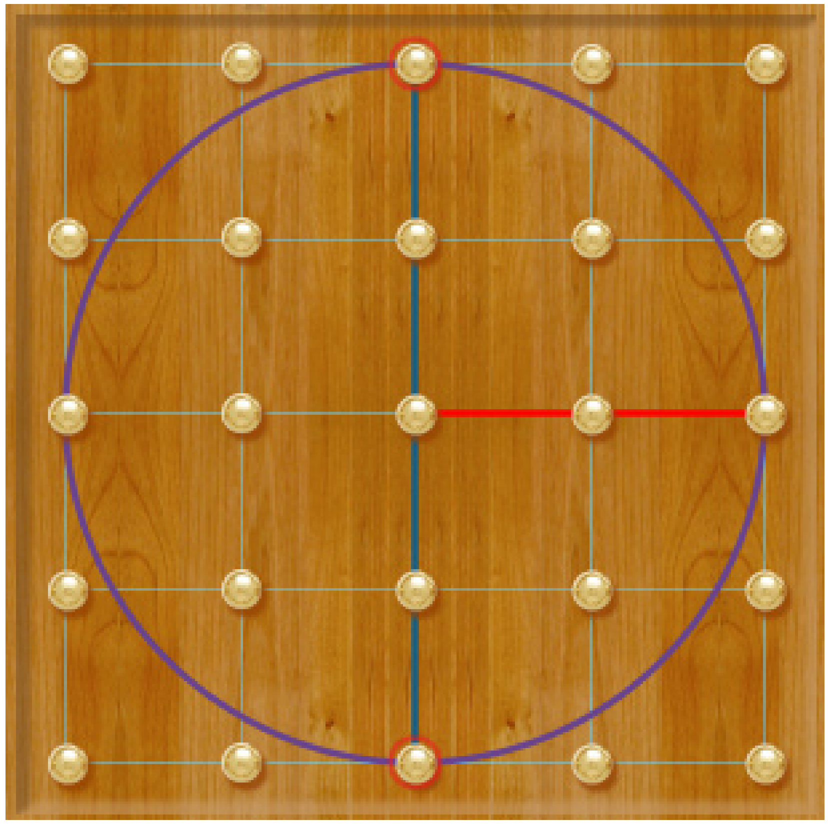
4.



# Parts of a Circle

The distance from the center of the circle to edge is the ***radius***. The line from any two points on the edge that passes through the center is the ***diameter***. The edge or boundry of a circle is the ***circumference***.

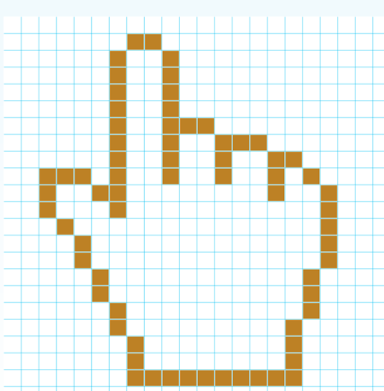
1. Copy this diagram on your Geoboard. Write the name of the part for each color.



**Purple** ____________________

**Red** ____________________

**Blue** ____________________



1. Use the line segment tool to find the length of the diameter and radius of this circle.

   diameter = _________ units

   radius = ________ units

Describe the relationship between the diameter and the radius.

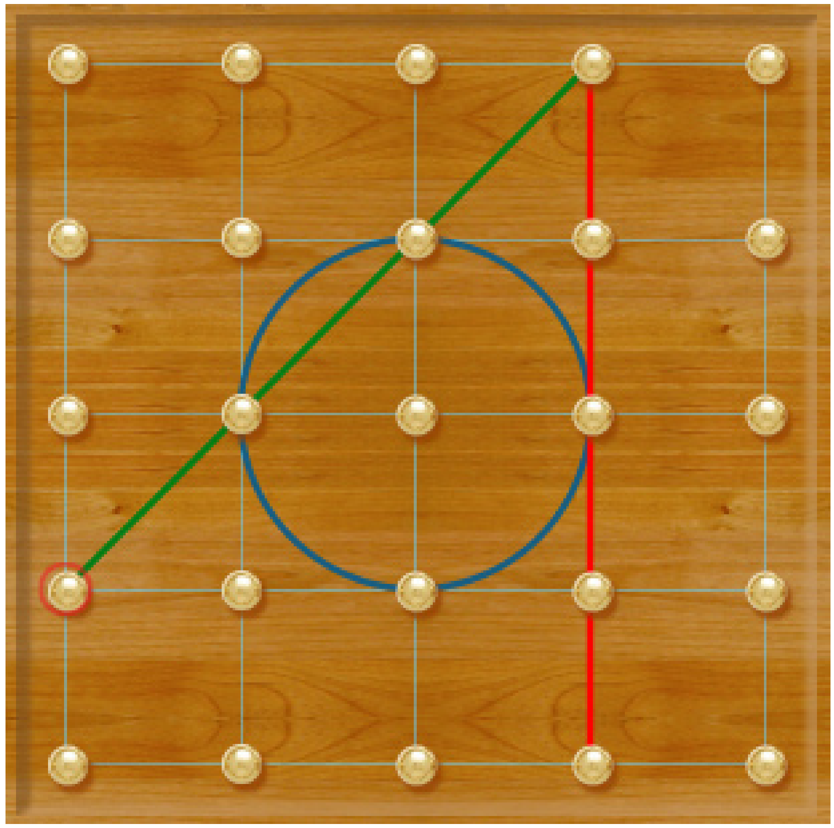
______________________________________________

______________________________________________

# Tangents and Chords

A straight line that touches a circle at only one point is called a ***tangent***. A line that passes through a circle and touches the circle at two points is called a ***chord***. For any circle, the longest chord is also the ***diameter***.

1. Copy these figures on your Geoboard. Write tangent, chord or circumference to describe each of the figure.

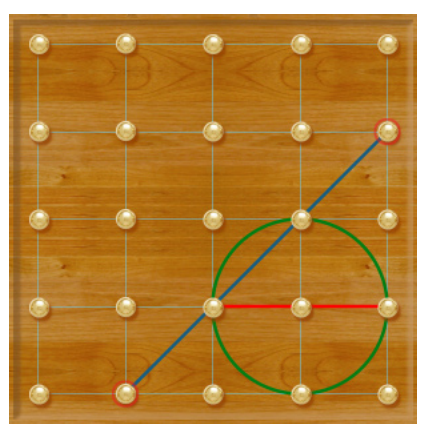


**Green** ____________________

**Red** ____________________

**Blue** ____________________

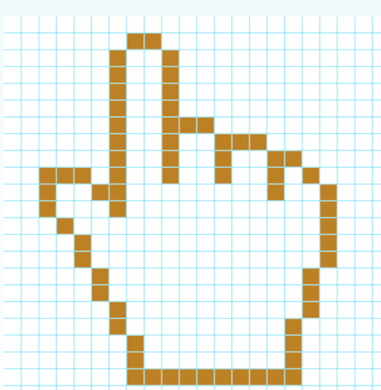
2. Copy these figures on your Geoboard. Write tangent, chord or circumference to describe each of figure.



**Green** ____________________

**Red** ____________________

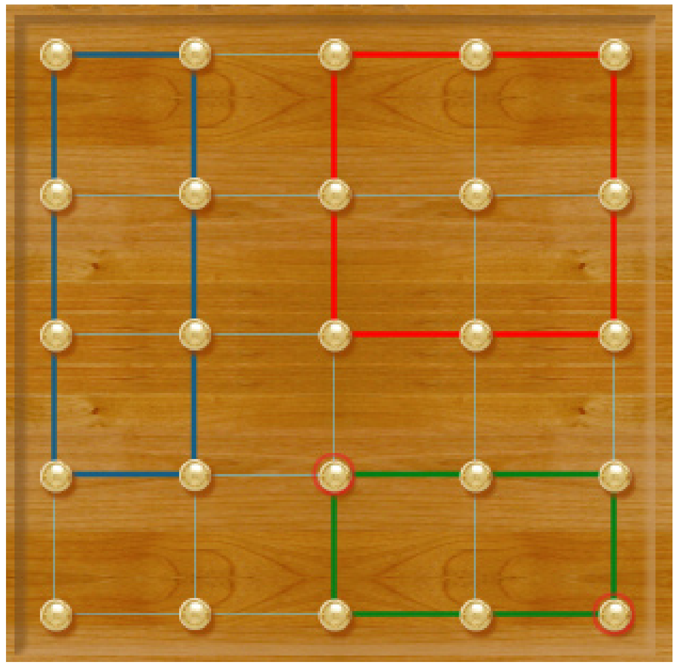
**Blue** ____________________



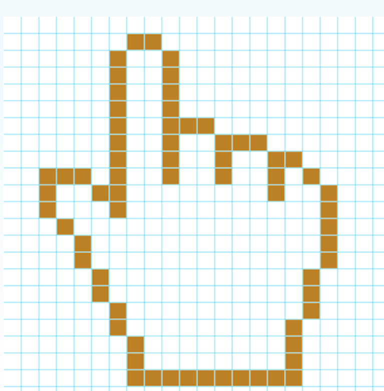
# Area and Perimeter of Rectangles

Draw some rectangles on your Geoboard and notice the length and width of each figure. The ***perimeter*** of a rectangle is the distance around the rectangle. ***Area*** is the amount of space inside a rectangle.

1. Copy these figures. Write the length, width, area and perimeter of each figure in the table.



| | Length | Width | Area | Perimeter |
|---|---|---|---|---|
| Blue | | | | |
| Red | | | | |
| Green | | | | |



This formula can be used to find the area of any rectangle.

**Area = length × width**

This formula can be used to find the perimeter of any rectangle.

**Perimeter = 2(length + width)**

# Trapezoids versus Parallelogams

*Trapezoids* and *parallelograms* are quadrilaterals.

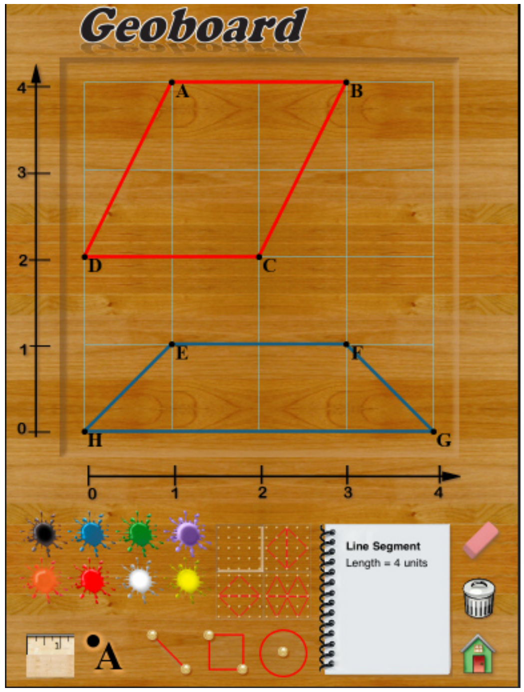



**Figure ABCD is a parallelogram.**

A parallelogram is a 4-sided shape formed by two pairs of parallel lines. Opposite sides are equal in length and opposite angles are equal in measure. To find the area of a parallelogram, multiply the base by the height.

AB || DC and AD || BC

The formula for finding the area is:

$$A = lw$$

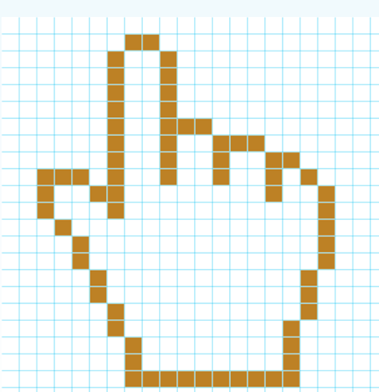
**Figure EFGH is a trapezoid.**

A trapezoid is a 4-sided figure with only one pair of parallel sides. For example, in this diagram EF and GH are parallel. To compute the area of a trapezoid, find the sum of the bases, multiply the sum by the height of the trapezoid, and then divide the result by 2.

The formula for the area of a trapezoid is:

$$A = \frac{(b_1 + b_2)h}{2}$$

*Select the point labelling tool, then tap the vertices of a figure to label the points.*



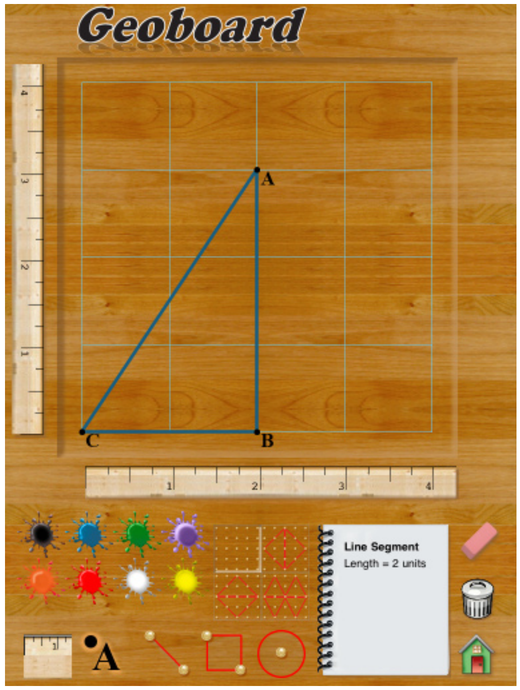
Copy these figures to your Geoboard.

1. How many sides of the parallelogram are parallel? __________
2. How many sides of the trapezoid are parallel? _________
3. With the Point Labelling tool selected, tap the Trash Can icon to erase the point labels. With a drawing tool selected, tap the Trash can icon to erase the figures from the Geoboard. Draw a different parallelogram on the Geoboard. Label the vertices A, B, C and D.
4. Draw a trapezoid with a base of 2 units and an altitude of 3 units. Label the vertices E, F, G and H.
5. Find the area of parallelogram ABCD and tapezoid EFGH.

# Area of a Triangle

A triangle is a three sided polygon. The area of a triangle is the space inside the figure. The area of a triangle can be find by multiplying the altitude times the base and then dividing the result by 2.

The formula for the area of a triangle is: $A = \frac{bh}{2}$




Copy this figure on your Geoboard.

The triangle ABC is a right triangle. Angle ABC measures 90°.

AB is the altitude of the triangle. BC is the base of the triangle.

Using the formula we can find the area of the triangle.

$$A = \frac{2 \cdot 3}{2}$$

$$A = 3$$

1. Draw a right triangle with an altitude of 1 unit and a base of 3 units. What is the area? __________

2. Draw a triangle with an altitude of 3 units and a base of 3 units. What is the area?

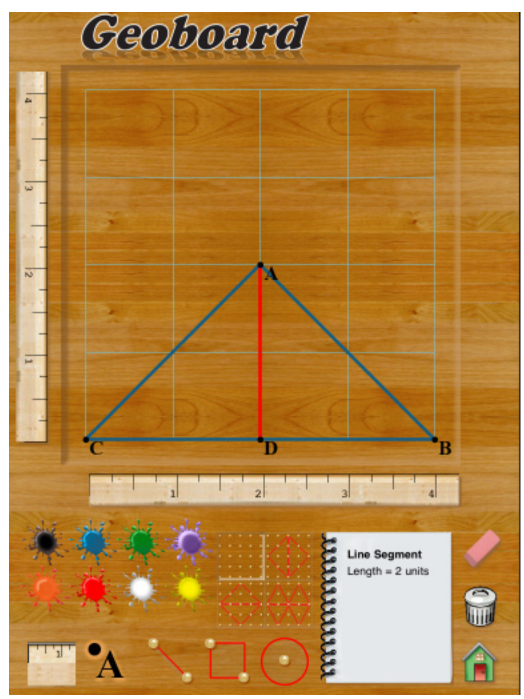
3. The figure on the right shows triangle ABC. AD is the altitude and BC is the base.

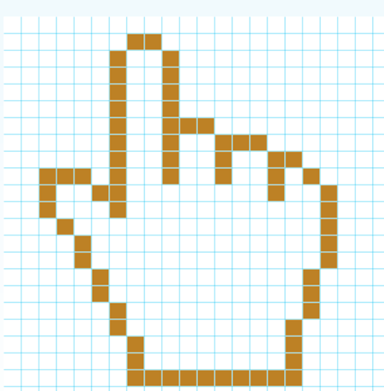
   Find the area.

   __________________

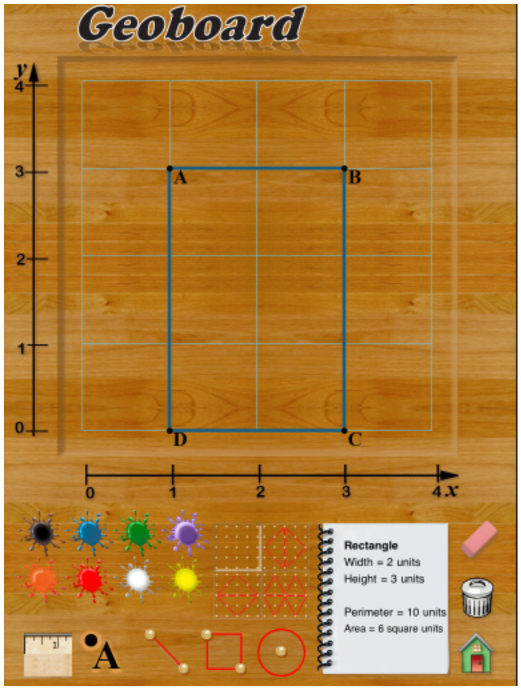
4. What is the area of triangle ABD?

   __________________



# Locating Points on a Coordinate Plane



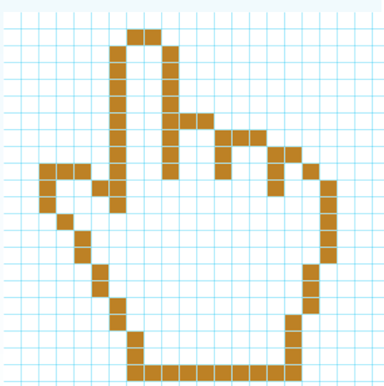

Points are defined on a coordinate plane using an ordered pair. The first number in the pair is the location on the *x*-axis. The second is the location on the *y*-axis.

The coordinates for rectangle ABCD are the following:

A (1,3)
B (3,3)
C (3,0)
D (1,0)

Use the Geoboard to connect these sets of coordinates. Write the name of the figure.

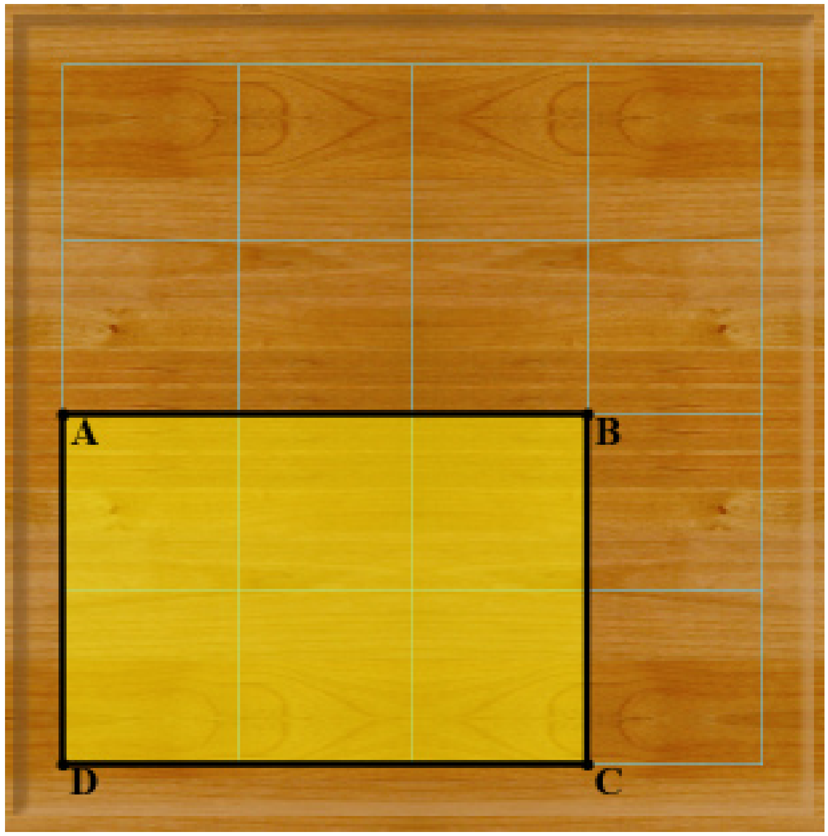
| | Coordinates | Shape |
|---|---|---|
| 1. | A(1,3), B(0,2), C(3,0) | |
| 2. | A(1,1), B(2,3), C(4,2), D(3,0) | |
| 3. | A(1,2), B(3,1), C(1,0) | |
| 4. | A(1,3), B(3,3), C(4,1), D(0,1) | |
| 5. | A(2,3), B(4,2), C(3,0), D(1,0), E(0,2) | |
| 6. | A(2,3), B(3,3), C(4,2), D(4,1), E(3,0), F(2,0), G(1,1), H(1,2) | |
| 7. | A(2,3), B(3,2), C(3,1), D(2,0), E(1,1), F(1,2) | |
| 8. | A(2,4), B(4,2), C(3,0), D(1,2) | |



# Area of a Rectangle

Draw rectangle ABCD on your Geoboard.  AD is the width of this rectangle. AB is the length of the rectangle.  This formula is used to find the area of a rectangle.

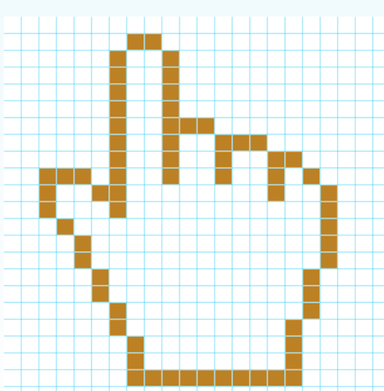
$$A = lw$$




Since the dimensions of this rectangle are 2 × 3, the area of the rectangle is 6 square units.

Draw rectangles with the dimensions given below.  Find the area:

| length | width | area |
|---|---|---|
| 4 | 2 | |
| 2 | 2 | |
| 3 | 2 | |
| 1 | 3 | |
| 2 | 3 | |



# Pick's Theorem

Hungarian mathematician Georg Pick published an interesting theorem in 1899, The theorem, known as Pick's Theorem gives a simple formula for finding the area of any polygon drawn on a geoboard. To use the formula you need to know the number of points on the boundary of the polygon and the number of points in the interior of the polygon.

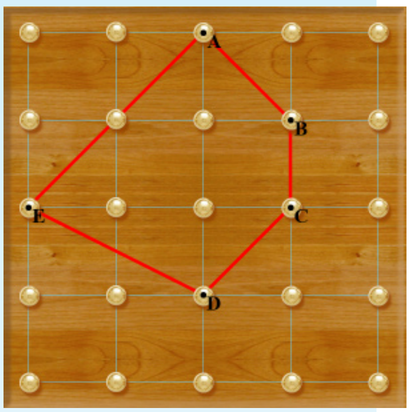
Here's the formula:

$$A = i + \frac{b}{2} - 1$$

where:

$i =$ number of interior points

$b =$ number of points on the boundary

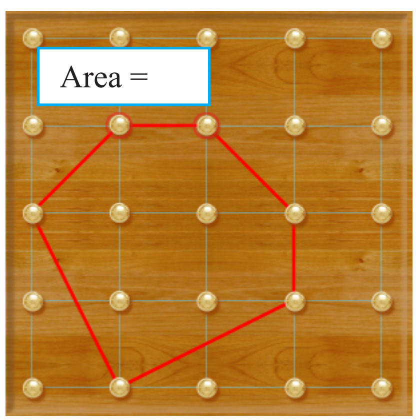



For example, figure ABCDE has 6 points on the boundary and 3 interior points. By substituting these values we can calculate the area, 5 square units.

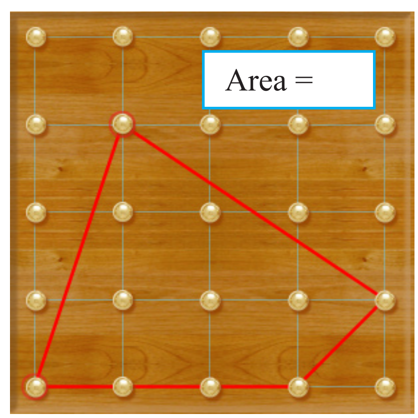
$$A = 3 + \frac{6}{2} - 1$$

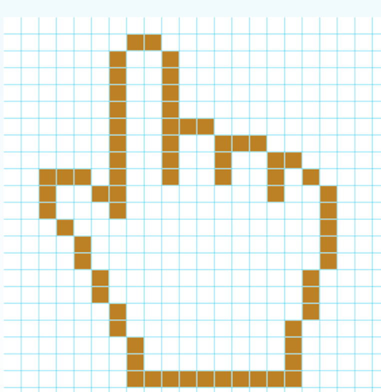
Use Pick's Formula to find the area of these polygons.

1.

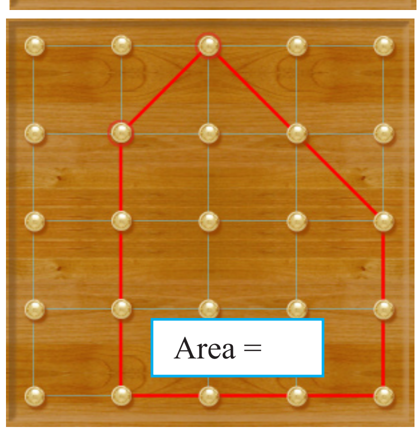



2.

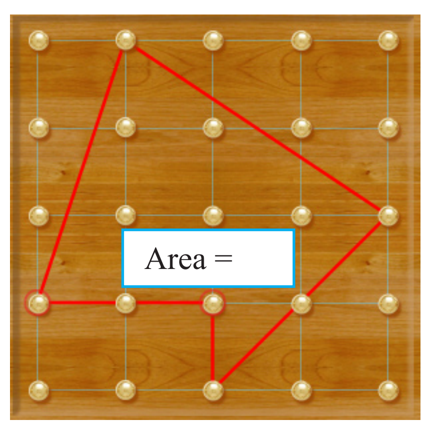


3.




4.



# Area of a Circle π

π = 3.14159265358979323
8462643383279502884197
1693993751058209 74944
5923078164062862089986
2803482534211706798214
808651 328230664709384
4609550582231725359408
128481117450284102 701
9385211055596446229489
5493038196442881097566
59334461 2847564823378
6783165271201909145648
56692346034861045432 6
6482133936072602491412
7372458700660631558817
4881520920 96282925409
1715364367892590360011
3305305488204665213841
4695194151160943305727
0365759591953092186117
38193261179 3105118548
0744623799627495673518
8575272489122793818301
1 94912983367336244065
6643086021394946395224
7371907021798 60943702
7705392171762931767523
8467481846766940513200
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178721468440901 224953
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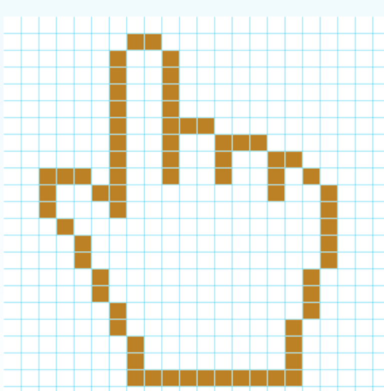
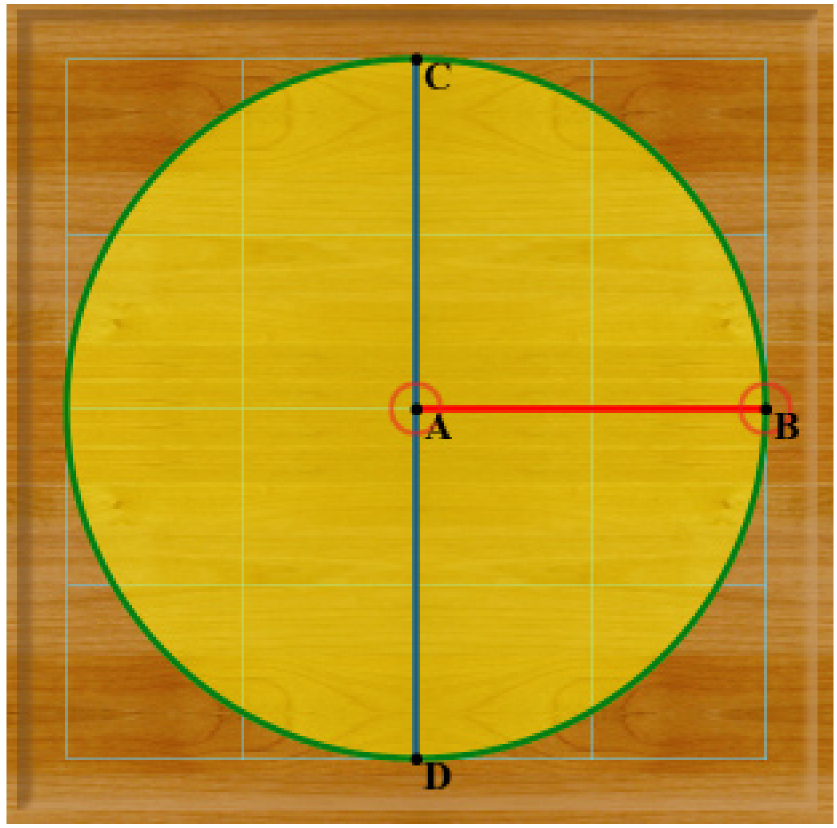
796892589235420...



Special terms are used to describe the parts of a circle. Copy this diagram on your Geoboard.




Point A is the center of the circle. The distance from point A to point B is the radius. The distance from point C to point D is the diameter. The circumference is the distance around the circle and the area is the amount of space inside the circle.

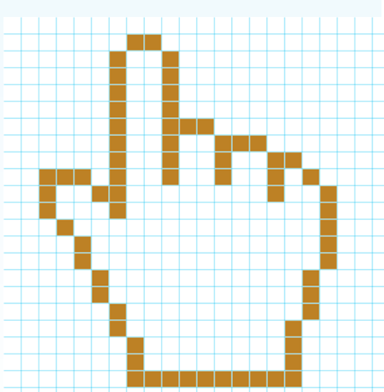
Use your Geoboard to complete this chart:

| Label | Name | Measurement |
|---|---|---|
| AB | Radius | |
| CD | Diameter | |
| | Circumference | |
| | Area | |

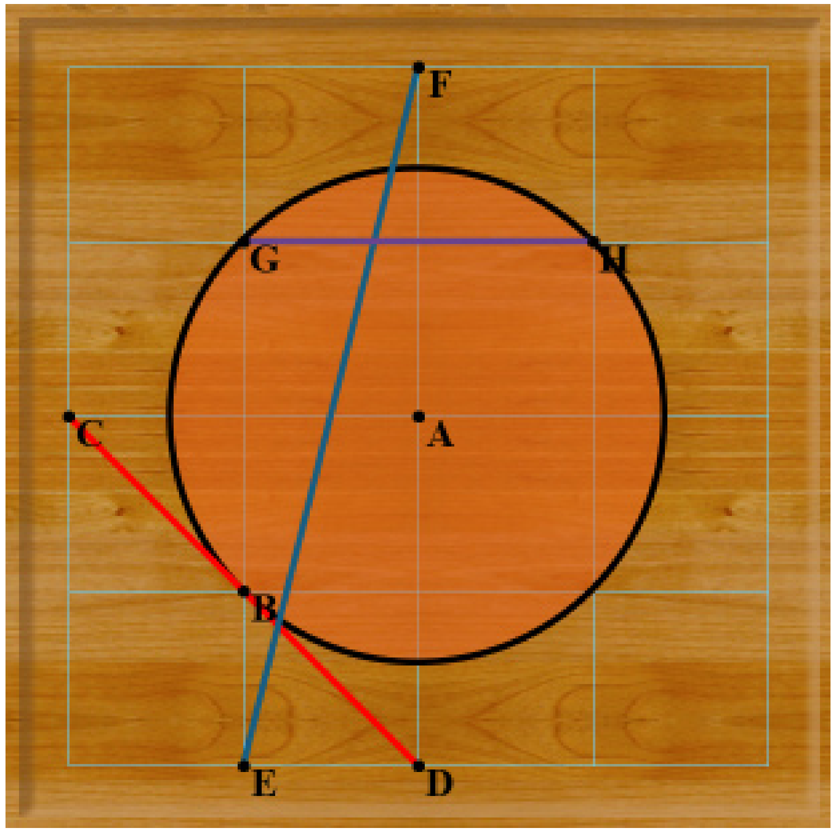
Pi is a special number. The Greek letter π is the symbol used in mathematics to denote the number pi. Pi is one of the most common constants in all of mathematics. Pi is defined as the circumference of any circle divided by its diameter.

Use a caclulator to divide the circumference of this circle by its diameter. What number is the result? ______________________

# Secants and Chords



Copy this diagram on your Geoboard.




Line CD is a tangent.  It touches the circle at only one point, Point B.

Line EF is a secant.  A secant is a line that passes through a circle and touches the circle at two points.

Line segment GH is a chord.  A chord starts and stops on the circle.  A chord which passes through the center of a circle is called the diameter.

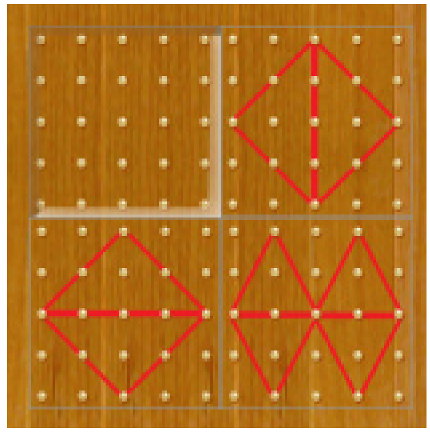
Draw a diameter on this circle by starting at point G and drawing a line segment through the center of the circle, point A.  Label the endpoint, point I.

# Symmetry

Imaginary mirrors can be put on your Geoboard to automatically draw reflections of any figure you draw.

**No Reflection**

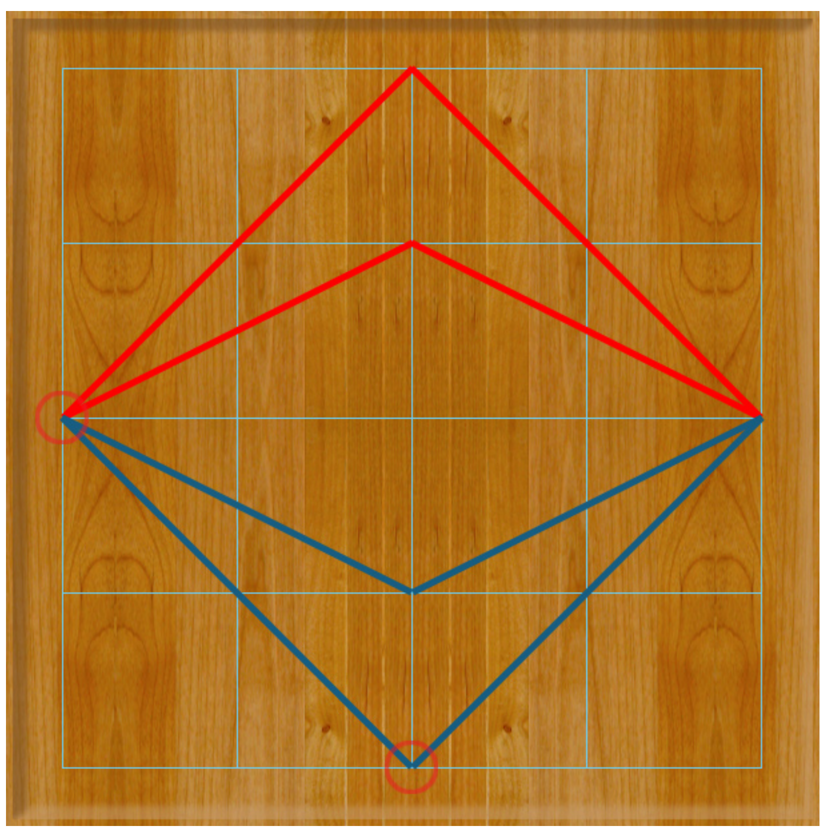
**Vertical Mirror (Horizonal Reflection)**

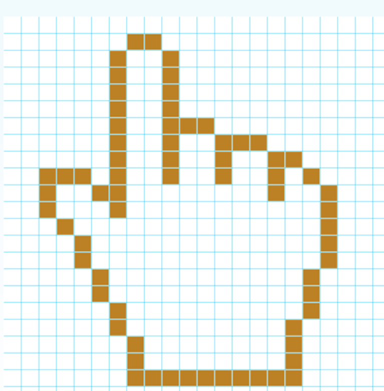


**Horizontal Mirror (Vertical Reflection)**

**Horizontal and Vertical Mirrors (Vertical and Horizontal Reflection)**

Let's make some symmetrical designs using the mirror feature. Copy this design on your Geoboard. Experiment creating your own designs and share your designs with your friends.

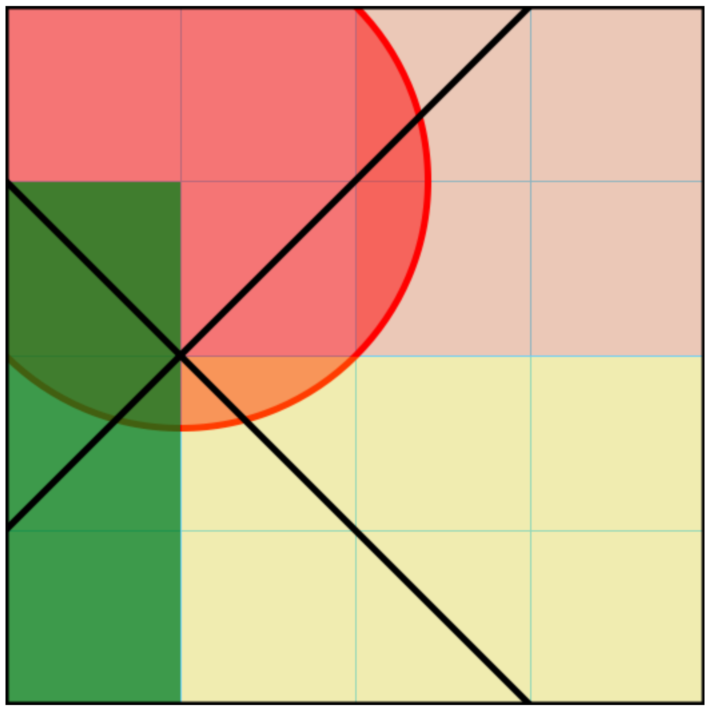


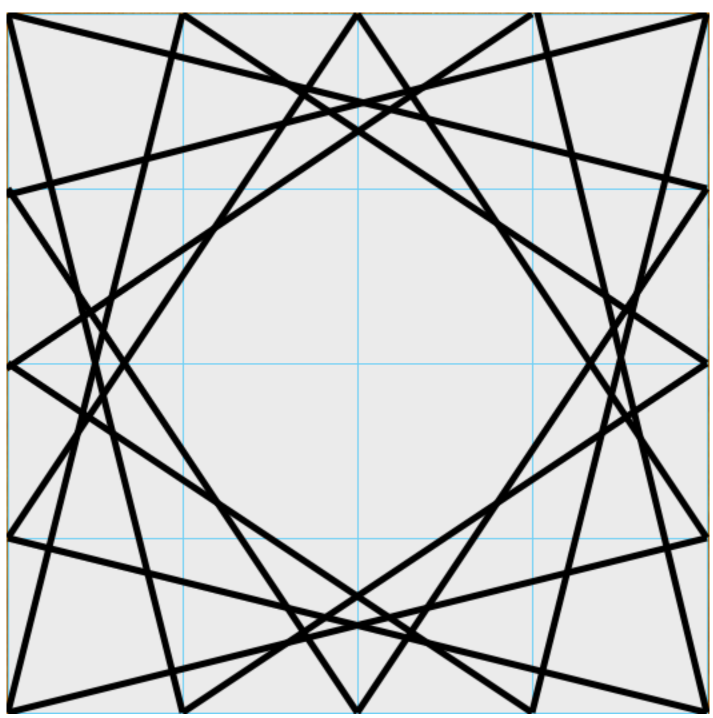


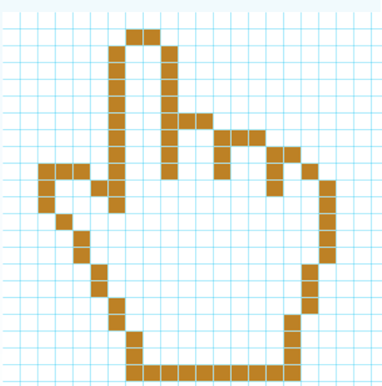
# GeoArt

Let's use the Geoboard to creatively explore the relationship between geometry and art. Erase the Geoboard and tap the ruler icon until you get a blank white canvas.

Try copying some of these modern art pieces and then make up some of your own. Press the Home button and Hold button on your iPad simultaneously to take a snapshot of your artwork. You can also email your picture to your friends.







# Hands-On Math: Geoboard

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