EXPLORATIONS

Activity 6

Walking the Fence Line

Objective

- To find the perimeter of a variety of shapes (polygons)

Materials

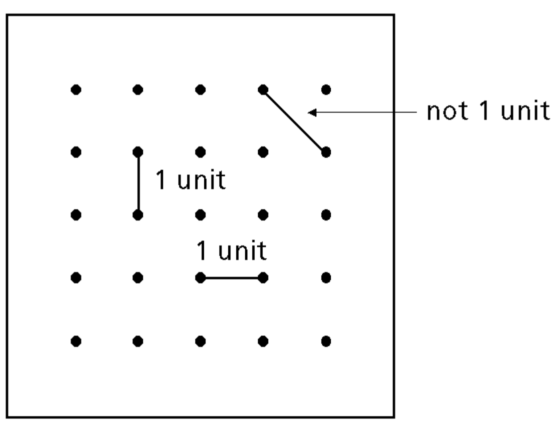
- TI-73
- Student Activity pages (pp. 68 – 71)

In this activity you will

- Find the lengths of diagonal geoboard segments.
- Find the perimeter of squares, rectangles, triangles, and other polygons.

Introduction

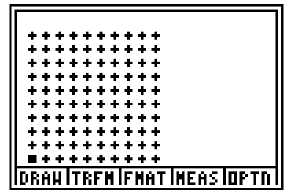
Perimeter is the amount needed to surround a region. When we want to find the perimeter of a shape, we need to know the distance around the border of the shape. The perimeter of a shape is the number of units it takes to travel the boundary and return to the starting place. Area deals with *covering*; perimeter deals with *surrounding*. Unless told otherwise, the shortest horizontal or vertical distance from one point to the nearest point(s) is one unit. It can be any unit of measure, such as one foot, one centimeter, one inch, or one mile.



Investigation

In this investigation, you will learn to find the perimeter of shapes.

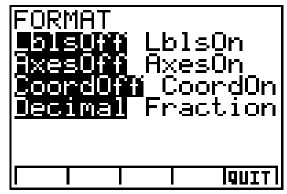
1. From the main Geoboard menu, select **4:10x10**.



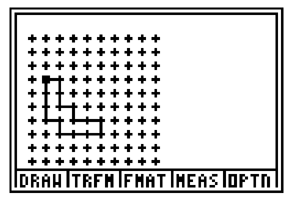
2. To format the geoboard, select **FMAT** and make sure that the following settings are selected:

   LblsOff (Labels are off)
   AxesOff (Axes are off)
   CoordOff (Coordinates are off)
   Decimal (Measurement is in decimal form)

   Select **QUIT** to exit the FORMAT menu.



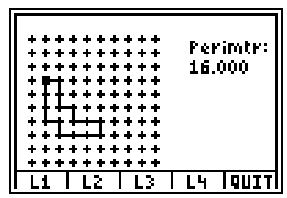
3. On your 10×10 board, construct this decagon and find the perimeter by counting units.



4. Check the answer with your TI-73.

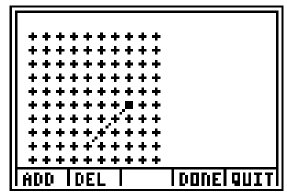
   To find the perimeter using the TI-73, move the cursor to any corner point of the shape. Select **QUIT**, **MEAS**, **3:Perimeter** and press [ENTER]. The perimeter appears in the upper right corner of your screen. The perimeter is 16 units.

   The perimeter of this shape is easy to determine because all of the sides are vertical or horizontal; just count the number of unit segments. However, the perimeter of shapes having diagonal segments is much more difficult to determine. Many diagonal segments have lengths that are irrational numbers. This means that their exact lengths can only be approximated.

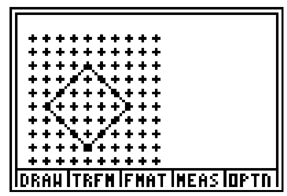


5. One way to find the exact value of a diagonal segment is to build a square with the diagonal segment as one side. In order to do this, we first need to build a connection between the diagonal segment and the area of the square built on it. We have determined the area of rectangles by multiplying the length and the width (or height). A special case of this occurs with squares, which always have the same measure for both the length and the width. A square with a side 7 units long has an area of 7×7, or 7^2 (seven squared), or 49 unit squares. A square with 9 units on each side has an area of 9×9, or 9^2, or 81 unit squares. Conversely, if a square has an area of 64, or 8^2 square units, then its side length is the square root of 64, which is 8 units. Similarly, if a square has 121 square units of area, then its side length is the square root of 121, which is 11 units.

Now suppose we want to find the exact length of the diagonal segment shown.

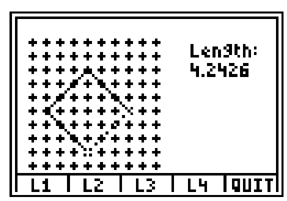


One way to do so is to first build a square that has this segment as one of its sides.



Then, we can find the area of this square using any method (counting squares and half-squares, surrounding rectangle, dissection or TI-73), which is 18 square units. Since the area of the square is 18 square units, the length of the side of the square must be $\sqrt{18}$ units. The original segment therefore has a length of $\sqrt{18}$ units as its exact measure. The number $\sqrt{18}$ is not an exact whole number nor an exact fraction nor an exact decimal, so we can only approximate it with decimals or fractions that are close to it.

A second way to find the length of this segment is to use the TI-73. Beginning at the lower vertex, select **MEAS**, **1:Length** [ENTER]. Move the cursor to the other end of the segment by pressing [▶] [▶] [▶] [▲] [▲] [▲] [ENTER]. The approximate length should appear in the upper right corner of your screen as 4.2426 units.



If this were the exact length of this segment, the length of this side squared should be 18 square units. Use your TI-73 to find 4.2426^2. This number is 17.999655, a little less than the expected value of 18. Notice that if we try 4.2427^2 (the next larger number in the same place value of ten thousandths), we get 18.000503 which is a little more than the expected value of 18.

Student Activity

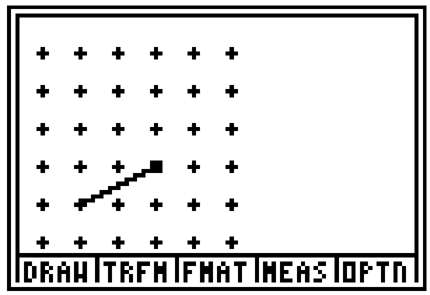
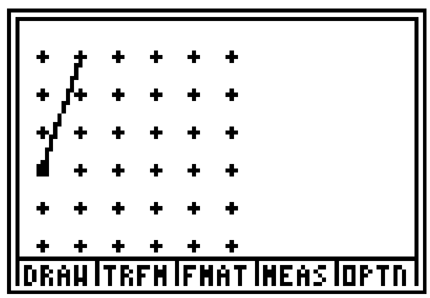
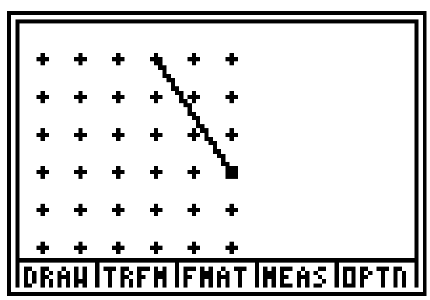
Name ____________________

Date ____________________

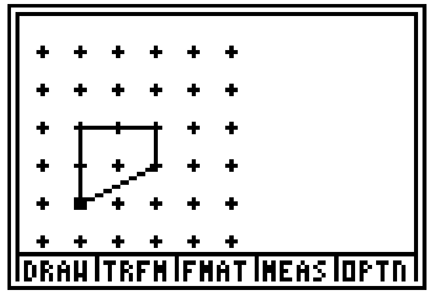
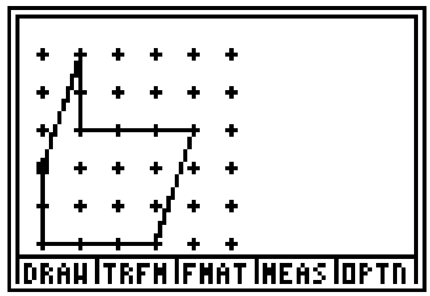
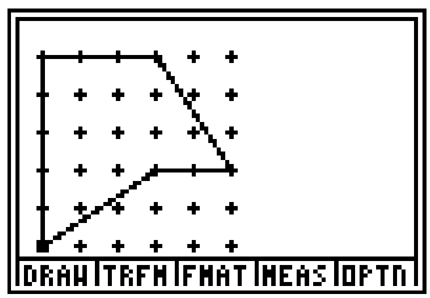
Activity 6.1: Walking the Fence Line

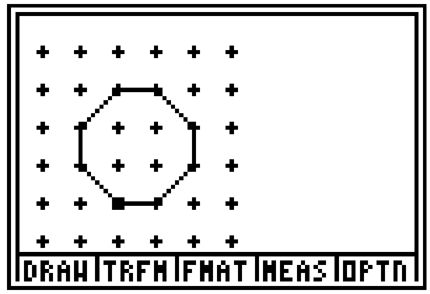
For each line segment:

1. Find the exact length by building squares.
2. Find the approximate length by using the **MEAS, 1:Length** feature of the Geoboard application.

1. Exact ______ Approximate ______	
2. Exact ______ Approximate ______	
3. Exact ______ Approximate ______	

Find the exact and approximate perimeter of each shape.
Hint: use the answers above.

4. Exact ______ Approximate ______	
5. Exact ______ Approximate ______	
6. Exact ______ Approximate ______	

7. The Bartholamews are building an octagonal corral for training young horses. They need to determine the amount of fence needed to build the corral. The blueprint calls for nearby vertical and horizontal posts to be 10 feet apart.	

a. Find the exact area of the corral.

____

b. Find the exact and approximate perimeter of the corral.

____

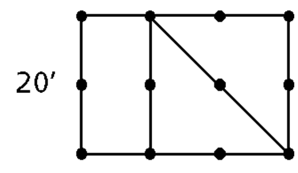
Student Activity

Name ____________________________

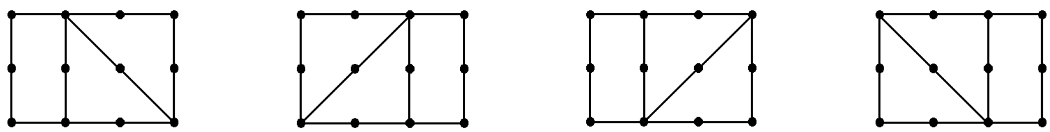
Date ____________________________

Activity 6.2: The Horse Barn Problem

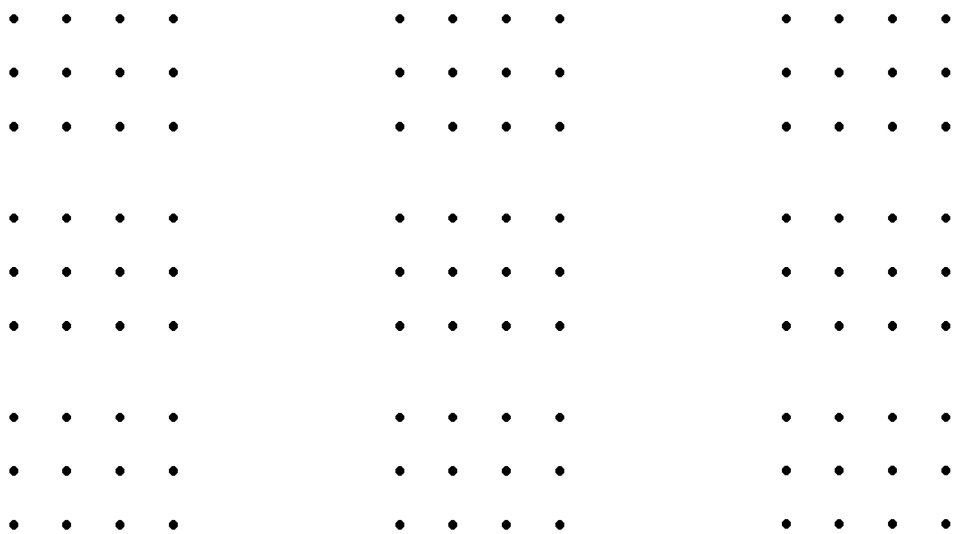
The Helfeldts have an enclosed 20×30-feet rectangular horse barn with support posts every 10 feet. They want to split the entire barn into three equal-in-area stalls. Use the Geoboard application to model this problem. One possibility is shown at the right.



Note: *For this problem, consider only noncongruent arrangements as being different. For example, the solutions below are all counted as one solution.*



1. Show all the different ways that the Helfeldts can use the entire barn to make three stalls that are equal in area.



2. Which ways require the smallest number of new walls? What is the total length?

____

____

3. Which way requires the largest number of new walls? What is the exact total length? What is the approximate total length?

____

____

⑥

The area is
3 square units

⑥

The perimeter is
8 units

⑥

The shape is a
hexagon

⑥

Each pair of
adjacent sides
forms a right angle

❻

The shape can be
split into
3 congruent squares

❻

There are 2
different groups of
3 parallel sides

Teacher Notes

Activity 6

Walking the Fence Line

Objective

- To find the perimeter of a variety of shapes (polygons).

NCTM Standards

- Select and apply techniques and tools to accurately find length… to appropriate levels of precision
- Solve problems that arise in mathematics and in other contexts
- Draw geometric objects with specified properties, such as side lengths

Investigation

Have students try to picture square roots visually as the side length of a square. For example, $\sqrt{19}$ is the side length of a square having 19 unit squares of area. Also, a square of 19 square units must be larger than one of 16 square units and less than one of 25 square units (i.e., $\sqrt{16} < \sqrt{19} < \sqrt{25}$ or $4 < \sqrt{19} < 5$). This means that a square of 19 square units has a side length of $\sqrt{19}$ units (that is, between 4 and 5 units long). Students can use the TI-73 to get better estimates of side lengths such as $\sqrt{19}$.

Answers to Student Activity pages

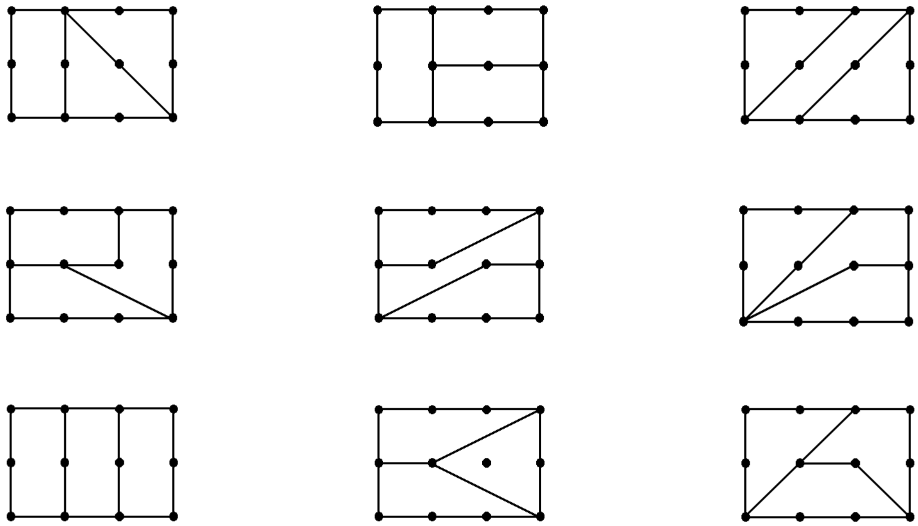
Activity 6.1: Walking the Fence Line

1. Exact: $\sqrt{5}$ Approximate: 2.2361
2. Exact: $\sqrt{10}$ Approximate: 3.1622
3. Exact: $\sqrt{13}$ Approximate: 3.6056
4. Exact: $5 + \sqrt{5}$ Approximate: 7.2361
5. Exact: $10 + 2\sqrt{10}$ Approximate: 16.325
6. Exact: $10 + 2\sqrt{13}$ Approximate: 17.211
7. **a.** 700 square feet

   b. Exact: $40 + 40\sqrt{2}$ feet Approximate: 96.569 feet

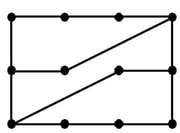
Activity 6.2: The Horse Barn Problem

1.



2. The total length is 40 feet for each solution.

3. The total length is exactly $20 + 20\sqrt{5}$ feet.
The total length is approximately 64.721 feet.



Group Problem Solving: The perimeter of polygons

The Group Problem Solving cards are challenge problems that can be used alone or with the individual sections of this book. The problems are designed to be used in groups of four (five or six in a group are possibilities using the additional cards) with each person having one of the first four clues. Students can read the information on their cards to others in the group but all should keep their own cards and not let one person take all the cards and do the work.

The numbers at the top of the cards indicate the lesson with which the card set is associated. The fifth and sixth clues (the optional clues) have the lesson number shown in a black circle.

The group problems can be solved using the first four clues. The fifth and sixth clues can be used as checks for the group's solution or they can be used as additional clues if a group gets stuck. Some problems have more than one solution. Any shape that fits all the clues should be accepted as correct.

With a little experience, students should be able to design their own group problems. They could then switch problems with other groups for additional problem solving practice.

One solution for this problem solving exercise: