Lesson Three: Classroom Space

Overview and Big Ideas

This lesson is designed to introduce the notion of comparing the areas of different enclosures (classrooms) by coordinating units of length measure to constitute units of area measure. The enclosures are rectangular or are formed by combinations of rectangular units. Instead of using grid paper or folding, students are challenged to find the area measure and construct the units of area measure using only a ruler. Students then partition a few of the enclosures and count the number of units formed by these partitions. The lesson culminates in the development of a formula for finding the area of any rectangle.

Materials

6 polygons labeled A-F (see Figure 8 below)

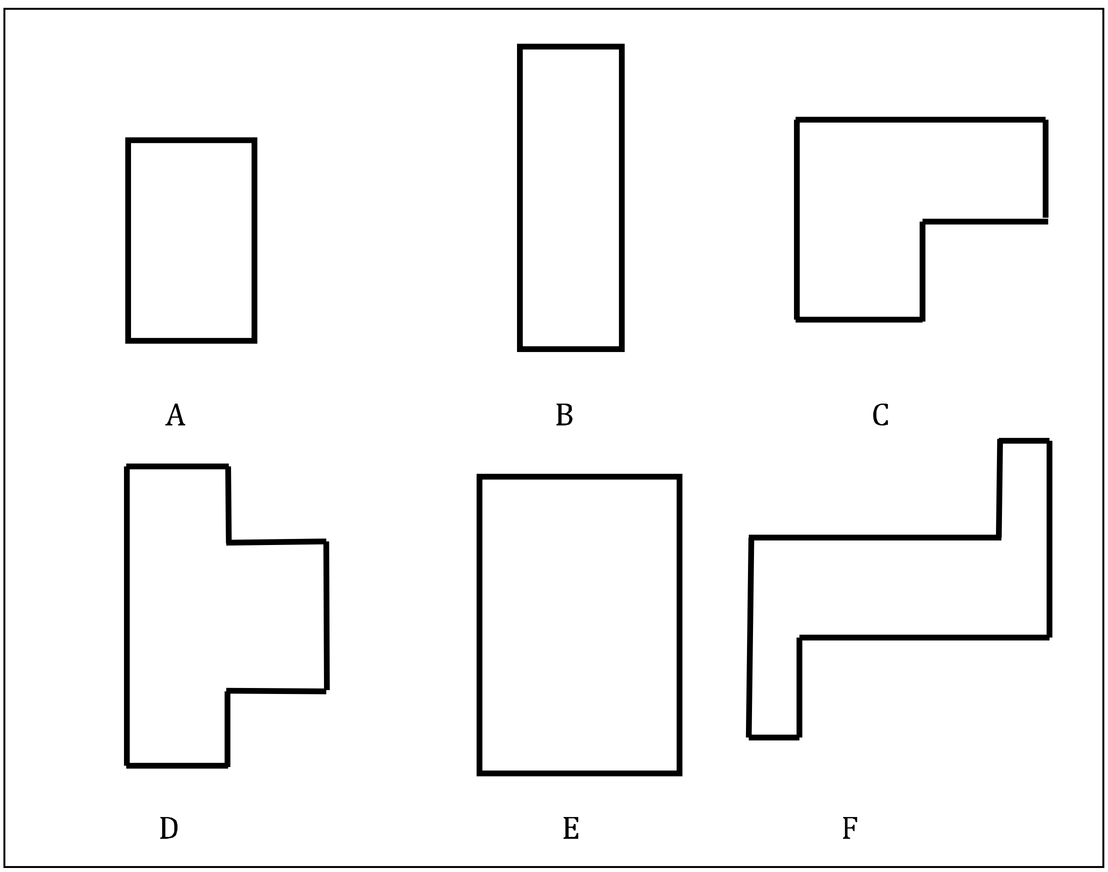
Unlined chart paper & black marker (draw the polygons on the large, unlined chart paper)

Rulers

Markers (several colors)

Student sets of polygons

Set of rectangles *(see Supplemental Materials at the end of this lesson)*



Polygon Dimensions
(in inches)

A = 5 x 8

B = 4 x 10

C = (5 x 8) + (5 x 4)

D = (4 x 12) + (4 x 6)

E = 12 x 8

F = (12 x 4)+ 2(2 x 4)

Shapes can be visually deconstructed, resulting in subsections where the area can be found as products of length and width, but sections of polygons are not delineated, nor are the figures labeled with dimensions.

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Part 1

Measuring Rectangular Shapes: *Coordinating Dimensions to Create Units*

Activity Structure

Whole Group Discussion

Present the class with the images of polygons A and B (Figure 8). Explain to the class that the figures represent floor plans for shapes and sizes of classrooms in a new elementary school. Tell the students that their job is to figure out the area (space covered) of the classrooms so the teachers can decide where to put each grade level -- younger students will get the smaller classrooms and older students will be assigned to the rooms with more area. Ask the students to find the area of each shape, but tell them they may not cut or fold the shapes. They may, however, use a ruler. Once students have compared A and B, the teacher should introduce a new classroom floor plan (polygon C) and ask the students to compare it to A and B.

Teacher Role

Activating Thinking about Previous Area Measurement Experiences

What activities have we done where we have talked about space covered?

Listen for ideas about the three rectangles and measuring area of hands activities.

What did we think about when we compared the three rectangles?

Listen for ideas about comparing length and width.
Listen for ideas about developing square or rectangular units used for comparison of areas.

What did we think about when we found the area of our hands?
How did we figure out the amount of space our hands covered?
What tools did we use? How did we use them?

Listen for ideas about covering and counting units arranged on the handprints.
Listen for ideas about issues that arose when students used various units to measure the handprint area.
Listen for ideas that relate to measurement principles.

Teacher Role (continued)

Discussion Prompts before Activity

The teacher should present the problem and ask the students to make conjectures as to which polygon covers more space.

Look at the shapes on the board. Each one of these shapes represents a classroom in a new elementary school. Our job is to figure out the area of each classroom so we can assign the rooms to different grade levels. Which classroom do you think is bigger? Why do you think so?

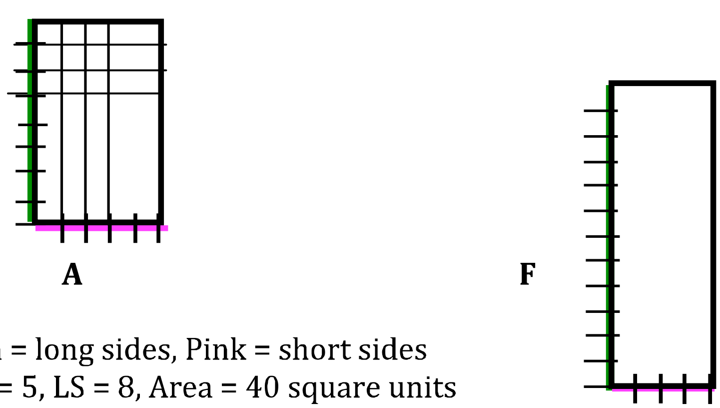
> This question is designed to help students begin to compare the classrooms and consider the length and width of the different polygons in order to compare them. Listen for reasoning about the length of the sides and the relationship between the lengths of the sides on different polygons.

Scaffolding Questions for Comparing Rectangles A and B

How could we use the ruler to figure out the area of each classroom?
How can the length of the sides help us figure out the area of a classroom?
How can we use the measurements of the short and long side to figure out space covered?

Listen for ideas about:

- *Measuring the lengths of the sides and delineating the lengths (marking inch lengths).*
- *Delineating and comparing long sides or short sides on two different shapes.*
- *Coordinating delineated adjacent lengths to structure arrays of square units (see Figure 9).*



Green = long sides, Pink = short sides
A: SS = 5, LS = 8, Area = 40 square units
F: SS = 4, LS = 12, Area = 48 square units

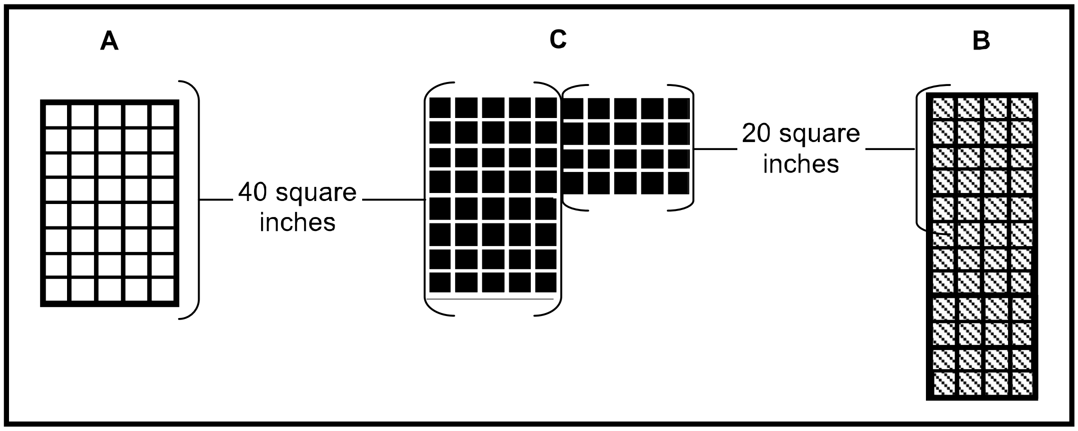
Figure 9. Using measurements to construct arrays.

Teacher Note

Make sure to label the side measures.

Comparing Floor Plans A, B, and C

Once students have compared A and B, the teacher should introduce a new classroom floor plan (polygon C) and ask the students to compare it to A and B *(see Figure 10)*.



Teacher Note

If students struggle to see that delineated measures can be used to structure arrays, ask them to think back to the activity when they measured the space their hands covered.

- What did we use to measure our hands? *(Students may remember that they used grid paper.)*
- What part of the grid paper were we using?
- What was the unit we used for measuring?
- How could we structure square units using our measurements of the long sides and short sides of the shapes we want to compare?
- If we don't have grid paper, how could we make it?

These questions are designed to help students see a relationship between the linear measures and the way in which they intersect to form rows and columns that result in arrays of square units. Be prepared to structure partial rows by drawing a line that runs from the inch mark on one side to and inch mark on the opposite side. Draw several of these lines to create a partial array and ask students to think about why you may be doing that.

- Why would I draw these lines?
- How do they help me think about measuring the space the shape covers?
- How do I know where to draw each line?

Teacher Support of Student Thinking

It may be helpful to highlight the sides being compared on each shape with the same color in order to support the comparisons and help students think along with the conversation (i.e., long side of shapes is highlighted in green and short side of shapes is highlighted in pink).

Students might suggest that after measuring the length of a side, they also need to measure the length across the center of the shape *(see Figure 11)*. This thinking presents an opportunity to help students consider the relationship between the length and position of opposite sides and the resulting space structured and develop the understanding that a measure from one side to the other will produce the same length from anywhere on the side. To promote this understanding, the teacher may decide to present a counter case to illustrate the relationship between the length of opposite sides and the resulting structure of the shape.

Measure of long side = 12 inches.
Students may suggest measuring across the middle of the figure, which, by definition of a rectangle, would also measure 12 inches.

A counter example shows that if the distance across the middle of the shape did not equal the measure of the long side, then the opposite side of the shape would not be the same length as the original side measured and the resulting shape would also be different.

Figure 11. Reasoning about where to measure lengths.

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Individual Student Writing (Reflection)

Ask students to spend 15 minutes writing an independent response to this question:

Can we use the length and width measurement to find the area of a rectangle?

Explain your thinking.

Draw diagrams to support your argument.

Teacher Reflection and Preparation

- ☐ Read students' journal responses to the reflection question.
- ☐ Note variety of responses and make conjectures about next steps with these students.
- ☐ Prepare enough copies of classroom spaces blackline masters (see end of lesson) so each pair of students can work with their own set.

Part 2

Further Measuring of Rectangular Shapes: *Coordinating Dimensions to Create Units*

Activity Structure

Partner Work

Students will work together to find the areas of the remaining 3 classroom shapes (D, E and F), make comparisons between the areas, and write a summary about their findings to present to the class. Ask students to work in pairs to find the measurements of the remaining 3 classrooms. Explain that similar to the first part of the lesson, they may not fold, cut, use congruency, or any other objects to complete the measurements. They may, however, use an inch ruler and a pencil. Partners will need to record their process and findings in their journals and be prepared to present their measurements to the rest of the class. Tell the students to be ready to defend their argument about the areas of the classrooms.

Discussion Prompts

For each figure, show the relation of its area to that of the area enclosed by Figure A. Use symbols to represent the relations of less than (<), equal to (=), or greater than (>).

Part 3

Constructing Units and Developing a Formula

Constructing Units in Given Rectangles

Give students a rectangle with the length measures denoted *(see the "Rectangles" section after the blackline masters)*. Ask students to:

- Find the Area.
- Find the Perimeter.
- Draw the area units in the rectangle.

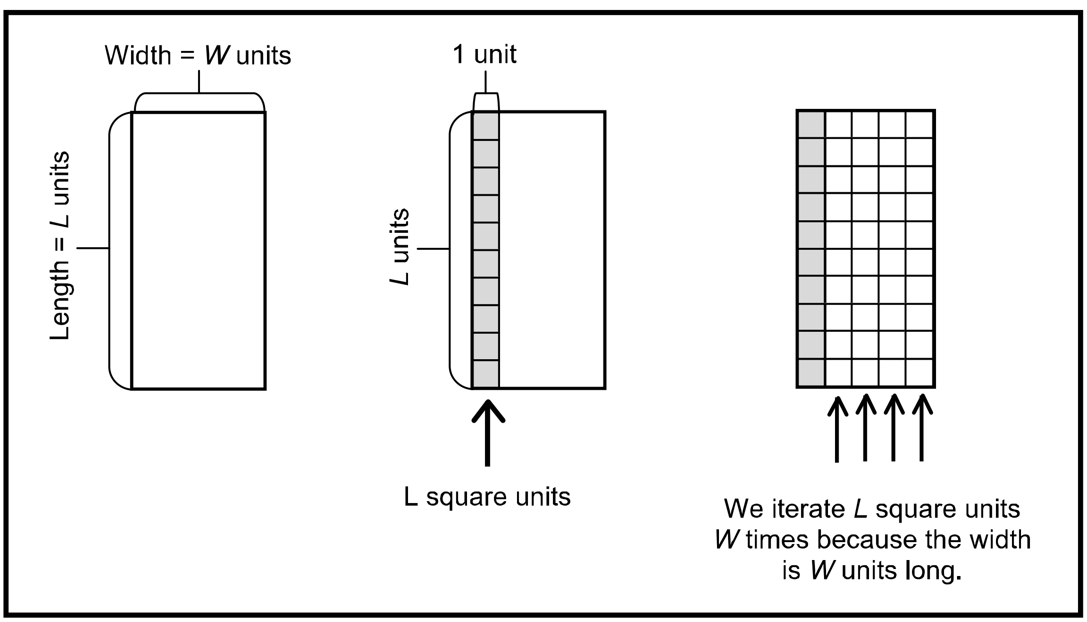
Students are asked to find the perimeter to help them think about the differences between length and area. Students should present their solutions and may repeat the task with other rectangles.

Culminating Activity: Developing a Formula for Area of a Rectangle

The lesson should culminate by having the students try to create a rule (an expression) that will help them find the area ALL the time, for ANY rectangle.

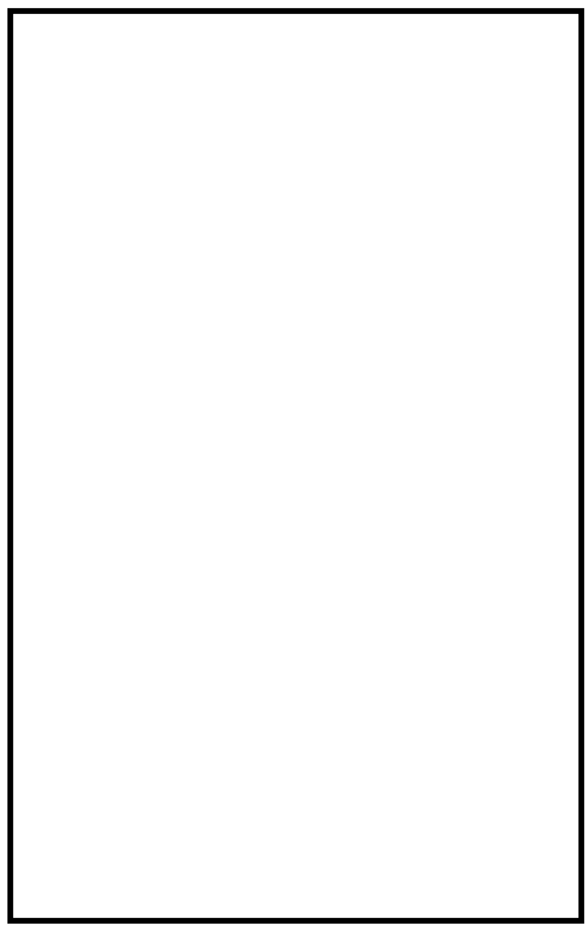
- Can we write an expression that we can use to find the area of ANY rectangle?
- Why does it work all the time?

Teacher Note: Students should be asked to justify why the formula will always work. The formula can be thought about as iterating a row (or column) of square units. The figure below shows an explanation (for the teacher's sake) for why the formula always works.

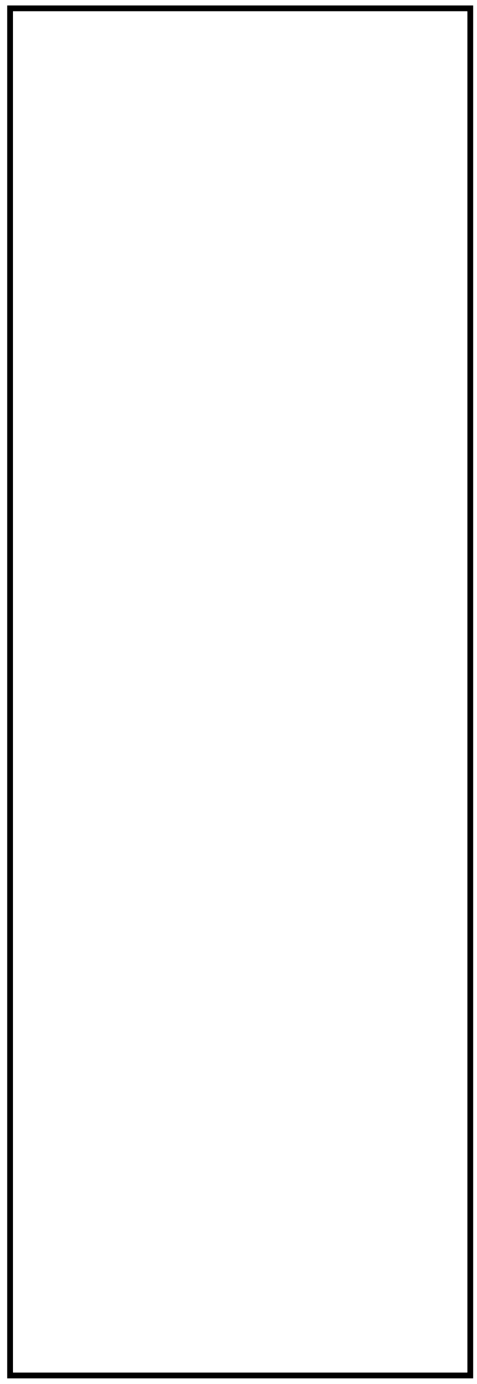


Classroom Shape Blackline Masters

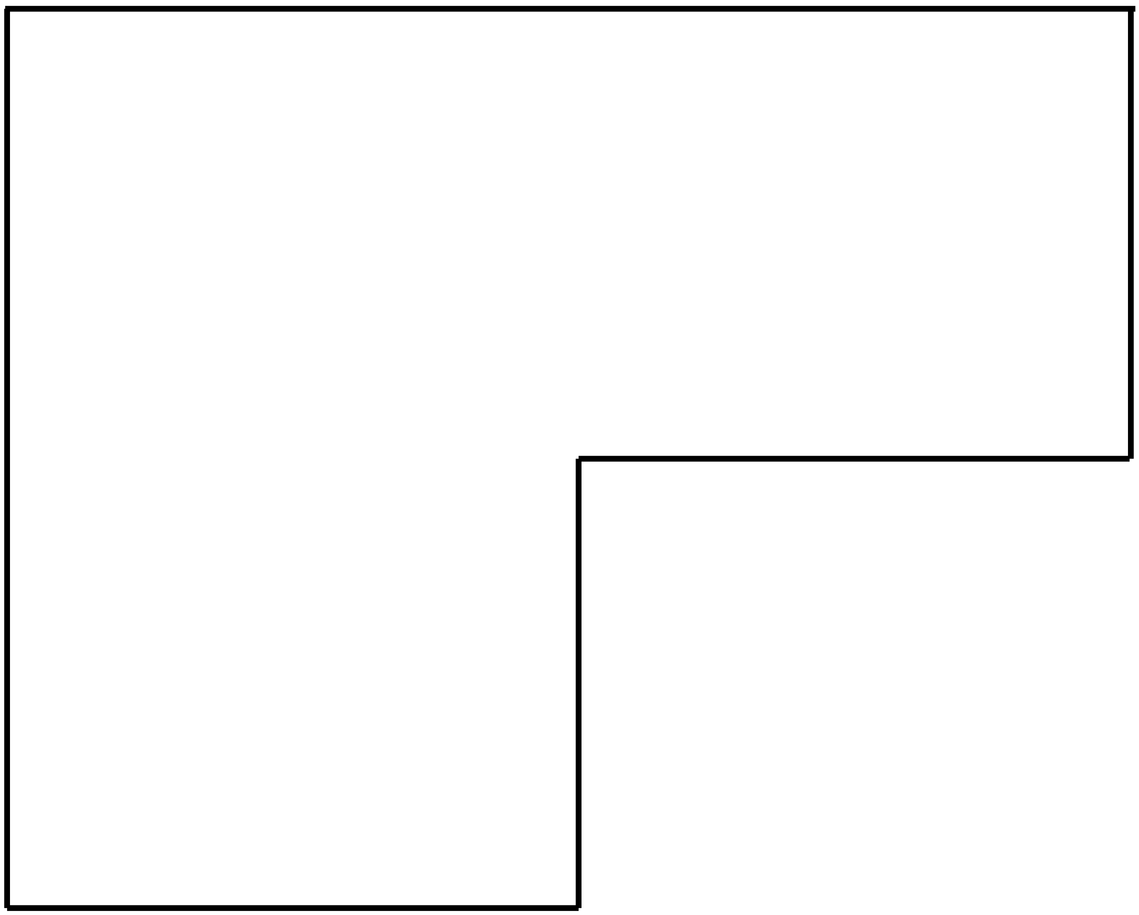
A



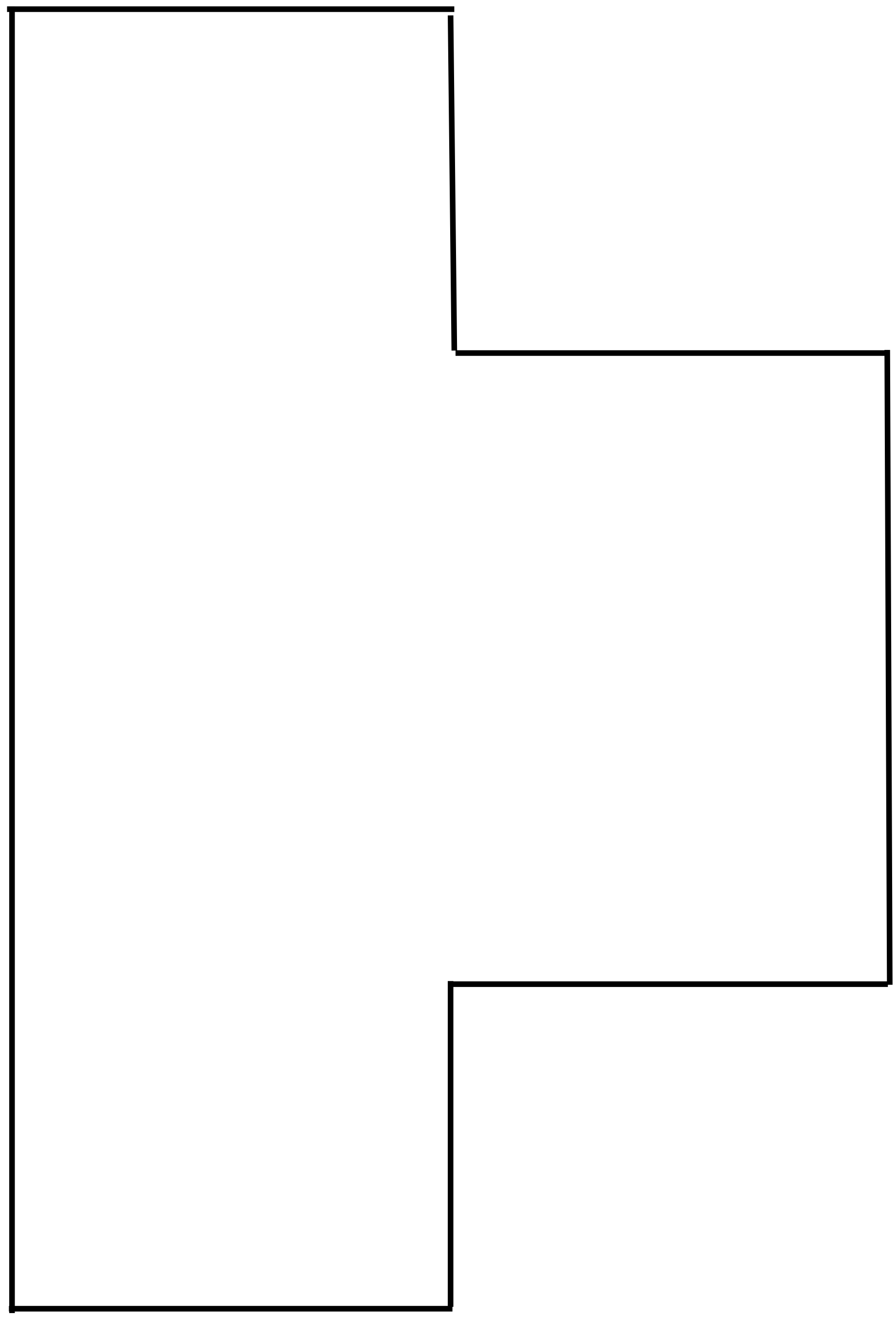
B



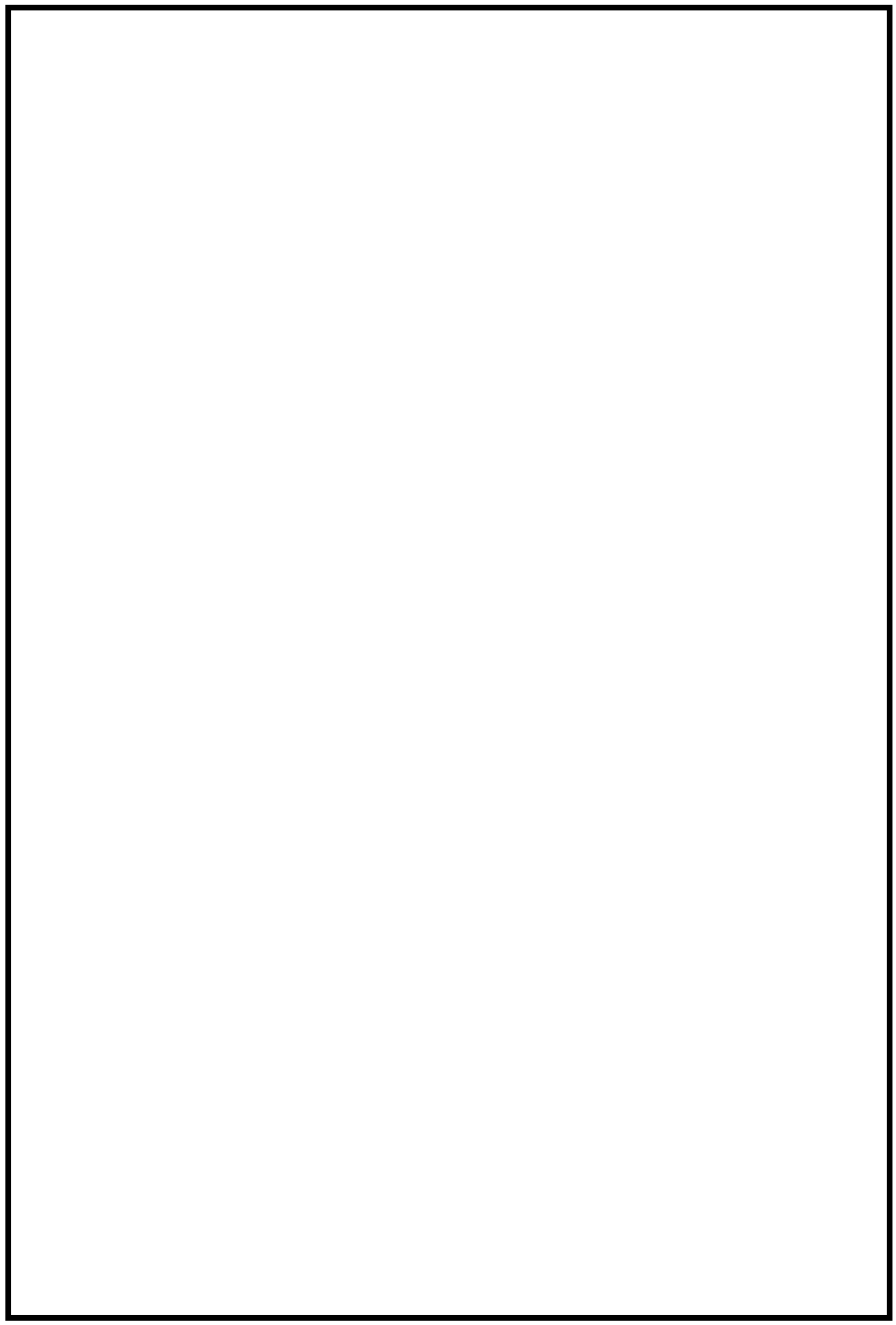
C



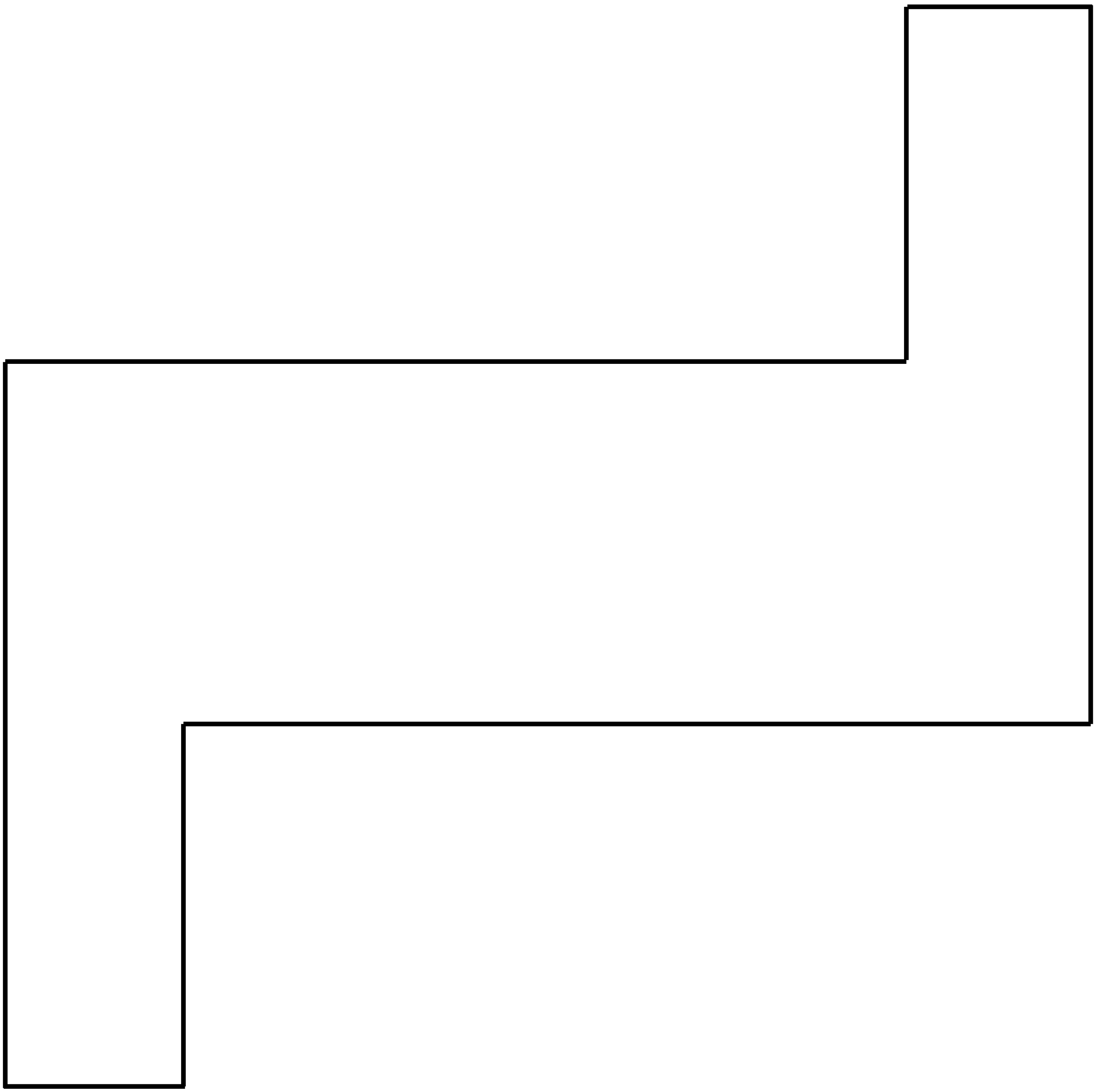
D



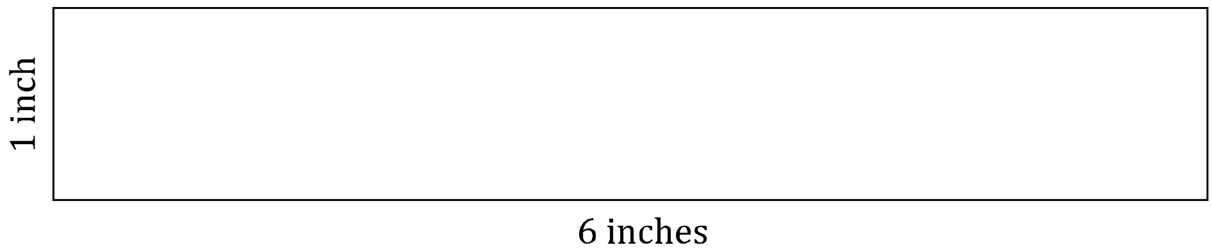
E

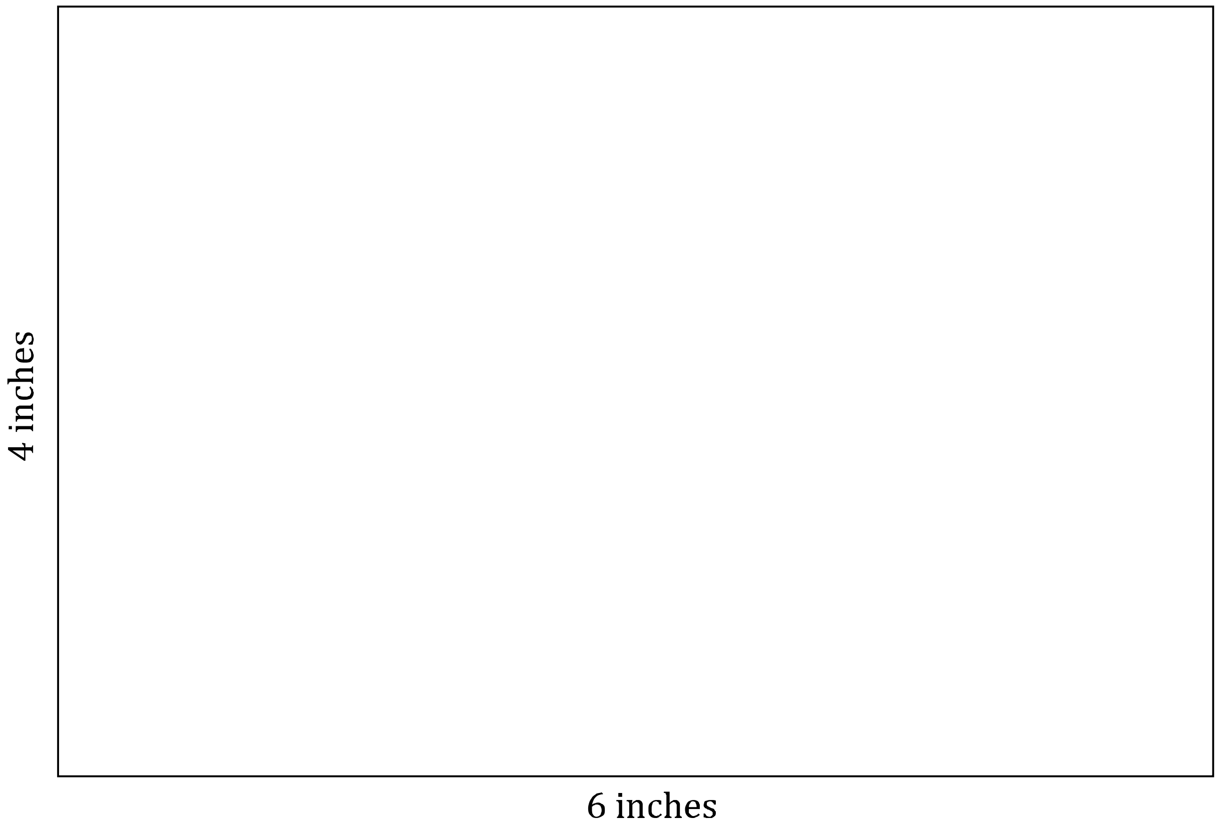


F



Rectangles




4 inches
6 inches