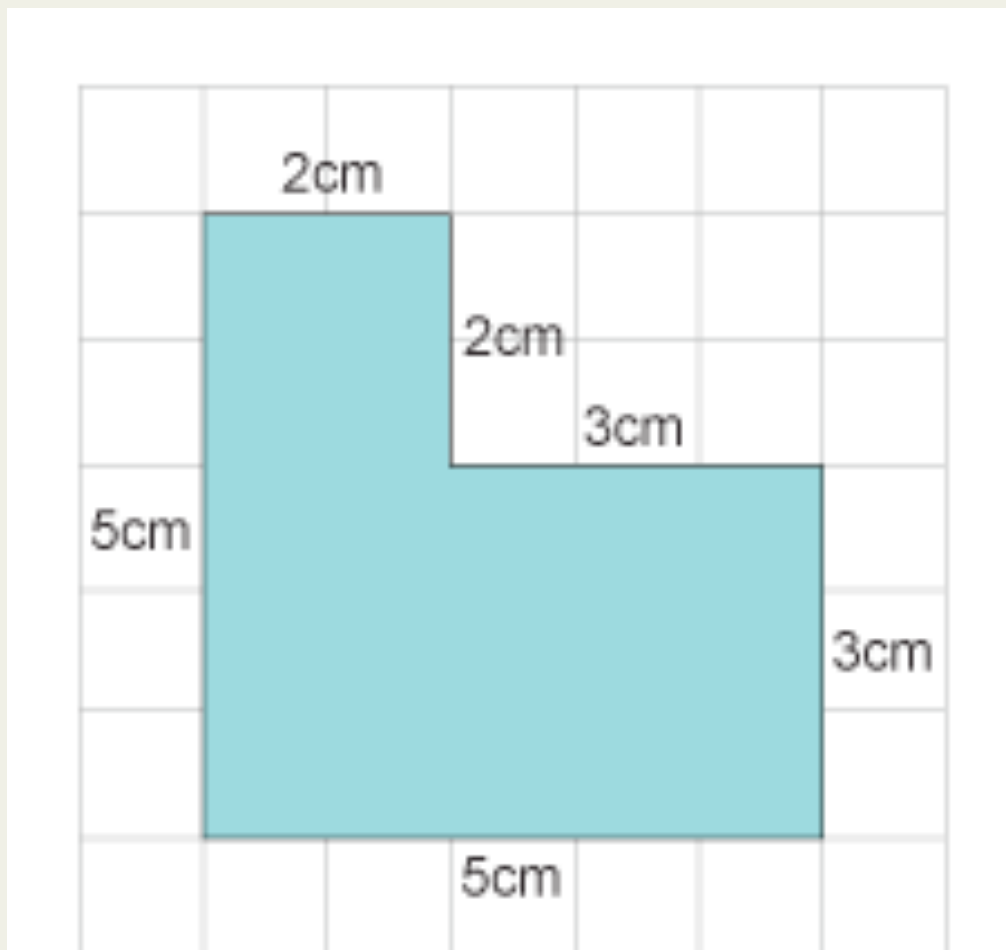


# Third Grade Area and Perimeter



North Carolina Department of Public Instruction



PUBLIC SCHOOLS OF NORTH CAROLINA  
State Board of Education | Department of Public Instruction

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## Overview

The implementation of the Common Core State Standards in Mathematics (CCSSM) is both an exciting and anxious time for teachers around the country. Part of the excitement is the CCSS inclusion of both the Content Standards and the Standards for Mathematical Practice. The Standards for Mathematical Practice provide a foundation for the process skills that all K-12 students should be developing during every lesson.

## Overview of the Units

The purpose of this document is to provide teachers with a set of lessons that are standards-based and align with the CCSS Content Standards and Standards for Mathematical Practice. By standards-based, we mean that students are learning mathematics by exploring mathematically-rich tasks and sharing strategies, ideas, and approaches with one another. During these lessons, the teacher's role is to truly facilitate learning by posing a task, asking questions that guide students' understanding, and assess students' mathematical understanding.

The phases of each lesson are:

- **Engage-** Students open the lesson by engaging in a brief activity to build upon students' prior knowledge.
- **Explore-** Students explore a mathematically rich task or activity that includes the main mathematical goals. During this phase, the teacher may model how to play a game or do an activity, but should not model or over teach strategies or procedures.
- **Explain-** Students discuss strategies and mathematical ideas from the Explore phase. The teacher may teach content and emphasize concepts or strategies here.
- **Elaborate-** Students complete a follow-up activity or task that extends their work from Explore and the discussion of concepts in Explain.
- **Evaluation of Students**
  - **Formative Assessment-** How can the teacher assess students during the lesson?
  - **Summative Assessment-** How can the teacher assess students' work after the lesson?

## Resources on the Common Core

This document is only a starting resource as teachers begin implementing the CCSS and the Standards for Mathematical Practice. The North Carolina Department of Public Instruction has also written Unpacking Documents available at <http://www.ncpublicschools.org/acre/standards/support-tools/> . These unpacking documents provide specific descriptions of each standard as well as examples.

This project was directed by Dr. Drew Polly at UNC Charlotte. Educators who collaborated to create these documents are Gail Cotton, Ryan Dougherty, Tricia Esseck, Marta Garcia, Tery Gunter, and Kayonna Pitchford along with the DPI staff.



## Unit Overview: Grade 3

### Mathematical Goals

In this unit, students will:

- Develop an understanding of the concept of area
- Understand and use square units
- Use non-standard and standard units to measure area
- Relate the areas of rectangles to rectangular arrays and multiplication
- Find the areas of rectilinear figures
- Develop an understanding of the concept of perimeter
- Describe the relationships between area and perimeter
- Calculate the perimeters of polygons
- Calculate the perimeters of rectilinear figures
- Find the missing side length of a rectilinear figure

### Lessons in the Unit

This unit should be taught after students have had experiences with multiplication (3.OA, 3.NBT.3) and measurement using rulers (3.MD.4). Students should also be familiar with shapes and their attributes, especially rectangles.

\*The amount of each material is specified in the lessons.

Lesson	Title and Description
1	<p><b>Ordering Rectangles:</b> Students order rectangles from least to greatest by size using direct comparison.</p> <p><b>Materials:</b> Ordering Rectangles set, teacher set of Ordering Rectangles.</p>
2	<p><b>Rectangle Comparison I:</b> Students compare the sizes of rectangles by cutting and reconfiguring them.</p> <p><b>Materials:</b> Rectangle Comparison sheet, teacher set of Ordering Rectangles, index cards, congruent construction paper rectangles, scissors, chart paper/ large construction paper, markers.</p>
3	<p><b>Tiling a Tabletop:</b> Students identify, create, and use square units to measure area.</p> <p><b>Materials:</b> Square tiles, large index cards, small index cards, notebook paper.</p>
4	<p><b>Geoboard Areas:</b> Students create figures on the geoboard to match different area measurements and verify those areas by counting square units.</p> <p><b>Materials:</b> Geoboards, rubber bands, dice, sticky notes.</p>
5	<p><b>Rectangle Comparison II:</b> Students compare the sizes of rectangles by counting the square units of area for each rectangle.</p> <p><b>Materials:</b> Rectangle Comparison - Square Units sheet, square tiles, inch rulers, Incomplete Rectangles sheet.</p>

6	<p><b>Mowing for Money:</b> Students multiply to find the areas of rectangles.</p> <p><b>Materials:</b> Inch grid paper or centimeter grid paper, colored pencils or crayons, tetrahedron dice or two dice per pair.</p> <p><b>Book:</b> Gabriel, Nat. (2002). Sam's Sneaker's Squares. New York: Kane Press, Inc.</p>
7	<p><b>Sticker Stumper:</b> Students multiply to find the areas of rectangles and use factors to determine the dimensions for a given area.</p> <p><b>Materials:</b> Sticker Stumper sheet, centimeter grid paper, colored pencils/ crayons.</p>
8	<p><b>A Square What?:</b> Students create square units (<math>\text{in}^2</math>, <math>\text{cm}^2</math>, <math>\text{dm}^2</math>, <math>\text{m}^2</math>, <math>\text{ft}^2</math>, <math>\text{yd}^2</math>) and use them to measure items and areas in the classroom.</p> <p><b>Materials:</b> rulers, tape, glue, construction, scissors, meter stick or yard stick, bulletin board paper.</p>
9	<p><b>Estimate and Solve – Customary Units:</b> Students determine the reasonable unit for area, then solve mathematical and real world area problems.</p> <p><b>Materials:</b> Constructed square units (feet, yards), inch color tiles, rulers, paper, Customary Square Unit Challenge sheet.</p>
10	<p><b>Estimate and Solve – Metric Units:</b> Students determine the reasonable unit for area and then solve mathematical and real world area problems involving metric units.</p> <p><b>Materials:</b> Constructed square units (decimeters, meters), centimeter cubes, rulers, paper, Metric Square Unit Mania sheet.</p>
11	<p><b>Breaking Apart Arrays I:</b> Students model creating large arrays and breaking them into two smaller arrays to solve a simpler problem.</p> <p><b>Materials:</b> 12-24 Inch color tiles per pair, rulers, Breaking Apart Arrays sheet, markers/crayons.</p>
12	<p><b>Breaking Apart Arrays II:</b> Students model the distributive property by breaking large arrays into two or more smaller arrays.</p> <p><b>Materials:</b> 12-24 Inch color tiles per pair, rulers, Breaking Apart Arrays II sheet, 1 marker or crayon per student, Large Array to Smaller Arrays sheet, Large Array to Smaller Arrays Rubric.</p>
13	<p><b>Finding the Areas of Complex Figures I:</b> Students find the area of a rectilinear figure by breaking it into two smaller rectangles.</p> <p><b>Materials:</b> Geoboards, rubber bands, dry erase boards and markers, Areas of Complex Figures sheet.</p>
14	<p><b>Finding the Areas of Complex Figures II:</b> Students find the area of a rectilinear figure by breaking it into two or more smaller rectangles.</p> <p><b>Materials:</b> Opening problem sheet, Areas of Complex Figures sheet.</p>

15	<p><b>Finding the Areas of Complex Figures III:</b> Students use given side lengths to calculate the area of a rectilinear figure.</p> <p><b>Materials:</b> Opening problem sheet, Area Answers sheet, computer with internet connection connected to projector.</p>
16	<p><b>Perimeter Parade Routes:</b> Students find the perimeter of polygons.</p> <p><b>Materials:</b> Twine or non-stretchy string – a length of about 24 inches per pair, pattern blocks, rulers, equilateral triangle grid paper.</p>
17	<p><b>Arranging Tables:</b> Students explore the relationship between a fixed area and different perimeters.</p> <p><b>Materials:</b> Grid paper, square tiles, large construction paper.</p> <p><b>Book:</b> Burns, Marilyn (1997). <i>Spaghetti and meatballs for all</i>. New York: Scholastic Press.</p>
18	<p><b>A Pen for Pugsy:</b> Students explore the relationship between a fixed perimeter and different areas.</p> <p><b>Materials:</b> Paperclips, centimeter grid paper, markers or crayons, calculators, computer with internet connection connected to projector.</p> <p><b>Book:</b> Pollack, Pam and Belviso, Meg. (2002). <i>Chickens on the move</i>. New York: The Kane Press.</p>
19	<p><b>Monster Mash:</b> Students create monsters with fixed areas or fixed perimeters.</p> <p><b>Materials:</b> Centimeter grid paper, construction paper, crayons or colored pencils, scissors, glue, computer with internet connection connected to a projector.</p>
20	<p><b>Robotic Racing:</b> Students use given side lengths to find the perimeters of polygons.</p> <p><b>Materials:</b> Opening problem sheet, Robotic Racing sheet.</p>
21	<p><b>Pedaling for Pennies</b> Students use given side lengths in standard units to find the perimeters of polygons.</p> <p><b>Materials:</b> Opening problem sheet, pattern blocks, Pedaling for Pennies sheet (one per student), calculators, computer with internet connection connected to projector</p> <p><b>Book:</b> Murphy, Stuart J. (2002). <i>Racing around</i>. New York: Harper Collins Publishers. (optional)</p>
22	<p><b>Area or Perimeter?:</b> Students determine whether a problem requires the calculation of area or perimeter and use area and perimeter to solve problems.</p> <p><b>Materials:</b> Sticky notes, Notebook paper, pencils, computer with internet connection and projector, Area or Perimeter? Cards, Area and Perimeter PowerPoint, Area and Perimeter Explanations sheet.</p>

### Assessment in this Unit

Students can be assessed in the following ways:

- Teacher observations and anecdotal notes
- Questions for teachers to ask students.
- Student work samples

### Common Core State Standards

#### **Geometric measurement: understand concepts of area and relate areas to multiplication and to addition.**

**3.MD.5** Recognize area as an attribute of plane figures and understand concepts of area measurement.

- a. A square with side length 1 unit, called “a unit square,” is said to have “one square unit” of area, and can be used to measure area.
- b. A plane figure which can be covered without gaps or overlaps by  $n$  unit squares is said to have an area of  $n$  square units.

**3.MD.6** Measure areas by counting unit squares (square cm, square m, square in, square ft, and improvised units)

**3.MD.7** Relate area to the operations of multiplication and addition.

- a. Find the area of a rectangle with whole-number side lengths by tiling it, and show that the area is the same as would be found by multiplying the side lengths.
- b. Multiply side lengths to find areas of rectangles with whole-number side lengths in the context of solving real world and mathematical problems, and represent whole-number products as rectangular areas in mathematical reasoning.
- c. Use tiling to show in a concrete case that the area of a rectangle with whole-number side lengths  $a$  and  $b + c$  is the sum of  $a \times b$  and  $a \times c$ . Use area models to represent the distributive property in mathematical reasoning.
- d. Recognize area as additive. Find areas of rectilinear figures by decomposing them into non-overlapping rectangles and adding the areas of the non-overlapping parts, applying this technique to solve real world problems.

#### **Geometric measurement: recognize perimeter as an attribute of plane figures and distinguish between linear and area measures.**

**3.MD.8** Solve real world and mathematical problems involving perimeters of polygons, including finding the perimeter given the side lengths, finding an unknown side length, and exhibiting rectangles with the same perimeter and different areas or with the same area and different perimeters.

### **Emphasized Standards for Mathematical Practice**

In this unit all of the Standards for Mathematical Practice are addressed.

1. Make sense of problems and persevere in solving them.
2. Reason abstractly and quantitatively.
3. Construct viable arguments and critique the reasoning of others.
4. Model with mathematics.
5. Use appropriate tools strategically.
6. Attend to precision.
7. Look for and make use of structure.
8. Look for and express regularity in repeated reasoning

## Lesson 1: Ordering Rectangles Overview and Background Information

*In this lesson students order rectangles from least to greatest by size using direct comparison.*

<b>Mathematical Goals</b>	By the end of the lesson students will: <ul style="list-style-type: none"> <li>• Use direct comparison and manipulatives to determine the area of rectangles</li> <li>• Describe the process of finding the area of rectangles as covering or tiling a two-dimensional surface</li> <li>• Compare the area of various rectangles</li> </ul>
<b>Common Core State Standards</b>	<b>Geometric measurement: understand concepts of area and relate areas to multiplication and to addition.</b> <b>3.MD.5</b> Recognize area as an attribute of plane figures and understand concepts of area measurement.
<b>Emphasized Standards for Mathematical Practice</b>	1. Make sense of problems and persevere in solving them. 3. Construct viable arguments and critique the reasoning of others. 6. Attend to precision.
<b>Prior Knowledge Needed</b>	Experiences with Multiplication and Division
<b>Vocabulary</b>	area, dimensions
<b>Materials</b>	Ordering Rectangles (1 set of shapes on cardstock per group of 4-5), one set of enlarged demonstration rectangles (optional)

### Tasks in the Lesson

<b>Engage</b>	2-3 minutes
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*It is important to structure the activity to ensure equal participation from students. This part of the lesson introduces the students to the concept of the “biggest” rectangle, without any previous discussion of what “biggest” means. The intent of the activity is for the students to express their understanding of what makes one shape bigger than another.*

Facilitate a discussion about the idea of “big.”

Suggested questions:

What makes something big? What does big mean?

Holding up a few rectangles ask:

How can you determine the biggest rectangle? What does biggest mean to you?

<b>Explore</b>	18-20 minutes
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*Students may discover different ways of thinking about the sizes of the rectangles through the discussion. Student thinking and reasoning will be challenged. No “correct” answers should be given during this part of the lesson. Students are to explain their thinking and justify their decisions.*

Provide groups of students with the Ordering Rectangles sets. Challenge the students to order them from “biggest” to “smallest,” according to their own definitions. Each group should have 3-4 students. Student will explore different rectangles.

Ask students to share their findings with the class. As students share, either record or have a student record findings so the class can see them.

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Allow students to explain their group’s reasoning for the orders of the rectangles. (Students may concentrate on the tallest rectangles and stand them each on their narrow ends, or focus on the orientation of the letters.)

Ask students, “what does ‘the biggest’ mean to you?”  
Which rectangle is the biggest? How do you know?  
Based on your idea of “the biggest,” which rectangles are the smallest?

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**Explain** 10 minutes

*Connecting the size of the rectangle to a candy bar helps students make connections to real-life experiences. This refocusing strategy helps students to focus on the amount of space inside the rectangle instead of the length of the longest side. Students should express and explain any differences in their orders using reasoning and proof.*

Refocus students by presenting the rectangles as candy bars.  
*What if the rectangles represented your favorite candy bar?  
Which candy bar you would want? Why?*

Allow students to discuss with their groups before responding.

Provide an opportunity for students to reorder the rectangles from the biggest chocolate bar to the smallest. Record student orders on the board.

Discuss any differences from the first order that were found. Did the students’ thinking change according to the context? Why?

Write the word **area** on the board.

Tell students: “*When we find how much space a flat shape covers or “takes up”, we are finding the area of the shape.*”

*Note: Although chocolate bars are three-dimensional, this lesson focuses on the top of the bars. If the thickness of the bars is the same, we can compare the areas of their surface to help students connect to the concept of area.*

Have students describe the areas of the rectangles by comparing them to each other.

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**Elaborate** 10 minutes

*Students may suggest overlapping the shapes to compare them, based on previous experiences using manipulatives. If students do not suggest overlapping, demonstrate measuring the sizes of two different-sized, similar-thickness books. First hold them side-by-side, then ask students if they could suggest a different way. After it is suggested, demonstrate holding one book in front of the other and use a think-aloud to determine the larger book. Students should resume their roles from the Engage portion of the lesson to provide structure for the activity.*

Ask: How can we prove that one rectangle has a greater area than another?

Possible student responses:

We can hold them next to each other.

We can overlap the rectangles to compare them.

Allow groups to overlap the rectangles to compare them, but do not allow cutting.

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Ask students to explain how their groups compared the shapes by overlapping them.  
Suggested question: When I overlap them, it is still a little difficult to visualize how they might compare.  
What is another way we can prove that one rectangle has a greater area than another?

Allow students to check their orders with the proven order.

Suggested questions:

Do you still agree with your order? Which pieces caused you difficulty before we were able to cut them? How did cutting the shapes help you determine their areas?

Although the purpose here is for students to reason and justify their reasoning, the following order of the rectangles from largest to smallest may help facilitate the discussion:

A, G, F, B, E, D, C.

Rectangles F and B are just  $1.5 \text{ cm}^2$  apart in area, and Rectangles B and E are just  $1 \text{ cm}^2$  apart in area, so students may have them in a slightly different order.

Part Two:

Have students write **area** and a description or explanation of area in their journals using words and pictures.

Allow students to mix around the room to share their entries with 3 other students.

Provide an opportunity for students to revise their entries when they return to their seats.

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### **Evaluation of students**

Formative: Take notes as you observe students and ask questions as they work.

Summative: Students' work in Elaborate can be collected as a summative assessment.

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### **Plans for Individual Differences**

Intervention:

Provide struggling students with an individual set of shapes to manipulate and compare.

Structure the journal entry by providing sentence starters or an example of a completed entry.

Extension:

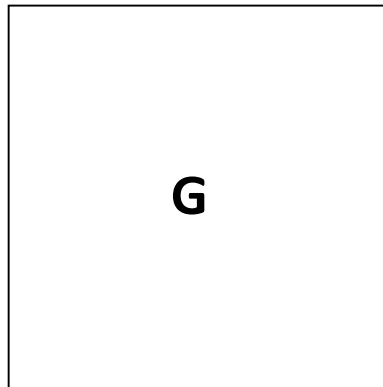
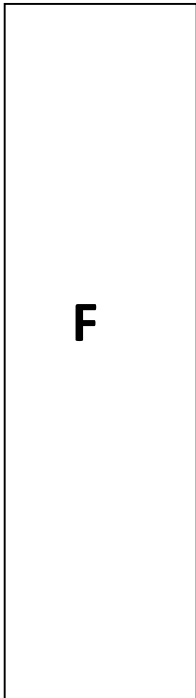
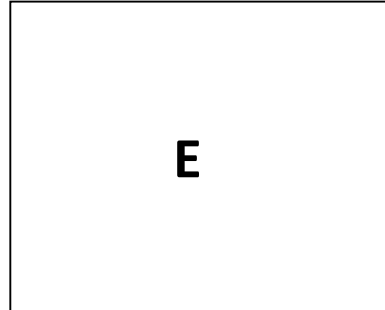
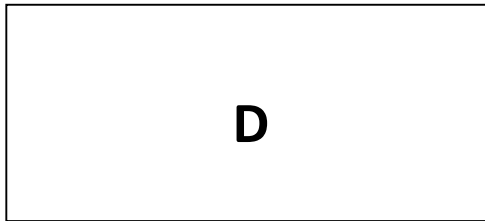
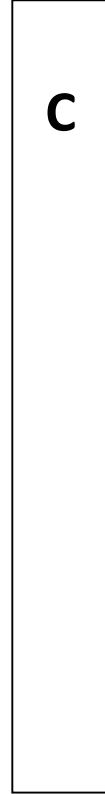
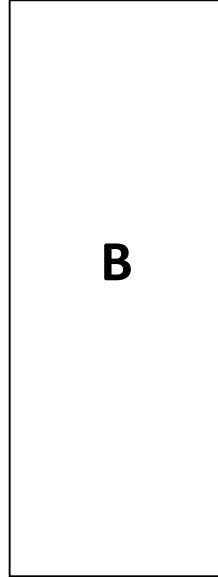
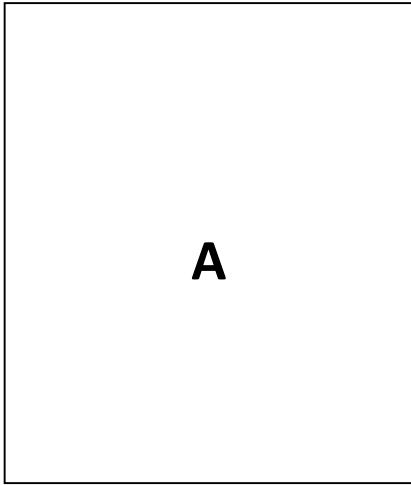
Provide students with a variety of different sized shapes (triangles, quadrilaterals, hexagons, etc., possibly from tangrams, pattern blocks, or attribute blocks). Challenge students to overlap them to determine their relative areas and order them from least to greatest or greatest to least.

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Lesson adapted from *Measuring in One and Two Dimensions*, NC-PIMS, 2007.

### Ordering Rectangles

Cut out each of the rectangles.  
Order the rectangles from largest to smallest.



## Lesson 2: Rectangle Comparison I Overview and Background Information

<b>Mathematical Goals</b>	By the end of the lesson students will: <ul style="list-style-type: none"> <li>• Determine the area of rectangles</li> <li>• Describe the process of finding the area of rectangles as covering or tiling a two-dimensional surface</li> <li>• Compare the areas of rectangles by cutting and reconfiguring them into similar dimensions.</li> </ul>
<b>Common Core State Standards</b>	<b>Geometric measurement: understand concepts of area and relate areas to multiplication and to addition.</b> <b>3.MD.5</b> Recognize area as an attribute of plane figures and understand concepts of area measurement.
<b>Emphasized Standards for Mathematical Practice</b>	1. Make sense of problems and persevere in solving them. 3. Construct viable arguments and critique the reasoning of others. 6. Attend to precision
<b>Vocabulary</b>	area, dimensions
<b>Materials</b>	Rectangle Comparison Sheet, 2 sheets per group of 4-5 Ordering Rectangles demonstration set (cut from Comparison sheet) 1 index card per student, 2 congruent construction paper rectangles, different colors, chart paper or large construction paper, scissors.

### Tasks in the Lesson

<b>Engage</b>	8-10 minutes
<p><i>Note: This part of the lesson focuses students on the concept of cutting a shape to compare its area to another shape. Some students may choose to cut their index cards into unexpected shapes, such as triangles or more complicated figures. Although this lesson focuses on the areas of rectangles, it is perfectly acceptable to explore decomposing rectangles into different shapes and recomposing them to determine that they continue to have the same area. Remember, the Standards focus only on finding the area of rectangles, so students should not be asked to find the area of non-rectangular shapes.</i></p> <p>Remind students of the previous lesson in which we compared the areas of rectangles by relating them to chocolate bars. Review using overlapping to compare area with the Ordering Rectangles demonstration set. Allow volunteers to demonstrate and justify their decisions.</p> <p><i>Ask: What other methods can we use to compare the areas of rectangles?</i></p> <p>Allow students to discuss the question with a partner before eliciting responses. Students should suggest cutting the figures.</p> <p>Distribute index cards to students. <i>Are the areas of the index cards the same? How do we know?</i></p> <p>Designate groups of 4-5 students. Challenge groups to cut their index cards in half in at least 2 different ways.</p> <p>Demonstrate the cutting and reconfiguring of a rectangle using a sheet of paper.</p> <p>a. Tape a sheet of paper to the board.</p>	

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- b. Compare the area of an identical sheet of paper to the one on the board by overlapping. *Are the areas of the two sheets of paper the same? How do we know?*
  - c. Cut the second sheet of paper in half, attaching the short ends and holding next to the uncut sheet.

Ask: *Are the areas of the sheets of paper still the same? How do we know?*

Compare by reassembling the paper and holding it next to or over to the original.

Allow the groups to reconfigure their pieces into different rectangles.

Introduce the activity. Allow students to predict the relationships of the rectangles and the order from least to greatest. Record 3-4 predictions on the board.

Notify the students that they may have to cut the rectangles into more than 2 pieces in order to compare the areas to the original rectangles. Encourage them to think carefully before cutting to avoid very small pieces.

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<b>Explore</b>	18- 20 minutes
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*Note: The main activity allows for further exploration into cutting and reconfiguring pieces of a shape to compare its size to another shape. It is important to guide student D through the construction of the chart for consistency. The student roles also provide structure for the activity. Teachers should explain that although students are assigned specific roles, they should each be able to explain the results of the activity.*

In groups of 4 or 5, students choose roles:

- 1- cut out "A" rectangles
- 2- cut out "B" rectangles
- 3- cut out "C" rectangles

4- Make a chart for the responses. Write the  $<$ ,  $>$ , or  $=$  symbols on the chart after the group has compared them.

5- Glue the shapes onto the chart. The uncut shapes should be glued to the top of the chart. The cut and reconfigured shapes can be glued and labeled in order from least to greatest, or students may simply list the shapes in order from least to greatest.

Instruct students A, B, and C to begin cutting. Demonstrate the construction of the chart for student D. Groups should post their completed charts on the board.

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<b>Explain</b>	8-10 minutes
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*This lesson is an extension of the previous lesson. Although no new information is presented, a deeper understanding of area should be developed through discussion and demonstration. Students are expected to identify area as the amount of space covered by a flat figure, and should focus on this attribute when comparing rectangles.*

Have students review the order of the rectangles and discuss any differences.

Ask students to justify their solutions. Most students will do this by cutting and reconfiguring the shapes to compare them.

Ask students: "How does cutting and rearranging parts of the shapes help?"

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The goal is to have students discuss how cutting and rearranging the shapes allows for the direct

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comparison of area.

If students have difficulty making the connection, remind them that when we consider area, we can think of the sizes of the imaginary chocolate bars to help visualize the concept.

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**Elaborate**

10-12 minutes

*The discussion provides an additional opportunity for students to revisit the objective of the lesson.*

*The verbal discussion provides a review of the lesson in preparation for the journal entry.*

*Ask: How does cutting and rearranging the pieces help us compare the areas of rectangles?*

Allow students to talk to a partner before choosing 3-4 students to respond. Students may mention that our comparisons are more accurate because we can more directly compare the rectangles instead of simply visualizing how overlapping pieces might compare.

Student charts should reflect the following information:

A1<A2      B1<B2      C1>C2      Order: B1, B2, A1, A2, C2, C1

Math Journal:

Students should compose a journal entry that includes:

- What did we do? What did I learn?
- How does this activity connect to what we did yesterday?

Allow students to share their entries with 2 other students.

Provide an opportunity for students to revise their entries when they return to their seats.

Collect journals and note student understandings or misunderstandings to be addressed at a later time.

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**Evaluation of Students**

Formative: Done through observations and questioning

Summative: The journal entry in the Elaborate section can be used as a summative assessment.

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**Plans for Individual Differences**

Intervention:

Teachers should be aware of any small motor difficulties and should guide students who have difficulty cutting to another role, such as gluing.

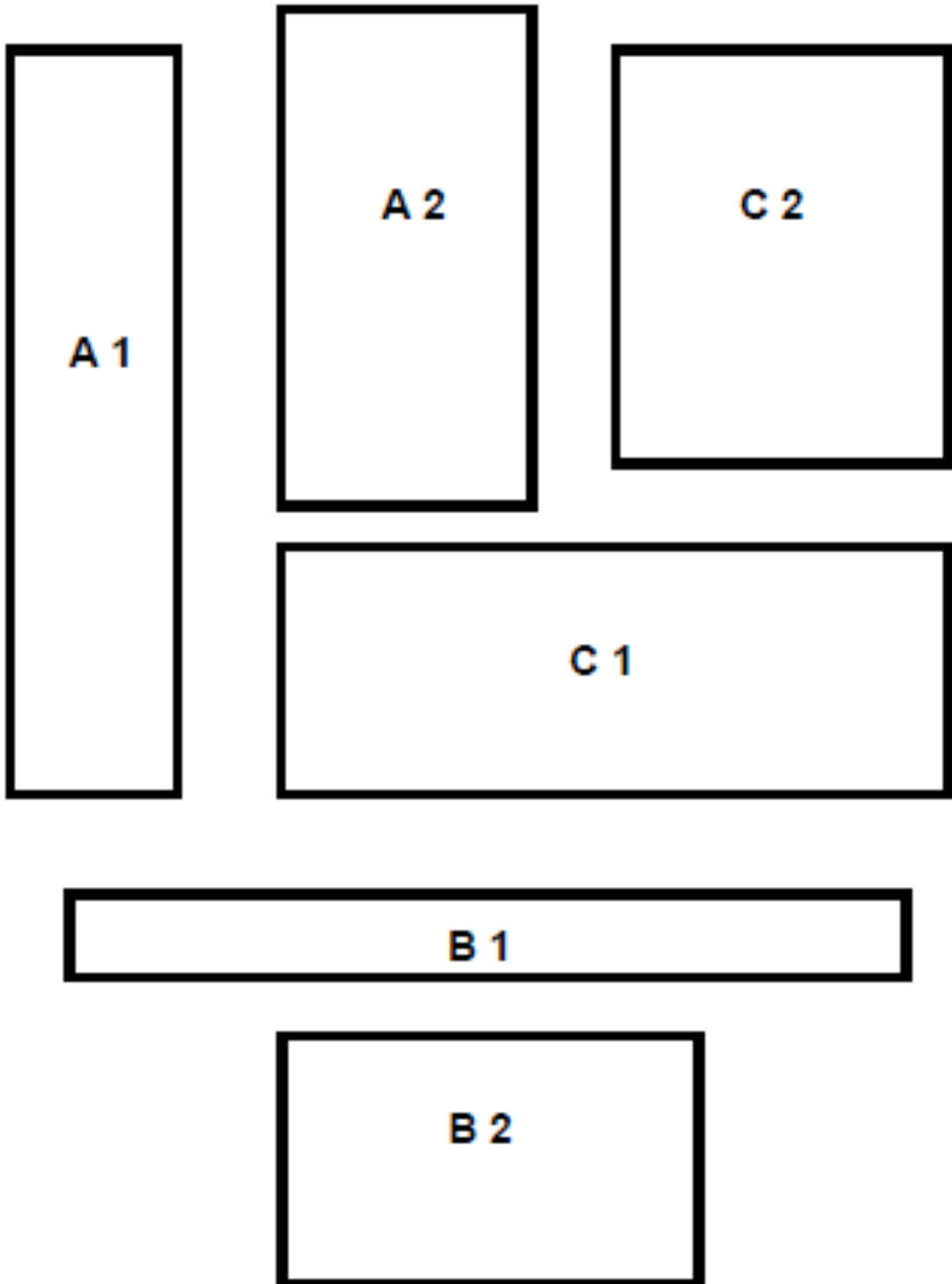
Struggling students may need to complete the activity with the teacher in a small group.

A journal starter may need to be provided to add structure to the entry.

Extension:

1. Provide advanced students with a 2 sets of paper tangrams.
  2. Challenge students to determine the relationships of the tangrams by cutting the shapes to compare the areas.
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Rectangular Comparison Sheet  
Lesson 2



## Lesson 3: Tiling a Tabletop

### Overview and Background Information

<b>Mathematical Goals</b>	By the end of the lesson students will: <ul style="list-style-type: none"> <li>• Define and use a square unit to measure the area of a rectangle</li> <li>• Communicate how they measured the area of a rectangle</li> </ul>
<b>Common Core State Standards</b>	<b>Geometric measurement: understand concepts of area and relate areas to multiplication and to addition.</b> <b>3.MD.5</b> Recognize area as an attribute of plane figures and understand concepts of area measurement. <b>a.</b> A square with side length 1 unit, called “a unit square,” is said to have “one square unit” of area, and can be used to measure area. <b>b.</b> A plane figure which can be covered without gaps or overlaps by $n$ unit squares is said to have an area of $n$ square units.
<b>Emphasized Standards for Mathematical Practice</b>	1. Make sense of problems and persevere in solving them. 3. Construct viable arguments and critique the reasoning of others. 6. Attend to precision. 7. Look for and make use of structure.
<b>Prior Knowledge Needed</b>	Experiences with multiplication and division Tiling a surface without gaps or overlaps
<b>Vocabulary</b>	square unit, dimensions, width, length
<b>Materials</b>	Square tiles (1 per pair), large index cards (5-6 per pair), small index cards (5-6 per pair), notebook paper (2 sheets per pair), scissors

### Tasks in the Lesson

<b>Engage</b>	10 minutes
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*Students in first grade practice covering an area with multiple copies of whole units to describe its size. This activity reviews the correct iteration of units, with the additional challenge of dealing with partial units. Students should estimate the amount of partial units, and combine partial units to develop appropriate estimates for whole units.*

Read (or have a student read) the task to the class.

*Jessie wants to tile a tabletop. She only has index cards and notebook paper to use for measuring. How can she describe the size of her tabletop using these units?*

Allow students to work in pairs to estimate, measure, and record the number of each unit it would take to cover the top of one desk.

While monitoring, remind students to try to avoid gaps and overlaps for the best estimates.

Discussion: Record the number of each unit required to tile the desktop. Ask:

- *How can we describe the number of index cards and sheets of notebook paper it would take to cover or tile the desk top?*
- *Why doesn't it take the same number of each unit to cover the same desk top?*
- *Which unit of measure was most appropriate for this space? (Which unit provided the closest estimate?)*

---

**Explore**

20 minutes

*Students are challenged to use just one square unit to measure a surface. Although they may use any of the listed strategies to complete the activity, students will soon see that a quick way to compute the number of square units it would take to cover the desk would be to measure the index card and multiply the answer by the number of index cards they used. Other students would insist on iterating the one unit across the entire desk and count the number of times they did so. Still others may imagine the array, and measure just the top and side lengths, then multiply the numbers to find the area. The discussion of the activity will reveal the students who may need additional experiences iterating units or choosing effective strategies.*

Jessie knows that she needs more exact measurements before visiting the home improvement store. She finds a square tile in her garage. How can Jessie use the square tile to help her find a closer estimate of the size of her table top?

Ask: *What are some different ways we could use the square tile to measure the desktop?*

Possible student responses:

- Use the square tile to measure the small index card, then multiply by the number of index cards it took to cover the desk
- Use the square tile to measure the large index card, then multiply by the number of index cards it took to cover the desk
- Use the square tile to measure the sheet of notebook paper, then multiply by the number of sheets it took to cover the desk
- Use the square tile to measure the top of the desk

Allow students to utilize one of the methods to measure the desk. Ask students to share their measurements. Record them for the whole class to see.

---

**Explain**

10 minutes

*Students revisit the concept of area as the amount of space covered by a flat shape. Here, students express area as square units. They should be able to verbalize the number of square units that it takes to cover the desk. In order to explain why the estimates were similar although they used different methods, they may make connections to converting from one measurement unit to another. For example, if they know that there are 12 inches in a foot and that it takes four feet to measure a length, then they could multiply the number of inches in a foot by the total number of feet to find the total number of inches. If they know how many square units fit on an index card or how many square tiles fit on a sheet of paper, they can multiply the number of square tiles by the number of index cards or sheets of paper to find out the number of square units it would take to cover the desk. They have converted the number of index cards or sheets of paper to the number of square tiles needed to cover the surface.*

Discuss the activity with the class. Suggested questions:

- Which method did you use?
  - Did all of the methods result in similar estimates? Why?
  - Draw a representation of the tabletop on the board. What is the length of the tabletop? Write “length” on the board and record the measurement.
  - What is the width of the tabletop? Write “width” on the board and record the measurement.
  - How can we describe the tabletop using the length and width, or dimensions? Write “dimensions” on the board and record the measurements.
  - How much material does Jessie need to cover her tabletop?
  - How can this amount be expressed in square units? Record inside the figure.
-



- 
- Can we use square units to describe the number of index cards or sheets of notebook paper it took to cover the desk? (No.)
  - Why not? (The index cards and the notebook paper were not squares.)

When we measured the desk top with square units, we found the area of the desk top. What is area? (The number of square units needed to cover a space.)

Ask: How can we describe the area of the desk top? (The area is \_\_\_\_\_ square units.)

---

**Elaborate**

18-20 minutes

*By turning index cards and sheets of paper into square units, the importance of square units is reinforced. Students should notice that the square units allow us to describe the dimensions of the desk, and that the orientation is not a factor.*

Discuss the importance of square units. Ask: How can we make the index cards and notebook paper into square units? Students should talk about fold and cutting them to create squares.

Allow students to create square units with the index cards and notebook paper by folding the corner across to the opposite side and removing and discarding the rectangle that is left. If desired, additional materials can be provided, or students can work in groups of 4 to explore.

Allow students to re-measure the desk with square units of index cards and notebook paper.

Discuss measurements and the importance of square units.

- How do the new measurements compare to the original measurements?
- Why is it important to express the measurement of the desk top in square units?

Students should talk about how square units allow them to build arrays to cover the desk top and that arrays are easy to count.

#### Math Journal

Students should respond to the following questions in their Math Journals using pictures, words, and/or numbers: What is area? How can we use square units to find the area of a surface?

Have students share their responses. Students may refine their own answers afterwards.

---

**Evaluation of Students**

Formative: Observe students as they work for: tiling with no gaps or overlaps and using appropriate estimates for partial units, precise explanations of their strategies.

Summative: Students' work in the Elaborate section can be used as a summative assessment.

---

**Plans for Individual Differences**

Intervention: Provide enough materials to completely cover the area for those students who have difficulty iterating the units.

Extension: Allow students to use centimeter cubes to estimate the area of the desk top in square centimeters. Students should explain their reasoning for their estimates.

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## Lesson 4: Geoboard Areas

### Overview and Background Information

<b>Mathematical Goals</b>	By the end of this lesson: <ul style="list-style-type: none"> <li>Students will determine the area of a two-dimensional shape on a Geoboard by counting smaller regions.</li> <li>Students will communicate their process of finding the area of a figure.</li> </ul>
<b>Common Core State Standards</b>	<b>Geometric measurement: understand concepts of area and relate areas to multiplication and to addition.</b> <b>3.MD.5</b> Recognize area as an attribute of plane figures and understand concepts of area measurement. <b>a.</b> A square with side length 1 unit, called “a unit square,” is said to have “one square unit” of area, and can be used to measure area. <b>b.</b> A plane figure which can be covered without gaps or overlaps by $n$ unit squares is said to have an area of $n$ square units. <b>3.MD.6</b> Measure areas by counting unit squares (square cm, square m, square in, square ft, and improvised units) <b>3.MD.7</b> Relate area to the operations of multiplication and addition.
<b>Emphasized Standards for Mathematical Practice</b>	1. Make sense of problems and persevere in solving them. 3. Construct viable arguments and critique the reasoning of others. 5. Use appropriate tools strategically. 7. Look for and make use of structure.
<b>Prior Knowledge Needed</b>	addition of single digits, identification of square units, area
<b>Vocabulary</b>	Area, dimensions
<b>Materials</b>	Geoboards (1 per student), rubber bands, dice (2 per pair), sticky notes

### Tasks in the Lesson

<b>Engage</b>	8-10 minutes
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*Students are provided with the opportunity to learn and practice the rules of the activity. They should be able to demonstrate the proper use and safety of geoboards and rubber bands before beginning the activity. It may be necessary to review these procedures with the class.*

Explain to students that they will be finding different combinations of square units for area measurements on the geoboard. Demonstrate one acceptable and one unacceptable combination of squares that measure 5 square units.

- Acceptable- all squares connected along their sides, half-units are acceptable.
- Unacceptable-some squares are connected at corners.

Have students work independently to build different combinations of a figure with an area of 5 square units. Share student examples.

<b>Explore</b>	12-15 minutes
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*This activity allows students to focus on constructing a figure with a specific area. They will check the area by counting the square units. Half-units are acceptable and will offer a challenge for students who easily grasp the counting of whole units.*

Introduce the student activity (Students will work in pairs):

Decide who will go first.

- 
- The first student rolls the dice and adds the numbers.
  - Both students build a figure on a geoboard with the area that matches the sum.
  - The students trade boards with their partners. The partners check the area.
  - The second student rolls the dice to begin the next round.

Allow students to engage in the activity for about 10 minutes.

---

**Explain**

8-10 minutes

*The activity provides students with the experience of figures with equivalent areas, but different shapes. This idea will be explored further in later lessons involving the study of perimeter and how it relates to area.*

Choose two students to demonstrate one round of the activity. Share the two solutions.

Discuss:

- *How are the solutions the same? How can we be sure?*  
We can count the square inches. Have students verify the areas by counting aloud.
- *How are the two solutions different?*
- *Who can build a different solution for the same area?*

Allow the class to build new figures. Choose 2 or 3 to share at the document projector. The class should count the square units to verify the area.

---

**Elaborate**

20-25 minutes

*A gallery walk provides an opportunity for students to individually demonstrate their understanding of counting square units. The teacher should circulate the room during this activity to listen for possible misunderstandings.*

Allow students to play for about 5 additional minutes.

Stop the class, but instruct the students to leave their figures on their boards.

Ask students to return to their desks if they are away.

Instruct students to write the area of the figure on the sticky note and place it on the back of the geoboard, or on the desk underneath the board.

Allow students to complete a gallery walk to view and determine the area of each figure.

Students should turn over or move the geoboard to check the answer.

Math Journals: Choose 2 student geoboards to share. Students find the area in their journals.

Students should write at least one sentence about how they determined each area.

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**Evaluation of Students**

Formative: While students are working, pose questions and observe students.

Summative: Students' work in the Elaborate section,

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**Plans for Individual Differences**

Intervention: Students having difficulty building figures on the geoboards should be provided with square tiles to build the figures.

Students having difficulty counting or recounting spaces should be given a tool, such as a counters or cubes to help them keep track of spaces that they have already counted. Also, using paper representations where students can draw or mark counted spaces may also help.

Extension: Advanced students can be challenged to find and demonstrate all of the possible whole square unit combinations for an area of 6, 7, or 8.

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## Lesson 5: Rectangle Comparison II Overview and Background Information

<b>Mathematical Goals</b>	By the end of the lesson students will: <ul style="list-style-type: none"> <li>Count square units to determine the area of a rectangle.</li> <li>Compare the area of various rectangles.</li> </ul>
<b>Common Core State Standards</b>	<b>Geometric measurement: understand concepts of area and relate areas to multiplication and to addition.</b> <b>3.MD.5</b> Recognize area as an attribute of plane figures and understand concepts of area measurement. <b>a.</b> A square with side length 1 unit, called “a unit square,” is said to have “one square unit” of area, and can be used to measure area. <b>b.</b> A plane figure which can be covered without gaps or overlaps by $n$ unit squares is said to have an area of $n$ square units.
<b>Emphasized Standards for Mathematical Practice</b>	1. Make sense of problems and persevere in solving them. 3. Construct viable arguments and critique the reasoning of others. 7. Look for and make use of structure. 8. Look for and express regularity in repeated reasoning.
<b>Prior Knowledge Needed</b>	Experiences with Multiplication and Division
<b>Vocabulary</b>	Area, dimensions, square unit
<b>Materials</b>	Rectangle Comparison - Square Units sheet (1 per student), Square tiles (10-12 per student), Inch rulers, Incomplete Rectangles activity sheet, Computer with internet connection and projector.

### Tasks in the Lesson

<b>Engage</b>	4-5 minutes
<p><i>This lesson serves as an extension of previous lessons. This engage portion reviews the lessons in which the students compared rectangles by overlapping and cutting the figures and introduces the concept for this lesson.</i></p> <p>Remind students of the rectangle comparisons that involved overlapping and cutting the rectangles to compare their areas..</p> <p>Provide students with the Rectangle Comparison – Square Units sheets.</p> <p>Have students predict which rectangles will be larger; A1 or A2, or, B1 or B2. Be sure students explain the reasoning supporting the predictions.</p> <p>Tell students that today they will compare the rectangles without cutting them out.</p>	
<b>Explore</b>	8-10 minutes
<p><i>Students continue to explore the concept of using square units to cover the area of a rectangle. It is important to pay close attention to the methods and strategies students use to determine and compare the areas of the rectangles.</i></p> <p>Distribute square tiles and rulers. <i>Your job will be to compare the rectangles by finding the area of each rectangle. You may work in pairs. You may use the square tiles and rulers to help you.</i></p>	

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Allow students to determine the number of square units in each rectangle. Students may work in pairs, if desired.

As students work, note different strategies that students use in order to determine the areas and compare the rectangles. Students may:

- draw each of the units inside the rectangle
- fill each rectangle with square tiles and count the number of tiles
- use tiles to measure the dimensions of the rectangles
- use the ruler to measure the dimensions of the rectangles and multiply them to find the areas
- use other strategies

---

**Explain**

8-10 minutes

*Sharing strategies allows students to become aware of different methods that may be helpful in finding the area of rectangles. Here, it is important for students to continue to make the connection between the arrays they used for multiplication and the area of a rectangle. Students who need to count each square unit will be exposed to student thinking that includes repeated addition and multiplication through the sharing of strategies.*

Choose students to share their strategies with the class. Students may demonstrate their solutions on the document projector or board.

Allow other students who used the same strategies to comment on their own thinking.

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**Elaborate**

8-10 minutes

*Students are given an opportunity to predict the areas of rectangles using partial square unit information. Students first visualize the square units covering the rectangles, then use strategies to check their predictions. Students should focus on ensuring the square units are the same sizes and are counted or multiplied accurately. This activity may also be used as an assessment.*

Distribute or display “Incomplete Rectangles” sheet.

Challenge students to predict the number of square units that would cover rectangle A.

Encourage students to demonstrate and share prediction strategies.

Challenge students to predict the number of square units that would cover rectangle B.

Encourage students to demonstrate and share prediction strategies.

Allow students to solve the problems independently. The assignment may be reviewed by having students share and demonstrate their solution strategies, or collected for evaluation.

Part Two: Exploring Area Online

Connect to <http://www.shodor.org/interactivate/activities/AreaExplorer/>.

Click on Show Outline.

Check the box to Only Draw Rectangular Shapes.

Allow students to find the area of the rectangle aloud. They may turn and talk to a partner before raising their hands to answer.

Type, or have a student type, the measurement in the box.

Click on Check Answer

Click on Draw New Shape.

Repeat until students seem to be able to correctly answer the questions consistently, or for 5 minutes.

Click on Draw New Shape.

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Have students draw the shapes in their Math Journals and find the area. They should explain how they found the area of the rectangle using at least one complete sentence.

---

**Evaluation of Students**

8-10 minutes

Formative: The teacher can ask questions during various phases of the lesson and make observations about students' ability to find the area of shapes.

Summative: Student work samples from the Elaborate phase can be collected as a summative assessment.

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**Plans for Individual Differences**

Intervention:

Provide support for the journal entry by completing an example on the board.

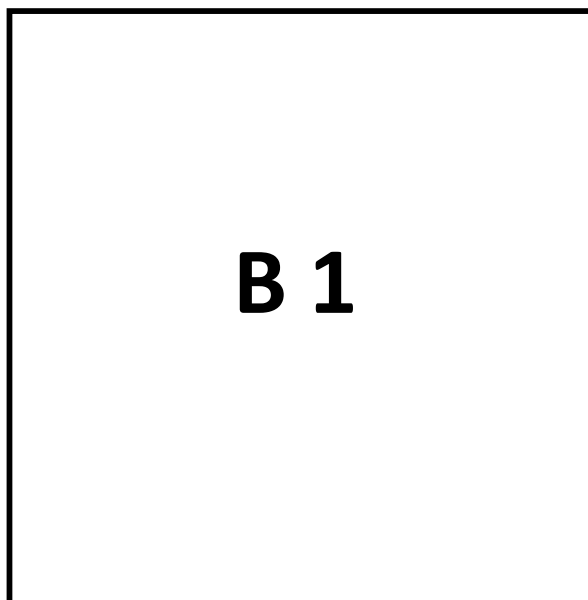
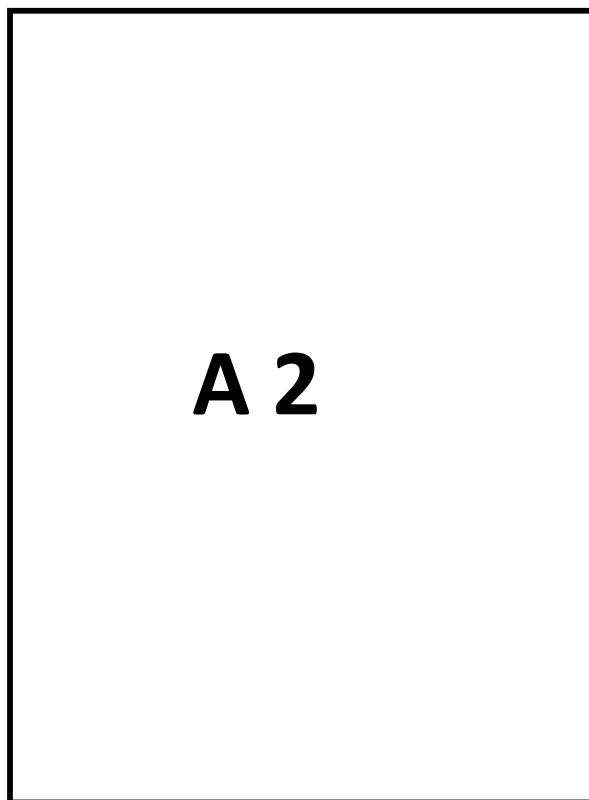
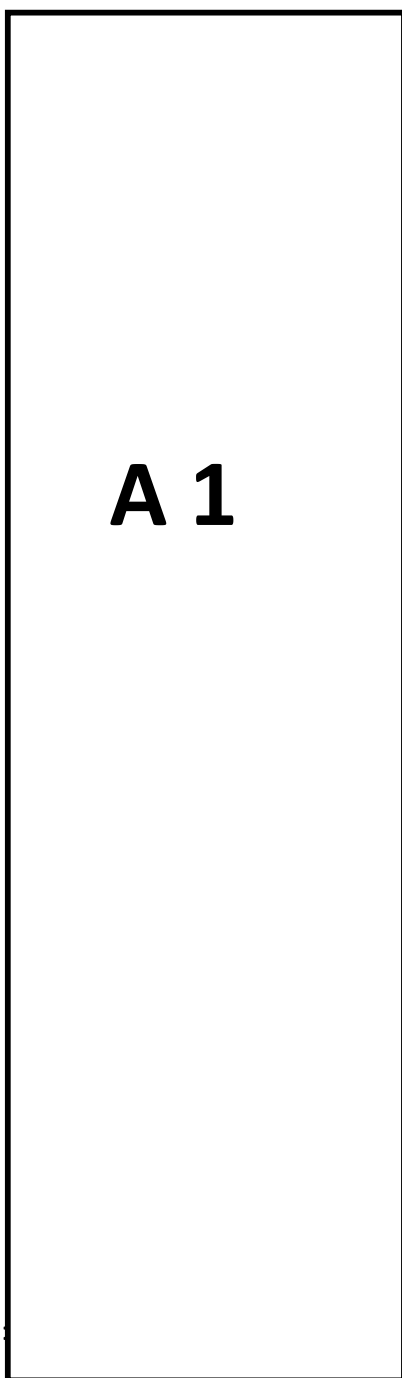
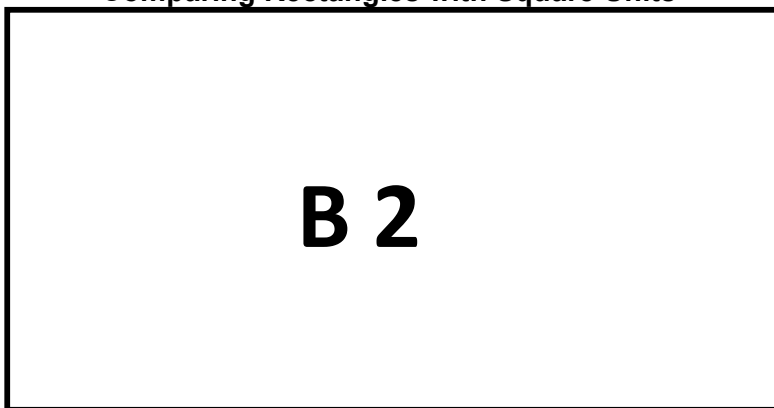
Extension:

Challenge advanced students to complete and compare the areas of two different rectangles in their journal entries.

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Lesson adapted from *Measuring in One and Two Dimensions*, NC-PIMS, 2007.

Comparing Rectangles with Square Units



Name \_\_\_\_\_

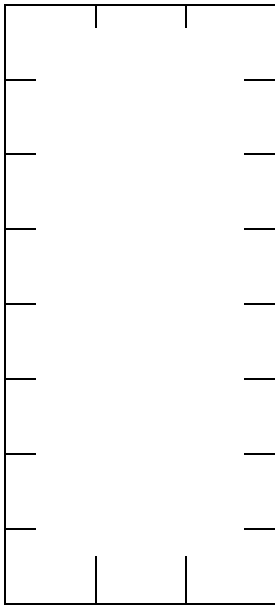
## Incomplete Rectangles

1. Predict the number of square units that would cover Rectangle A.

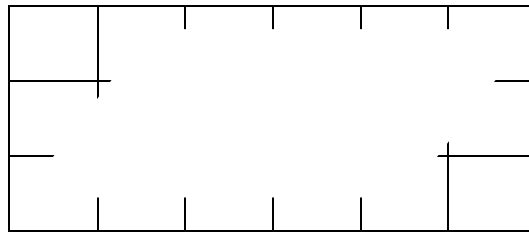
\_\_\_\_\_ square units

2. Find the number of square units that would cover Rectangle A.

\_\_\_\_\_ square units



Rectangle A



Rectangle B

3. Predict the number of square units that would cover Rectangle B.

\_\_\_\_\_ square units

4. Find the number of square units that would cover Rectangle B.

\_\_\_\_\_ square units

5. Explain how you found the area of the two shapes.



## Lesson 6: Mowing for Money

### Overview and Background Information

<b>Mathematical Goals</b>	By the end of the lesson students will: <ul style="list-style-type: none"> <li>Determine the area of a rectangle by counting square units</li> <li>Communicate the process of finding the area of a rectangle</li> </ul>
<b>Common Core State Standards</b>	<b>Geometric measurement: understand concepts of area and relate areas to multiplication and to addition.</b> <b>3.MD.6</b> Measure areas by counting unit squares (square cm, square m, square in, square ft, and improvised units) <b>3. MD.7</b> Relate area to the operations of multiplication and addition.
<b>Emphasized Standards for Mathematical Practice</b>	1. Make sense of problems and persevere in solving them. 3. Construct viable arguments and critique the reasoning of others. 7. Look for and make use of structure. 8. Look for and express regularity in repeated reasoning.
<b>Prior Knowledge Needed</b>	Experiences exploring area and square units
<b>Vocabulary</b>	width, length, row, column
<b>Materials</b>	Inch grid paper or centimeter grid paper, colored pencils or crayons (a different color for each partner), tetrahedron dice or two dice per pair  Gabriel, Nat. (2002). Sam’s Sneaker’s Squares. New York: Kane Press, Inc.

### Tasks in the Lesson

<b>Engage</b>	8-10 minutes
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Read the book to the class.

While reading, stop and discuss pages 18-19 and pages 25-27.

*If the book is not available, the teacher can set the following scenario:*

*Sam wants to earn money for a new bike. He begins cutting lawns for his neighbors. He soon realizes that it takes him much longer to mow Mr. Hill’s lawn than it does to mow Mrs. Green’s lawn and wonders if he should charge Mr. Hill more. Sam comes up with a plan to measure the lawns, called “Sneaker Squares.” He counts the number of steps it takes to walk along the length and the width of the lawns, then multiplies the numbers to find the areas of the lawns. He finds out that Mr. Hill’s lawn is larger than Mrs. Green’s lawn, and charges him more.*

The teacher should demonstrate the way Sam counted his Sneaker Squares by walking heel to toe along the length of a rug or a wall. The dimensions of the yards can be written on the board for discussion: Mr. Hill – 18 x 20 steps, Mr. Green – 20 x 10 steps.

---

**Explore**

13-15 minutes

*Introduce the activity as “Mowing for Money.” In this activity, students will roll dice to determine lawn dimensions, and compute areas to find the amount of money they received for mowing that lawn. If tetrahedron dice are not available, students may play with two cube dice by adding the numbers that are rolled to determine the dimensions. For example, if a student rolls a 3 and a 2, the sum is 5. This sum will be the width. The student rolls again to determine the length. Play continues to the teacher’s discretion. The teacher may choose to set a time limit, or to have each student roll 5 times to limit the game. Students will add their areas to find the total amount of money they made for that day and compare the amount to their partner’s to determine the winner.*

Separate students into pairs. Distribute grid paper, colored pencils or crayons and dice.

Explain that the students are mowing lawns for extra money. They make \$1 for each square unit they mow. Demonstrate rolling the dice and drawing a rectangle using the units that are rolled using one color of crayon or marker.

Students should compute the amount of money they would make for mowing the lawn. Calculators can be used.

The partner then rolls, and completes the activity using a different color of crayon or marker. Whoever has the most money at the end of the activity “wins” the game.

As students work, make note of specific strategies that you want them to share during the Explain phase of the lesson.

---

**Explain**

8-10 minutes

*Students will share their strategies for finding the areas of the lawn. Some students will choose to use repeated addition of the length of one side of the rectangle, some students will count each square unit in the rectangle, and other students may multiply the dimensions to find the area. This activity further reinforces the concept of building and using arrays to find the area of a rectangle.*

Allow students to share their earnings with the class.

Discuss the strategies that students used to compute area.

Suggested questions:

- How did you determine the area?
- Why did you use those strategies?

After a few students have shared ask:

- How are these strategies different?
- What was the same about some of these strategies?

---

**Elaborate**

8-10 minutes

*This brief discussion raises an important point about using common units and provides a preview of the goal for the next lesson. Although Sam’s measurements will be consistent due to the size of his foot, this portion of the lesson is meant to raise an issue for student consideration.*

*When we talk about measuring, we need to be sure of the units. In the story, Sam used his “Sneaker Squares” to measure the lawns. Mr. Hill offered to help Sam measure the lawn, but Sam said no. Would Sam’s Sneaker Squares be the same as Mr. Hill’s or Mrs. Green’s? Why or why not? (Sam’s shoes are smaller than Mr. Hill’s or Mrs. Green’s, so his units will be smaller.)*

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Demonstrate using Teacher Squares versus a student's sneaker squares to measure a rug or another defined area of the classroom. Write the measurements on the board.

Choose two additional students to measure the same area. Display the measurements.

*How much would I earn if I mowed this part of the lawn? How much would \_\_\_\_\_ earn? Is there a problem with this method?*

Possible student response: The amount you earn is based on the size of your foot. If you have a smaller foot, you earn more money. This is a problem because there is no way to check to make sure the measurements are correct.

*Since neither Mr. Hill nor Mrs. Green could use their own steps to measure the lawn, how could they check Sam's measurements?*

Some students may suggest borrowing Sam's shoes or watching Sam measure the lawn. Others may suggest using a different tool, such as a ruler or yardstick. Students will explore the sizes and uses of standard square units in a later lesson.

---

### **Evaluation of Students**

Formative:

While students are working, pose questions and observe them to check for their understanding.

Summative:

Teacher may use students' grid sheets as an assessment.

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### **Plans for Individual Differences**

Intervention:

Calculators should be provided for students who need support adding or multiplying. Students may also use one die to roll for the length or the width to limit the number of facts used in the activity.

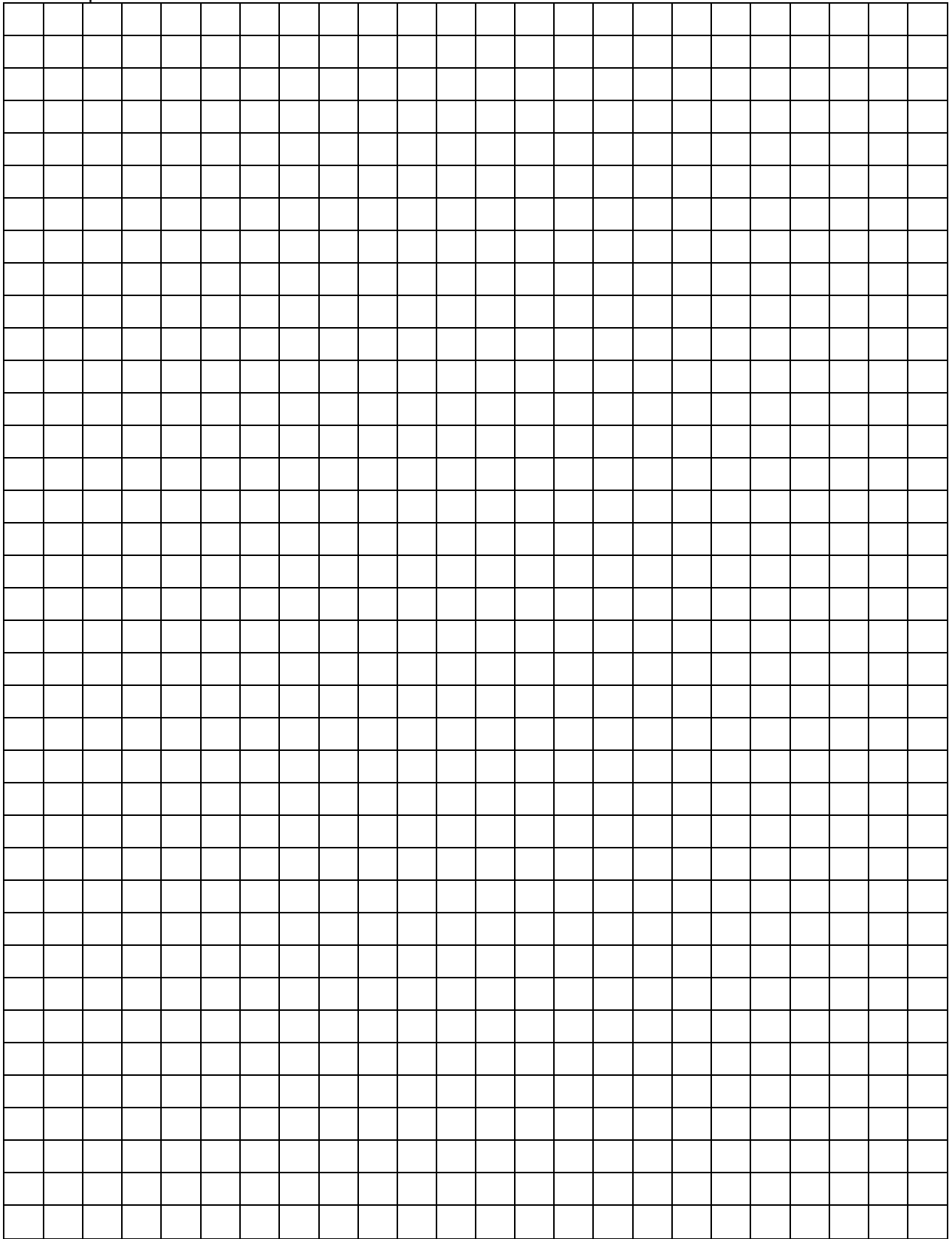
Extension:

Students may use two tetrahedron dice and smaller grid paper to work with larger numbers.

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Lesson adapted from *Measuring in One and Two Dimensions*, NC-PIMS, 2007.

Grid Paper



## Lesson 7: Sticker Stumper Overview and Background Information

<b>Mathematical Goals</b>	By the end of the lesson students will use the dimensions of rectangles to determine their areas.
<b>Common Core State Standards</b>	<b>Geometric measurement: understand concepts of area and relate areas to multiplication and to addition.</b> <b>3.MD.6</b> Measure areas by counting unit squares (square cm, square m, square in, square ft, and improvised units) <b>3. MD.7</b> Relate area to the operations of multiplication and addition.
<b>Emphasized Standards for Mathematical Practices</b>	1. Make sense and persevere while solving problems. 7. Look for and make use of structure. 8. Look for and express regularity in repeated reasoning.
<b>Prior Knowledge Needed</b>	Experiences with area and square units
<b>Vocabulary</b>	area, dimensions, factors, multiples
<b>Materials</b>	Sticker Stumper sheet (1 per student) Centimeter Grid Paper (Lesson 6), 1 per student Colored pencils or crayons Notebook paper (1 sheet per student)
<b>Resources</b>	Calculators (optional)

### Tasks in the Lesson

<b>Engage</b>	4-5 minutes
<p><i>The sticker factory scenario provides an additional opportunity for students to apply the finding of area to a more realistic situation. Some students may want to spend more time designing stickers than solving the problems, however, so teachers should remain aware of how students are spending their time. Early finishers may be allowed to design the stickers, if desired.</i></p> <p>Distribute the materials to students and providing the following introduction: <i>You are owners of the Stuck on Stickers factory. Your factory makes sticker sheets for customers according to their requirements. You have two new sticker orders that need to be filled. Working in pairs, you will use grid paper to show how the orders will be filled.</i></p>	
<b>Explore</b>	5-7 minutes
<p><i>Two types of problems are presented to the students in this activity. First, students are asked to find the area of the stickers given the dimensions. Then, students are asked to provide the dimensions given the area. Question 2 stretches the students to think more flexibly since there are multiple solutions. Students should make the connection between factors and dimensions and begin to list the dimensions for a given area.</i></p> <p>Students work through the activity to answer questions 1 and 2.</p> <p>As students are working make observations about strategies that students are using. If students struggle support them by asking questions about the task. Have a few pairs share with the class the dimensions of the rectangles for question 2.</p>	

---

**Explain**

8-10 minutes

*The discussion of student solutions after the completion of Order 2 provides students with the opportunity to share and listen to multiple solution strategies. The discussion also leads students toward the connection between factors and dimensions.*

Ask:

- *How are Order 1 and Order 2 different? (Order 1 gave the dimensions and we had to find the number of stickers, Order 2 gave the number of stickers and we had to find the dimensions.)*
- *What do you notice about the relationship of the dimensions of the rectangles and the number of stickers in Order 1? (We can multiply the columns and rows to find the number of stickers.)*
- *What do you notice about the total number of stickers and the lengths of the sides of the rectangles in Order 2? (The lengths of the sides are factors of the total number of stickers.)*
- *Are there more possibilities for Order 2? How can we find them?*

---

**Elaborate**

25-28 minutes

*The Elaborate step provides students to discover multiple solutions to the problem. Explicit connections between factors and rectangle dimensions have already been made to support students when solving the problem. Students are not required to find all of the possible solutions at this point, so only about 5 minutes should be provided for this portion of the lesson. The remaining solutions should be identified through discussion. The majority of the time should be spent making more explicit connections between the dimensions of the rectangles and their areas.*

Have students answer question #3. They should use the grid paper to show each solution.

Allow students to report different solutions for Order 2. Draw and label the rectangles on the board.

Discuss:

- *Have we found all of the possible solutions for a? How do you know?*
- *Have we found all of the possible solutions for b? How do you know?*
- *Have we found all of the possible solutions for c? How do you know?*

Encourage students to relate the dimensions of the rectangles to the factors of the area.

**Math Journal**

Have students answer question 4. They should attach their responses to their Stuck on Stickers sheet and submit for evaluation.

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**Evaluation of Students**

Formative: As students work, pose questions and observe them,

Summative: Students' journal entry on question 4.

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**Plans for Individual Differences**

Intervention: Provide inch color tiles for students who exhibit difficulty drawing the rectangles on the grid sheet.

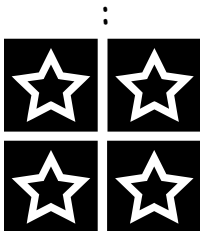
Extension: Challenge students to find all of the possible sticker configurations for 48 stickers. *Which configuration should you choose? Why?*

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Lesson adapted from *Measuring in One and Two Dimensions*, NC-PIMS, 2007.

Name \_\_\_\_\_

## Sticker Stumper



### Order Specifications:

- All sticker sheets must be rectangular.
- All dimensions must be whole units.
- All stickers must be arranged in rows and columns with no spaces or overlaps.

### 1. Order Number 1.

Happy Face Designs sent an order for the stickers it wants. How many stickers will fit on each sheet?

Item	Length	Width	Number of Stickers
a. Sticker Sheet	10 stickers	4 stickers	
b. Sticker Sheet	8 stickers	3 stickers	
c. Sticker Sheet	5 stickers	4 stickers	

### 2. Order Number 2.

The Hearts and Flowers Company sent an order for the number of stickers per sheet it wants to sell. What will be the length and Width of each sticker sheet?

Item	Length	Width	Number of Stickers
a. Sticker Sheet			36 stickers
b. Sticker Sheet			12 stickers
c. Sticker Sheet			24 stickers

3. The Hearts and Flowers Company wants your factory to design more than one sheet for their total number of stickers. Choose Sticker Sheet a, b, or c. Use the grid paper to show your plan for the sticker sheets.

4. Choose one Sticker Sheet from Order 1 and one Sticker Sheet from order two. In your Math Journal, show how you found the answers using words, numbers, and pictures.

## Lesson 8: A Square What?

### Overview and Background Information

<b>Mathematical Goals</b>	By the end of the lesson students will: <ul style="list-style-type: none"> <li>• Use square units to measure area.</li> <li>• Communicate their process of determining the areas of rectangles.</li> </ul>
<b>Common Core State Standards</b>	<b>Geometric measurement: understand concepts of area and relate areas to multiplication and to addition.</b> 3.MD.6 Measure areas by counting unit squares (square cm, square m, square in, square ft, and other units)
<b>Emphasized Standards for Mathematical Practices</b>	1. Make sense of problems and persevere in solving them. 3. Construct viable arguments and critique the reasoning of others. 4. Model with mathematics. 5. Use appropriate tools strategically. 6. Attend to precision.
<b>Prior Knowledge Needed</b>	Experiences with finding the area of rectangles, counting square units, exposure to conversions (10 cm = 1 dm, 10 dm = 1 m, 100 cm = 1 m, 12 in = 1 ft, 3 ft = 1 yd), multiplication and division, using a ruler to accurately measure length
<b>Vocabulary</b>	Square units (cm, in, ft, yd, dm, m)
<b>Materials</b>	Rulers, tape , glue, construction paper (12" x 18" – 2 colors per group), scissors, bulletin board paper (a little more than 1 square meter)

### Tasks in the Lesson

<b>Engage</b>	10 minutes
<p><i>It is important to review the measurements needed for this lesson. In this lesson, they will need to use their knowledge of the units of length in order to build square units. The conversion chart should remain posted and available throughout the lesson.</i></p> <p>Say to the class: <i>When Sam measured the lawns, he used Sneaker Squares as his unit. Today, we will create standard units to use for measuring area.</i></p> <p>Review measurement conversions for in, ft, yd, and cm, dm, m. List the measurements needed for the lesson on the board while eliciting the measurements from the class:</p> <ul style="list-style-type: none"> <li>• 12 in. = 1 ft., 3 ft. = 1 yd., 10 cm. = 1 dm., 10 dm. = 1 m.</li> </ul> <p>Review the meaning of a “square unit” – a square unit has the dimensions of that unit. For example, the dimensions of one square inch is 1 inch by 1 inch. Display the example.</p> <p>Have the students formulate the additional dimensions needed for the activity:</p> <ul style="list-style-type: none"> <li>• 1 sq. ft. = 1 ft. by 1 ft. (12 in. by 12 in.)</li> <li>• 1 sq. yd. = 1 yd. by 1 yd. (3 ft. by 3 ft.)</li> <li>• 1 sq. dm. = 1 dm. by 1 dm. (10 cm. by 10 cm.)</li> <li>• 1 sq. m. = 1 m. by 1 m. (10 dm. by 10 dm.)</li> </ul>	

<b>Explore</b>	20 minutes
<p><i>Although some students may want to measure the square unit instead of creating it from individual units, it is important to stress that the first square unit should be constructed as directed. Students need a sense of the magnitude of 144 square inches or 100 square centimeters in order to better understand the sizes of square feet or square centimeters.</i></p>	



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Divide the class into 4 groups. Each group will have a task:

- Group 1 – construct a square decimeter from square centimeters
- Group 2 – construct a square meter from square decimeters
- Group 3 – construct a square foot from square inches
- Group 4 – construct a square yard from square feet

Demonstrate using the ruler to measure a square cm and a square in. Cut out the units.

Students should cut out each individual unit to build the first larger unit, gluing the smaller units to a sheet of construction paper. Additional copies can be made by measuring. The small unit can be cut from one color, while the larger unit may be cut from another color.

Students should label the units. Allow about 20 minutes for units to be constructed. Students in Group 4 may assist the other groups if they complete the activity early.

---

**Explain****5 minutes**

*Students with small units will report that drawing and cutting all of the units were difficult, while the square foot to square yard group will not. Surprises may include the sizes of the square units, especially the square yard or square meter. Linking this activity back to the Sneaker Squares extends the idea of measuring with square units, while reinforcing the need to use standard units to measure. If desired, the lesson may be continued the next day.*

Provide an opportunity for each group to share their units. Discuss the building of the units.

Suggested questions:

- *What was easy about the activity? What was difficult about the activity?*
- *Were there any surprises? Which units would be appropriate to measure the lawns?*

---

**Elaborate****18-20 minutes**

*Using the units to measure will assist students in developing measurement benchmarks to which they may refer later. These benchmarks will help students make reasonable estimates and use appropriate units of measure.*

Each group should use their new square units (square decimeters, square meters, square feet, square yards) to measure objects or areas in the room. Encourage each group to estimate first, then measure. Each group should share what they found and post their constructed units on the board.

In math journals, students should note objects in the room that are about

- one square decimeter, one square foot, one square yard, one square meter

---

**Evaluation of Students**

Formative: As students are working, teachers should observe how students measure.

Summative: Students' work can be collected as a summative assessment.

---

**Plans for Individual Differences**

Intervention: Students with small motor difficulties may need to be assigned to the square foot to square yard group to avoid cutting very small units. Students experiencing difficulties with the units may be given yard sticks or meter sticks to determine the length of a yard or meter before building a square yard or meter.

Extension: Students should measure items with each of the constructed units.

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Lesson adapted from *Measuring in One and Two Dimensions*, NC-PIMS, 2007.

## Lesson 9: Estimate and Solve – Customary Units Overview and Background Information

<b>Mathematical Goals</b>	By the end of the lesson students will: <ul style="list-style-type: none"> <li>Use multiplication or addition to find the area of a rectangle with whole number side lengths.</li> <li>Describe how the process of multiplying the dimensions of a rectangle with whole number side lengths is similar to covering or tiling a rectangle with regions that are 1 square unit.</li> </ul>
<b>Common Core State Standards</b>	<b>Geometric measurement: understand concepts of area and relate areas to multiplication and to addition.</b> <b>3.MD.6</b> Measure areas by counting unit squares (square cm, square m, square in, square ft, and improvised units) <b>3. MD.7</b> Relate area to the operations of multiplication and addition. <b>a.</b> Find the area of a rectangle with whole-number side lengths by tiling it, and how that the area is the same as would be found by multiplying the side lengths.
<b>Emphasized Standards for Mathematical Practice</b>	1. Make sense of problems and persevere in solving them. 3. Construct viable arguments and critique the reasoning of others. 5. Use appropriate tools strategically. 6. Attend to precision.
<b>Prior Knowledge Needed</b>	Experiences finding the areas of rectangles
<b>Vocabulary</b>	area, square units, dimensions
<b>Materials</b>	Customary Square Unit Challenge sheet, Constructed square units (feet, yards), inch color tiles, rulers.

### Tasks in the Lesson

Engage	10-12 minutes
<p><i>This lesson will have students apply estimation skills and find the area of rectangles using customary units. The opening problem provides an opportunity for students to consider the sizes of the units and make a reasonable estimate.</i></p> <p>Opening problem: <i>Mike says the area of his desk top is about 288 square feet. Jake says the area of the desk top is about 288 square inches. Whose estimate is reasonable? Why?</i></p> <p>Have students talk to a partner to predict which estimate is reasonable and why. Choose a few students to share their predictions.</p> <p>Discuss:</p> <ul style="list-style-type: none"> <li><i>Whose estimate is reasonable? Why?</i>  A square unit measures the same on each side. A square inch would measure one inch on each side. A square foot would measure one foot on each side. That unit would be too large for the area of the desk to measure 288 square feet.</li> <li><i>Is 288 square feet close to the area of an object in the classroom?</i> (e.g., the classroom floor in a center, a large classroom rug, a short classroom wall, etc.)</li> </ul>	

---

**Explore**

10-12 minutes

*Part I of Customary Square Unit Challenge requires students to first determine the unit used to measure the area of the rectangle, then measure, or use inch tiles, to find the area. Students may draw the individual units inside the rectangle, use inch tiles to fill the rectangle, use inch tiles to determine the dimensions of the rectangle, or use the ruler to measure the rectangle.*

Distribute Customary Square Unit Challenge. Review the example with the class. As students are working, observe for different problem solving strategies to be shared later.

As students work, ask: How did you find the area? How can you check your answer?

---

**Explain**

10-12 minutes

*The discussion around Part I should focus students on choosing the correct unit BEFORE measuring the rectangles.*

Choose a few students who demonstrated different problem solving strategies to share their strategies and their solutions. Students may demonstrate and share using the document projector, if desired. As students are sharing, elicit additional comments from other students who used the same or similar strategies.

---

**Elaborate**

22-25 minutes

*Part II moves students to solving area problems using customary units. Students may draw a representation of the problem showing the individual square units in the rectangles or the dimensions of the rectangles.*

Assign Part II to individuals or pairs.

Allow the students to work through the problems. They may use the constructed units, rulers, and inch tiles to help them solve the problems. Choose a few students who demonstrated different problem solving strategies to share their strategies and their solutions.

As students are sharing, elicit additional comments from other students who used the same or similar strategies.

**Math Journal**

Have students choose 1 problem from Part I or Part II.

Allow students to solve the problem in their journals using a different method than the one used the first time.

Have students reflect in their journals:

- The first time I solved this problem I  (state the solution strategy) . This time I  (state the solution strategy) . The  (strategy)  worked best for me because  .

Example: The first time I solved this problem I used the tiles to fill in the rectangle. This time I used a ruler. Using tiles worked best for me because they were easy to count.

---

**Evaluation of Students**

Formative: As students work, pose questions and observe them to check their understanding.

Summative: Students' work from their math journal.

---

**Plans for Individual Differences**

Intervention: The teacher may need to help students complete the activity in a small group. The constructed units should be near the table and in view for frequent reference.

Extension: Have students write area problems to be solved using customary units. The problems can be kept on index cards in a file for early finishers.

---

### Customary Square Unit Challenge

Part I

- a. Circle or underline the unit that is used to measure the area of each rectangle
- b. Find the area of each rectangle.

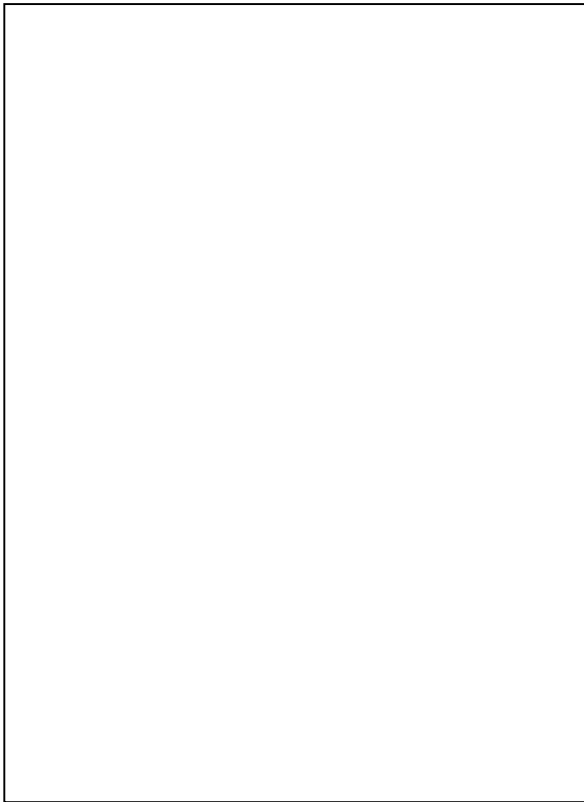
Example:



square inches                  square feet

area 1 x 3 = 3 square inches

1.



square yards                  square inches

area \_\_\_\_\_

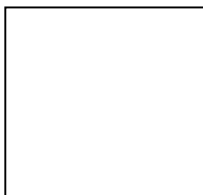
2.



square inches  
square feet

area \_\_\_\_\_

3.



square foot                  square inch

area \_\_\_\_\_

Part II

Answer each question by finding the area and circling the correct unit.

4. Michelle is making a mosaic in art class. The tile that she is using measures 6 by 6. What is the area of the tile?

\_\_\_\_\_ square in      square ft

5. Kenny needs new carpet in his bedroom. His bedroom measures 4 by 5. How much carpet does Kenny's Mom need to order?

\_\_\_\_\_ square ft      square yd

6. Jen is making placemats for a special birthday dinner. Each placemat must measure 12 by 18. How much material will Jen use for each placemat?

\_\_\_\_\_ square in      square ft

7. Paul is painting an accent wall in his room. The wall measures 8 by 12. What is the area of the wall that Paul is painting?

\_\_\_\_\_ square ft      square yd

## Lesson 10: Estimate and Solve – Metric Units

### Overview and Background Information

<b>Mathematical Goals</b>	By the end of the lesson students will use multiplication or addition to find the area of a rectangle with whole number side lengths.
<b>Common Core State Standards</b>	<b>Geometric measurement: understand concepts of area and relate areas to multiplication and to addition.</b> <b>3.MD.6</b> Measure areas by counting unit squares (square cm, square m, square in, square ft, and improvised units) <b>3. MD.7</b> Relate area to the operations of multiplication and addition. <b>a.</b> Find the area of a rectangle with whole-number side lengths by tiling it, and how that the area is the same as would be found by multiplying the side lengths.
<b>Emphasized Standards for Mathematical Practice</b>	1. Make sense of problems and persevere in solving them. 3. Construct viable arguments and critique the reasoning of others. 5. Use appropriate tools strategically. 6. Attend to precision.
<b>Prior Knowledge Needed</b>	Experiences finding the area of rectangles.
<b>Vocabulary</b>	area, square units, dimensions
<b>Materials</b>	Metric Square Unit Mania sheet, Constructed square units (decimeters, meters), Centimeter cubes, rulers, meter sticks (optional)

### Tasks in the Lesson

<b>Engage</b>	8-10 minutes
<p><i>This lesson will have students apply estimation skills and find the area of rectangles using metric units. The opening problem provides an opportunity for students to consider the sizes of the units and make a reasonable estimate.</i></p> <p>Opening problem: <i>Michelle says the area of her candy bar is about 90 square centimeters. Jill says the area of the candy bar is about 90 square meters. Whose estimate is reasonable? Why?</i></p> <p>Have students talk to a partner to predict which estimate is reasonable and why. Choose a few students to share their predictions. Instruct students to use rulers to draw a rectangle that they estimate to be about the size of a candy bar. Have students work in pairs to use the centimeter cubes to measure the rectangles. Refer to the square meters that were constructed in an earlier lesson. Choose a few students to share their solutions and reasoning.</p> <p>Introduce the activity. <i>Today you will solve problems in which you must not only find the area of each rectangle, but you must also choose the metric units that are appropriate for measuring the areas of the rectangles.</i></p>	
<b>Explore</b>	10-12 minutes
<p><i>Part I of Metric Square Unit Mania requires students to first determine the unit used to measure the area of the rectangle, then measure, or use centimeter cubes, to find the area. Students may draw the individual units inside the rectangle, use centimeter cubes to fill the rectangle, use centimeter cubes to determine the dimensions of the rectangle, or use the ruler to measure the dimensions of the rectangle.</i></p> <p>Distribute Metric Square Unit Mania. Review the example with the class.</p>	

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Assign students to complete Part I individually or in pairs. As students are working, observe for different problem solving strategies to be shared later.

---

**Explain**

8-10 minutes

*The discussion around Part I should focus students on choosing the correct unit BEFORE measuring the rectangles. The students should be able to decide by observing the rectangle which of the given units represents the more reasonable solution. Once the unit has been chosen, only then should the students discuss the measurement of that unit.*

Choose a few students who demonstrated different problem solving strategies to share their strategies and their solutions. Students may demonstrate and share using the document projector, if desired.

As students are sharing, elicit additional comments from other students who used the same or similar strategies.

---

**Elaborate**

22-25 minutes

*Part II moves students to solving area problems using metric units. Students are asked to determine the area measurement and choose the appropriate unit of measure. Students must consider the sizes of each square unit, and should refer to constructed units for assistance.*

Assign Part II to individuals or pairs. Allow the students to work through the problems. They may use the constructed units, rulers, and centimeter cubes to help them solve the problems.

Choose a few students who demonstrated different problem solving strategies to share their strategies and their solutions. As students are sharing, elicit additional comments from other students who used the same or similar strategies.

**Math Journals**

Have students choose 1 problem from Part I or Part II. Allow students to solve the problem in their journals using a different method than the one used the first time.

The first time I solved this problem I \_\_\_(state the solution strategy). This time I (state the solution strategy). This (strategy) worked best for me because \_\_\_\_.

Example: The first time I solved this problem I used the tiles to fill in the rectangle. This time I used a ruler. Using tiles worked best for me because they were easy to count.

---

**Evaluation of Students**

Formative: As students work, pose questions and observe them to check their understanding.

Summative: Students' work from their math journal can be used as a summative assessment.

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**Plans for Individual Differences**

Intervention: The teacher may need to help students complete the activity in a small group. The constructed units should be near the table and in view for frequent reference.

Extension: Have students write area problems to be solved using metric units. The problems can be kept on index cards in a file for early finishers.

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Name \_\_\_\_\_

### Metric Square Unit Mania

#### Part I

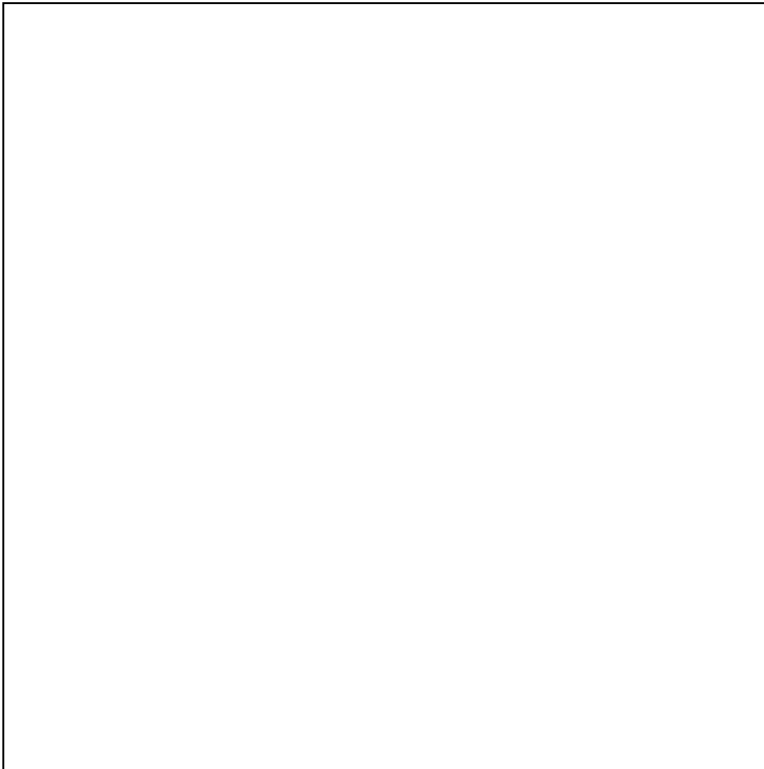
- Circle or underline the unit that is used for each rectangle
- Find the area of each rectangle.

Example:



area 2 x 3 = 6 square centimeters    square decimeters

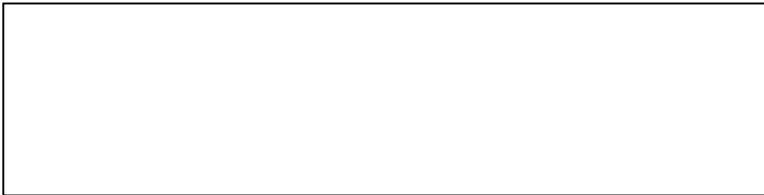
1.



square meters  
square decimeters

area: \_\_\_\_\_

2.



square centimeters  
square decimeters

area \_\_\_\_\_

3.



square centimeters    square decimeters

area \_\_\_\_\_



Part II

Answer each question by finding the area and circling the correct unit.

4. Michael measured a rectangular sheet of paper to make a bookmark. The length is 15. The width is 4. What is the area of the sheet of paper?

\_\_\_\_\_ square cm      square m

5. Kimmie measured the cover of her favorite book. The width is 15. The length is 30. What is the area of the cover of her book?

\_\_\_\_\_ square cm      square dm

6. John is making a collage for art class. The dimensions of the paper are 3 by 2. How much space must John cover with pictures to make his collage?

\_\_\_\_\_ square dm      square m

7. Why is it important to use the correct unit when finding the area of a rectangle?

## Lesson 11: Breaking Apart Arrays I

### Overview and Background Information

<b>Mathematical Goals</b>	By the end of the lessons students will: <ul style="list-style-type: none"> <li>Find the area of a rectangle by breaking it into smaller rectangles</li> <li>Discuss how they broke a rectangle into two smaller rectangles</li> </ul>
<b>Common Core State Standards</b>	<b>Geometric measurement: understand concepts of area and relate areas to multiplication and to addition.</b> <b>3. MD.7</b> Relate area to the operations of multiplication and addition. a. Find the area of a rectangle with whole-number side lengths by tiling it, and how that the area is the same as would be found by multiplying the side lengths.
<b>Emphasized Standards for Mathematical Practice</b>	4. Model with mathematics. 6. Attend to precision. 7. Look for and make use of structure. 8. Look for and express regularity in repeated reasoning.
<b>Prior Knowledge Needed</b>	Building arrays Multiplication and Division
<b>Vocabulary</b>	dimensions, rows, columns
<b>Materials</b>	Breaking Apart Arrays sheet, 12-24 Inch color tiles per pair, Rulers
<b>Resources</b>	None needed

### Tasks in the Lesson

Engage	10 minutes
<p><i>This portion of the lesson recalls a strategy that was used to multiply larger numbers or to calculate unknown products. The teacher should record all of the students' suggestions for breaking apart the numbers on the board or a chart. Recordings should be consistent. For instance for the problem <math>8 \times 7</math>, make sure that the numbers that make the 8 are always before the numbers that break up 7 (e.g., <math>(7+1) \times 7</math>, <math>8 \times (6+1)</math>).</i></p> <p>Begin by telling students: <i>One strategy we used when multiplying larger numbers was to break the large number into two smaller numbers. For example, if I wanted to multiply <math>8 \times 7</math>, how could I break apart the 8 to make a simpler problem?</i></p> <p>Expected student response: Students should suggest some of the combinations to make 7:  <math>7 + 1</math>, <math>6 + 2</math>, <math>5 + 3</math>, etc.</p> <p>Follow-up by asking, <i>Which addends would you choose for this problem? Why?</i>  Continue by asking, <i>Could I use the same strategy to multiply <math>9 \times 7</math>? How?</i></p> <p>The goal is to use the questions above to help students see how they can decompose (break apart) the various numbers to make easier multiplication problems.</p> <p>List the possibilities on the board or a chart.</p> <p>Suggested questions:</p> <ul style="list-style-type: none"> <li><i>Will all of these expressions result in the same answer? (yes)</i></li> <li><i>How do we know? (We did not change the numbers, we just broke them into smaller pieces. When we add them back together, they will be the same numbers we started with.)</i></li> <li><i>Let's try a few just to be sure. Allow 3 or 4 students to choose an expression to talk through step-by-step.</i></li> </ul>	

---

**Explore**

10 minutes

*This portion of the lesson walks students through the steps they will need to follow for the activity. Encourage students to separate the arrays in different ways. In the activity, Students A and B will alternate building arrays and separating them with the ruler.*

Pair students and allow them to determine Student A and Student B. Distribute color tiles and rulers. Introduce the activity by providing an example:

- Student A uses the tiles to build a 4 x 5 array.
- Student B uses the ruler to make one vertical or horizontal separation in the array, creating 2 smaller arrays.
- Both students determine and record the dimensions of each smaller array.
- The students add up the products to determine if the final product matches the original array.

---

**Explain**

5 minutes

*In this discussion, the distributive property is made concrete through the use of the tiles. The students should share ideas about the abstract concept and the concrete use of the tiles.*

Discuss:

- *What are the dimensions of the arrays that you found?* Choose 4 or 5 pairs to respond. Record their dimensions across the board.
- *Will all of these arrays result in the same sum?* (yes)
- *How can we be sure?* (We can solve the expressions.)

Choose 2 or 3 expressions for students to solve aloud.

---

**Elaborate**

28-30 minutes

*Students continue to work in pairs to complete the Breaking Apart Arrays I activity. The activity provides additional practice in breaking larger arrays into smaller arrays to determine area. Encourage students to continue to use the tiles even if they have discovered a pattern to help them. Not all of the Break-Aparts can be done with each number of tiles.*

Distribute the Breaking Apart Arrays I sheet. Review the directions and the roles (Student A and Student B). Allow the students to work through the activity.

Close the lesson by facilitating a discussion:

Allow students who had the same number of tiles to discuss their work in small groups.

In those groups, students should discuss their findings and make additions or corrections, if necessary. As the students are discussing, the teacher should visit each group, listening for misunderstandings and incomplete reasoning.

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**Evaluation of Students**

Formative: As students work, observe and record notes about students' strategies.

Summative: Students' activity sheet can be collected as a summative assessment.

---

**Plans for Individual Differences**

Intervention: Students may need to complete the Breaking Apart Arrays I activity in a small group with the teacher.

Extension: Students may choose another number from the sheet to complete the activity.

---

Name \_\_\_\_\_

### Breaking Apart Arrays I

Directions:

1. Choose the number of tiles you will use for this activity:

12      14      16      18      20      21      22      24

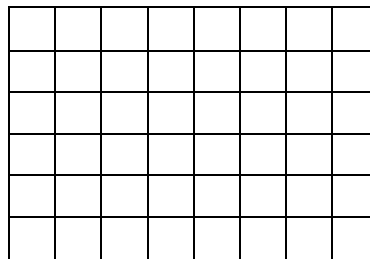
2. Count out the number of tiles you need. You will only use these tiles.

3. Complete the chart.

	Array 1	Array 2
Break-Apart 1		
Break-Apart 2		
Break-Apart 3		
Break-Apart 4		
Break-Apart 5		
Break-Apart 6		
Break-Apart 7		
Break-Apart 8		
Break-Apart 9		
Break-Apart 10		
Break-Apart 11		
Break-Apart 12		

4. a. Show how to separate the following array into two smaller arrays.

b. Label and find the area of each array that you create.



area \_\_\_\_\_

If you have time pick another number of tiles and work on breaking the array apart in different ways.

## Lesson 12: Breaking Apart Arrays II Overview and Background Information

<b>Mathematical Goals</b>	By the end of the lesson students will: <ul style="list-style-type: none"> <li>• Demonstrate the distributive property using the concept of area</li> <li>• Communicate how the area of a rectangle relates to both the multiplication of the dimensions as well as the process of tiling a two-dimension surface with square units.</li> </ul>
<b>Common Core State Standards</b>	<b>Geometric measurement: understand concepts of area and relate areas to multiplication and to addition.</b> <b>3.MD.7</b> Relate area to the operations of multiplication and addition. <b>c.</b> Use tiling to show in a concrete case that the area of a rectangle with whole number side lengths $a$ and $b + c$ is the sum of $a \times b$ and $a \times c$ . Use area models to represent the distributive property in mathematical thinking.
<b>Emphasized Standards for Mathematical Practice</b>	4. Model with mathematics. 6. Attend to precision. 7. Look for and make use of structure. 8. Look for and express regularity in repeated reasoning.
<b>Prior Knowledge Needed</b>	Experiences finding the area of rectangles
<b>Vocabulary</b>	Distributive property
<b>Materials</b>	Breaking Apart Arrays II sheet, Large Array to Smaller Arrays sheet, 12-24 Inch color tiles per pair, rulers, 1 marker or crayon per student

### Tasks in the Lesson

<b>Engage</b>	3-5 minutes
<p><i>This lesson builds upon the previous one by requiring students to break the larger array into four smaller arrays. The breaking of the array into the smaller arrays allows students to demonstrate the distributive property.</i></p> <p>Start a discussion with students:  <i>One strategy we used when multiplying larger numbers was to break the larger numbers into smaller numbers, multiply, then add the products to find the answer. For example, if Sean did not know the fact and wanted to find the area of a room that was 7 feet wide and 6 feet long, how could he break apart the numbers to make easier facts?</i></p> <p>Possible student responses: <ul style="list-style-type: none"> <li>• Break up the 7 and keep the 6 whole (e.g., <math>6 \times 12 + 1 \times 12</math>)</li> <li>• Keep the 7 whole and break up the 6 (e.g., <math>7 \times 5 + 7 \times 1</math>)</li> </ul> Continue to ask for responses until a few different combinations have been found.</p> <p>Follow up: <i>Will all of these expressions result in the same answer? How do we know?</i></p> <p>Allow students to choose an expression to talk through step-by-step to prove that <math>7 \times 6</math> is equal to the sum of two smaller arrays.</p>	

<b>Explore</b>	10-12 minutes
<p><i>This portion of the lesson walks students through the steps they will need to follow for the activity. Encourage students to separate the arrays in a different manner from the example. In the activity, Students A and B will alternate building arrays and separating them with the ruler.</i></p> <p>Pair students and allow them to determine Student A and Student B. Distribute color tiles and rulers.</p> <p>Introduce the activity by providing an example:</p> <ul style="list-style-type: none"> <li>• Student A uses the tiles to build a 4 x 5 array.</li> <li>• Student B uses the ruler to make one vertical separation and one horizontal separation in the array, creating 4 smaller arrays.</li> <li>• Both students determine and record the dimensions of each small array.</li> <li>• The students add up the products to determine if the final product matches the original array.</li> </ul>	
<b>Explain</b>	10-12 minutes
<p><i>This discussion mirrors the one from the Engage portion of the lesson. Here, the use of the distributive property is made concrete through the use of the tiles. The intention is to have students make an explicit connection between the abstract property and the concrete demonstration using the tiles.</i></p> <p>Facilitate a discussion by asking the following questions:</p> <ul style="list-style-type: none"> <li>• <i>What are the dimensions of the arrays that you found?</i> <ul style="list-style-type: none"> <li>• Choose 4 or 5 pairs to respond. Record their dimensions on the board.</li> </ul> </li> <li>• <i>Will all of these arrays result in the same sum? How can we be sure?</i></li> </ul> <p>Choose 2 or 3 expressions for students to solve aloud.</p>	
<b>Elaborate</b>	28-30 minutes
<p><i>Students continue to work in pairs to complete the Breaking Apart Arrays II activity. The activity provides additional practice in breaking larger arrays into smaller arrays to determine area. Encourage students to continue to use the tiles even if they have discovered a pattern to help them. Not all of the Break-Aparts can be done with each number of tiles.</i></p> <p>Distribute the Breaking Apart Arrays sheet. Review the directions and the roles (Student A and Student B). Allow the students to work through the activity.</p> <p>Distribute grid paper sheets and Large Array to Smaller Array rubrics. Instruct students to use the markers and rulers to separate each grid into four smaller arrays. Instruct students to record the dimensions and products for each array on the grid. Have students add the products in the margin to find the area of the entire grid.</p>	
<b>Evaluation of Students</b>	
Formative: As students work, pose questions and observe them.	
Summative: Students' work from the elaborate section.	
<b>Plans for Individual Differences</b>	
Intervention: Students may need to complete the Breaking Apart Arrays I activity in a small group with the teacher.	
Extension: Students may choose another number from the sheet to complete the activity.	

Name \_\_\_\_\_

### Breaking Apart Arrays II

Directions:

1. Choose the number of tiles you will use for this activity:

12      14      16      18      20      21      22      24

2. Count out the number of tiles you need. You will only use these tiles.

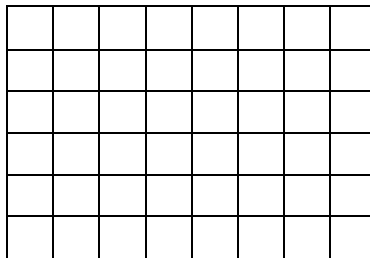
3. Complete the chart.

	Array 1	Array 2	Array 3	Array 4
Break-Apart 1				
Break-Apart 2				
Break-Apart 3				
Break-Apart 4				
Break-Apart 5				
Break-Apart 6				
Break-Apart 7				
Break-Apart 8				
Break-Apart 9				
Break-Apart 10				
Break-Apart 11				
Break-Apart 12				

4. a. Show how to separate the following array into four smaller arrays.

b. Label each array.

c. Find the area of the large array.

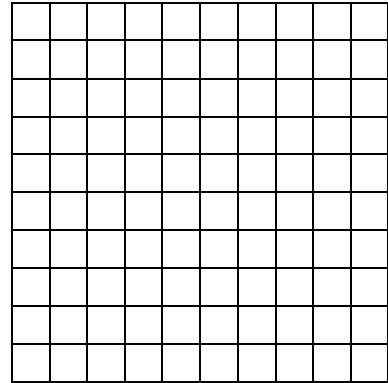
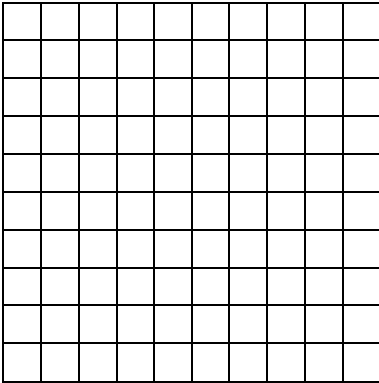


area \_\_\_\_\_

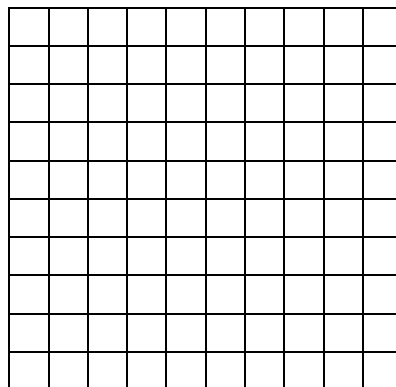
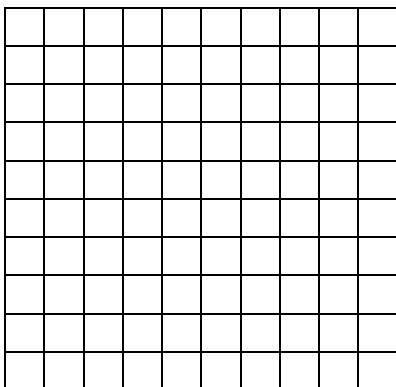
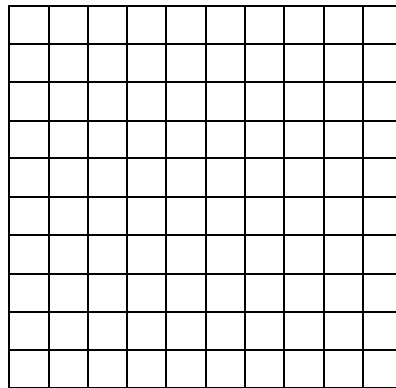
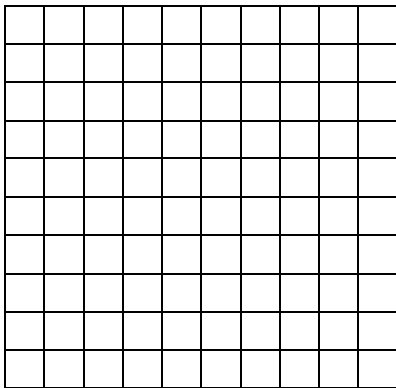
Name \_\_\_\_\_

### Large Array to Smaller Arrays

- I. a. Separate each grid into two smaller arrays.
- b. Label each array.
- c. Show how to find the area of the grid.



- II. a. Separate each grid into four smaller arrays.
- b. Label each array.
- c. Show how to find the area of the grid.





## Lesson 13: Finding the Areas of Complex Figures I Overview and Background Information

<b>Mathematical Goals</b>	By the end of the lesson students will: <ul style="list-style-type: none"> <li>Find the area of a large, rectilinear figure by decomposing it into smaller rectangles</li> <li>Communicate their process of finding the area of a rectilinear figure</li> </ul>
<b>Common Core State Standards</b>	<b>Geometric measurement: understand concepts of area and relate areas to multiplication and to addition.</b> <b>3.MD.7</b> Relate area to the operations of multiplication and addition. <b>d.</b> Recognize area as additive. Find areas of rectilinear figures by decomposing them into non-overlapping rectangles and adding the areas of the non-overlapping parts, applying this technique to solve real world problems.
<b>Emphasized Standards for Mathematical Practice</b>	1. Make sense and persevere when solving problems. 7. Look for and make use of structure. 8. Look for and express regularity in repeated reasoning.
<b>Prior Knowledge Needed</b>	Identifying the dimensions of a rectangle, Finding area by counting, adding, or multiplying, Horizontal and vertical line segments, Modeling the distributive property
<b>Vocabulary</b>	decompose, rectangle, dimensions
<b>Materials</b>	Geoboards, rubber bands,, Areas of Complex Figures sheet,

### Tasks in the Lesson

<b>Engage</b>	8-10 minutes
<p><i>In this lesson, students transition from finding the areas of rectangles to finding the areas of rectilinear figures (combined rectangles). This lesson expects students to break the figure into rectangles, and use the dimensions of smaller rectangles to determine the area. Some students may visualize the rectilinear figure as one large rectangle with a “piece missing,” consequently finding the dimensions of this larger rectangle, then subtracting the “missing” portion to find the area of the figure. This method can be explored if a student suggests it, however, the Standard specifies adding the area of multiple rectangles.</i></p> <p>Create an L-shaped figure on the geoboard and display for the class.</p> <p>Discuss the figure:  <i>How is this shape like the ones we have been using for area?</i>  Possible responses: They all have right angles. We have been using rectangles, and this figure looks like rectangles “stuck together.”  <i>How is this shape different from the ones we have been using for area?</i>  Possible responses: This shape is not just one rectangle. We cannot find the dimensions for the whole shape.  <i>How do you suppose we find the area of this rectangle?</i>  We can count the number of square units in the figure.</p> <p>Allow students to count aloud as each square unit is identified in the figure. Continue the discussion by asking:  <i>Is there another way we can find the area of the figure?</i>  We can break it into smaller rectangles.</p>	

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If students do not suggest this method, continue to question/think aloud:

*I know that I can find area by using the dimensions of a rectangle. We said that this figure looks like two rectangles stuck together. Is there a way I can show both of the rectangles? Where can I break this figure apart into two rectangles?*

Allow students to suggest a horizontal or vertical line and draw it or on the figure or use another rubber band to show the separation.

*How can I now find the dimensions and areas of the rectangles?*

Choose one student for each step of the process: find the length, find the width, calculate the area. Record each step on the board or document projector. This calculation should be displayed during the student activity for reference.

Conclude by asking: *How can I find the area of the whole figure? How can I check my work?*

---

**Explore****18-20 minutes**

*The main activity requires students to record each step they used to calculate the area in order to ensure they are not simply counting the number of square units in the figure. The teacher should monitor this process closely as the students are working.*

Introduce the activity. You may want to model this as well.

*Today, you will work in pairs to build and find the areas of figures with only right angles. Each person will build a figure on the geoboard, draw the figure, and find the area. When you are done, you will pass the geoboard to your partner. They will draw your figure and label the dimensions.*

*They will then calculate the area of the figure, showing each step of their problem solving process, just like what is on the board. When you are done, compare your answers and strategies for each person's figure.*

Distribute geoboards, rubber bands, dry erase boards, and dry erase markers to students.

Guide students in creating a chart on their boards. Headings: *Name, Figure, Area.*

Designate pairs, or have student choose partners, and direct the students to begin the activity.

Remind the students not to remove their figures or erase their charts when they have finished.

As students are working, visit each pair to monitor the understanding of directions, answer any questions, watch for different problem solving strategies, identify interesting figures, and listen for misunderstandings or difficulties.

---

**Explain****10-12 minutes**

*This discussion mirrors the Engage discussion. The discussion is meant to reinforce the procedure of using dimensions of smaller rectangles to find the area of a larger, rectilinear figure. Student misunderstandings or mistakes should be discussed within the contexts of the problems.*

Facilitate a discussion about the activity that students just completed. Choose three interesting figures. Display one figure to discuss.

*Where can I break this figure apart into two rectangles?* Allow students to suggest a horizontal or vertical line and draw it or on the figure or use another rubber band to show the separation.

- *How can I now find the dimensions and areas of the rectangles?*
-

---

Choose one student for each step of the process: find the length, find the width, calculate the area. Record each step on the board or document projector.

Address the student pair that solved the problem.

- *Did you solve it in the same way? If not, How did you find the area?*

Record the responses on the board and ask *How do these strategies compare?*

Repeat for the other figures. If any further misunderstandings or difficulties were observed while students were working, address them here.

---

**Elaborate**

22-25 minutes

*The Elaborate portion of this lesson allows students the opportunity to reflect on their learning and evaluate their own understanding of the goal of the lesson. Students should be able to describe, using complete sentences, how to find the area of a rectilinear figure. Encourage students to think about the steps they took to solve their partner's geoboard problems and to draw an example to help them write their explanations.*

Introduce the assignment: *In your Math Journals, I want you to explain, in your own words, how to find the area of a figure with right angles that is not a rectangle. You can use pictures and numbers to help you. Remember to use complete sentences.*

Allow students about 6 minutes to write and draw in their journals. Provide 3 minutes for students to pair with other students to share what they have written. Allow two minutes for volunteers to share what they have written with the entire class.

#### Finding Areas of Complex Figures Sheet

*The Finding Areas of Complex Figures sheet provides students with an opportunity for independent practice finding the areas of rectilinear figures. The sheet may be assigned as homework or an in-class assessment. Students should be able to accurately compute areas for at least two out of the three rectilinear figures.*

Distribute and review the Finding Areas of Complex Figures sheet.

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**Evaluation of Students**

Formative: As students work, pose questions and observe them.

Summative: Students' work from the Elaborate section.

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**Plans for Individual Differences**

Intervention: Students may need to outline or color the each rectangle with a different color rubber band on the geoboard or marker on the Finding Areas of Complex Figures sheet to identify the rectangles that create the larger, rectilinear figure.

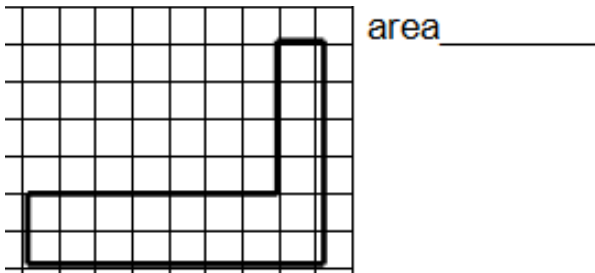
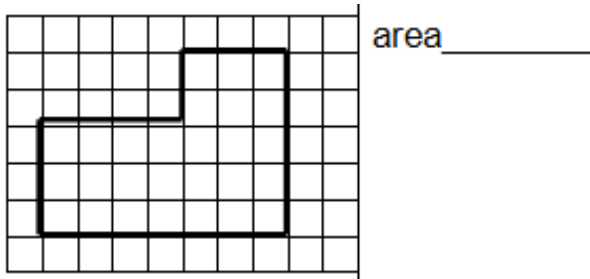
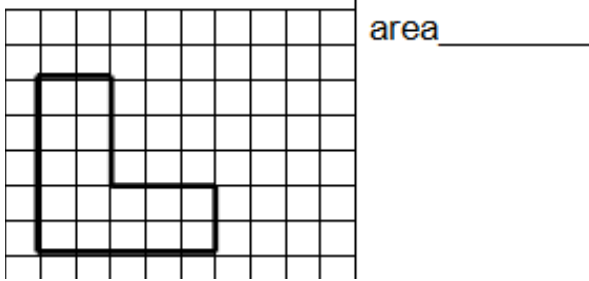
Extension: Have students cut 2 copies of rectilinear figures from centimeter grid paper and mount on index cards. Students should mount one copy on the front of the card. The second copy should be mounted on the back of the card. Students should show one way to find the areas of the figures and record on the back of the card. Keep the cards in a center.

---

Name \_\_\_\_\_

### Areas of Complex Figures

- A. Separate each figure into two rectangles.
- B. Label the dimensions of the rectangles.
- C. Find the area of the figure.



Describe how you found the area for one of the figures above. How do you know that your answer is correct?

## Lesson 14: Finding the Areas of Complex Figures II Overview and Background Information

<b>Mathematical Goals</b>	By the end of the lesson students will: <ul style="list-style-type: none"> <li>Find the area of a large, rectilinear figure by decomposing it into smaller rectangles</li> <li>Communicate their process of finding the area of a rectilinear figure</li> </ul>
<b>Common Core State Standards</b>	<b>Geometric measurement: understand concepts of area and relate areas to multiplication and to addition.</b> <b>3.MD.7</b> Relate area to the operations of multiplication and addition. d. Recognize area as additive. Find areas of rectilinear figures by decomposing them into non-overlapping rectangles and adding the areas of the non-overlapping parts, applying this technique to solve real world problems.
<b>Emphasized Standards for Mathematical Practice</b>	7. Look for and make use of structure. 8. Look for and express regularity in repeated reasoning.
<b>Prior Knowledge Needed</b>	Identifying the dimensions of a rectangle, Finding area by counting, adding, or multiplying, Horizontal and vertical line segments, Modeling the distributive property
<b>Vocabulary</b>	dimensions, area, decompose
<b>Materials</b>	Opening problem sheet, Areas of Complex Figures sheet, Centimeter cubes or square tiles

### Tasks in the Lesson

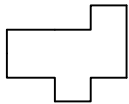
<b>Engage</b>	12-15 minutes
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*In the previous lesson, students found the areas of rectilinear figures by breaking the figure into two rectangles. In this lesson, students will find the areas of even more complex figures. These figures may be broken into more than two rectangles.*

*The Areas of Complex Figures I sheet should be reviewed and discussed before beginning this lesson.*

1. Display and read the opening problem to the class.

Justin is replacing the carpet in his bedroom. His bedroom is shaped like this:



How can Justin find the amount of carpet he needs to order?

Discuss the figure:

- *How is this shape like the ones used yesterday for area?*
- *How is this shape different from the ones we used yesterday?*
- *How do you suppose we find the area of this figure?*

Find the area of the figure:

- Allow students to count aloud as each square unit is identified in the figure.
- *Where can I break this figure apart into rectangles?* Allow students to suggest horizontal or

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vertical lines and draw them on the figure.

- *How can I now find the dimensions and areas of the rectangles?* Choose one student for each step of the process: find the length, find the width, Calculate the area. Record each step on the board or document projector. This calculation should be displayed during the student activity for reference.
- *Now I have **three** areas. What can I do to find the area of the whole figure?*
- *How can I check my work?*

4. Probe:

- *Is there another way I could separate the rectangles? Turn and talk to a partner about a different way to separate the rectangles.*
- Have volunteers or choose students to demonstrate two additional ways of separating the figure into rectangles and calculating the area.

---

**Explore****18-20 minutes**

*The Areas of Complex Figures sheet provides practice working towards the stated goal of the lesson. Only the first two problems should be completed during this phase of the lesson. The third problem will be completed after the discussion.*

Introduce the activity:

- *Today, you will continue to work on finding the areas of figures with only right angles. With a partner, you will find two **different** ways to break apart the figures to calculate their areas. You will record one way on your paper, and your partner will record another way. Only work on problems 1 and 2 at this time.*
- It may be necessary to demonstrate the procedure for the activity.

Facilitate the activity:

- Assign pairs or allow students to choose partners.
- Encourage students to use colored pencils, markers, or crayons on the grids for their solutions to easily be seen.
- As students are working, visit each pair to monitor the understanding of directions, answer any questions, watch for different problem solving strategies, identify interesting figures, and listen for misunderstandings or difficulties. Also, ensure students label each rectangle with its dimensions.

Suggested questions to ask as students work:

- How are you determining the amount of carpet?
- How can we use what we know about covering rectangles to help us?

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**Explain****10-12 minutes**

Debrief:

Choose a student to display their work and explain their solution to problem 1 with the class.

Discuss:

- *Who solved the problem by making different rectangles? Allow volunteers or choose students to share their solutions on the document projector. Raise your hand if you solved the problem like \_\_\_\_\_.*
- *Is there another way to break apart the figure?*

Repeat for Problem 2.

If any further misunderstandings or difficulties were observed while students were working, address them here.

---

**Elaborate**

15-17 minutes

*Problem 3 on the Areas of Complex Figures II sheet can be broken into three or more rectangles, depending on how students visualize the problem. Allowing students to work independently first provides the teacher with information about individual student thinking. Sharing strategies in pairs exposes students to others' thinking and reasoning. The discussion exposes students to the thinking of several students.*

Continue the discussion with students:

*Some complex figures can be broken into more than three parts.*

- *Look at problem number 3. Think about a way to break that figure into three or more parts. Allow about 30 seconds thinking time.*
- *Draw your divisions and find the area. Allow about 3 minutes for students to complete the problem.*
- *Now you will find someone who broke the apart the figure in a different way. Decide who will be Student A and who will be Student B. Student A will share their solution first, then Student B. Allow about 2 minutes for pairs to share.*

Choose 4 or 5 solutions to be displayed at the same time by overlapping the papers, covering problems 1 and 2.

- *How are these solutions alike?*
- *How are the solutions different?*

*How can we check to be sure the area is correct?*

**Math Journal**

Have students complete the following prompt with at least two complete sentences on the back of the Areas of Complex Figures II sheet or in a Math Journal:

- The part of today's lesson I understood best was \_\_\_\_\_ because \_\_\_\_\_. The part of today's lesson that I am still confused about is \_\_\_\_\_.

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**Evaluation of Students**

Formative:

As students work, pose questions and observe them to check for their understanding.

Summative:

Students' work from the elaborate section can be used as a summative assessment.

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**Plans for Individual Differences**

Intervention: Provide scaffolding questions for the students, reminding them to think step-by-step when solving these types of problems.

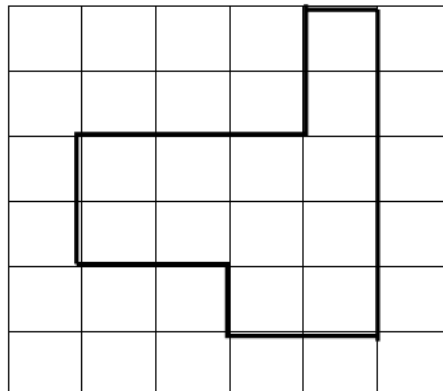
- *Can we cut the figure into smaller pieces?*
- *How can we find the areas of the smaller pieces?*
- *What can we do with the areas of the smaller pieces to find the area of the larger figure?*

Students who exhibit significant difficulties may still need to count the square units to find area or reproduce the figures using cubes or tiles to identify the smaller rectangles.

Extension: Have students cut 2 copies of complex rectilinear figures from centimeter grid paper and mount on index cards. Students should mount one copy on the front of the card. The second copy should be mounted on the back of the card. Students should show one way to find the area of the figure and record on the back of the card. Keep the cards in a center for the class.

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**Justin is replacing the carpet in his bedroom. His bedroom is shaped like this:**



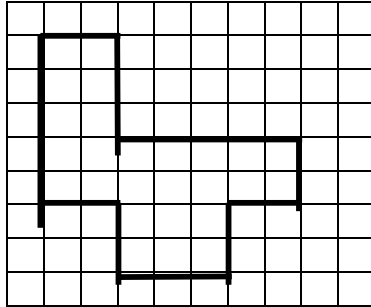
**How can Justin find the amount of carpet he needs to order?**



Name \_\_\_\_\_

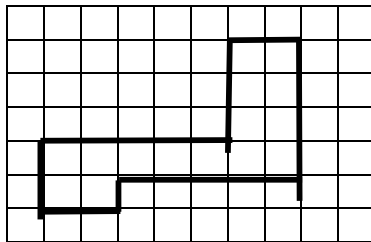
### Areas of Complex Figures II

- A. Separate each figure into rectangles.
- B. Label the dimensions of the rectangles.
- C. Find the area of the figure.



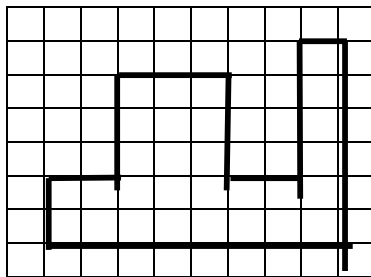
Stephanie is replacing the tiles on her bathroom floor. How many square units of tile should Stephanie buy?

area \_\_\_\_\_



Jordan is mowing Mrs. Nelson's lawn. How many square units must Jordan mow?

area \_\_\_\_\_



Mr. Simms is replacing the floor in his home. How many square units of flooring should he buy?

area \_\_\_\_\_

## Lesson 15: Finding the Areas of Complex Figures III

### Overview and Background Information

<b>Mathematical Goals</b>	By the end of the lesson students will: <ul style="list-style-type: none"> <li>Find the area of a large, rectilinear figure by decomposing it into smaller rectangles</li> <li>Communicate their process of finding the area of a rectilinear figure</li> </ul>
<b>Common Core State Standards</b>	<b>Geometric measurement: understand concepts of area and relate areas to multiplication and to addition.</b> <b>3.MD.7</b> Relate area to the operations of multiplication and addition. <b>d.</b> Recognize area as additive. Find areas of rectilinear figures by decomposing them into non-overlapping rectangles and adding the areas of the non-overlapping parts, applying this technique to solve real world problems.
<b>Emphasized Standards for Mathematical Practice</b>	7. Look for and make use of structure. 8. Look for and express regularity in repeated reasoning.
<b>Prior Knowledge Needed</b>	Identifying the dimensions of a rectangle Finding area by counting, adding, or multiplying Horizontal and vertical line segments Decomposing a rectilinear figure into separate rectangles
<b>Vocabulary</b>	decompose, area, dimensions
<b>Materials</b>	Opening problem sheet, How Much Area? activity sheet, Markers or crayons, Computer with internet connection and projector

### Tasks in the Lesson

#### Engage

10-12 minutes

*In this lesson, students will find the areas of complex figures using given side length measurements without grids. Students may have difficulty identifying the measurements to use for the rectangles. The teacher may wish to trace the rectangle in a color and circle or write the measurements used to find the area of the rectangle with the same color.*

*The Areas of Complex Figures II sheet from Lesson 14 should be reviewed and discussed before beginning this lesson.*

Display and read the opening problem to the class.

Michelle is painting a design on her bedroom wall:

How much of her wall will be covered by the design?



Discuss the figure:

- How is this shape like the ones used yesterday for area?*
- How is this shape different from the ones we used yesterday?*
- How do you suppose we find the area of this figure?*

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Find the area of the figure:

- *Where can I break this figure apart into rectangles? Allow students to suggest horizontal or vertical lines and draw them on the figure.*
- *How can I now find the dimensions and areas of the rectangles?*

Choose one student for each step of the process: locate the length, locate the width, calculate the area. Record each step on the board or document projector. This calculation should be displayed during the student activity for reference.

Continue by asking:

- *What can I do to find the area of the whole figure? How can I check my work?*
- *Is there another way I could separate the rectangles? Turn and talk to a partner about a different way to separate the rectangles.*
- Have volunteers or choose students to demonstrate two additional ways of separating the figure into rectangles and calculating the area.

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**Explore**

12-15 minutes

*The structure for this activity is a modification of a Cooperative Learning Structure. Here, students take turns solving the problems one step at a time in pairs. It is necessary for students to be reminded of appropriate pair behaviors and expectations before beginning the activity. The pairs can be assigned by the teacher or chosen by the students. Students will only complete problems 1-3 during this activity. Students may use calculators to solve the problems.*

Distribute What is the Area? Activity sheet, one per pair.

Review and demonstrate the steps for each problem:

- Student A uses a colored pencil to draw one rectangle and find the area.
- Student B uses a different color to draw and find the area of the next rectangle.
- Student A repeats for the following rectangle.
- Student B repeats for the next rectangle, or finds the area for the figure.
- During the activity, the students pass the paper back and forth, with each student completing one step of the process until the problem is done.
- Each student must check the previous step before proceeding.

Allow students to work through the activity. Provide questions to help them but do not over teach or give answers during this phase.

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**Explain**

12-15 minutes

Choose a student to display their work and explain their solution to problem 1 Follow up by asking:

- *Who solved the problem by making **different** rectangles? Allow volunteers or choose students to share their solutions on the document projector.*
- *How did you find the dimensions of this rectangle? Choose a rectangle which may have required students to use a partial side measurement.*
- *How do you know your answer is correct?*
- *Is there another way to break apart the figure?*

Repeat for Problems 2 and 3. If any further misunderstandings or difficulties were observed while students were working, address them here.

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**Elaborate**

20-22 minutes

*If necessary, the lesson may be continued the next day. The computer activity aligns with problems 4 and 5 on the Area Answers sheet. Students may notice that some of the words are spelled differently than they are accustomed. It may be necessary to point out to students that this difference is simply due to European spelling rules.*

Display [http://www.bgfl.org/bgfl/custom/resources\\_ftp/client\\_ftp/ks2/maths/perimeter\\_and\\_area/index.html](http://www.bgfl.org/bgfl/custom/resources_ftp/client_ftp/ks2/maths/perimeter_and_area/index.html)

Choose the Area example. Beginning with Level 1, work through each of the levels with the class.

*Problems 4 and 5 on the Area Answers sheet provide a further challenge to students by removing some of the length measurements. The students must determine the missing measurements using the given measures. Students may work with the same partners or choose different partners for this activity.*

Begin the activity by giving students directions:

*For problems 4 and 5, you will work together to find the areas of the figures. Please notice, though, that some side length measurements are missing. Work with your partner to find the lengths of the sides and the area of the figure.*

As students work, continue to support their exploration by asking questions about how they are finding the dimensions and areas of figures.

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**Evaluation of Students**

Formative:

As students work, pose questions and observe them to check for their understanding.

Summative:

Students' work from the elaborate section can be used as a summative assessment.

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**Plans for Individual Differences**

Intervention: Provide scaffolding questions for the students, reminding them to think step-by-step when solving these types of problems.

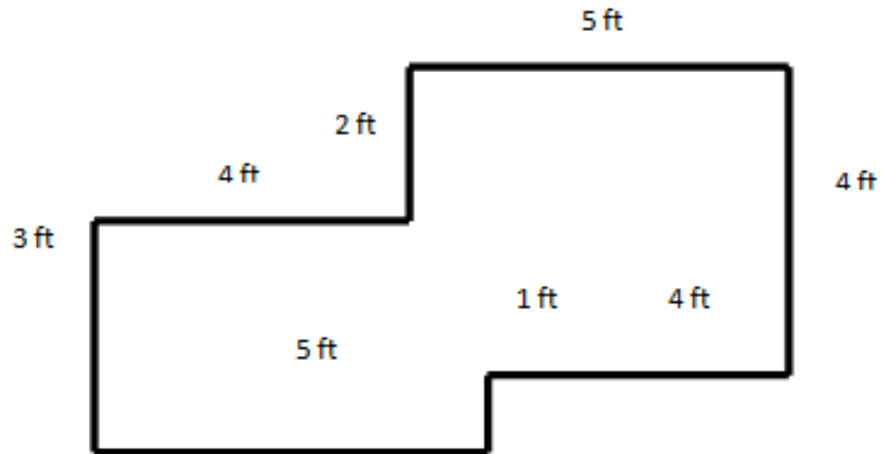
- *Can we cut the figure into smaller pieces? How can we find the areas of the smaller pieces? What can we do with the areas of the smaller pieces to find the area of the larger figure?*

Extension: Garden Walkway task

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### Opening Problem – Finding the Areas of Complex Figures III

Michelle is painting a design on her bedroom wall:



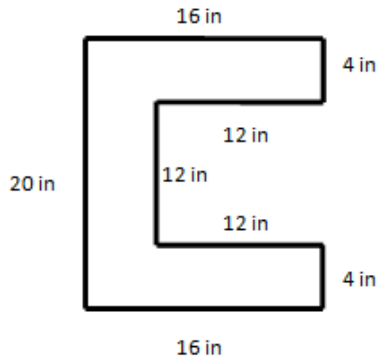
How much of her wall will be covered by the design?

Names \_\_\_\_\_

What is the Area?

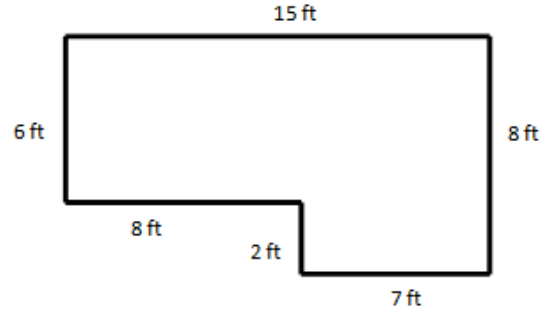
Solve each problem. Make sure you show your work.

1)



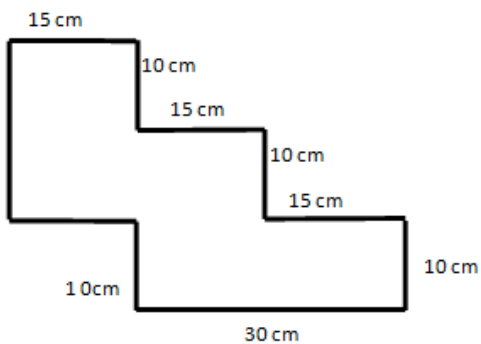
The East Elementary Cougars are painting their mascot's name on the wall by the office. How much space will be taken up by the "C"?

2)



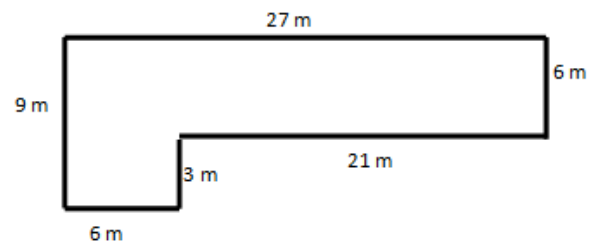
Mike is replacing the floor in his kitchen. How much tile does he need to buy?

3)



Marty is making a design on his patio table using tiles. How many square centimeters of tile will he need for his design?

4)

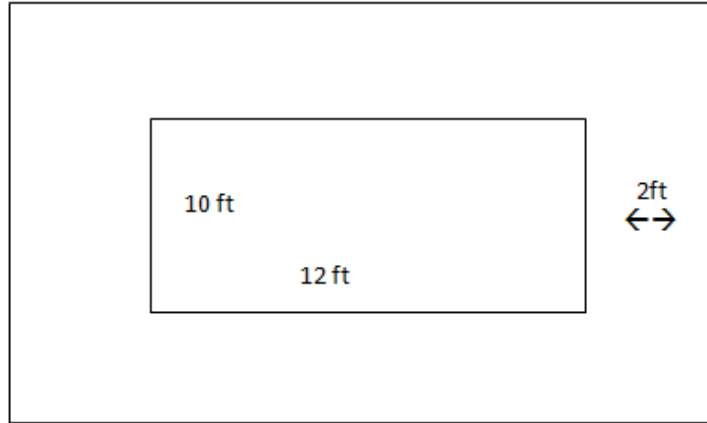


Sarah is mowing the grass in her backyard. She has already mowed 18 square meters. How much more grass will she mow?

Name \_\_\_\_\_

### Garden Walkway

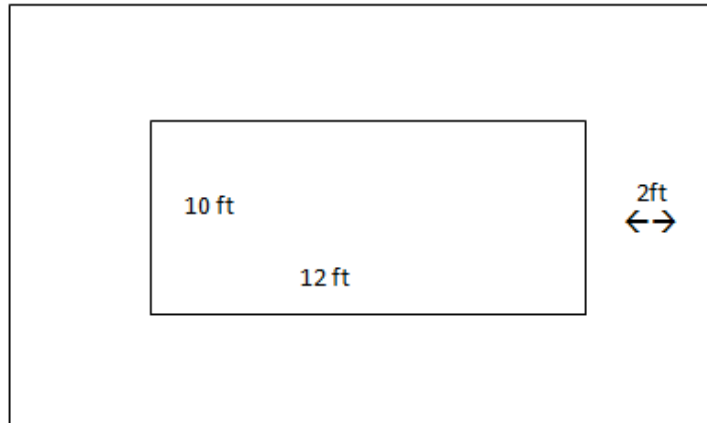
A garden measures 12 feet by 10 feet. It is surrounded by a walkway that is 2 feet wide. Find the area of a) the garden, b) the walkway, c) the entire space.



Name \_\_\_\_\_

### Garden Walkway

A garden measures 12 feet by 10 feet. It is surrounded by a walkway that is 2 feet wide. Find the area of a) the garden, b) the walkway, c) the entire space.



## Lesson 16: Perimeter Parade Routes Overview and Background Information

<b>Mathematical Goals</b>	By the end of the lesson students will: <ul style="list-style-type: none"> <li>Find the perimeter of a polygon</li> <li>Explain that perimeter is a measurement of length around a figure.</li> </ul>
<b>Common Core State Standards</b>	<b>Geometric measurement: recognize perimeter as an attribute of plane figures and distinguish between linear and area measures.</b> <b>3.MD.8</b> Solve real world and mathematical problems involving perimeters of polygons, including finding the perimeter given the side lengths, finding an unknown side length, and exhibiting rectangles with the same perimeter and different areas or with the same area and different perimeters.
<b>Emphasized Standards for Mathematical Practice</b>	5. Use appropriate tools strategically. 6. Attention to precision. 7. Look for and make use of structure.
<b>Prior Knowledge Needed</b>	using a ruler to measure length, area
<b>Vocabulary</b>	Perimeter, dimensions, figure
<b>Materials</b>	Twine or non-stretchy string (24 inches per pair), pattern blocks (2 hexagons, 3 blue rhombi, 4 triangles, and 2 trapezoids per pair), rulers, equilateral triangle grid paper, markers or crayons.

### Tasks in the Lesson

<b>Engage</b>	5-7 minutes
<i>This lesson introduces the concept of perimeter. Before introducing the Opening Problem, cover the shapes with pattern blocks.</i>	
Introduce and display the Opening Problem: <i>The ants of Hollow Log are having a parade for their annual Hollow Log Community Picnic Day. They want to design a parade route that goes all the way around edge of the lake. What is the distance the ants have to march?</i>	
Ask students: <i>I have a ruler and some string. How can I find the distance the ants will have to march?</i>	
Choose a student volunteer to demonstrate holding the pattern blocks while guiding the string around the figure. Demonstrate holding the string where the path ends and measuring the length on a ruler.	
Ask students: How long will the ants have to travel? How do you know?	
<b>Explore</b>	12-15 minutes
<i>Students will work together to find the perimeter of a figure they build with pattern blocks. The string reinforces the idea of perimeter as the distance around a figure, and the teacher should ensure students are using the string and ruler at this point in the lesson.</i>	
Distribute 1 copy triangle grid sheet per pair, rulers, string, and pattern blocks.	
Assign partners or allow students to choose partners.	



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Allow students to work together to:

- build a lake using the pattern blocks – all touching sides must be the same length, no “tip to tip”, no holes
- use string to measure around the lake
- measure the string to determine the distance around the lake.
- record and color the design on the grid paper

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**Explain**

10-12 minutes

*The formal idea of perimeter is introduced here, as well as the relationships between area and perimeter, which will be explored more fully in following lessons. The students should be made aware of the fixed area of the pattern block figures, but the conversation should focus on the finding of the perimeter of the figure. Using a triangle as an alternative measuring tool to the string and ruler is also introduced here.*

Write “perimeter” on the board. *The word “perimeter” can be broken into two parts. So what do you think “perimeter” means?*

*When we find the perimeter, we find the distance around a figure.*

*How did we find the perimeter for Hollow Log Community Lake?*

Remind students that we used string and measured how far it was to go around the entire figure.

*How is finding perimeter different from finding area?*

Possible student responses:

- “When we found the area, we found the amount of space the figure would cover.”
- “When we found the area, we found the space inside. But the perimeter is about the outside of the shape.”
- “When we found the perimeter, we measured around the figure, but the area we measured inside.”

*What is true about the areas of all of the lakes? How do you know?*

*Who thinks they made the lake with the shortest perimeter?* Have students report short perimeters until the shortest is found. Collect the paper.

*Who thinks they made the lake with the longest perimeter?* Have students report long perimeters until the longest is found collect the paper.

*Ask: How are these lakes alike? How are these lakes different?*

Students hopefully talk about the observation that the smallest perimeter has the pattern blocks clustered together and the largest perimeter has the pattern blocks more spread out.

Transition students into using the green triangle as another measuring tool.

*Another way to measure the perimeter is to use a green triangle. If I measure the length of one side of the triangle, I find that it is about 1 inch long. Demonstrate using the ruler to measure the triangle. I can then use the triangle to measure around the lake to find the perimeter. Demonstrate using the green triangle to measure around the shortest perimeter, counting aloud. Repeat for the longest perimeter. As you work through this, keep students engaged by asking students what the perimeter is.*

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**Elaborate**

22-25 minutes

*Students will experience an additional opportunity to explore perimeter as the distance around a figure. The relationship between area and perimeter is again explored. With a smaller set of pattern blocks, students should be able to build and measure the perimeter of more than one figure during this time.*

Distribute a second triangle grid sheet per pair. Direct students to modify their pattern block collections: *For this activity, you need to use one hexagon, one trapezoid, two blue parallelograms, and three triangles. Please put the rest of the pieces away. Find all of the different lake shapes you can build with these pieces. Color them on the grid paper, find the perimeter for each shape, and cut them out. You may use the string and the ruler, or a green triangle to measure the perimeter.*

Allow students to work for about 10 minutes.

As students finish cutting out figures, they should post them on the board in order from shortest perimeter to longest perimeter. Stop the activity after 10 minutes to allow time for discussion.

Discuss:

- *How can you describe the shapes with the shortest perimeters?*
- *How can you describe the shapes with the longest perimeters?*
- *Who used the string and a ruler to find the perimeter?*
- *Who used the triangle to find the perimeter?*

**Math Journal**

Have students respond to the journal prompt:

1. What is perimeter?
2. Use 3 pattern blocks to build a figure. Show how to find the perimeter of the figure.

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**Evaluation of Students**

Formative:

As students work, pose questions and observe them to check for their understanding.

Summative:

Students' work from the Elaborate section can be used as a summative assessment.

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**Plans for Individual Differences**

Intervention:

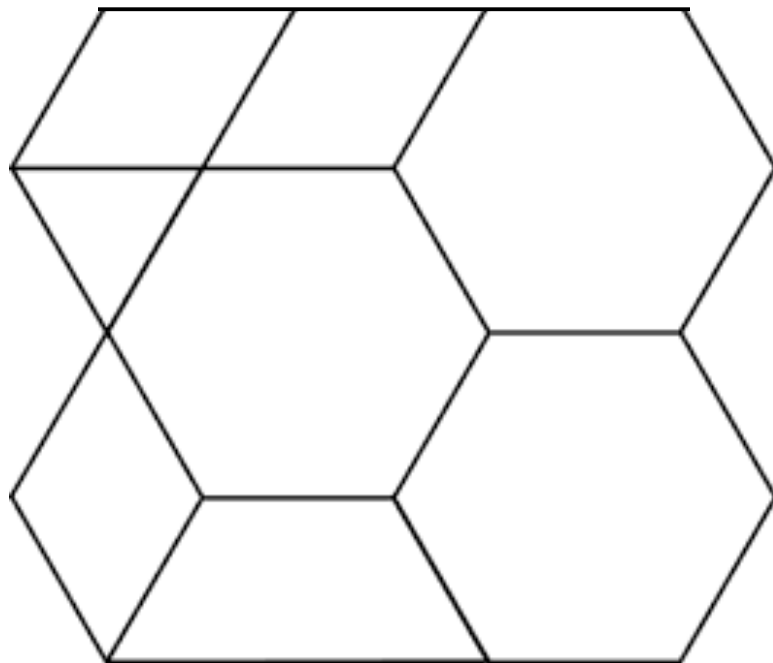
If students are struggling with the idea of perimeter or counting, pair them with a more capable student or spend extra time working with them on the activity.

Extension:

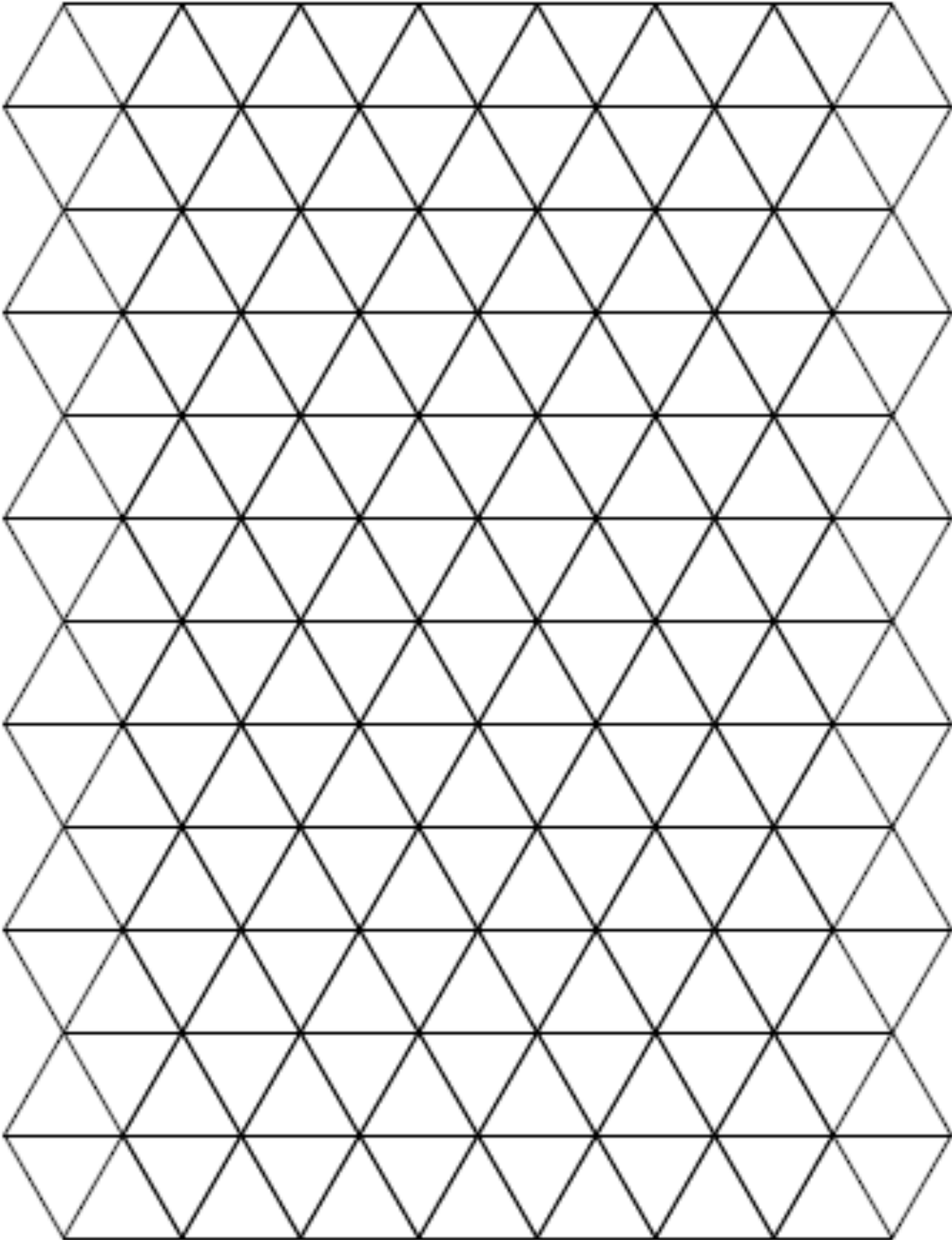
Make sure students are able to clearly and accurately explain what perimeter means before looking to Extend this lesson. Challenge students to find the largest perimeter possible using the set of pattern blocks from the Elaborate portion of the lesson.

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**The ants of Hollow Log are having a parade for their annual Hollow Log Community Picnic Day. They want to design a parade route that goes all the way around edge of the lake. What is the distance the ants have to march?**



Triangular grid paper



## Lesson 17: Arranging Tables Overview and Background Information

<b>Mathematical Goals</b>	By the end of the lesson students will: <ul style="list-style-type: none"> <li>Demonstrate changes in perimeter for a given area.</li> </ul>
<b>Common Core State Standards</b>	<b>Geometric measurement: recognize perimeter as an attribute of plane figures and distinguish between linear and area measures.</b> <b>3.MD.8</b> Solve real world and mathematical problems involving perimeters of polygons, including finding the perimeter given the side lengths, finding an unknown side length, and exhibiting rectangles with the same perimeter and different areas or with the same area and different perimeters.
<b>Emphasized Standards for Mathematical Practice</b>	1. Make sense of problems and persevere in solving them. 5. Use appropriate tools strategically.
<b>Prior Knowledge</b>	area, perimeter, building arrays
<b>Vocabulary</b>	Area, perimeter, building arrays
<b>Materials</b>	Grid paper (lesson 6), Square tiles, large construction paper Burns, Marilyn (1997). <i>Spaghetti and meatballs for all</i> . New York: Scholastic Press.

### Tasks in the Lesson

Engage	12-15 minutes
<p><i>If the book is not available, read the scenario.</i></p> <p>The students should model the changes in the seating plan with square tiles while the teacher models the changes at the document projector. Scenario: Mrs. Comfort is having a dinner party. There are 32 people expected to eat, including her family. She has a seating chart that looks like this (show all 8 tables separated). When the first four guests arrive, they push two tables together so Mr. and Mrs. Comfort can sit with them (push two tables together). When the next 6 guests arrive, they push two more tables to the first group so they can all sit together (push two more tables over to make a square group of four tables). That is still not enough room, so they push over two more tables (make a group of six tables). That is still not enough room, so they push over two more tables (make a group of 8 tables). Mrs. Comfort starts to protest, but no one listens. Four more guests arrive, but there is no place for them to sit. So, Mrs. Comfort's sister suggests making two groups of four tables (separate the group of 8 into two groups of 4). Two more guests arrive, but they have nowhere to sit, so the neighbor suggests pushing the tables into one long line. The next two guests arrive, and they split the line of 8 tables into two lines of 4 tables each. Four more guests arrive. Mrs. Comfort's son divides the groups of four tables into pairs. The final 8 guests arrive. Mr. Comfort divides the pairs of tables into single tables, just as Mrs. Comfort had planned.</p> <p>Have students count out 8 square tiles per student. They will model the story as it is read aloud. Read the story aloud. Stop each time the tables are moved and discuss:</p> <ul style="list-style-type: none"> <li><i>What happens to the area?</i> It does not change. We still have 8 tables (8 square units)</li> <li><i>What happens to the perimeter?</i> It gets smaller.</li> <li><i>Why?</i> Each time they push two tables together, it removes places for two people to sit.</li> </ul> <p>Continue reading the story to the end.</p>	

<b>Explore</b>	18-20 minutes
<p><i>Students will work in pairs to create and record table arrangements for exactly 12 people. Each arrangement should be recorded in a different color for easy identification on the grid sheet. Students should also be encouraged to organize their work for easier discussion. Students may trace the squares or cut the arrangements from extra sheets of inch grid paper.</i></p> <p><i>Mrs. Comfort had a seating plan that only used 8 tables for 32 people.</i></p> <p><i>Suppose she decided to order 6 tables. Make a chart showing the number of people who could come to dinner for each seating arrangement.</i></p> <p>Allow students to solve the problem, recording their solutions on construction paper.</p>	
<b>Explain</b>	10-12 minutes
<p><i>After students discuss their findings in groups of four, have volunteers demonstrate at the document projector why 10 is the fewest and 24 is the most people who can come to dinner seated at 6 tables.</i></p> <p>Provide time for pairs to group into fours to compare their findings.</p> <p>Conclude and discuss the activity:</p> <ul style="list-style-type: none"> <li><i>We learned earlier that we can make different shapes with figures that have the same area. We learned that those different shapes may have different perimeters although they have the same areas.</i></li> <li><i>What is the fewest number of people who could come to dinner? (10)</i></li> <li><i>What is the most who could come to dinner? (24)</i></li> </ul>	
<b>Elaborate</b>	12-15 minutes
<p><i>The Elaborate portion refocuses the students to use rectangular arrays to demonstrate area.</i></p> <p>Ask students: <i>Suppose Mrs. Comfort wanted all of her tables touching in arrays.</i></p> <ol style="list-style-type: none"> <li><i>What is the fewest who could come to dinner? (10)</i></li> <li><i>What is the most who could come to dinner? (14)</i></li> <li><i>What do you notice about the array that seats the fewest and the array that seats the most? The array with the fewest seats is clustered together. The array with the most seats is more spread out.</i></li> </ol> <p><b>Closing Task</b></p> <p><i>The Party Tables Rental store is running a special. Mrs. Comfort can rent 12 tables for price of six. On the grid paper, show all of the arrays that Mrs. Comfort can make using 12 tables. Label the number of people who can come to dinner for each array with <math>P=?</math></i></p>	
<b>Evaluation of Students</b>	
Formative: As students work, pose questions and observe them.	
Summative: Students' work from the elaborate section.	
<b>Plans for Individual Differences</b>	
Intervention: Students who have difficulty counting the number of units around the arrangement may need to use an additional square tile to keep track of the units, similar to the triangle used to measure the perimeter in a previous lesson.	
Extension: Students find the least and greatest number who could eat at 16, 20, or 24 tables.	

## Lesson 18: A Pen for Pugsy

### Overview and Background Information

<b>Mathematical Goals</b>	By the end of the lesson students will: <ul style="list-style-type: none"> <li>• Find all of the areas of a rectangle given a fixed perimeter</li> <li>• Compare the areas of rectangles given a fixed perimeter</li> </ul>
<b>Common Core State Standards</b>	<b>Geometric measurement: recognize perimeter as an attribute of plane figures and distinguish between linear and area measures.</b> <b>3.MD.8</b> Solve real world and mathematical problems involving perimeters of polygons, including finding the perimeter given the side lengths, finding an unknown side length, and exhibiting rectangles with the same perimeter and different areas or with the same area and different perimeters.
<b>Emphasized Standards for Mathematical Practice</b>	1. Make sense of problems and persevere in solving them. 5. Use appropriate tools strategically. 6. Attend to precision.
<b>Prior Knowledge Needed</b>	Introduction to finding the area and perimeter of a rectangle
<b>Vocabulary</b>	area, perimeter, dimensions, rows, columns
<b>Materials</b>	36 large paperclips per pair, Centimeter grid paper, Markers/ crayons Pollack, Pam and Belviso, Meg. (2002). <i>Chickens on the move</i> . New York: The Kane Press.

### Tasks in the Lesson

#### Engage

12-15 minutes

*Before beginning the lesson, have students count out 24 paperclips and clip them together into a loop to model the different fences in the story. If the book is not available, read the scenario below while students act out the changes in the fence with the paper clip loops.*

*Scenario: Grandpa brings chickens and the materials to make a 24 ft. long chicken coop to Tom, Gordon, and Anne. The first coop they make is a 9 x 3 coop (pause for students to create each coop with the paper clips), but it is too skinny. The next day, they make it a little wider, and the coop is now 8 x 3, but now the chickens are too close to the garden and get wet when the garden is watered. Tom, Gordon, and Anne move the coop up the hill and build it to be 6 x 6. The chickens have much more room, but it is too far up the hill. The children finally settle on a triangular coop that measures 8 feet on each side to fit under the apple tree near the house.*

Read the story aloud, stopping to allow the students to model the fence each time it changes using the paper clip loop and for the teacher to record the dimensions and perimeter.

Ask: *The first chicken coop is 9 x 3. How many square feet do the chickens have to roam inside? How do we know?* Continue with the different sized chicken coops during the story.

Continue the discussion by asking

- *What stayed the same throughout the story? What changed throughout the story?*
- *If you were the children in the story, which coop would you choose? Why?*

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**Explore**

18-20 minutes

*Before beginning the activity, have students add 12 paper clips to their loops for a total of 36. Distribute the grid paper while the students are adding the paper clips.*

Introduce the activity: *Lily's Mom agreed to adopt a new puppy for the family. Before Lily can bring Pugsy home, she needs to build an exercise pen for him in the backyard. Lily has 36 feet of fencing. Find all of the rectangular pens that Lily can make.*

Provide directions. Students should: model each rectangular pen with the paper clip loop, record the pen on the grid paper, label each pen with the perimeter (P) and the area (A). Allow students to work in pairs to complete the activity. Calculators may be used.

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**Explain**

10-12 minutes

*Students may need assistance with organizing their answers when reporting.*

*Ask: How many different pens can Lily make? How can we be sure?*

Have students read the dimensions of their pens. List the dimensions of each rectangular pen on the board, starting with the rectangle with a side measure of 1 foot. Continue until all 9 rectangles have been listed. It may be necessary to remind students that a 13 x 5 rectangle is the same as a 5 x 13 rectangle in size.

*What is true about the perimeters of all of the pens? How do we know?*

We used all 36 paper clips in the fencing each time.

*What is true about the areas of each of the pens?*

Have students provide area measures for each of the pens and record on the board.

*What do you notice about the area measurements?*

Students should notice that the areas become larger as the rectangle approaches a square.

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**Elaborate**

12-15 minutes

*It is not necessary for the class to reach a consensus about the best pen for Lily's back yard here. The purpose of the discussion is for the students to think about the areas of the pens and which size pen would best fit in the back yard.*

Display the Lily's Back Yard sheet. Discuss the items in the back yard.

*Which pen should Lily choose? Why?*

Have students discuss with their partners. Ask the class the number of votes for each pen, recording the votes on the board. Ask each group why they chose that particular pen.

Draw the most popular pen on the Lily's Back Yard sheet. Ask the class if the pen is a good fit for the backyard and why or why not. Student reasoning should include the amount of space left in the backyard and the amount of space taken by the pen.

Math Journal: Suppose Lily had 20 feet of fencing. Find the pens she could make.

Computer activity (time permitting): [http://www.mathplayground.com/area\\_perimeter.html](http://www.mathplayground.com/area_perimeter.html)

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**Evaluation of Students**

Formative: As students work, pose questions and observe them.

Summative: Students' work from the elaborate section.

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**Plans for Individual Differences**

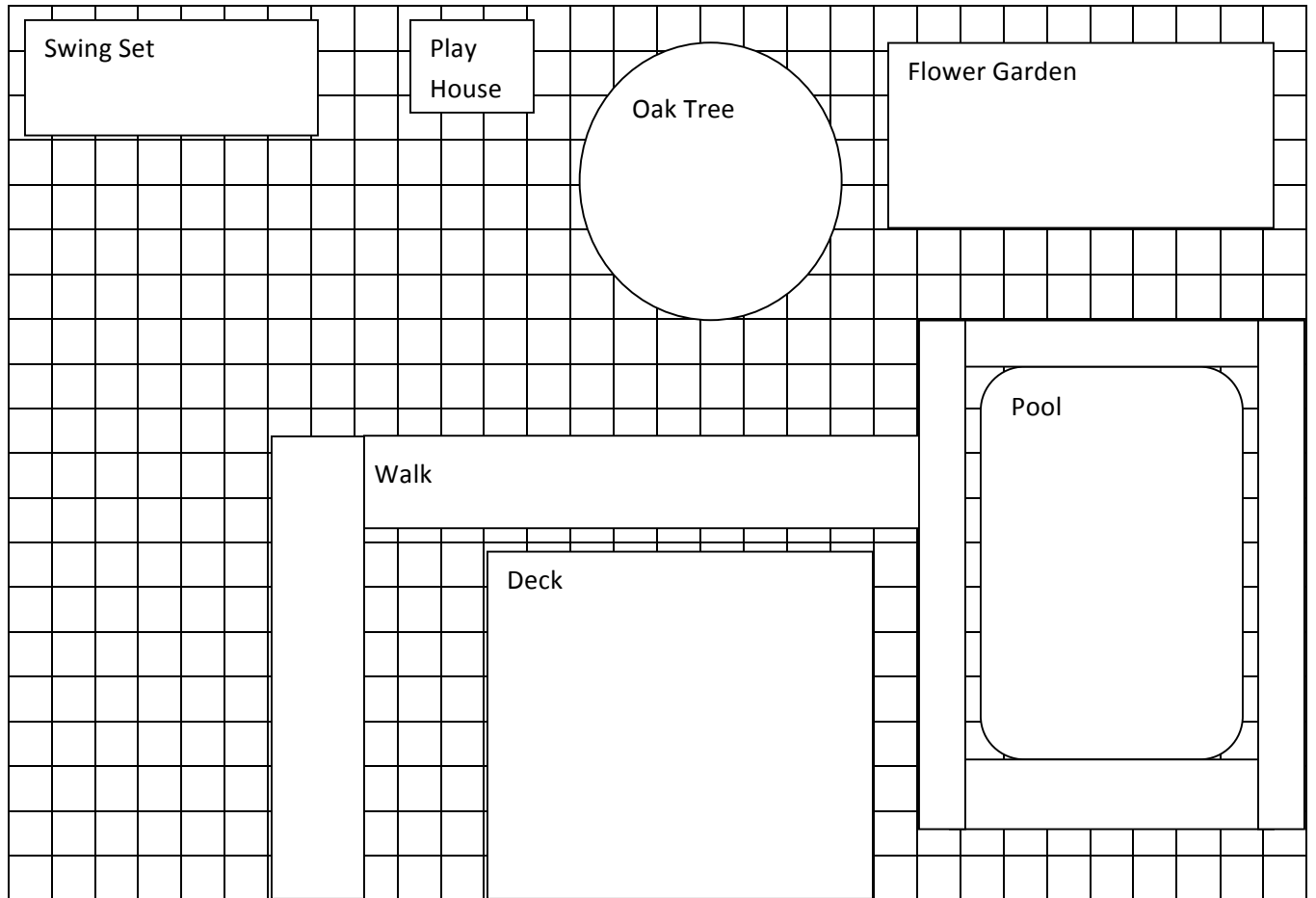
Intervention: Students may focus on the factors of 24 or 36 instead of the addends of 24 or 36. Provide the hint of dividing 24 or 36 in half, and finding addends to equal that number to find the dimensions of the rectangle.

Extension: Challenge students to find all of the pens for 40 or more feet of fencing.

Adapted from Measuring in One and Two Dimensions, NC-PIMS, 2007.



# Lily's Back Yard



## Lesson 19: Monster Mash

### Overview and Background Information

<b>Mathematical Goals</b>	By the end of the lesson students will: <ul style="list-style-type: none"> <li>Determine the perimeter of a figure with a fixed area</li> <li>Determine the area of a figure with a fixed perimeter.</li> </ul>
<b>Common Core State Standards</b>	<b>Geometric measurement: recognize perimeter as an attribute of plane figures and distinguish between linear and area measures.</b> <b>3.MD.8</b> Solve real world and mathematical problems involving perimeters of polygons, including finding the perimeter given the side lengths, finding an unknown side length, and exhibiting rectangles with the same perimeter and different areas or with the same area and different perimeters.
<b>Emphasized Standards for Mathematical Practice</b>	1. Make sense of problems and persevere in solving them. 5. Use appropriate tools strategically.
<b>Prior Knowledge Needed</b>	Finding the area and perimeter of rectangles
<b>Vocabulary</b>	Area, perimeter
<b>Materials</b>	Centimeter grid paper (1 sheet per student), construction paper for mounting (2 sheets per student), crayons or colored pencils, scissors, glue, Monster example, Computer with projector or computer lab with internet connection

### Tasks in the Lesson

#### Engage

5-7 minutes

*This lesson allows students to use their creativity to continue to explore the relationship between area and perimeter. Make an example of a Monster before the lesson.*

Begin by saying, *We have been exploring area and perimeter of different figures. Today, you will create monsters that are made out of rectangles.*

Display the example. *The first monster will have an area of 63 square centimeters. Please help me find the perimeter of this monster.* Record the perimeter near the figure.

*The second monster will have a perimeter of 46 centimeters. Please help me find the area of this monster.* Record the area near the figure.

Introduce the activity: *You will also create two monsters. The first monster will have an area of 63 square centimeters. The second monster will have a perimeter of 46 centimeters. Your monsters must: have one arm, one leg, one head, and follow the lines on the grid. Only draw the outlines for your monsters. I will let you know when you may color them and cut them out.*

#### Explore

28-30 minutes

*This portion of the lesson provides an opportunity for an informal peer assessment. Students should carefully check each other's work to ensure it meets the criteria specified earlier. Having students assess at this time also allows them to make changes to their work before it is shared with the class.*

Provide time for students to create their monsters. When they have worked for about 10 minutes, stop the activity.

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*You should have the first monster drawn. Trade papers with a partner. Check your partner's monster. Does the monster have an area of 63 square centimeters? Does it follow the other rules?*  
Stop the activity again after about 10 additional minutes.

*You should have the second monster drawn. Trade papers with a partner. Check your partner's monster. Does the monster have a perimeter of 46 centimeters? Does it follow the other rules?*

Allow students to work for the remainder of the time.

Instruct the students to color and cut out their monsters. They may also add details such as a face at this time.

Have students write their name and the area and perimeter on the back of each figure.

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**Explain****10-12 minutes**

*The lesson may be suspended at this point, if necessary.*

*The discussion relates the current lesson to the previous two lessons by having students review what they already know about fixed areas and fixed perimeters. The teacher will need to facilitate having the students order their monsters on the board by first determining who has the shortest perimeter/smallest area, then finding the next shortest/smallest, and so on.*

Have students attach their first monsters ( $A=63$ ) to the board in order from shortest perimeter to longest perimeter.

Facilitate a discussion by asking:

- *What do you notice about the monsters as the perimeter increases?*  
The monsters become longer/taller.
- *Why?*  
Their square units become more spread out as the perimeter increases.
- *How does this result relate to what happened with the tables in Spaghetti and Meatballs for All?*  
If the square units are more spread out, there are more sides showing; there are more places for "people to sit."

Have students display their second monsters ( $P=46$ ) in order from smallest area to largest area.

:

- *What do you notice about the monsters as the area increases?* (The monsters become shorter/smaller.)
- *Why?* (There are not as many sides showing. With fewer turns, there can be more square units for the same perimeter.)
- *How does this result relate to what happened in Chickens on the Move and A Pen for Pugsy?* (We found out that the area gets larger the closer we get to a square when the perimeter is the same.)

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**Elaborate****15-17 minutes**

*A signal should be chosen and practiced before the activity. The signal may be a bell, music, or other sound that will alert the students that it is time to move on to the next partner.*

*As students are discussing, the teacher should monitor the conversations to ensure students are finding the area and perimeter for each figure and to identify any misconceptions to be addressed at the conclusion of the activity. The activity can be limited by time or the number of pairs formed.*

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1. Have students mount their monsters onto the construction paper. They should write their name and the area and perimeter for each monster on the back.
  2. Allow students to mix around the room until the signal is given. At the signal, they should trade papers and take turns finding the area and perimeter for one of their partner's figures. At the next signal, students will return the papers and mix around the room until the next signal when they find a new partner and repeat the process.
  3. Address any difficulties the students may have encountered.

Time permitting, students could use computers to work on either of these websites:

<http://www.shodor.org/interactivate/activities/PerimeterExplorer/>

<http://www.shodor.org/interactivate/activities/AreaExplorer/>

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### **Evaluation of Students**

Formative: As students work, pose questions and observe them.

Summative: Students' work from the elaborate section.

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### **Plans for Individual Differences**

Intervention: Students may work in a small group and use smaller numbers.

Extension: Challenge students to find the monster with the longest perimeter with an area of 63 square centimeters and the largest area with a perimeter of 46 centimeters.

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## Lesson 20: Robotic Racing

### Overview and Background Information

<b>Mathematical Goals</b>	By the end of the lesson students will: <ul style="list-style-type: none"> <li>Find the perimeter of a polygon given the side lengths.</li> </ul>
<b>Common Core State Standards</b>	<b>Geometric measurement: recognize perimeter as an attribute of plane figures and distinguish between linear and area measures.</b> <b>3.MD.8</b> Solve real world and mathematical problems involving perimeters of polygons, including finding the perimeter given the side lengths, finding an unknown side length, and exhibiting rectangles with the same perimeter and different areas or with the same area and different perimeters.
<b>Emphasized Standards for Mathematical Practice</b>	1. Make sense of problems and persevere in solving them. 3. Construct viable arguments and critique the reasoning of others. 6. Attend to precision.
<b>Prior Knowledge Needed</b>	Introduction to perimeter, properties of squares and rectangles, recognizing lines of symmetry in a figure
<b>Vocabulary</b>	perimeter, polygon, recognizing lines of symmetry in a figure
<b>Materials</b>	Opening problem sheet, Robotic Racing sheet

### Tasks in the Lesson

<b>Engage</b>	5-7 minutes
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*This lesson transitions students from counting pattern blocks or squares on a grid or to finding the perimeter by adding side lengths.*

Opening problem:

*Jane's class is building a robot for a competition. The robot must follow a path around a figure one time. The robot must travel at least 25 units in order to go to the next round. Which path should Jane's class choose in order to go to the next round?*

*Turn and talk to a partner about which path Jane's class should choose and why.*

Conclude by having students share their answers and strategies with the entire class.

<b>Explore</b>	10-12 minutes
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*The Robotic Racing activity can be completed individually or in pairs. Assign just the first three problems for this part of the activity.*

Distribute Robotic Racing sheets and review directions. Students are to use the given side lengths to determine the paths that Jane's class could use for each round of the competition. Allow time for students to work through problems 1 – 3. As students work ask them, "How are you finding the perimeter of the shape?"

<b>Explain</b>	12-15 minutes
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*As students are discussing which paths Jane's class should choose, their reasoning should include the computation of perimeter. If students do not offer perimeter equations, the teacher should ask addition sentences for each figure have been shared.*

If students worked in pairs, have them choose different partners for checking.

Provide time for the pairs to review their answers for questions 1-3.

---

Discuss as a whole group:

- *Which path should Jane's class choose for Problem #1? How do you know?*  
The perimeter for figure A=  $9+12+15=36$  units, the perimeter for figure B= $11+11+11=33$  units
- *Which path should Jane's class choose for Problem #2? How do you know?*  
Perimeter A= $5+5+6+5+5+6=32$  units, Perimeter B=  $8+10+8+10=36$  units
- *Which path should Jane's class choose for Problem #3? How do you know?*  
Perimeter A =  $4+4+4+4=12$  units, Perimeter B =  $6+5+6+3= 20$  units

---

**Elaborate**

22-25 minutes

*Problems 4 and 5 include missing side lengths. Students must find the missing lengths, then find the perimeter. Students may work in pairs or individually to solve the problems. During the discussion, students should clearly state their methods for finding the missing side lengths.*

Allow students to solve problems 4 and 5.

Discuss:

- *How did you find the missing side length for figure A in Problem #4?*  
(Figure A is a square so all sides are the same length.)
- *How did you find the missing side length for figure B in Problem #4?*  
Opposite sides are equal in a rectangle, so if the side across from the missing side is 9 units, the missing side is also 9 units.
- *Which path should Jane's class choose? Why?*  
Perimeter A =  $7+7+7+7= 28$  units, Perimeter B =  $6+9+6+9= 34$  units.
- *How did you find the missing side length for figure A in Problem #5?*  
Figure A has a line of symmetry, which means the two sides of the triangle are the same length. OR In an isosceles triangle, two sides are the same length.
- *How did you find the missing side length for figure B in Problem #5?*  
Figure B shows the length of the side across from the missing side as 5 units, so since it is the same length, the missing side should be 5 units long. There is a line of symmetry for Figure B, so the sides are the same length.
- *Which path should Jane's class choose? Why?*  
Perimeter A =  $10+10+12=32$  units, Perimeter B =  $5+7+5+10=27$  units

**Math Journal**

*Allow up to 5 minutes for students to complete their journals. If there is time, have students pair and share. If not, the journals may be shared at the beginning of the next lesson.*

Journal Prompt: Draw a path for the robot that is a polygon. The robot goes 20-30 units.

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**Evaluation of Students**

Formative: As students work, pose questions and observe them.

Summative: Students' work from the elaborate section.

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**Plans for Individual Differences**

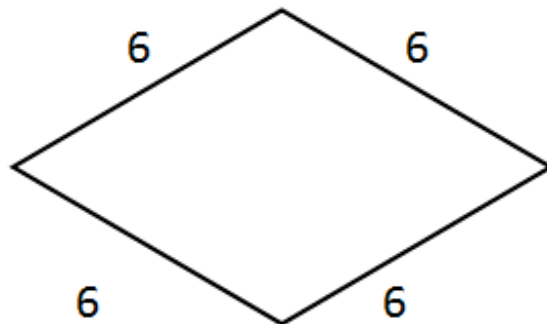
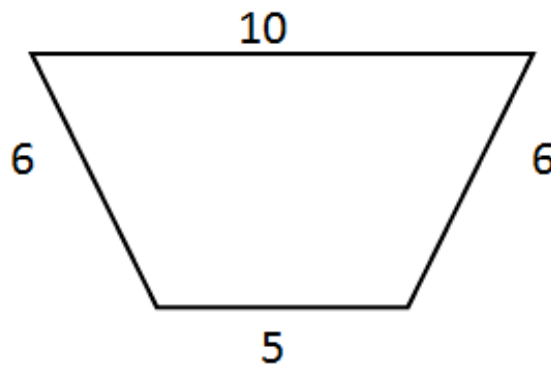
Intervention: Students may need to physically trace the path the robot travels to ensure they go around the entire figure.

Extension: Challenge advanced students to write equations using multiplication for figures with congruent sides. For example, the equation for the perimeter of the square in problem 4 could be written as  $4 \times 7 = 28$  units.

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### Robotic Racing – Opening Problem

**Jane’s class is building a robot for a competition. The robot must follow a path around a figure one time. The robot must travel at least 25 units in order to go to the next round. Which path should Jane’s class choose in order to go to the next round?**



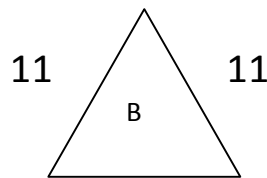
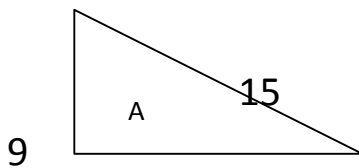
Name \_\_\_\_\_

### ROBOTIC RACING

Help Jane's class decide which paths they could use for the robot competition. For each problem, find the perimeter for each path and circle the path they should use. Remember to show your work.

#### Part A

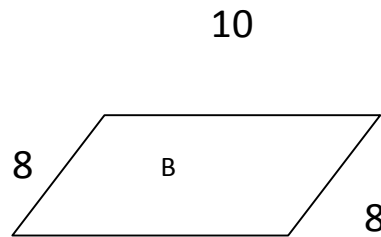
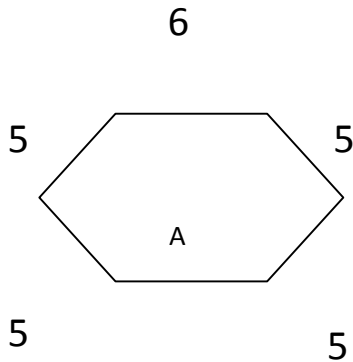
1. The path must be at least 36 units long.



12

11

2. The path must be at least 34 units long.

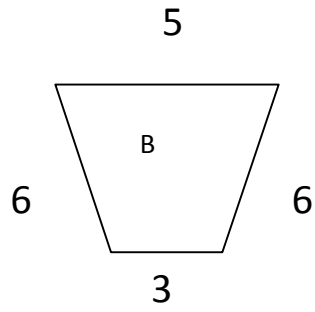
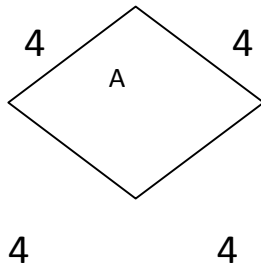


6

10

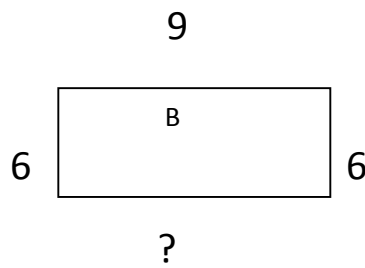
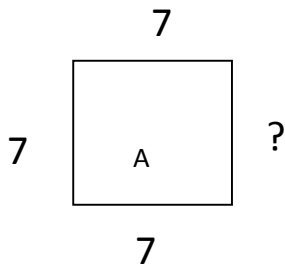


3. The path must be at least 20 units long.

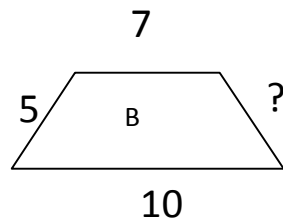
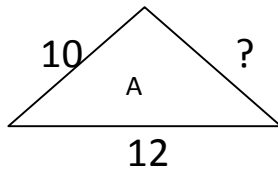


Part B

4. The path must be at least 30 units long.



5. The path must be at least 28 units long.



## Lesson 21: Pedaling for Pennies

### Overview and Background Information

<b>Mathematical Goals</b>	By the end of the lesson students will: <ul style="list-style-type: none"> <li>Find the perimeter of a polygon given the side lengths</li> </ul>
<b>Common Core State Standards</b>	<b>Geometric measurement: recognize perimeter as an attribute of plane figures and distinguish between linear and area measures.</b> <b>3.MD.8</b> Solve real world and mathematical problems involving perimeters of polygons, including finding the perimeter given the side lengths, finding an unknown side length, and exhibiting rectangles with the same perimeter and different areas or with the same area and different perimeters.
<b>Emphasized Standards for Mathematical Practice</b>	2. Reason abstractly and quantitatively. 4. Model with mathematics. 6. Attend to precision.
<b>Prior Knowledge Needed</b>	Finding the perimeter of two-dimensional shapes
<b>Vocabulary</b>	polygons, perimeter
<b>Materials</b>	Pattern blocks, Opening problem sheet, Pedaling for Pennies sheet, calculators, Error Analysis sheet. Murphy, Stuart J. (2002). <i>Racing around</i> . New York: Harper Collins Publishers.

### Tasks in the Lesson

<b>Engage</b>	13-15 minutes
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*The book Racing Around describes Mike’s attempt to ride in a 15 km bike race. Although his big brother and sister believe he is too small to finish such a long distance, Mike trains around familiar paths and enters the race anyway. Along the route, he encounters challenges, but does not give up. At the end, he surprises his brother and sister by finishing the race. As the book is read, the illustrations of each path should be displayed. If the book is not available, begin the lesson with the Opening Problem.*

Present the Opening Problem: *Gina is entering a bike race to raise money for the local animal shelter. She will collect one dollar for each km (1 penny for each 10 m) she rides. How much money will she collect if she completes the race by riding the route one time?*

Allow students to turn and talk to a partner about the problem. After about 1 minute, choose a student to answer the question and explain the problem solving process.

Questions for discussion:

- How is this problem like the ones we solved in the previous lesson?*  
We have to find the perimeter of a polygon to solve the problem.
- How is this problem different from the ones we solved in the previous lesson?*  
We only solved for “units” in the previous lesson. This problem includes kilometers.

*Today we will find the perimeter of polygons using standard unit side lengths.*

Connect to: [http://www.bgfl.org/bgfl/custom/resources\\_ftp/client\\_ftp/ks2/maths/perimeter\\_and\\_area/index.html](http://www.bgfl.org/bgfl/custom/resources_ftp/client_ftp/ks2/maths/perimeter_and_area/index.html)

Students work on rectangles and triangles perimeter tasks for Levels 1 and 2.

---

**Explore**

10-12 minutes

*Students will work to determine the perimeters for the figures in problems 1-4. It may be necessary to remind students to remember the unit when writing the perimeter.*

Distribute the Pedaling for Pennies sheets and calculators. Allow students to work individually or in pairs to solve problems 1-4. As students work ask them, "How are you finding the perimeter of this figure?"

---

**Explain**

10-12 minutes

*As students share their problem solving strategies, they should explicitly state whether they added the numbers around the figure, added the numbers in pairs, or multiplied.*

Have students pair with different partners to compare and check their answers. After about 5 minutes, review the answers: 1) 8 km, 2) 9,300 ft, 3) 8 mi, 4) 2,540 m. Ask student volunteers to share their problem solving process for the problems.

---

**Elaborate**

22-25 minutes

*The Level 3 problems on the perimeter and area website work through finding missing side lengths. It is necessary for students to work through the examples to prepare for solving problems 5-6 on the Pedaling for Pennies sheet.*

Connect to [http://www.bgfl.org/bgfl/custom/resources\\_ftp/client\\_ftp/ks2/maths/perimeter\\_and\\_area/index.html](http://www.bgfl.org/bgfl/custom/resources_ftp/client_ftp/ks2/maths/perimeter_and_area/index.html)

Work through the perimeter problems for Level 3.

Allow students to work individually or in pairs to solve problems 5-6. Discuss the activity by reviewing the answers: 5) 8,800 m, 6) 28 mi. Choose students to demonstrate the methods they used to find the missing side lengths. Elicit alternative solution strategies for each problem.

**Error Analysis**

Allow students to complete an Error Analysis on the activity. The students should reflect on their performance and revisit any problems they missed. The Error Analysis sheet may be used, or the students may copy the chart onto the back of the Pedaling for Pennies sheet or notebook paper. The Error Analysis sheet should be collected.

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**Evaluation**

Formative: Pose questions and observe students as they are working.

Summative: Student work from the Elaborate section.

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**Plans for Individual Differences**

Intervention: Students may need to complete number 6 before number 5 and draw the grid lines inside the figure to find the missing side lengths. Scaffolding questions should guide the solution of number 5.

Extension: If Gina raises \$1 for each km she rides during the week, how much money would she raise for Monday, Thursday, and Friday? If Gina raises \$2 for each mile she rides during the week, how much money would she raise for Tuesday, Wednesday, and Saturday?

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## Lesson 22: Area or Perimeter? Overview and Background Information

<b>Mathematical Goals</b>	By the end of the lesson students will: <ul style="list-style-type: none"> <li>• Use clues to determine whether to find the area or the perimeter to solve a problem</li> <li>• Communicate how they solved problems involving area or perimeter</li> </ul>
<b>Common Core State Standards</b>	<b>Geometric measurement: recognize perimeter as an attribute of plane figures and distinguish between linear and area measures.</b> <b>3.MD.8</b> Solve real world and mathematical problems involving perimeters of polygons, including finding the perimeter given the side lengths, finding an unknown side length, and exhibiting rectangles with the same perimeter and different areas or with the same area and different perimeters.
<b>Emphasized Standards for Mathematical Practice</b>	1. Make sense of problems and persevere in solving them. 2. Reason abstractly and quantitatively. 3. Construct viable arguments and critique the reasoning of others. 6. Attend to precision.
<b>Prior Knowledge Needed</b>	Experiences finding area of rectilinear shapes and perimeters of all shapes
<b>Vocabulary</b>	Area, perimeter, dimensions
<b>Materials</b>	Sticky notes (2 per group of 4), Notebook paper (1 per student), pencils, calculators, Area and Perimeter PowerPoint presentation, internet connected computer, Area or Perimeter? Card set

### Tasks in the Lesson

<b>Engage</b>	12-15 minutes
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*The internet activity reviews finding area and perimeter of rectangles. The students must remember to add to find the perimeter and multiply to find the area. The problems also involve missing side lengths, which students must account for in their computations. As students solve the problems, they should be asked to explain their problem solving process following each answer, by responding to, "How do you know?"*

*The PowerPoint presentation reviews finding area and perimeter. It also provides context for problems. As the problems are presented, ask the class why area or perimeter are appropriate to answer the question (area problems involve covering a shape, perimeter involves measuring around a shape).*

Connect to <http://www.funbrain.com/cgi-bin/poly.cgi>. For each problem, have students discuss use at least 5 seconds of thinking time before raising their hands. Students should be prepared to explain their reasoning for each answer.

Continue until students are able to consistently answer the questions correctly (90% or better).

Connect to the Area and Perimeter PowerPoint.

Work through the tasks with the students. For each ask:

- *What do we know about the problem?* (The problem involves covering a space/ The problem involves finding the distance around a figure.)

- 
- *How can we solve the problem?* (We can multiply the side lengths to find the amount of space that is covered/We can add the side lengths to find the distance around the figure.)
  - *Will we need to use area or perimeter to solve the problem?*
- 

**Explore**

18-20 minutes

*Students will work in groups of 4 to sort the cards by whether they need to use area or perimeter to solve the problems. They will not solve the problems at this time. Students should be given specific roles to ensure equal participation in the activity.*

*It may be necessary to demonstrate one round of the activity and write the roles on the board.*

Display the Area and Perimeter Explanations sheet and review with the students. The sheet may be displayed for reference during the activities. Review the directions: *For this activity, you will determine whether you need to find the area or the perimeter of the figure to answer the question. You will sort your cards into two piles, one for area, one for perimeter. No problems will be solved at this time. Be sure the entire group agrees to the way you have sorted the cards.*

Arrange the students in groups of 4. Assign roles and review directions:

- Student A: reads the first problem aloud
- Student B: asks, “What do we know about the problem?” and listens for responses from A, C, and D. A, C, and D should mention that the problem either involves covering a space or finding the distance around a figure.
- Student C: asks, “How can we solve the problem?” and listens for responses from A, B, and D. A, B, and D should describe either adding the side lengths to find the area or multiplying the length and width to find the area.
- Student D: asks, “Will we need to use area or perimeter to solve the problem?” and listens for responses from A, B, and C. A, B, and C should answer the question and give a reason for their answer.
- The roles rotate for the next question, with B reading the problem aloud.

Distribute the “Area or Perimeter?” cards and sticky notes. Have two students in the group write “Area” on one note and “Perimeter” on the other. The notes will be used to mark the categories of problems.

Allow the groups time to sort the cards.

**Explain**

10-12 minutes

*The discussion allows students to listen to and critique the reasoning of others. Discussing the problems before they are solved increases students’ understanding of each problem.*

Elicit the problem numbers in each category from one group and list on the board. Take no comments at this time. Ask groups with differences from the posted list to explain the reasoning for their choices. Gather consensus from the class before changing the list. Be sure to return to the original group and ask for their agreement or disagreement.

Continue until all problems have been sorted. Erase the board and direct students to shuffle the cards and place them in the middle of the group for the next activity

**Elaborate**

10-12 minutes

*Solving the problems after a thorough discussion will increase student confidence and success with the assignment. Students should attempt to solve the problems independently, referring to the Area and Perimeter Explanations for assistance.*

Distribute notebook paper and calculators. Direct students to fold the notebook paper into eighths and number the boxes.

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Students are to work independently taking a card and solving the problem in the correct box. Students should write “Area” or “Perimeter” for each problem and clearly show whether they added or multiplied by writing an appropriate number sentence to solve the problem.

Cards should be returned to the middle when completed.

Math Journal prompt:

I know to find area when the problem \_\_\_\_\_. One example of when to find area is \_\_\_\_\_.

I know to find perimeter when the problem \_\_\_\_\_. One example of when to find perimeter is \_\_\_\_\_.

Example of Journal

I know to find area when the problem asks about covering something.

One example of when to find area is carpeting a room.

I know to find perimeter when the problem asks about going around something.

One example of when to find perimeter is framing a picture.

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### **Evaluation of Students**

Formative: As students work, pose questions and observe them .

Summative: Students’ work from the elaborate section.

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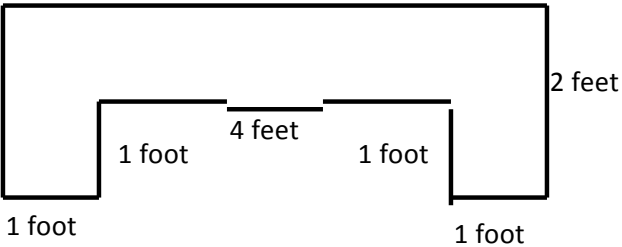
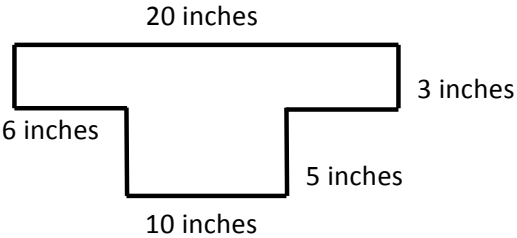
### **Plans for Individual Differences**

Intervention: Students may need additional practice solving area and perimeter problems with missing side lengths at <http://www.funbrain.com/cgi-bin/poly.cgi>

Extension: Have students write problems involving area or perimeter on index cards. They should write the problem on the front and the answer on the back. The cards may be kept in a file in a center for all students to use for independent practice.

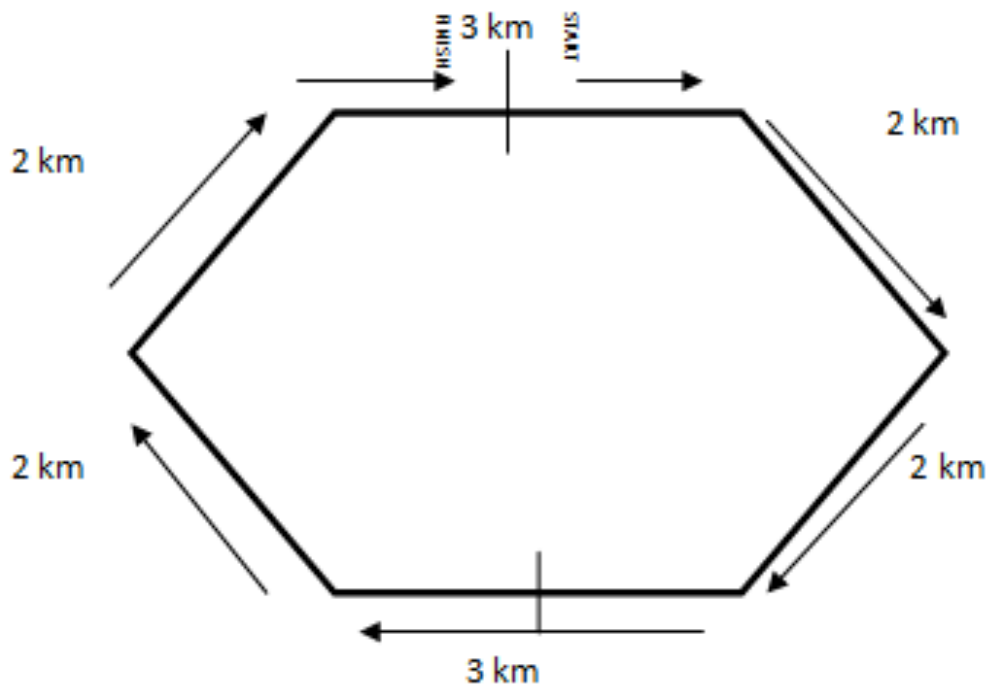
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**Area or Perimeter? Cards to be Cut Out**

<p>Jess is building a frame to fit a picture he painted. The picture measures 18 inches by 15 inches. About how much wood will Jess need to make the frame?</p>	<p>Nora is buying carpet for her living room. The living room measures 12 feet by 15 feet. How much carpet does Nora need to purchase?</p>
<p>Tanya is buying a dry erase board for her bedroom wall. The board measures 75 centimeters by 100 centimeters. How much of her wall will be covered by the board?</p>	<p>Sam is building a wire fence around his vegetable garden. The garden measures 3 yards by 6 yards. How much fencing will he need?</p>
<p>Jordan is buying a new couch for her living room. The couch measures 3 feet wide by 9 feet long. How much of her living room floor will be taken by the couch?</p>	<p>Chris is buying wallpaper border for his bathroom. The bathroom measures 2 meters by 3 meters. How much wallpaper border does Chris need to buy?</p>
<p>Olivia is painting a design on her wall. How much of her wall will be covered by the design?</p> 	<p>Tucker is making a poster for class president. He wants to glue ribbon around the edges. How much ribbon will he need?</p> 

Pedaling for Pennies – Opening Problem

**Gina is entering a bike race to raise money for the local animal shelter. She will collect one dollar for each km (1 penny for each 10 m) she rides. How much money will she collect if she completes the race by riding the route one time?**



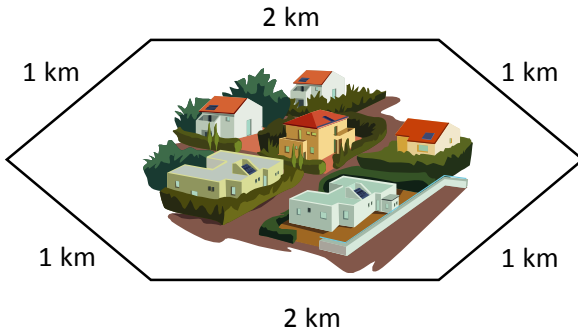


Name \_\_\_\_\_

**Pedaling for Pennies**

Gina is training for the Pedaling for Pennies fundraiser. Find the distance she rides each day.

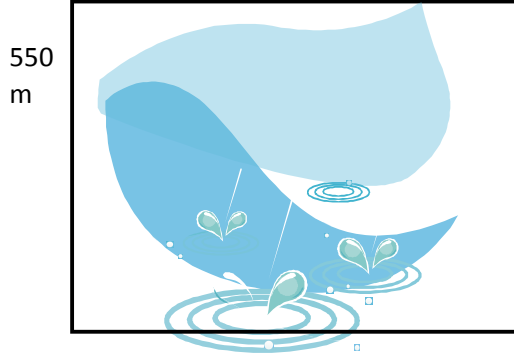
1. Monday



P= \_\_\_\_\_

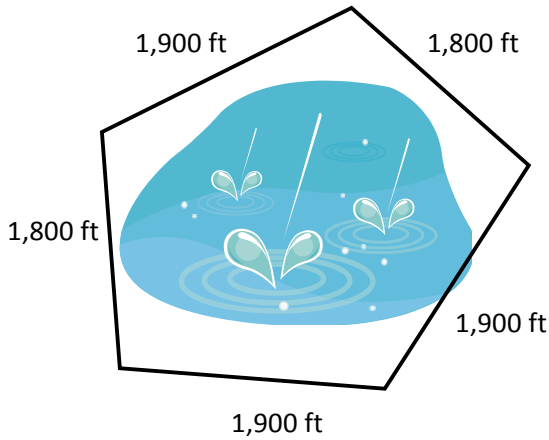
4. Thursday

720 m



P= \_\_\_\_\_

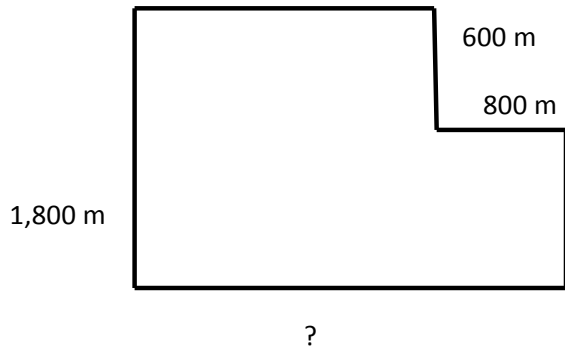
2. Tuesday



P= \_\_\_\_\_

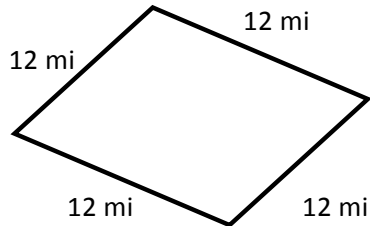
5. Friday

1,800 m



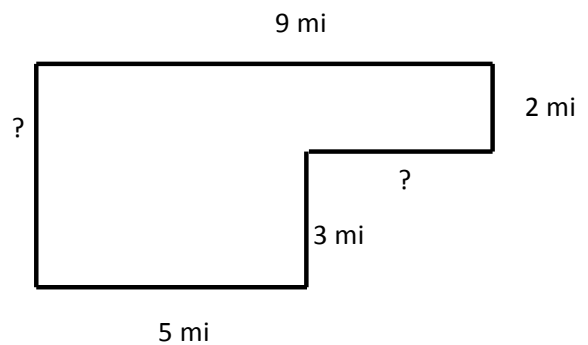
P= \_\_\_\_\_

3. Wednesday



P= \_\_\_\_\_

6. Saturday



P = \_\_\_\_\_

Name \_\_\_\_\_

**Error Analysis**

<b>Problem Number</b>	<b>My Mistake (What I did)</b>	<b>Corrected Solution (My new work)</b>	<b>I Still Need Help (Yes/No)</b>