BRIDGES IN MATHEMATICS 5

GRADE 5 SUPPLEMENT

Set D3 Measurement: Area of Polygons

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Skills & Concepts

★ develop and use the area formula for a right triangle by comparing with the formula for a rectangle (e.g., two of the same right triangles make a rectangle)

★ develop, use, and justify the relationships among area formulas of triangles and parallelograms by decomposing and comparing with areas of right triangles and rectangles

★ determine the area of a trapezoid by the composition and decomposition of rectangles, triangles, and parallelograms

★ compare areas of polygons using different units of measure within the same measurement system (e.g., square feet, square yards)

★ measure and draw line segments to the nearest eighth-inch and millimeter

★ identify, draw, and construct models of regular and irregular polygons including triangles, quadrilaterals, pentagons, hexagons, and octagons to solve problems

★ solve single- and multi-step word problems about the perimeters and areas of quadrilaterals and triangles, and verify the solutions

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Bridges in Mathematics Grade 5 Supplement
Set D3 Measurement: Area of Polygons

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Bridges in Mathematics is a standards-based K–5 curriculum that provides a unique blend of concept development and skills practice in the context of problem solving. It incorporates the Number Corner, a collection of daily skill-building activities for students.

The Math Learning Center is a nonprofit organization serving the education community. Our mission is to inspire and enable individuals to discover and develop their mathematical confidence and ability. We offer innovative and standards-based professional development, curriculum, materials, and resources to support learning and teaching. To find out more, visit us at www.mathlearningcenter.org.

Set D3 ★ Activity 1

ACTIVITY

Area of Parallelograms, Part 1

Overview
Students work on geoboards to find the area of several rectangular and non-rectangular parallelograms. Today's activities help students move from what they know about finding the area of a rectangle toward a more general formula for all parallelograms. If time allows at the end of the session, students build a variety of polygons on the geoboard and find the area of each in square units.

Skills & Concepts
★ describe, classify, construct, and draw rectangles and parallelograms

★ recognize that a square that is 1 unit on a side is the standard unit for measuring area

★ find the area of parallelograms and rectangles

You'll need
★ Area Problems (page D3.5, run a display copy)

★ Geoboard Paper (page D3.6, run a display copy and a class set)

★ Finding the Area of More Polygons (page D3.7, run a class set)

★ overhead geoboard and rubber bands

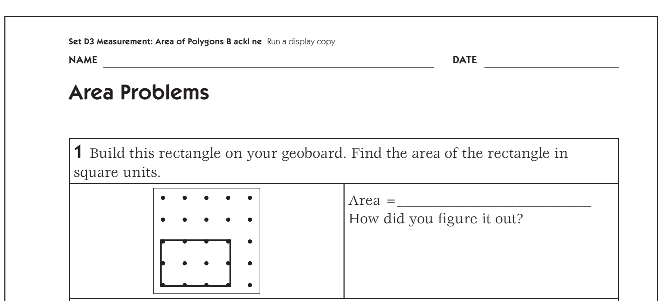
★ class set of geoboards and rubber bands

★ class set of rulers

★ a piece of paper to mask parts of the overhead

Instructions for Area of Parallelograms, Part 1
1. To start the activity, review the concept of area. Discuss some of the following questions:
- What does the word area mean?
- What is the difference between area and perimeter? (Have a volunteer show the area and the perimeter of a piece of paper or a wall chart.)
- How do people measure perimeter? How do they measure area? What units do they use for each type of measurement? (Review the fact that perimeter is measured in linear units such as centimeters, meters, inches, feet, yards, and so on, while area is measured in square units such as square centimeters, square meters, square inches, square feet, and so on.)
- What are some of the reasons people might want to measure area?

2. Explain that over the next few days, students will learn how to find the area of polygons other than rectangles and squares. Today, they will build some different shapes on geoboards and find the area of each. Have helpers distribute geoboards and rubber bands to each student as you place the top section of the Area Problems sheet on display. Keep the rest of the sheet covered for now.


Set D3 Measurement: Area of Polygons Blackline Run a display copy

NAME ______________ DATE ______________

Area Problems

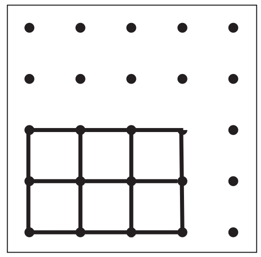
1 Build this rectangle on your geoboard. Find the area of the rectangle in square units.

Area = ______________

How did you figure it out?

Activity 1 Area of Parallelograms, Part 1 (cont.)

3. Read the first problem with the class. Clarify that the smallest square on the geoboard has an area of 1 square unit. Have students build the rectangle shown in the first problem on their geoboards and determine its area in square units. Ask the children to pair-share solutions and strategies. Then call on a volunteer to bring her geoboard up to the document camera or overhead and explain how she found the area of the rectangle.

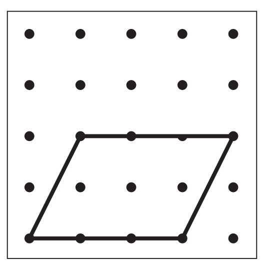


Kate *It's 6 because you can just count the squares. See where I put the rubber bands to show?*

Teacher *6 whats?*

Students *The area is 6 square units. You can see that it's 2 rows of 3 squares, so that makes 6. It's 2 × 3. That's 6 square units.*

4. Ask your volunteer if you can borrow her geoboard for a moment. Then, as the class watches, shift the rubber band over a peg to the right, as shown below. Ask students to identify the new shape you have created. You may have to review the fact that a parallelogram is a quadrilateral with two pairs of parallel sides. Squares and rectangles are examples of parallelograms, but there are non-rectangular parallelograms as well.



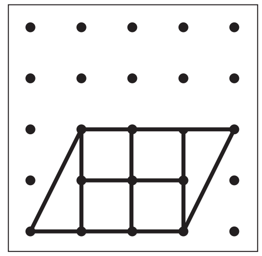
Students *I think it's a diamond now.*
There's no such thing as diamond in math, remember? Maybe it's a rhombus.
But all the sides have to be equal on a rhombus. Those sides don't look equal.
Well, it's definitely not a square or a rectangle.
I know! It's a quadrilateral because it has 4 sides.

Teacher *You're right that this shape is a quadrilateral, but it's a special kind of quadrilateral. So far, no one has mentioned parallelogram. Does anyone remember the definition of a parallelogram? No? Who'd like to look it up for us?*

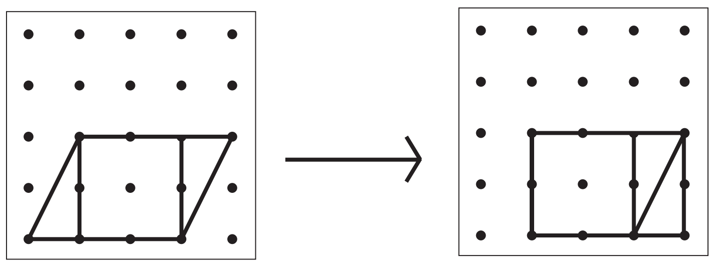
5. Once the shape has been identified by name, ask students to build it on their own geoboards by shifting the rubber band over 1 peg to the right, just as you did. Then ask them to find the area of the parallelogram. Give them a minute to wrestle with the problem. Then call 2 or 3 volunteers up to the document camera or overhead to show and explain their solutions and strategies.

Activity 1 Area of Parallelograms, Part 1 (cont.)

Whitney *First I saw that there were 4 squares in the middle. I can show them with rubber bands. Then I could see that the triangles on both sides fit together, so that's 2 more squares. I think the area of this parallelogram is 6 squares.*



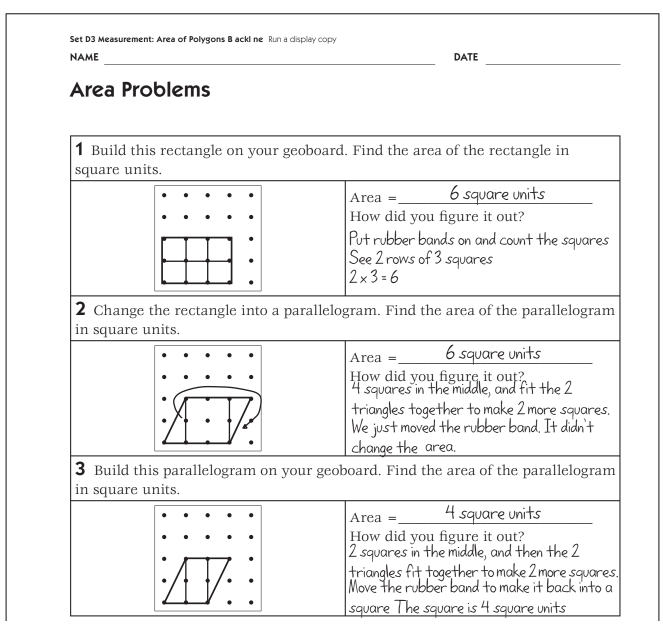
Pedro *My idea is kind of like Whitney's, but I moved over the triangle from one side to the other, and it turned back into a rectangle, like this, see? The area is definitely 6 square units.*



Kyra *I thought the same thing as Whitney and Pedro. Then I realized that the area had to stay the same from the rectangle to the parallelogram because we just moved the rubber band over. We didn't change anything else, so the area has to be the same.*

DeAndre *At first I thought that the area changed because of the diagonal lines, but with Pedro's way, you can see that the two triangles fit back together, so it's still 6.*

6. Place the Area Problems sheet on display again. Work with students' input to summarize their thinking on the first two problems. Then reveal the third problem. Read it with the students and have them build the parallelogram on their geoboards. After they have had a minute to find the area, call on volunteers to share their thinking as you record on the display master.



Set D3 Measurement: Area of Polygons B ackl ne Run a display copy

NAME ______________________ DATE ______________

Area Problems

1 Build this rectangle on your geoboard. Find the area of the rectangle in square units.

Area = 6 square units
How did you figure it out?
Put rubber bands on and count the squares
See 2 rows of 3 squares
2 x 3 = 6

2 Change the rectangle into a parallelogram. Find the area of the parallelogram in square units.

Area = 6 square units
How did you figure it out?
4 squares in the middle, and fit the 2 triangles together to make 2 more squares. We just moved the rubber band. It didn't change the area.

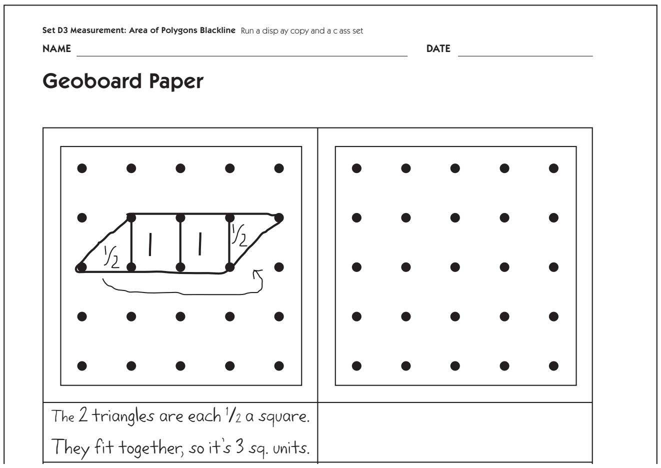
3 Build this parallelogram on your geoboard. Find the area of the parallelogram in square units.

Area = 4 square units
How did you figure it out?
2 squares in the middle, and then the 2 triangles fit together to make 2 more squares. Move the rubber band to make it back into a square The square is 4 square units

Activity 1 Area of Parallelograms, Part 1 (cont.)

7. Give students each a piece of geoboard paper as you reveal the last two problems. Read the text with the students and clarify as needed. If necessary, work problem 4 together. Give students a minute to see if they can make a non-rectangular parallelogram with an area of 3 square units on their geoboard. Then work with their input to make a labeled sketch on your display copy of the geoboard paper.

> ***Students*** *I see how to do it! You can do one with 2 squares in the middle, and then a little triangle on both sides.*
> *Hey, this is cool! Just make a rectangle that's 3 squares big and move the rubber bands to make a parallelogram.*



8. When students understand what to do, have them work individually or in pairs to build and record the area of the 4 parallelograms in problems 4 and 5. As they finish, ask students to check their solutions and strategies with at least one other classmate, and then start work on Finding the Area of More Polygons. (Students who are unable to finish or even start this sheet can be assigned to complete it for homework or during a designated seat work period the following day.)

9. Reconvene the class 5–10 minutes before the end of the period. Ask volunteers to show and explain some of the parallelograms they built with areas of 3, 2, 9, and/or 12 square units.

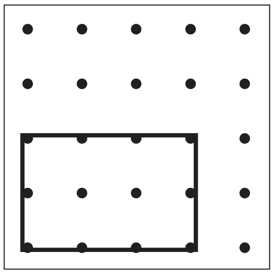
INDEPENDENT WORKSHEET

Use Set D3 Independent Worksheet 1 to provide students with more practice determining the area of irregular and regular polygons.

NAME ______________________ **DATE** ____________

Area Problems

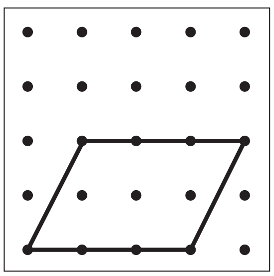
1 Build this rectangle on your geoboard. Find the area of the rectangle in square units.



Area = ______________________

How did you figure it out?

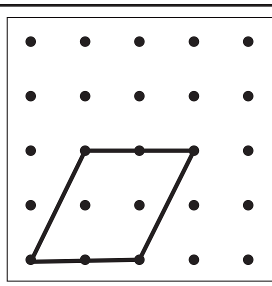
2 Change the rectangle into a parallelogram. Find the area of the parallelogram in square units.



Area = ______________________

How did you figure it out?

3 Build this parallelogram on your geoboard. Find the area of the parallelogram in square units.



Area = ______________________

How did you figure it out?

4 Build a parallelogram on your geoboard that has an area of 3 square units. Record the parallelogram you built on geoboard paper. Use labeled sketches, numbers, and/or words to prove that the area is 3 square units.

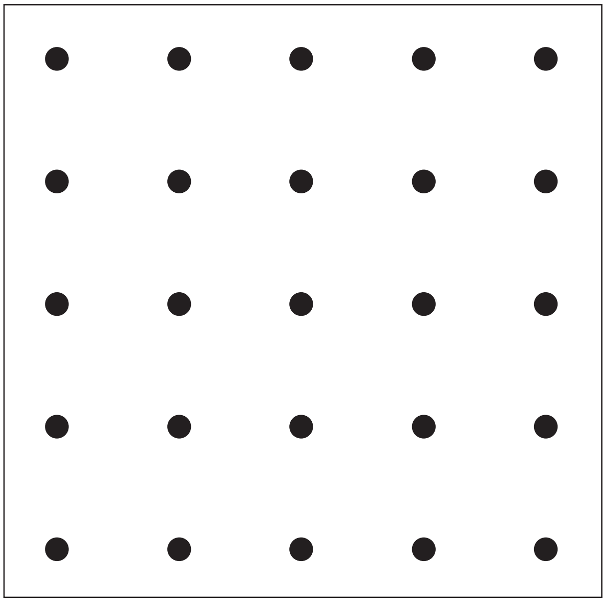
5 Build and record parallelograms with the following areas:

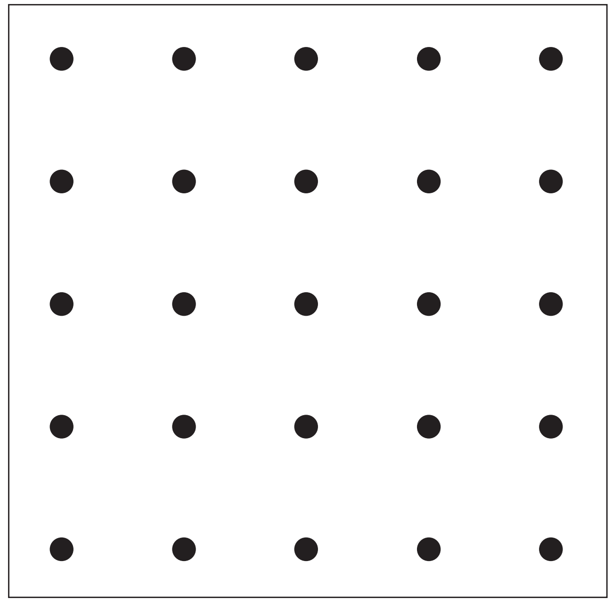
- 2 square units
- 9 square units
- 12 square units

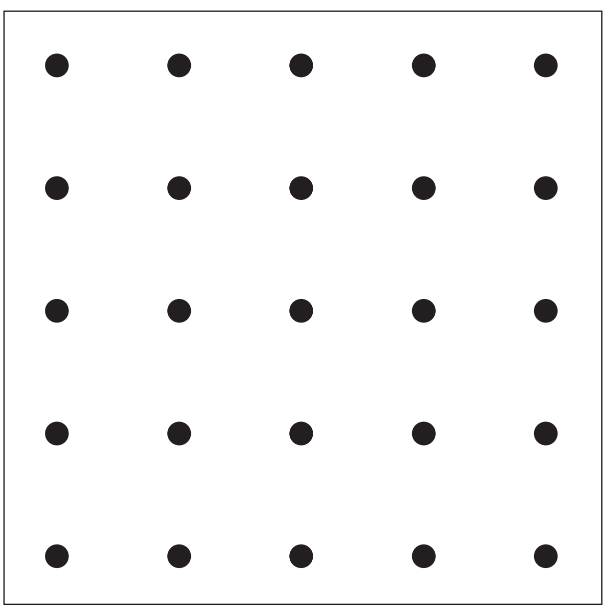
Use labeled sketches, numbers, and/or words to prove each area.

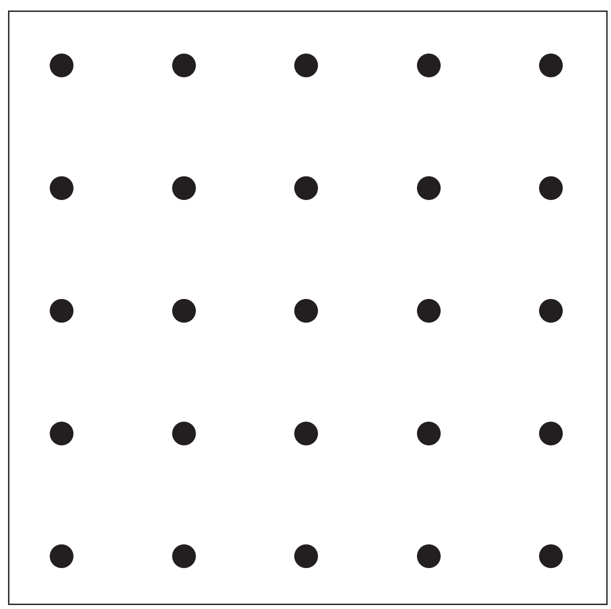
NAME ______________________________ **DATE** ______________

Geoboard Paper





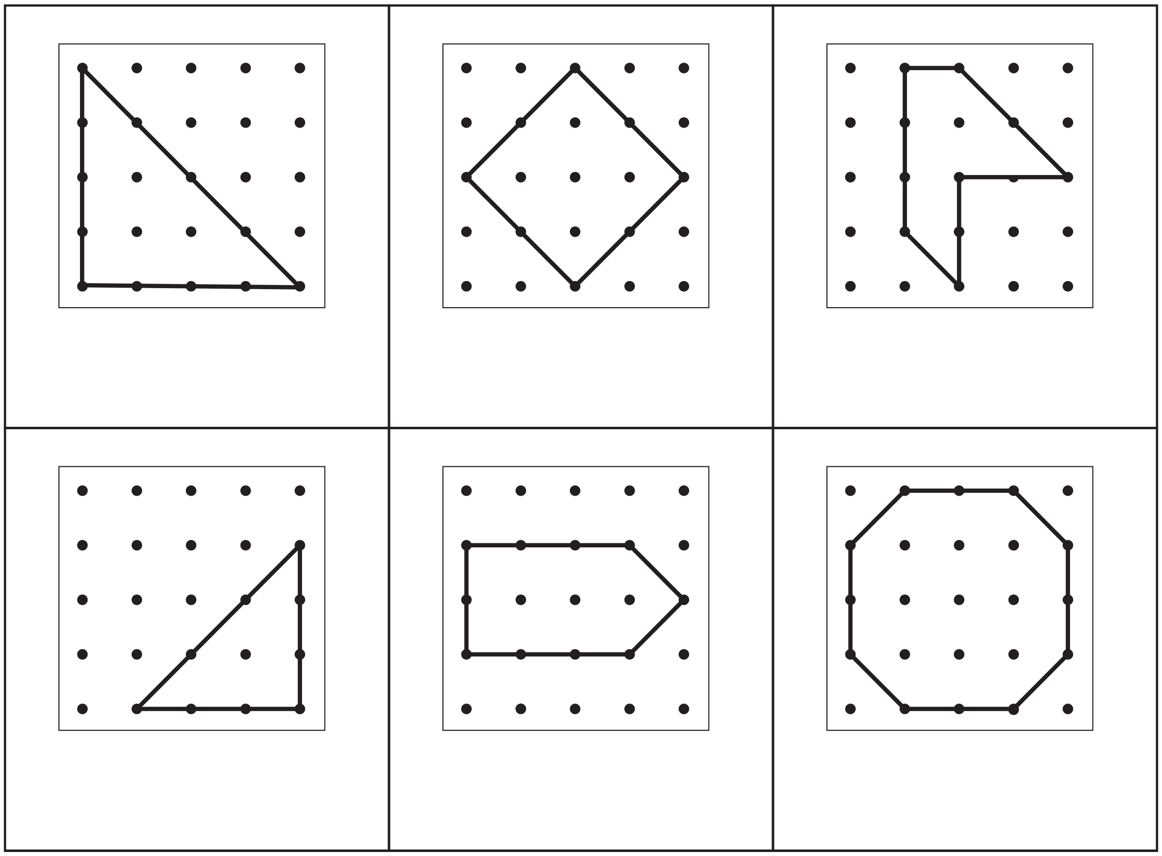




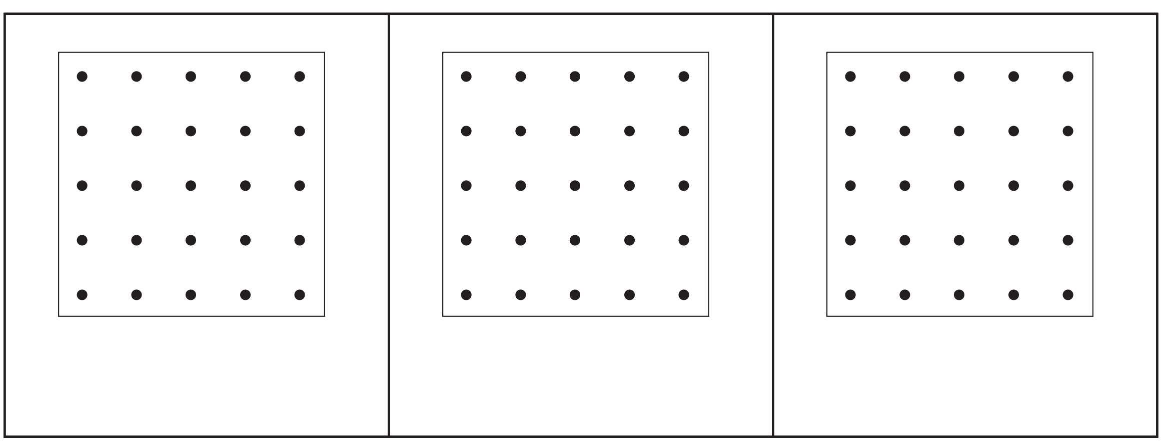
NAME ______________________________ **DATE** ______________

Finding the Area of More Polygons

1 Find the area of each of the polygons below in square units. Use labeled sketches, numbers, and/or words to prove each of your answers.



2 Build and record 3 different polygons (not rectangles) that each have an area of 6 square units. Use labeled sketches, numbers, and/or words to prove that the area of each polygon is really 6 square units.



Set D3 ★ Activity 2

ACTIVITY

Area of Parallelograms, Part 2

Overview

Students work in pairs to find the area of several non-rectangular parallelograms. After they share their solutions and strategies for doing so, the teacher introduces a general area formula for parallelograms: base x height, or *bh.* Students then complete two worksheets in which they apply the formula.

Skills & Concepts

- ★ identify, draw, and construct models of parallelograms, including rectangles and squares
- ★ develop, use, and explain the area formula for parallelograms

You'll need

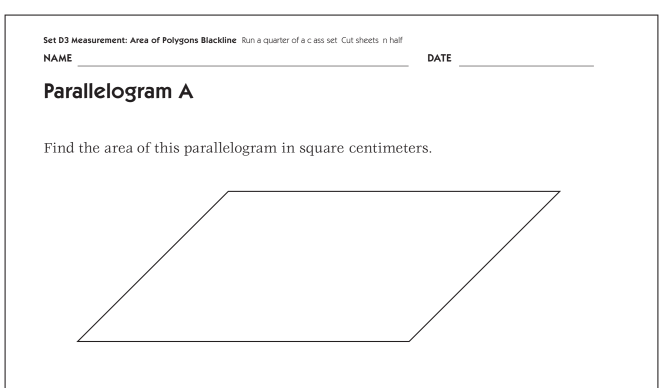
- ★ Parallelogram A (page D3.14, quarter class set)
- ★ Centimeter Grid Paper (page D3.15, half-class set plus a few extra)
- ★ More Parallelograms to Measure (page D3.16, half-class set)
- ★ Finding the Area of Parallelograms (pages D3.17 & D3.18, class set)
- ★ access to base ten pieces
- ★ class sets of scissors and rulers

Instructions for Area of Parallelograms, Part 2

1. Open today's session by asking students to summarize what they learned in the previous activity about finding the area of non-rectangular parallelograms. Give them a minute to pair-share, and then call on a few volunteers to share their ideas with the class.

> ***Students*** *It's easy to find the area of shapes on a geoboard. You can just count the squares.*
> *We thought it would be hard to do the area of a parallelogram, but then we found out the two triangles on the ends fit together.*
> *We found out we could turn a slanty parallelogram back into a rectangle on the geoboard, and then it's easy to find the area.*

2. Explain that the class is going to do some more work with parallelograms today. Have students pair up, or assign partners in preparation for the next activity. Then give each pair a copy of Parallelogram A, and place a few sheets of centimeter grid paper on each table. Explain that their task is to find the area of this parallelogram in square centimeters.


Set D3 Measurement: Area of Polygons Blackline Run a quarter of a c ass set Cut sheets n half

NAME ________________ DATE ________

Parallelogram A

Find the area of this parallelogram in square centimeters.

Activity 2 Area of Parallelograms, Part 2 (cont.)

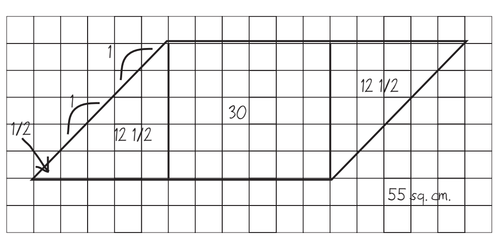
3. Spend a minute or two discussing some possible ways to approach the problem before student pairs go to work. It may be helpful to review the size of a square centimeter, and have students estimate the area of the parallelogram as well.

> ***Teacher*** *You are going to work with your partner to find the area of this parallelogram in square centimeters. How big is a square centimeter, anyway?*
>
> ***Students*** *Really little!*
> *One of those little base ten units is a square centimeter.*
> *It's one of the little squares on the grid paper.*
>
> ***Teacher*** *What would you estimate the area of parallelogram A to be in square centimeters? Talk with your partner for a few moments, and then let's see what people think.*
>
> ***Students*** *I don't see how you can do the triangle parts on the ends.*
> *Can we cut out the parallelogram? Then we could put it on the grid paper and count the squares.*
> *I think it's about 6 centimeters up and 10 over, so maybe the area is 60 square centimeters.*
> *Can we cut it apart into pieces? I think I see how to turn it into a rectangle.*
>
> ***Teacher*** *It sounds like people have some ideas about how they're going to find the area of this parallelogram. What are some tools that might be helpful for this job?*
>
> ***Students*** *Scissors and grid paper!*
> *A ruler to make a straight line so you can cut off the triangle at one end and move it.*
> *We're going to cut out the parallelogram and trace it onto the grid paper.*

4. When students have some ideas about how to proceed, have them go to work. As they finish, have them share and compare their solutions and strategies with at least one other pair. If some pairs complete the task before others, give them a copy of the More Parallelograms to Measure, and challenge them to find the areas of parallelograms B, C, and D as well.

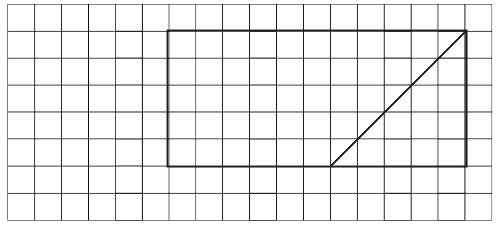
5. When most pairs have finished, reconvene the class and ask several volunteers to share and explain their results, at the document camera if possible.

> ***Jenna*** *First we cut out the parallelogram. Then we traced around it on the grid paper and counted the squares. We got 30 in the middle. Then each triangle is 12 and a half, so that's 25. It's 55 square centimeters in all.*



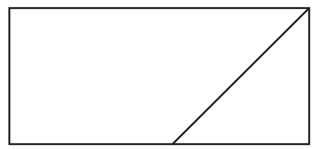
> ***Brandon*** *We cut out the parallelogram and put it on the grid paper. We were going to trace around it and count the squares, but then we saw that we could cut off the triangle on one side and move it over, like this.*

Activity 2 Area of Parallelograms, Part 2 (cont.)



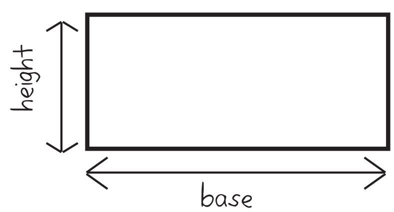
Pedro *Then we could see that it's 5 squares along the side and 11 over. That's 55 square centimeters.*

Sara *We did kind of the same thing, but after we cut out the parallelogram, we just cut off the triangle on the left side and moved it over to make a rectangle. We measured and multiplied. It was 5 × 11, so it's 55.*



6. Now distribute copies of More Parallelograms to Measure to all the student pairs. Give them a few minutes to find the area of at least one of the parallelograms on the sheet; more than one if they have time. Ask the children to use one of the strategies just shared, or devise another, preferably more efficient than tracing and counting the squares. Circulate as students work to provide support as needed. Encourage pairs to work on different parallelograms so the class can report the area of all three within a short amount of time.

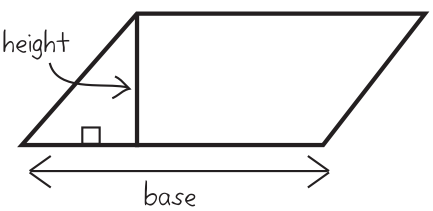
7. When all the students have had time to find the area of at least one of the parallelograms, reconvene the class to share their results. (Parallelogram B is 39 square centimeters; Parallelogram C is 60 square centimeters, Parallelogram D is 28 square centimeters.) Then sketch a rectangle on the board and label it to introduce the terms *base* and *height*. Explain that the *height* of a figure tells how far it is from the *base* or bottom of the figure to the top of the figure.



8. Next, sketch a parallelogram on the board and label the base. Ask students to pair-share where they think the height of the parallelogram would be located. Then invite a volunteer to come up to the board and draw in the height. As he or she does so, explain that the height of a figure is always perpendicular to the base.

Erika *I think the height is right here. It's the same as where we cut the triangle off so we could make the parallelogram into a rectangle.*

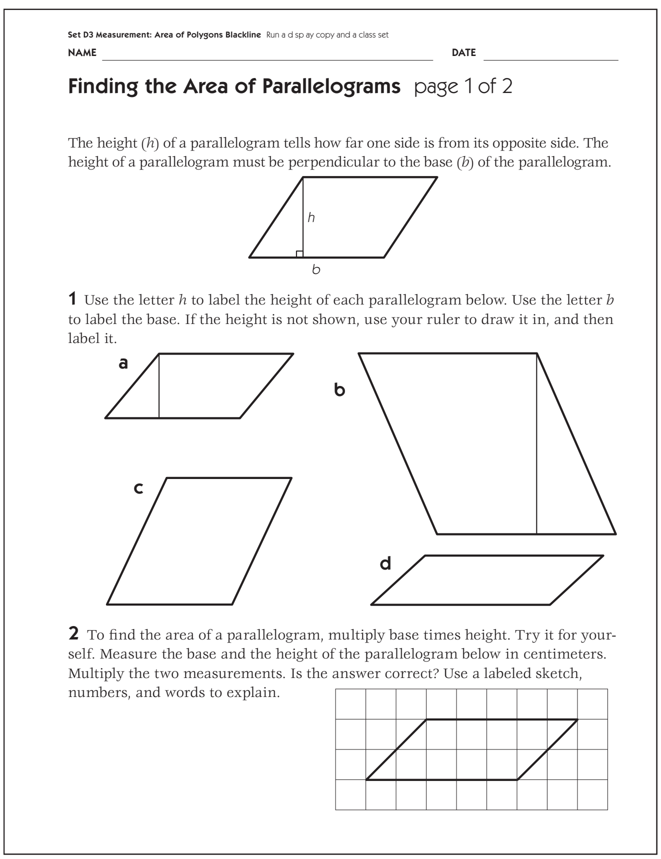
Activity 2 Area of Parallelograms, Part 2 (cont.)



9. Now write the formula for finding the area of a parallelogram: base × height, or *bh*, on the board. Discuss this formula with the class, and work with input from the students to explain it.

> ***Teacher*** *Here is the formula mathematicians use for finding the area of a parallelogram: base times height, or* bh. *Talk with the person next to you about this formula. How does it work? Would it work for any parallelogram, including rectangles and squares?*
>
> ***Students*** *It's the same as length times width.*
> *The height is like the line that can turn a slanty parallelogram into a rectangle.*
> *I think the base is kind of like the length, and the height is kind of like the width.*

10. Give students each a copy of Finding the Area of Parallelograms. Read over both sheets with the class and clarify as necessary. One image that may be helpful to students in identifying the height of each parallelogram on the first sheet is this: if a figure were to slide into the room on its base, what would be the height of the shortest door it could get through without bending over?


Set D3 Measurement: Area of Polygons Blackline Run a display copy and a class set

NAME ______________________ DATE ____________

Finding the Area of Parallelograms page 1 of 2

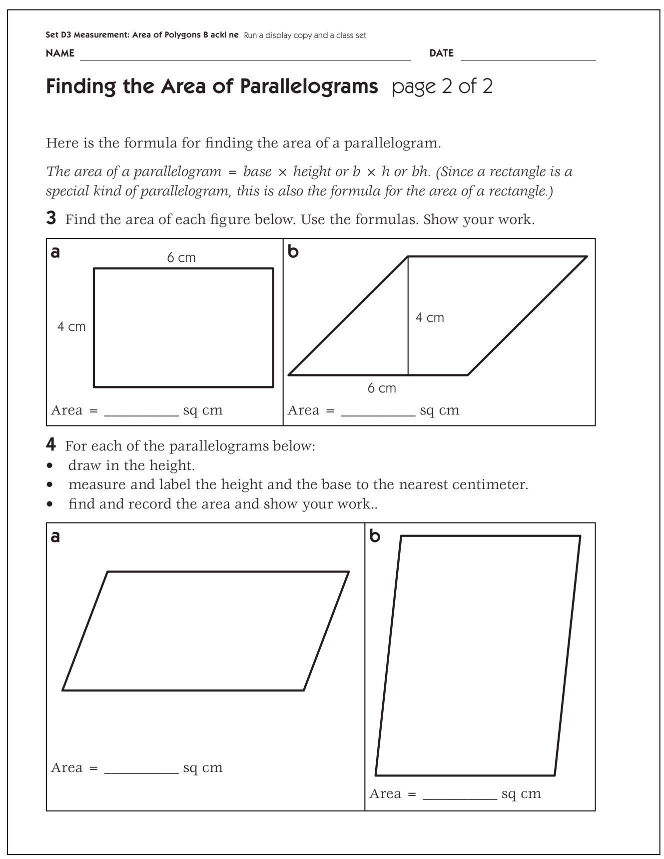
The height (*h*) of a parallelogram tells how far one side is from its opposite side. The height of a parallelogram must be perpendicular to the base (*b*) of the parallelogram.

h
b

1 Use the letter *h* to label the height of each parallelogram below. Use the letter *b* to label the base. If the height is not shown, use your ruler to draw it in, and then label it.

a **b** **c** **d**

2 To find the area of a parallelogram, multiply base times height. Try it for yourself. Measure the base and the height of the parallelogram below in centimeters. Multiply the two measurements. Is the answer correct? Use a labeled sketch, numbers, and words to explain.


Set D3 Measurement: Area of Polygons Blackline Run a display copy and a class set

NAME ______________________ DATE ____________

Finding the Area of Parallelograms page 2 of 2

Here is the formula for finding the area of a parallelogram.

The area of a parallelogram = base × height or b × h or bh. (Since a rectangle is a special kind of parallelogram, this is also the formula for the area of a rectangle.)

3 Find the area of each figure below. Use the formulas. Show your work.

a 6 cm, 4 cm — Area = ________ sq cm

b 4 cm, 6 cm — Area = ________ sq cm

4 For each of the parallelograms below:
- draw in the height.
- measure and label the height and the base to the nearest centimeter.
- find and record the area and show your work..

a Area = ________ sq cm

b Area = ________ sq cm

Activity 2 Area of Parallelograms, Part 2 (cont.)

11. When students understand what to do, have them go to work on the two sheets individually or in pairs. Circulate to provide support, or meet with students who feel they need help to complete the sheets.

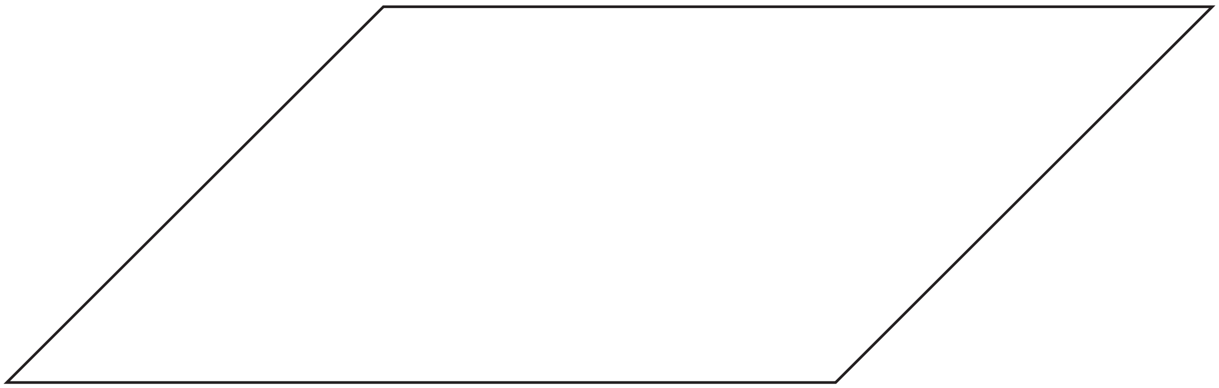
INDEPENDENT WORKSHEET

Use Set D3 Independent Worksheet 2 to provide students with more practice finding the area of parallelograms.

NAME ______________________________ DATE ______________

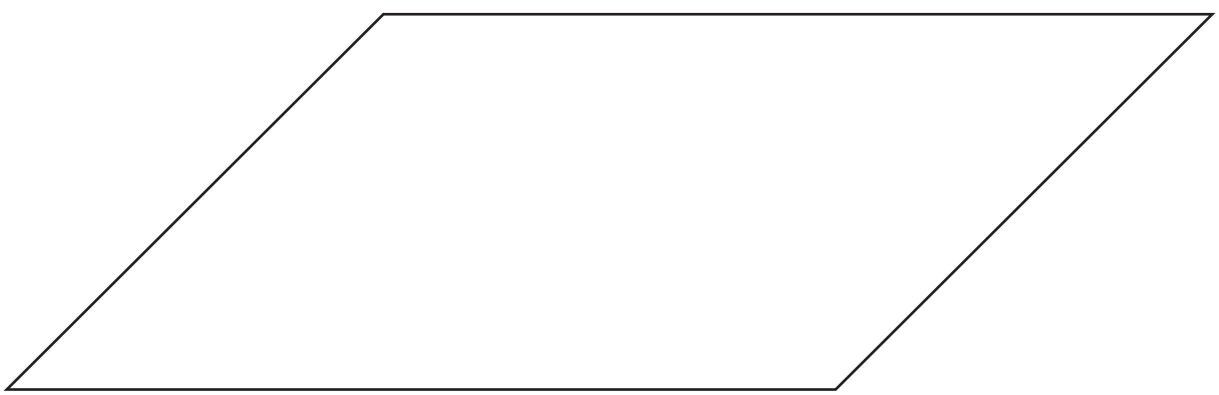
Parallelogram A

Find the area of this parallelogram in square centimeters.



Parallelogram A

Find the area of this parallelogram in square centimeters.



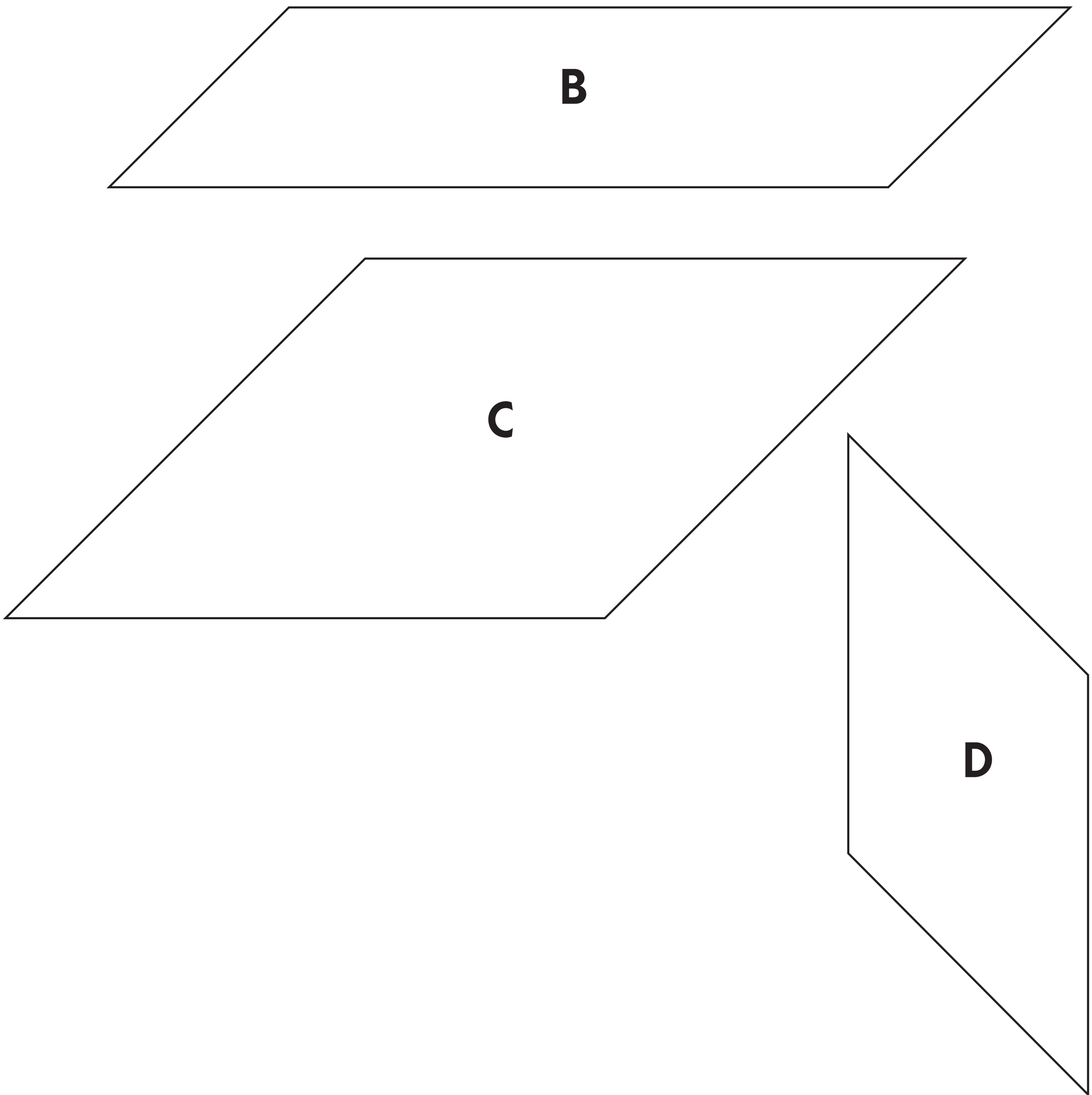
NAME ______________________________ **DATE** ______________

Centimeter Grid Paper

NAME ______________________________ **DATE** ______________

More Parallelograms to Measure

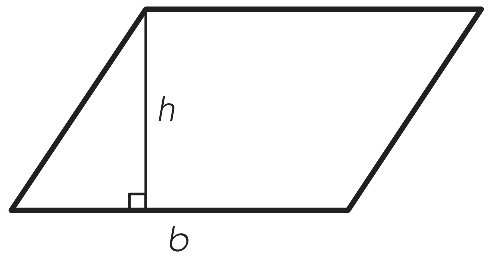
Find the area of these parallelograms in square centimeters.



NAME ______________________________ **DATE** ______________

Finding the Area of Parallelograms page 1 of 2

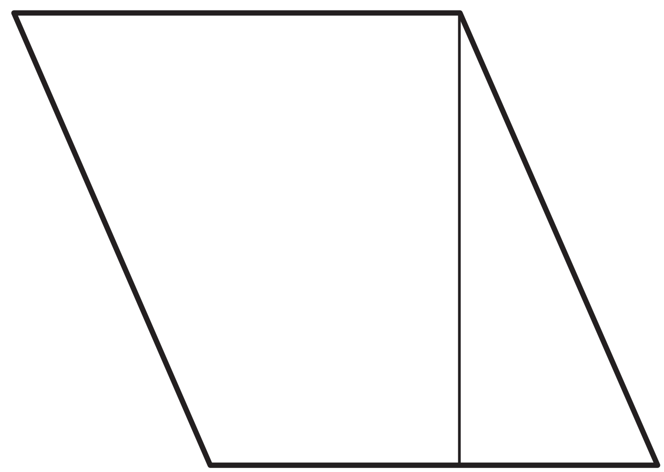
The height (*h*) of a parallelogram tells how far one side is from its opposite side. The height of a parallelogram must be perpendicular to the base (*b*) of the parallelogram.



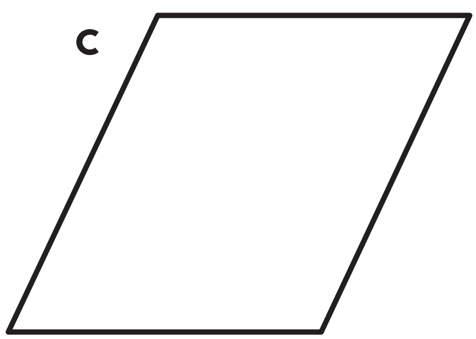
1 Use the letter *h* to label the height of each parallelogram below. Use the letter *b* to label the base. If the height is not shown, use your ruler to draw it in, and then label it.

a

b

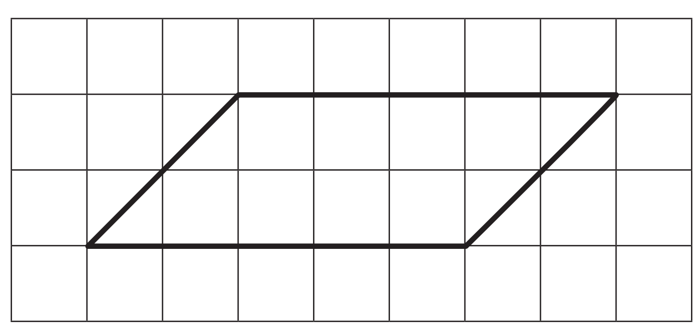


c



d

2 To find the area of a parallelogram, multiply base times height. Try it for yourself. Measure the base and the height of the parallelogram below in centimeters. Multiply the two measurements. Is the answer correct? Use a labeled sketch, numbers, and words to explain.



NAME ______________________________ **DATE** ______________

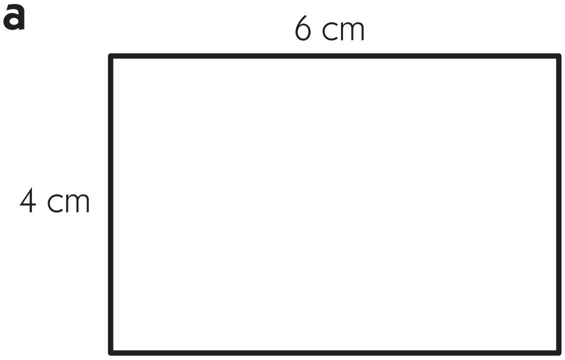
Finding the Area of Parallelograms page 2 of 2

Here is the formula for finding the area of a parallelogram.

The area of a parallelogram = base × height or b × h or bh. (Since a rectangle is a special kind of parallelogram, this is also the formula for the area of a rectangle.)

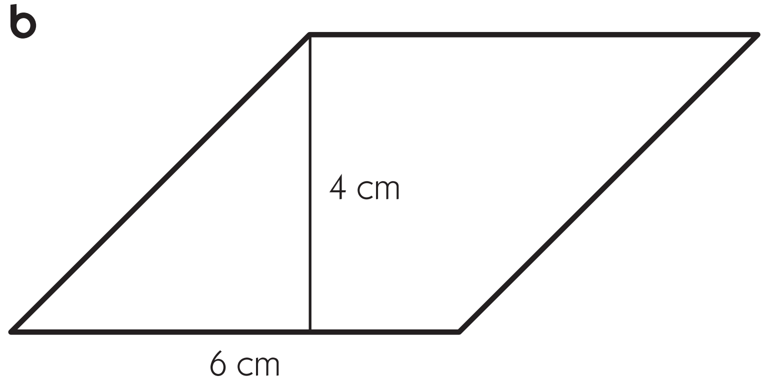
3 Find the area of each figure below. Use the formulas. Show your work.

a



Area = __________ sq cm

b

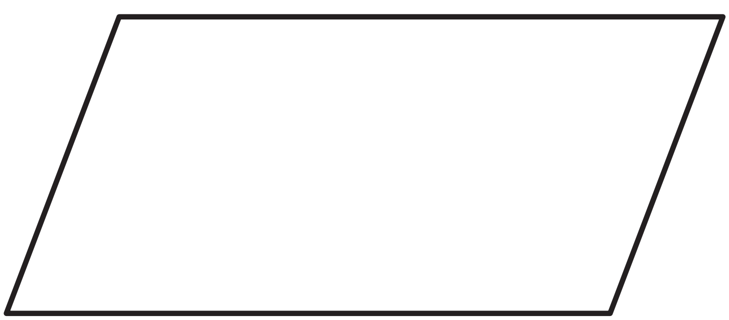


Area = __________ sq cm

4 For each of the parallelograms below:

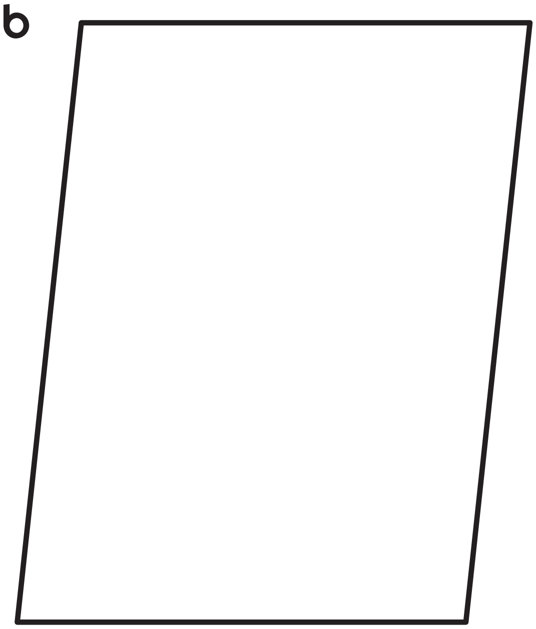
- draw in the height,
- measure and label the height and the base to the nearest centimeter,
- find and record the area and show your work.

a



Area = __________ sq cm

b



Area = __________ sq cm

Set D3 ★ Activity 3

ACTIVITY

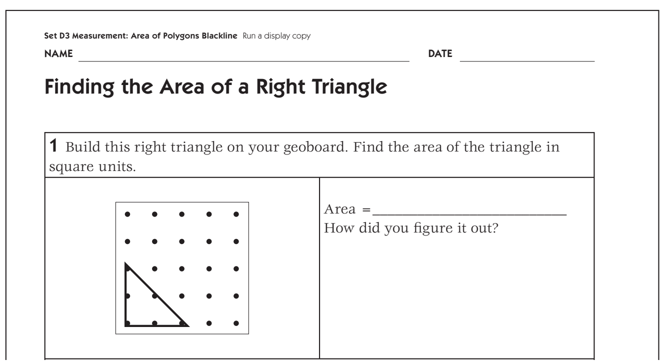
Area of Right Triangles

Overview
Students work on geoboards to find the area of several right triangles. After they share and explain their strategies, the teacher introduces the area formula for a right triangle and the class discusses how and why it works.

Skills & Concepts
- ★ develop and use the area formula for a right triangle by comparing with the formula for a rectangle (e.g., two of the same right triangles make a rectangle)
- ★ identify, draw, and construct models of right triangles and rectangles to solve problems

You'll need
- ★ Finding the Area of a Right Triangle (page D3.23, run a display copy)
- ★ More Triangles to Measure (page D3.24, class set)
- ★ Geoboard Paper (page D3.15, a few copies)
- ★ overhead geoboard and rubber bands
- ★ class set of geoboards and rubber bands
- ★ access to scissors and rulers
- ★ a piece of paper to mask parts of the display master

Instructions for Area of Right Triangles
1. Let students know that they are going to do some more work with area today. Place the top section of Finding the Area of a Right Triangle on display as helpers distribute geoboards and rubber bands to each student.


Set D3 Measurement: Area of Polygons Blackline Run a display copy
NAME DATE

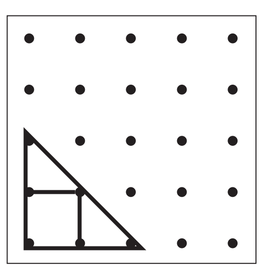
Finding the Area of a Right Triangle

1 Build this right triangle on your geoboard. Find the area of the triangle in square units.

Area =
How did you figure it out?

2. Read the first problem with the class, and take a minute to review the definition of right triangle (a triangle that has a 90° angle). Then ask students to copy the right triangle shown in the problem onto their geoboards and find the area in square units. After they have had a minute or two to work, ask them to pair-share their solutions and strategies. Then invite 2 or 3 volunteers to share and explain their work at the document camera or overhead.

> ***Maria*** *You can see 1 square in the middle and 2 little triangles. They're each half a square, so the whole thing is 2 square units. I put rubber bands on so you can see the square and the triangles.*



Activity 3 Area of Right Triangles (cont.)

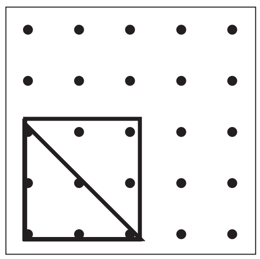
Jeffrey *I did it the same way, but I didn't put the rubber bands on like Maria did.*

3. Chances are, students will respond in a manner similar to the children in the dialogue above, identifying a square and mentally combining the two smaller triangles to create a second square. Press children to explain how they know that each of the smaller triangles is half a square unit. Then, unless it has already come up in discussion, ask students if the entire right triangle is half of a larger square. Give them a minute to explore and discuss the idea among themselves, and then ask a volunteer to share his thinking.

Garrett *Look, you can make this square around the whole triangle.*

Paula *You can see that the triangle is half the square; it's like cutting a sandwich in half on the diagonal, like my dad does when he makes the lunches.*

Pedro *If you use that way, it's easy to see that the area of the triangle is 2, because the whole square is 4, and just cut that in half.*

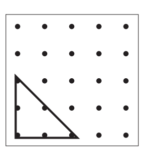
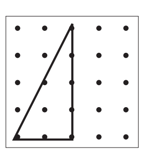


4. Reveal the next problem on the display sheet. Ask students to replicate the second right triangle on their geoboards and find the area. After they have had a minute or two to work, reconvene the class. Have a couple of volunteers share their strategies and solutions. Then work with input from the class to enter the information for both problems on the display sheet.

Set D3 Measurement: Area of Polygons Blackline Run a disp ay copy

NAME ______________________ DATE ______________

Finding the Area of a Right Triangle

1 Build this right triangle on your geoboard. Find the area of the triangle in square units.	
	Area = ______________ How did you figure it out?
2 Now build this right triangle on your geoboard. Find the area of the triangle in square units.	
	Area = ______________ How did you figure it out?

Activity 3 Area of Right Triangles (cont.)

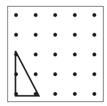
5. Now give students each a copy of More Triangles to Measure. Read the instructions on the sheet with the class, and clarify as necessary. Ask them to write a response to the last question in their math journal or on the back of the sheet.

Set D3 Measurement: Area of Polygons Blackline Run a class set

NAME ______________________ DATE ____________

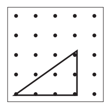
More Triangles to Measure

1 Build this right triangle on your geoboard. Find the area of the triangle in square units.



Area = ______________
How did you figure it out?

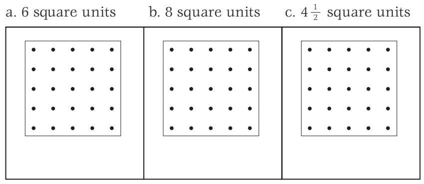
2 Now build this right triangle on your geoboard. Find the area of the triangle in square units.



Area = ______________
How did you figure it out?

3 Build 3 right triangles, one with an area of 6 square units, one with an area of 8 square units, and one with an area of $4\frac{1}{2}$ square units. Record your work below. Use labeled sketches, numbers, and/or words to prove that the area of each triangle you have drawn is correct.

a. 6 square units b. 8 square units c. $4\frac{1}{2}$ square units



4 The formula for the area of a right triangle is $\frac{1}{2}$ base × height, or $\frac{1}{2}bh$. Use labeled sketches, numbers, and words to explain why this works.

6. When students understand what to do, have them go to work individually or in pairs. Circulate to provide support as needed. While some students will quickly latch onto the idea of surrounding the triangle with a rectangle, others may want to cut the triangles apart and fit the pieces together. Provide these students with geoboard paper so they can experiment. As they do so, they may discover that the right triangles in problems 1 and 2 can both be pieced together to form rectangles.

7. As students finish, have them share and compare their solutions and strategies with at least one other classmate. Children who finish well ahead of their classmates can be challenged to construct other triangles, including non-right triangles, with areas of 6, 8, and $4\frac{1}{2}$ square units on their geoboards. Give these students geoboard paper on which to record their work.

8. When there are 5–10 minutes remaining in the period, reconvene the class to read and discuss the last question on the display master.

For discussion:

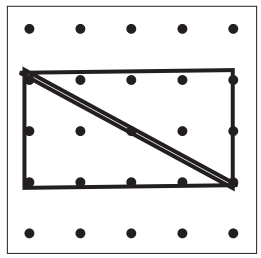
The formula for finding the area of a right triangle is $\frac{1}{2}$ base × height, or $\frac{1}{2}bh$.

- Show how and why this formula works.
- Do you think this formula works for all types of triangles? Why or why not?

Activity 3 Area of Right Triangles (cont.)

Teacher *Talk with the person sitting next to you about the formula shown here. Does* $\frac{1}{2}$ *base* × *height make sense as a way to find the area of a right triangle? Why or why not? Can you find a way to show how it works on your geoboard? Take a minute to talk it over, and then let's hear some ideas.*

Students *That formula just looks weird.*
But not if you remember that base times height is the way to find the area of a rectangle.
I know how to show it on a geoboard! Just make a right triangle and put a rectangle around it like this, see? Then you can see that the area of the triangle is half the area of the rectangle!
Oh yeah! So the whole rectangle takes up 8 squares. That means the triangle must be 4 square units.

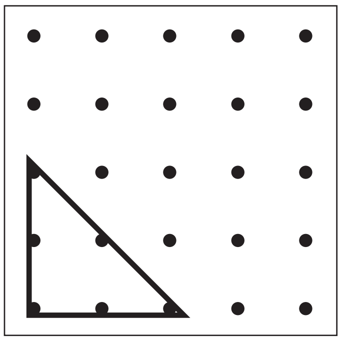


9. Conclude the session by letting students know they'll be doing some more work with area tomorrow.

NAME ______________________ **DATE** ______________

Finding the Area of a Right Triangle

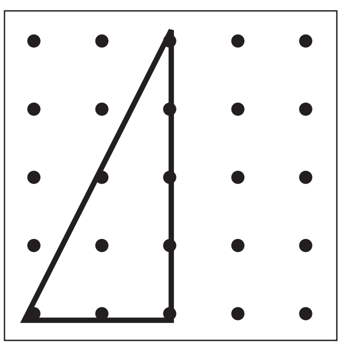
1 Build this right triangle on your geoboard. Find the area of the triangle in square units.



Area = ______________________

How did you figure it out?

2 Now build this right triangle on your geoboard. Find the area of the triangle in square units.



Area = ______________________

How did you figure it out?

For discussion:

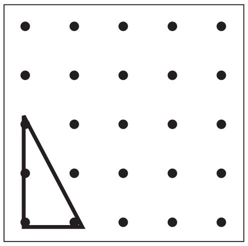
The formula for finding the area of a right triangle is $\frac{1}{2}$ base × height, or $\frac{1}{2}bh$.

- Show how and why this formula works.
- Do you think this formula works for all types of triangles? Why or why not?

NAME ______________________________ **DATE** ______________

More Triangles to Measure

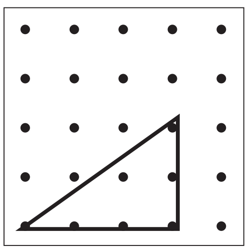
1 Build this right triangle on your geoboard. Find the area of the triangle in square units.



Area = ______________________

How did you figure it out?

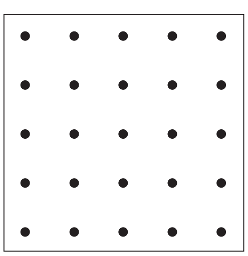
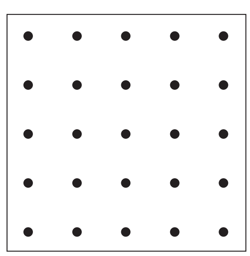
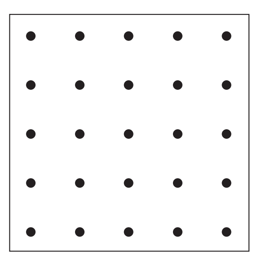
2 Now build this right triangle on your geoboard. Find the area of the triangle in square units.



Area = ______________________

How did you figure it out?

3 Build 3 right triangles, one with an area of 6 square units, one with an area of 8 square units, and one with an area of $4\frac{1}{2}$ square units. Record your work below. Use labeled sketches, numbers, and/or words to prove that the area of each triangle you have drawn is correct.

a. 6 square units	b. 8 square units	c. $4\frac{1}{2}$ square units
		

4 The formula for the area of a right triangle is $\frac{1}{2}$ base × height, or $\frac{1}{2}bh$. Use labeled sketches, numbers, and words to explain why this works.

Set D3 ★ Activity 4

ACTIVITY

Polygons to Order

Overview

The teacher reviews the formulas for finding the area of rectangles, non-rectangular parallelograms, and triangles with the class. Students then work in pairs to estimate and determine the area in square centimeters of 6 different polygons.

Skills & Concepts

★ develop and use the area formula for a right triangle by comparing with the formula for a rectangle (e.g., two of the same right triangles make a rectangle)

★ develop, use, and justify the relationships among area formulas of triangles and parallelograms by decomposing and comparing with areas of right triangles and rectangles

★ measure to the nearest millimeter

You'll need

★ Area Formulas (page D3.28, run a display copy)

★ Polygons to Order (page D3.29, run a half-class set plus a few extra on 3 or 4 different colors of copy paper)

★ Polygons Record Sheet (page D3.30, class set)

★ access to Centimeter Grid Paper (page D3.15)

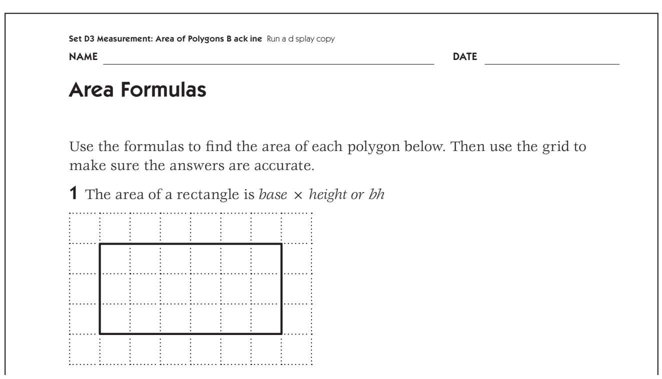
★ rulers, scissors, gluesticks (class set of each)

★ 12" x 18" newsprint (half-class set plus a few extra)

★ piece of paper to mask parts of the display master

Instructions for Polygons to Order

1. Let students know that they are going to spend some more time investigating area of various polygons today. Then place the top portion of the Area Formulas overhead on display, keeping the rest covered for now. Read the instructions with the class.


Set D3 Measurement: Area of Polygons Blackline Run a display copy

NAME DATE

Area Formulas

Use the formulas to find the area of each polygon below. Then use the grid to make sure the answers are accurate.

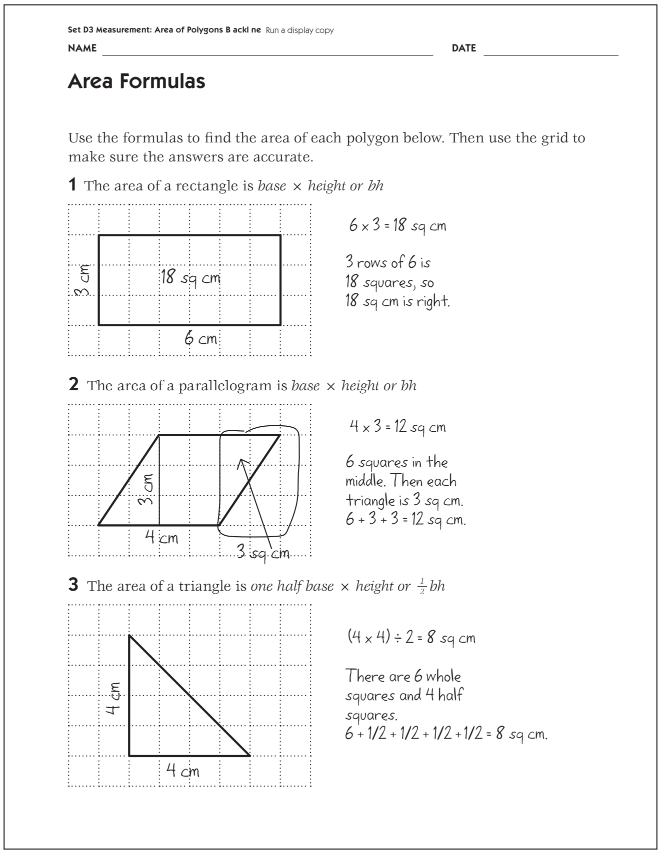
1 The area of a rectangle is *base × height or bh*

2. Review the formula for finding the area of a rectangle (base × height). Have a volunteer come up to measure and label the base and height of the rectangle (6 cm and 3 cm). Work with input from the class to record the equation that will yield the area (6 × 3 = 18 sq cm). Then call another volunteer to come up and confirm the answer by counting the grid squares.

Activity 4 Polygons to Order (cont.)

> ***Anna*** *Yep, it works. You can see that there are 3 rows of 6 in that rectangle, so the answer has to be 18 square centimeters.*

3. Reveal the second and then the third problems on the Area Formulas sheet. As you show each problem, repeat step 2, recording on the sheet as you go.


Set D3 Measurement: Area of Polygons Blackline Run a display copy

NAME ____________ DATE ____________

Area Formulas

Use the formulas to find the area of each polygon below. Then use the grid to make sure the answers are accurate.

1 The area of a rectangle is *base* × *height or bh*

2 The area of a parallelogram is *base* × *height or bh*

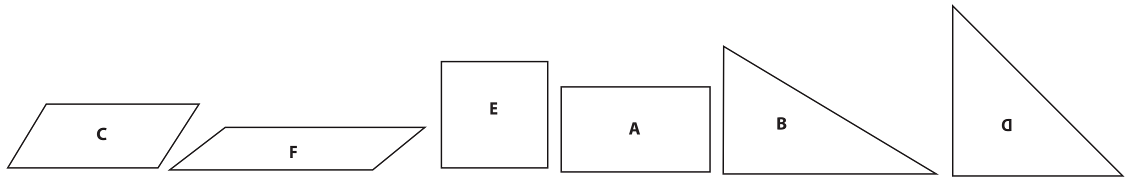
3 The area of a triangle is *one half base* × *height or* $\frac{1}{2}$ *bh*

4. Now ask students to pair up, or assign partners. Give each pair a copy of the Polygons to Order blackline. (If you give each pair at a table a different color sheet, they'll be able to keep track of their own polygons more easily.) Have them work together to carefully cut apart the 6 polygons along the heavy lines.

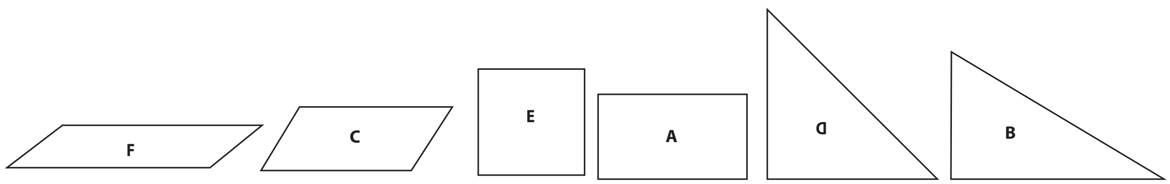
5. Let students know that in a minute, they'll be estimating and finding the area of each polygon in square centimeters. Before they do, ask them to use their estimation skills to place the 6 in order, from smallest to largest area. Have them discuss their thinking with their partners as they sequence the polygons, and then choose a few volunteers to share their ideas with the class.

> ***DJ*** *It's kind of hard to tell. First we thought the rectangle was the smallest, but then we set the parallelograms on top of the rectangle, and it looked like they were smaller. Same with the square. The triangles are definitely bigger than the square and the rectangle.*

Activity 4 Polygons to Order (cont.)



> ***Maria*** *We said F is the smallest because it's so skinny. We put C next, and then E. After that, we put A, but we think B might be bigger than D. Even though D is taller, B is longer.*



6. Asks students to get out their rulers (if they haven't done so already), and give each student a copy of the Polygons Record Sheet. Review the instructions on the sheet with the class, and let them know where they can find the large paper when they are ready for it. Explain that each pair is responsible for turning in a large sheet with the polygons glued on and labeled, and each partner is responsible for completing his or her own record sheet. Let students know that while they are expected to measure each polygon carefully, and use the formula to find its area, they can also use grid paper to double-check their answers. When students understand what to do, have them go to work.

CHALLENGE

7. Pairs who complete the assignment well before other students may be asked to create a seventh polygon with an area of 36 square centimeters and glue it to their large sheet of paper with the other 6 shapes. Challenge them to create a polygon that is not a right triangle, rectangle, or parallelogram. Remind them to label their polygon with its dimensions and area, and show how they found the area after they have glued it to the paper.

INDEPENDENT WORKSHEET

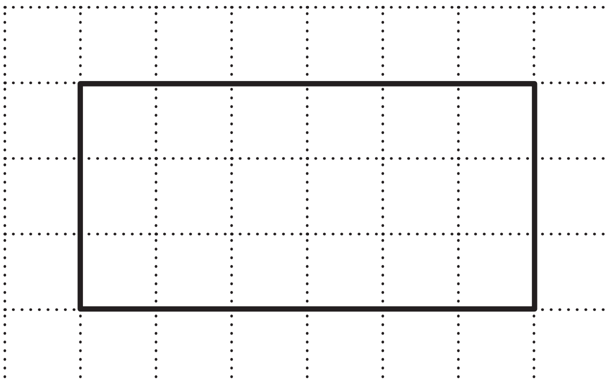
Use Set D3 Independent Worksheets 3 and 4 to provide students with more practice using formulas to determine the areas of right triangles, rectangles, and parallelograms.

NAME ______________________________ **DATE** ______________

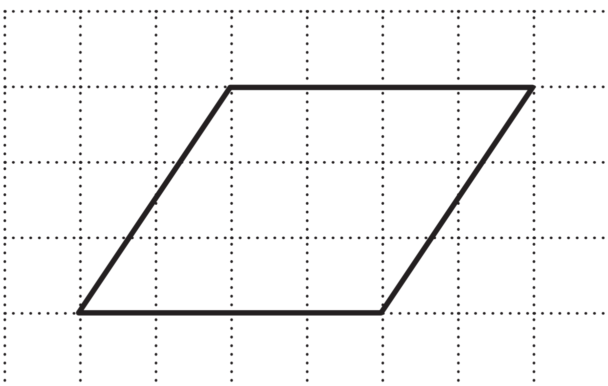
Area Formulas

Use the formulas to find the area of each polygon below. Then use the grid to make sure the answers are accurate.

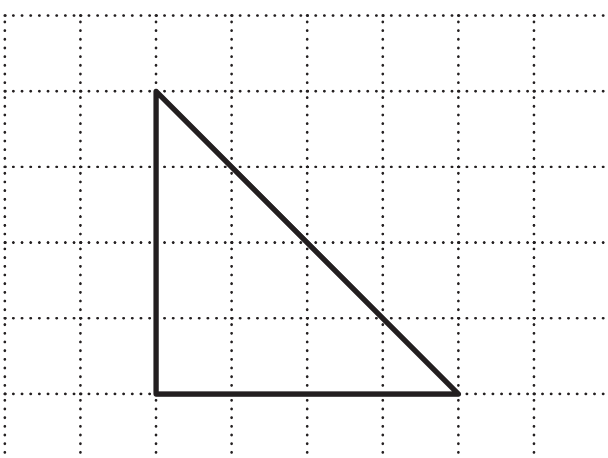
1 The area of a rectangle is *base* × *height or bh*



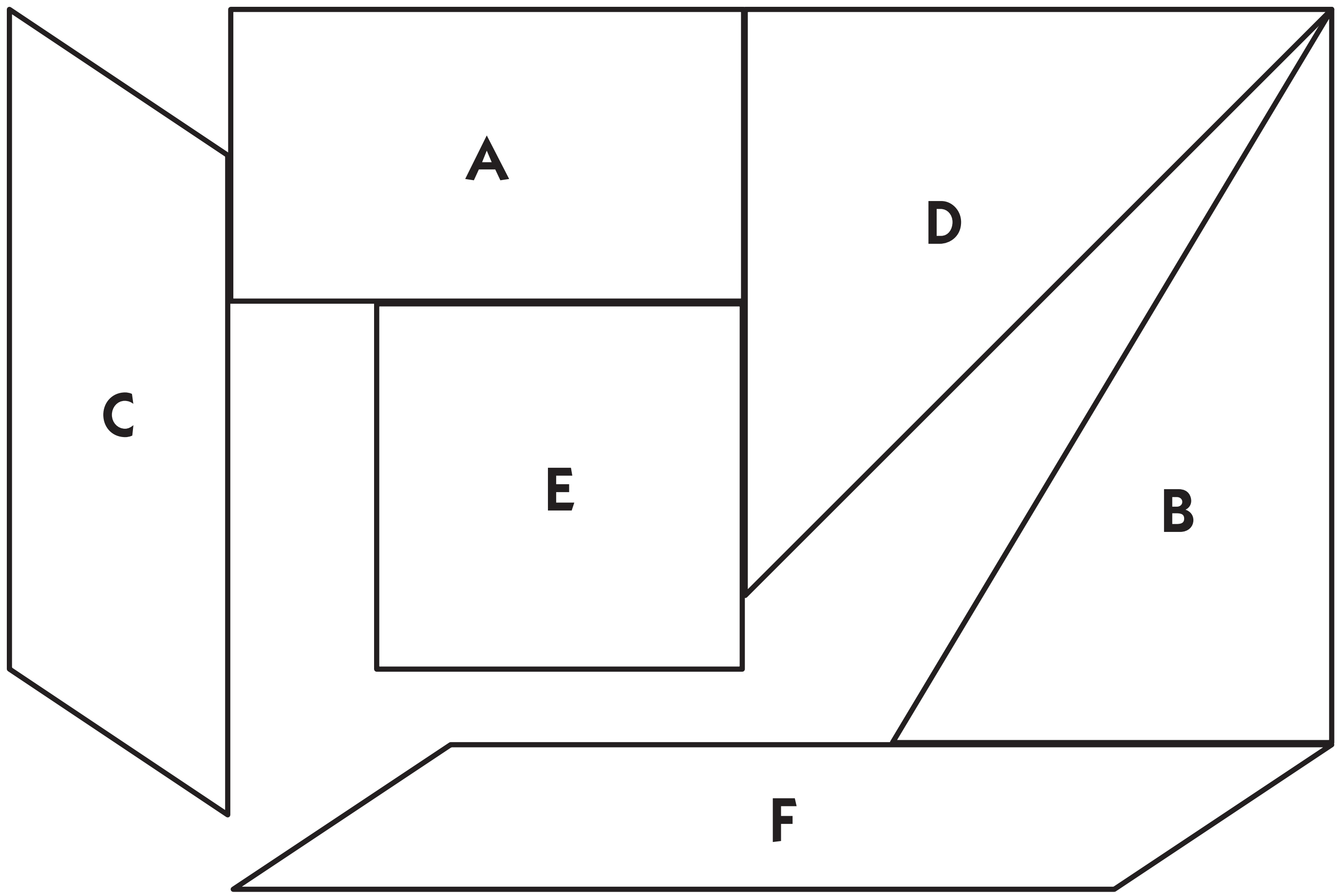
2 The area of a parallelogram is *base* × *height or bh*

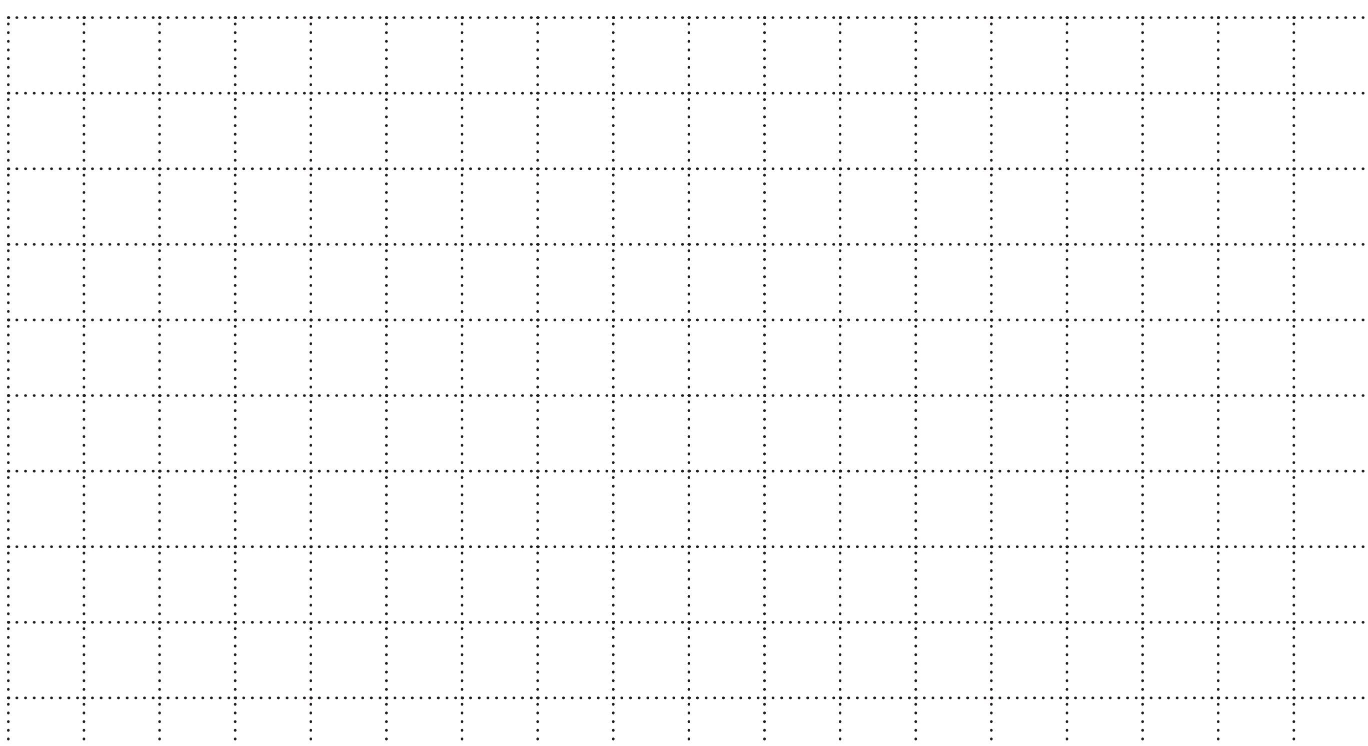


3 The area of a triangle is *one half base* × *height or* $\frac{1}{2}bh$



Polygons to Order





NAME ______________________________ **DATE** ______________

Polygons Record Sheet

1 Work with your partner to carefully cut out the 6 polygons and put them in order, from smallest to largest area.

2 After you've agreed on the order, write the letters of the polygons where you think they belong in the boxes below.

Smallest Area		→			Largest Area

3 Estimate the area of each polygon and find its actual area in square centimeters. Remember to label your work with the correct units (square centimeters). Record your work on the chart below.

Polygon Letter	Your Estimate in square centimeters (sq. cm)	Actual Area in square centimeters (sq. cm)

4 Glue the polygons onto a large sheet of paper in order from smallest area to largest area. Label each polygon with its base, height, and area. For each polygon, use sketches, numbers and/or words to show how you found the area.

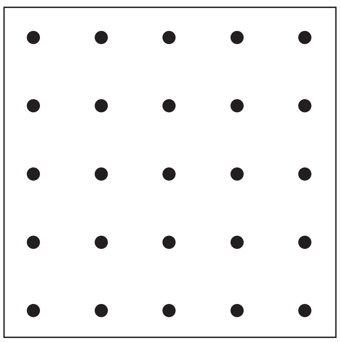
NAME ______________________________ **DATE** ______________

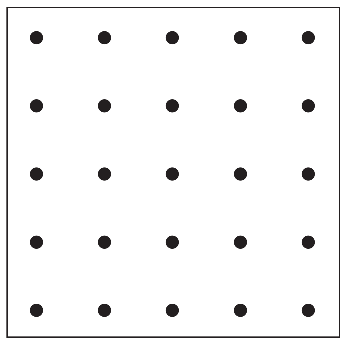
Set D3 ★ Independent Worksheet 1

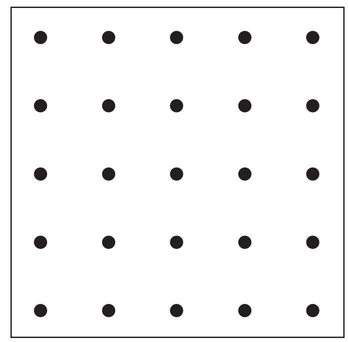
INDEPENDENT WORKSHEET

Geoboard Polygons

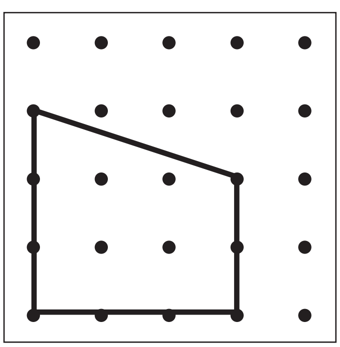
1 Build and record 3 different polygons (not rectangles) that each have an area of 2 square units. Use labeled sketches, numbers, and/or words to prove that the area of each polygon is really 2 square units.

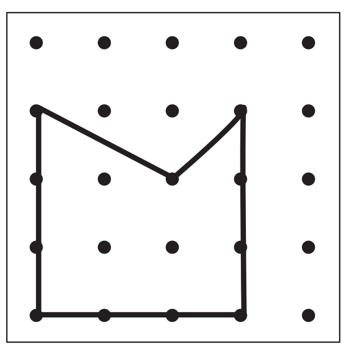


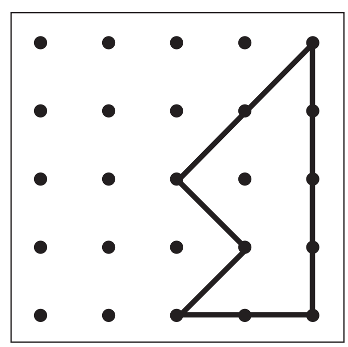




2 Find the area of each of the polygons below in square units. Use labeled sketches, numbers, and/or words to prove each of your answers.







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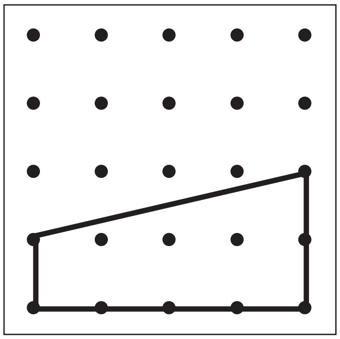
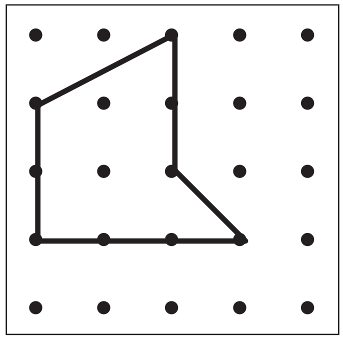
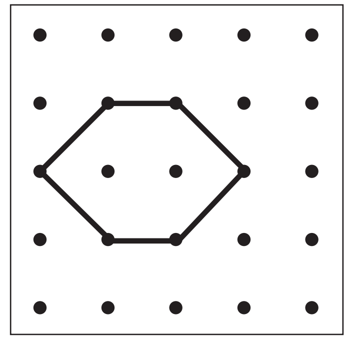
Independent Worksheet 1 Geoboard Polygons (cont.)

3 Find the area of each of the polygons below in square units. Use labeled sketches, numbers, and/or words to prove each of your answers.



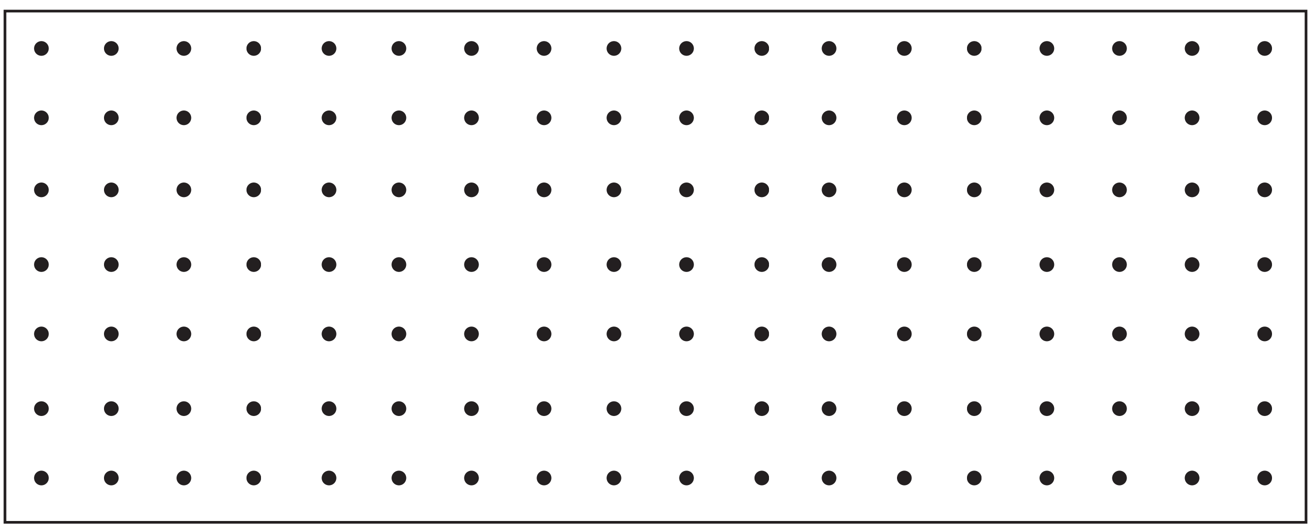




CHALLENGE

4a Here is a giant geoboard. On this geoboard, draw a right triangle, a rectangle, and a square that follow the rules below.

- The rectangle's area must be 3 times as big as the area of the right triangle.
- The square's perimeter must be 2 times as big as the perimeter of the rectangle.



4b Label each of the polygons you drew with its base, height, area, and perimeter.

NAME ______________________________ **DATE** ______________

Set D3 ★ Independent Worksheet 2

INDEPENDENT WORKSHEET

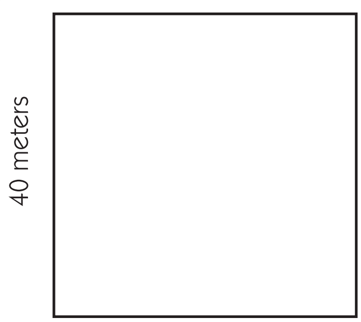
Finding Perimeter & Area of Quadrilaterals

To find the perimeter of any quadrilateral, add the side lengths. For rectangles, you can use the formula 2 times length plus 2 times width, or $2l + 2w$.

The formula for finding the area of all parallelograms, including rectangles is base × height, or bh.

1 Use the formulas above to find the perimeter and area of each figure on this page. Show your work.

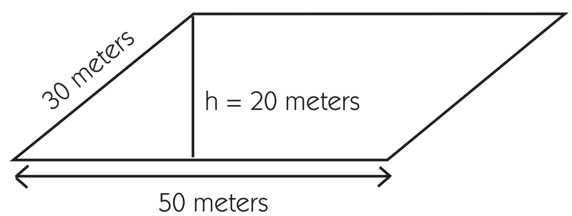
a Square



Perimeter = _______ meters

Area = _______ square meters

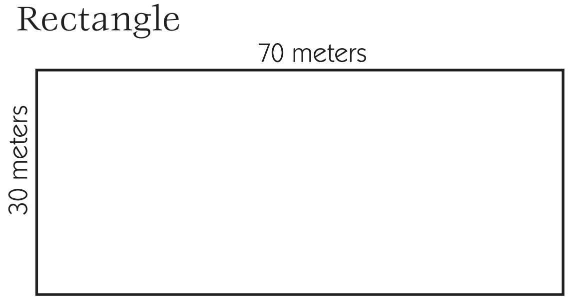
b Parallelogram



Perimeter = _______ meters

Area = _______ square meters

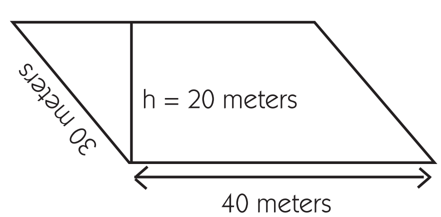
c Rectangle



Perimeter = _______ meters

Area = _______ square meters

d Parallelogram



Perimeter = _______ meters

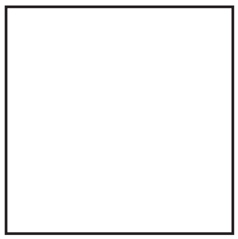
Area = _______ square meters

Independent Worksheet 2 Finding Perimeter & Area of Quadrilaterals (cont.)

3 For each quadrilateral below:

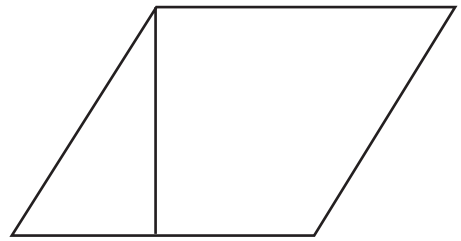
- Measure and label the base and height in centimeters.
- Use the information to find the area of the quadrilateral. Show your work.

a



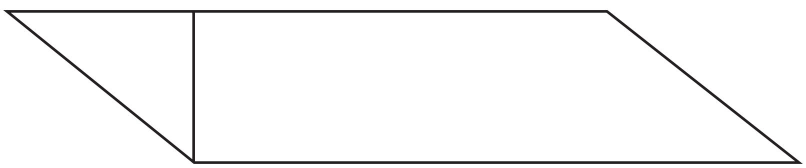
Area = _______ sq. cm

b



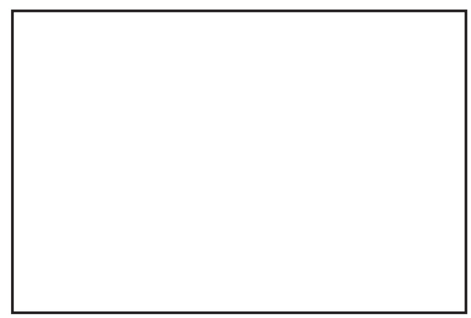
Area = _______ sq. cm

c



Area = _______ sq. cm

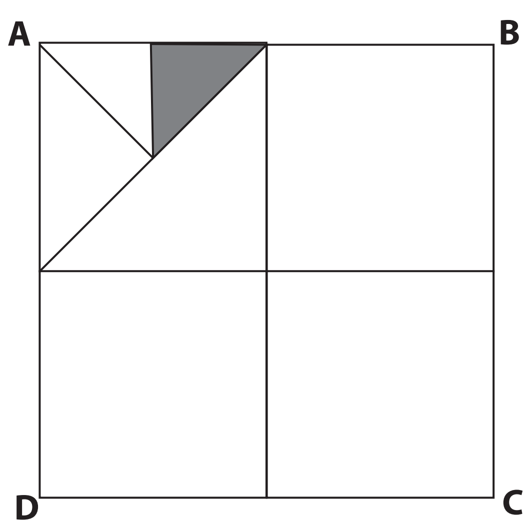
d



Area = _______ sq. cm

CHALLENGE

4 The area of square ABCD is 64 square feet. What is the area of the gray triangle? Use sketches, numbers and/or words to solve the problem. Show all of your work.



NAME ______________________________ DATE ______________

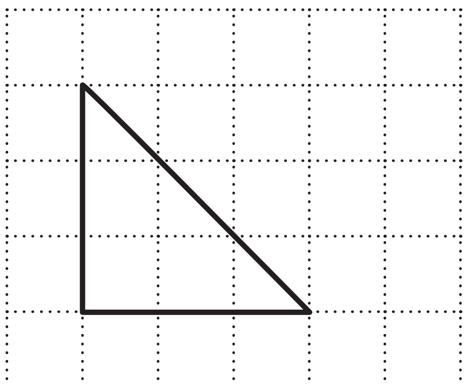
Set D3 ★ Independent Worksheet 3

INDEPENDENT WORKSHEET

Finding the Area of Right Triangles

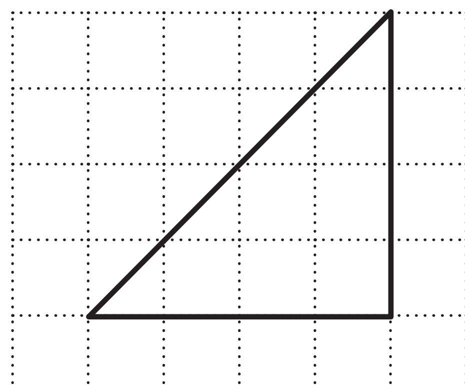
1 The formula for the area of a right triangle is $\frac{1}{2}$base × height, or $\frac{1}{2}bh$. Use the formula to find the area of each right triangle below. Show your work. Use the grids to check your answers.

a



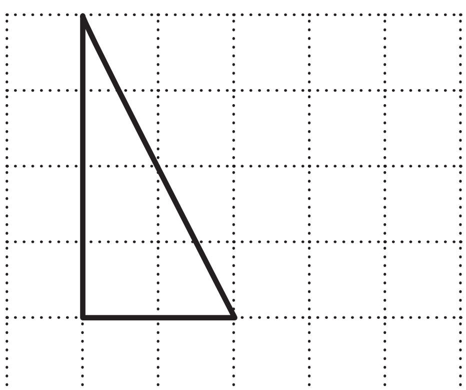
Area = ________ sq. cm

b



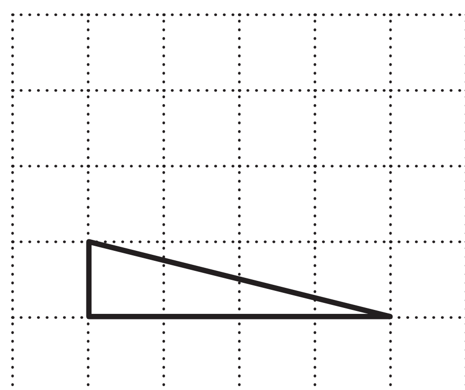
Area = ________ sq. cm

c



Area = ________ sq. cm

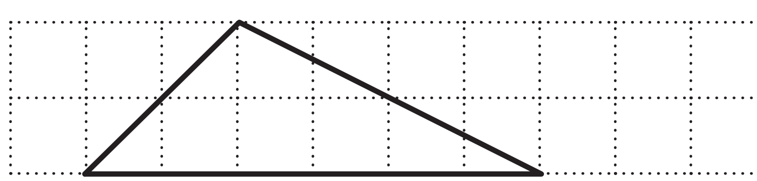
d



Area = ________ sq. cm

CHALLENGE

e Hint: Divide the triangle into 2 right triangles. Find the area of each and add them.

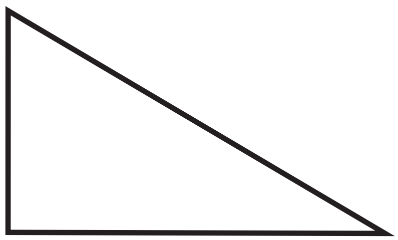
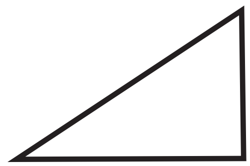
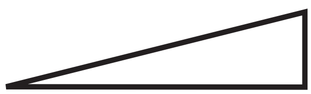
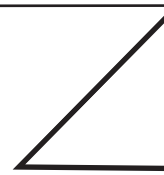


(Continued on back.)

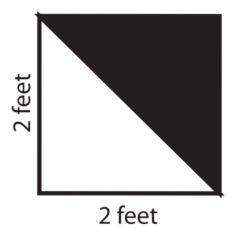
Independent Worksheet 3 Finding the Area of Right Triangles (cont.)

3 For each right triangle below:

- Measure and label the base and height in centimeters.
- Use the information to find the area of the right triangle. Show your work.

a  Area = ____________________	**b**  Area = ____________________
c  Area = ____________________	**d**  Area = ____________________

4 The drill team wants to make new black and white flags, using the plan below.



a How many square feet of white fabric will it take to make 1 flag? How many square feet of black fabric will it take to make 1 flag? Show your work.

b The team needs to make 20 flags. The black fabric costs 50¢ a square foot. The white fabric is on sale for 45¢ a square foot. How much will they have to pay for all the fabric to make 20 flags? Show your work.

NAME ______________________________ DATE ______________

Set D3 ★ Independent Worksheet 4

INDEPENDENT WORKSHEET

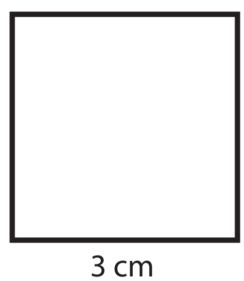
Rectangles, Parallelograms & Right Triangles

The formula for finding the area of all parallelograms, including rectangles, is base × height, or *bh*.

The formula for finding the area of all triangles is $\frac{1}{2}$base × height, or $\frac{1}{2}bh$.

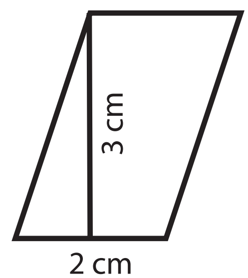
1 Use the formulas above to find the area of each figure on this page. Show your work. Label your answers with the correct units.

a Square



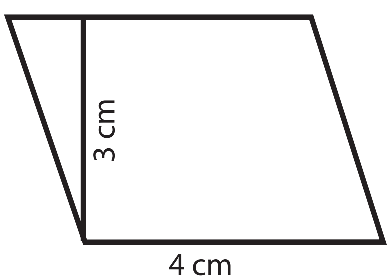
Area = ______________

b Parallelogram



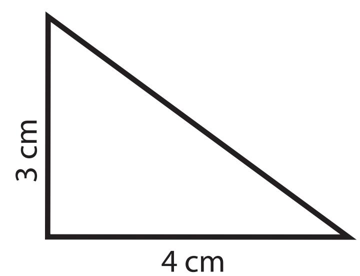
Area = ______________

c Parallelogram



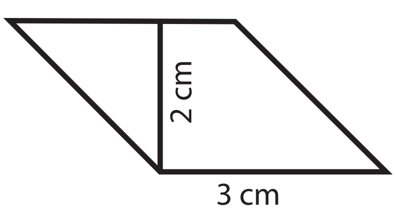
Area = ______________

d Right Triangle



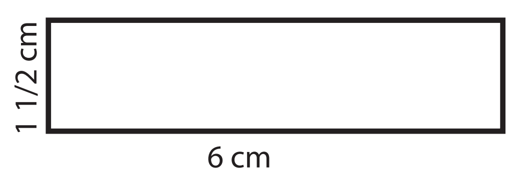
Area = ______________

e Parallelogram



Area = ______________

f Rectangle



Area = ______________

Independent Worksheet 4 Rectangles, Parallelograms & Right Triangles (cont.)

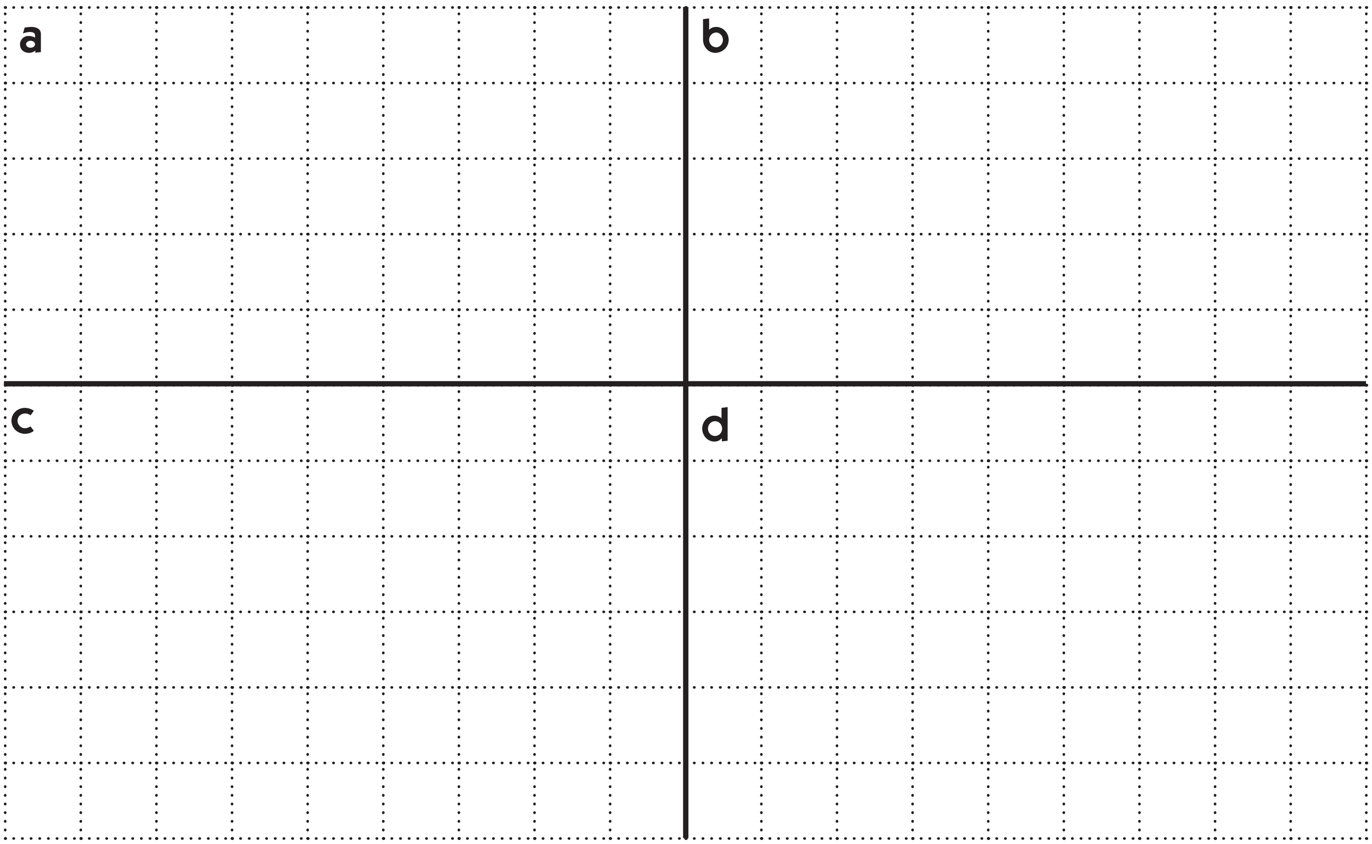
2 On the centimeter grid below, draw the following shapes. Label each shape with its base, height, and area.

a A rectangle with an area of 15 square centimeters.

b A right triangle with an area of 8 square centimeters.

c A parallelogram that is not a rectangle with an area of 10 square centimeters.

d A right triangle with an area of 12 square centimeters.



3 Miss Smith wants to make a paper sailboat to put up on the wall in her kindergarten classroom. How many square inches of butcher paper will she need in each color? Show all of your work. If you need more space, use another piece of paper and attach it to this sheet.