Lesson 8

Area of Triangles

Goals

- Draw a diagram to show that the area of a triangle is half the area of an associated parallelogram.
- Explain (orally and in writing) strategies for using the base and height of an associated parallelogram to determine the area of a triangle.

Learning Target

I can use what I know about parallelograms to reason about the area of triangles.

Lesson Narrative

In this lesson, students reason about areas of triangles. They see that they can find the area of a triangle by applying strategies such as decomposing and rearranging, or enclosing and subtracting. They can also use the relationship between parallelograms and triangles.

Students observe that the area of a triangle is half of the area of a parallelogram that shares the same base as the triangle and has the same height. Students arrive at this observation by:

- Recalling that two copies of a triangle can be composed into a parallelogram
- Reasoning about one or more rectangles that have the same height as the triangle.

An optional activity is included to help students make another, related observation: that a triangle can be decomposed and rearranged into a parallelogram that shares the same base but is half the triangle's height.

In making these observations and applying them to find the areas of triangles on and off a grid, students practice looking for and making use of structure.

Access for Students with Diverse Abilities

- Action and Expression (Activity 1, Activity 2)

Access for Multilingual Learners

- MLR7: Compare and Connect (Activity 2)

Instructional Routines

- 5 Practices
- MLR7: Compare and Connect
- Notice and Wonder

Required Materials

Materials to Gather

- Math Community Chart: Lesson
- Geometry toolkits: Warm-up, Activity 1
- Math Community Chart: Warm-up
- Sticky notes: Warm-up
- Glue or glue sticks: Activity 2
- Tape: Activity 2

Required Preparation

Activity 2:
The student workbook contains two copies of Parallelograms A, B, C, and D. Each student will need 2 copies of a parallelogram.

Students need access to tape *or* glue; it is not necessary to have both.

Lesson Timeline

Warm-up	Activity 1	Activity 2	Lesson Synthesis	Cool-down (Assessment)
10 min	25 min	25 min	10 min	5 min

Lesson Narrative (continued)

A note about terminology:

At this point, students have not yet learned about bases and height in a triangle. They are not expected to use these terms when referring to measurements used to find the area of a triangle or when describing the connections between a triangle and a related parallelogram. While students may use the terms intuitively, the meanings of a triangle's base and height will be formalized in the next lesson.

Math Community

Today, students use sticky notes to document actions in the "Doing Math" sections of the Math Community Chart that they see or hear throughout the lesson. During the *Lesson Synthesis,* students share what they noticed, and then they suggest additions for the chart as part of the *Cool-down*. The work today continues to build a foundation for developing math community norms in a later exercise and is the start of students identifying strengths in the actions of their peers.

Student Learning Goal

Let's use what we know about parallelograms to find the area of triangles.

Instructional Routines

Notice and Wonder

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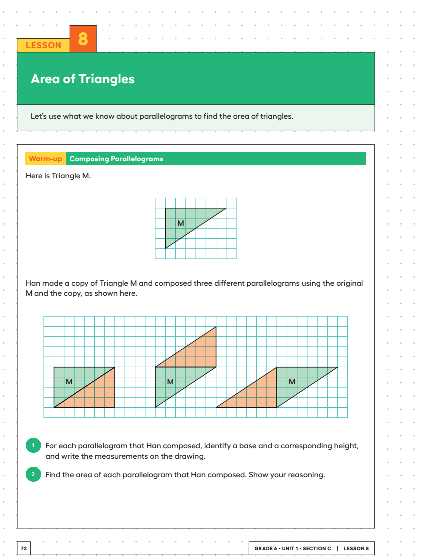
Building on Student Thinking

When identifying bases and heights of the parallelograms, some students may choose a non-horizontal or non-vertical side as a base and struggle to find its length and the length of its corresponding height. Ask them to see if there's another side that could serve as a base and has a length that can be more easily determined. Clarify that we can use the grid to measure a length only if the segment is parallel to the grid lines.

Students may not immediately recall that squares and rectangles are also parallelograms. Prompt them to recall the defining characteristics of parallelograms, by asking:

> *"What makes a figure a parallelogram? What are its characteristics?"*

Student Workbook


LESSON 8

Area of Triangles

Let's use what we know about parallelograms to find the area of triangles.

Warm-up Composing Parallelograms

Here is Triangle M.

Han made a copy of Triangle M and composed three different parallelograms using the original M and the copy, as shown here.

1 For each parallelogram that Han composed, identify a base and a corresponding height, and write the measurements on the drawing.

2 Find the area of each parallelogram that Han composed. Show your reasoning.

Warm-up

Composing Parallelograms

10 min

Activity Narrative

This *Warm-up* has two aims: to solidify what students learned about the relationship between triangles and parallelograms and to connect their new insights back to the concept of area.

Students are given a right triangle and the three parallelograms that can be composed from two copies of the triangle. Though students are not asked to find the area of the triangle, they may make some important observations along the way. They are likely to see that:

- The triangle covers half of the region of each parallelogram.
- The base-height measurements for each parallelogram involve the numbers 6 and 4, which are the lengths of two sides of the triangle.
- All parallelograms have the same area of 24 square units.

These observations enable them to reason that the area of the triangle is half of the area of a parallelogram (in this case, any of the three parallelograms can be used to find the area of the triangle). In upcoming work, students will test and extend this awareness, generalizing it to help them find the area of any triangle.

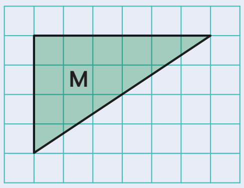
Launch

Arrange students in groups of 2. Display the image of the three parallelograms for all to see. Ask students to think of at least one thing that they notice and at least one thing that they wonder. Give students 1 minute of quiet think time, and then 1 minute to discuss with their partner the things that they notice and wonder.

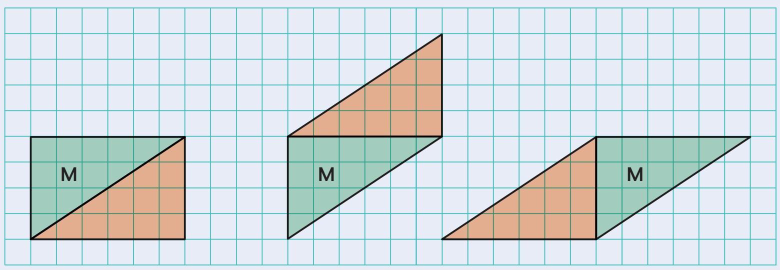
Give students 2–3 minutes of quiet time to complete the activity and access to their geometry toolkits. Follow with a whole-class discussion.

Student Task Statement

Here is Triangle M.

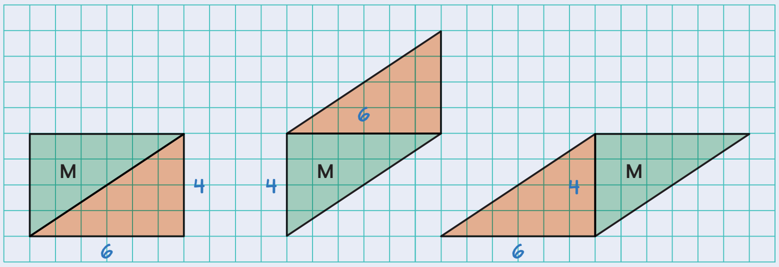


Han made a copy of Triangle M and composed three different parallelograms using the original M and the copy, as shown here.



1. For each parallelogram that Han composed, identify a base and a corresponding height, and write the measurements on the drawing.

First parallelogram: $b = 6$ and $h = 4$, second parallelogram: $b = 4$ and $h = 6$, third parallelogram: $b = 6$ and $h = 4$



2. Find the area of each parallelogram that Han composed. Show your reasoning.

The area of each parallelogram is 24 square units.

Sample reasoning: The base and height measurements for the parallelograms are 4 units and 6 units, or 6 units and 4 units. $4 \cdot 6 = 24$ and $6 \cdot 4 = 24$.

Activity Synthesis

Ask one student to identify the base, height, and area of each parallelogram, as well as how they reasoned about the area. If not already answered by students in their explanations, discuss the following questions:

"Why do all the pictured parallelograms have the same area even though they all have different shapes?"

They are composed of the same parts—two copies of the same right triangles. They have the same pair of numbers for their base and height. They all can be decomposed and rearranged into a 6-by-4 rectangle.

"What do you notice about the bases and heights of the parallelograms?"

They are the same pair of numbers.

"How are the base-height measurements related to the right triangle?"

They are the lengths of two sides of the right triangles.

"Can we find the area of the triangle? How?"

Yes, the area of the triangle is 12 square units because it is half of the area of every parallelogram, which is 24 square units.

Math Community

After the *Warm-up*, display the revised Math Community Chart created from student responses in Exercise 3. Tell students that today they are going to monitor for two things:

- "Doing Math" actions from the chart that they see or hear happening.
- "Doing Math" actions that they see or hear that they think should be added to the chart.

Provide sticky notes for students to record what they see and hear during the lesson.

Instructional Routines

5 Practices

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Access for Students with Diverse Abilities (Activity 2, Student Task)

Action and Expression: Internalize Executive Functions.
Invite students to verbalize their strategy for finding the areas of the triangles before they begin. Students can speak quietly to themselves, or share with a partner.
Supports accessibility for: Organization, Conceptual Processing, Language

Activity 1

More Triangles

25 min

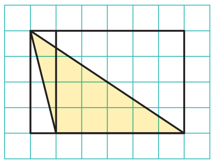
Activity Narrative

In this activity, students apply what they have learned to find the area of various triangles. They use reasoning strategies and tools that make sense to them. Students are not expected to use a formal procedure or to make a general argument. They will think about general arguments in an upcoming lesson.

Monitor for different ways of reasoning about the area. Here are some paths that students may take, from more elaborate to more direct:

- Draw two smaller rectangles that decompose the given triangle into two right triangles. Find the area of each rectangle and take half of its area. Add the areas of the two right triangles. (This is likely used for B and D.)

  For Triangle C, some students may choose to draw two rectangles around and on the triangle (as shown here), find half of the area of each rectangle, and *subtract* one area from the other.



- Enclose the triangle with one rectangle, find the area of the rectangle, and take half of that area. (This is likely used for right triangle A.)
- Duplicate the triangle to form a parallelogram, find the area of the parallelogram, and take half of its area. (This is likely used with any triangle.)

Launch

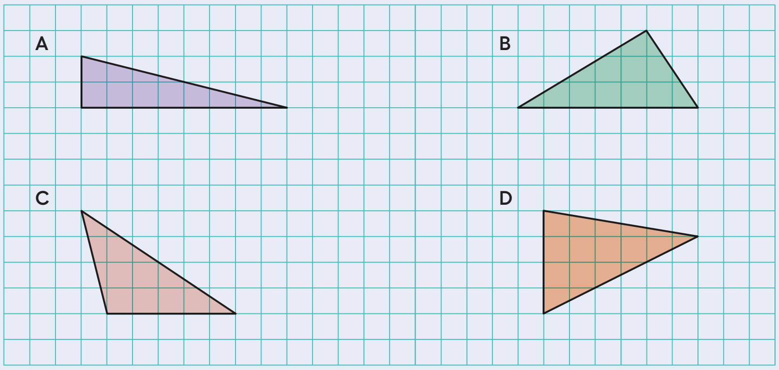
Tell students that they will now apply their observations from the past few activities to find the area of several triangles.

Arrange students in groups of 2–3. Give students 6–8 minutes of quiet work time and a few more minutes to discuss their work with a partner. Ask them to confer with their group only after each person has attempted to find the area of at least two triangles. Provide access to their geometry toolkits (especially tracing paper).

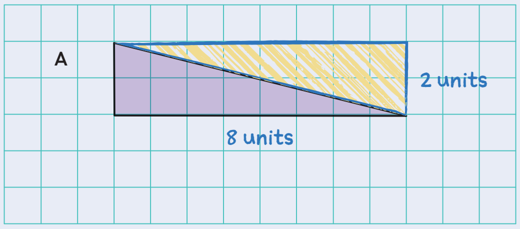
Select students who reasoned in different ways to share later.

Student Task Statement

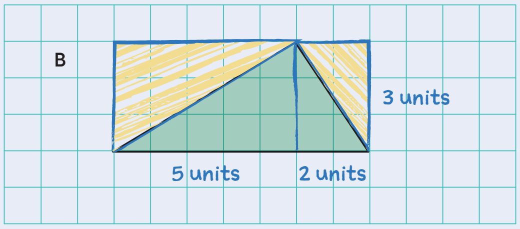
Find the areas of at least two of these triangles. Show your reasoning.



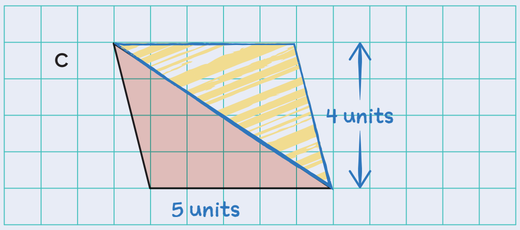
A: 8 square units. Sample reasoning: $8 \cdot 2 = 16$, so the area of the rectangle is 16 square units. The area of the triangle is half of that of the rectangle, so it is 8 square units.



B: 10.5 square units. Sample reasoning: $5 \cdot 3 = 15$, so the area of the left rectangle is 15 square units. The area of the left triangle is then 7.5 square units. $2 \cdot 3 = 6$, so the area of the right rectangle is 6 square units and the area of the right triangle is 3 square units. The sum of the areas of the small triangles which make up the large triangle is $7.5 + 3 = 10.5$, so the large triangle has an area of 10.5 square units.



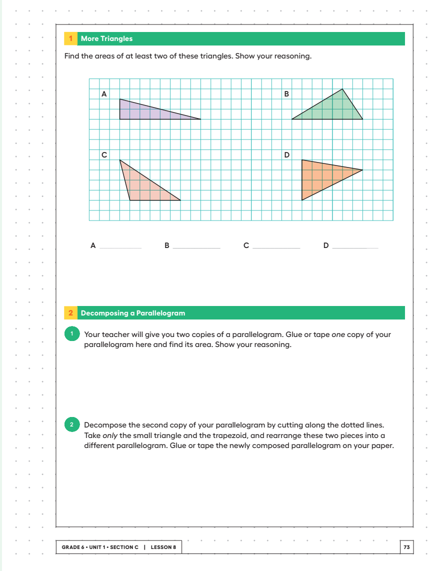
C: 10 square units. Sample reasoning: If we make a copy of the triangle, rotate it, and join them along the longest side we would get a parallelogram. The base length is 5 units and the height is 4 units, so the area of the parallelogram is 20 square units. The area of the triangle is half of that area, so it is 10 square units.



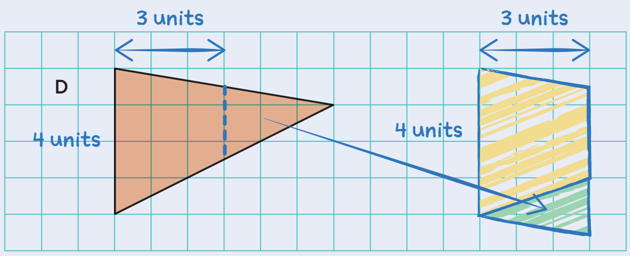
Building on Student Thinking

At this point students should not be counting squares to determine area. If students are still using this approach, steer them in the direction of recently learned strategies (decomposing, rearranging, enclosing, or duplicating).
Students may not recognize that the vertical side of Triangle D could be the base and try to measure the lengths of the other sides. If so, remind them that any side of a triangle can be the base.

Student Workbook



D: 12 square units. Sample reasoning: Decompose the triangle into a trapezoid and a small triangle by drawing a vertical line 3 units from the left side. Rotate the small triangle to line up with the bottom side of the trapezoid to create a parallelogram. To get the area of that parallelogram: $4 \cdot 3 = 12$



Activity Synthesis

The goal of this discussion is for students to see a wide range of ways to reason about the area of triangles.

Invite previously selected students to share their approach and display their reasoning for all to see. Sequence the presentations as shown in the *Activity Narrative*—starting with the most elaborate (most likely a strategy that involves enclosing a triangle) and moving toward the most direct (most likely duplicating the triangle to compose a parallelogram).

Connect the different responses to the learning goals by asking questions such as:

"Did anyone else reason the same way?"

"Did anyone else draw the same diagram but think about the problem differently?"

"Can this strategy be used on another triangle in this set? Which one?"

"Is there a triangle for which this strategy would not be helpful? Which one, and why not?"

Activity 2: Optional

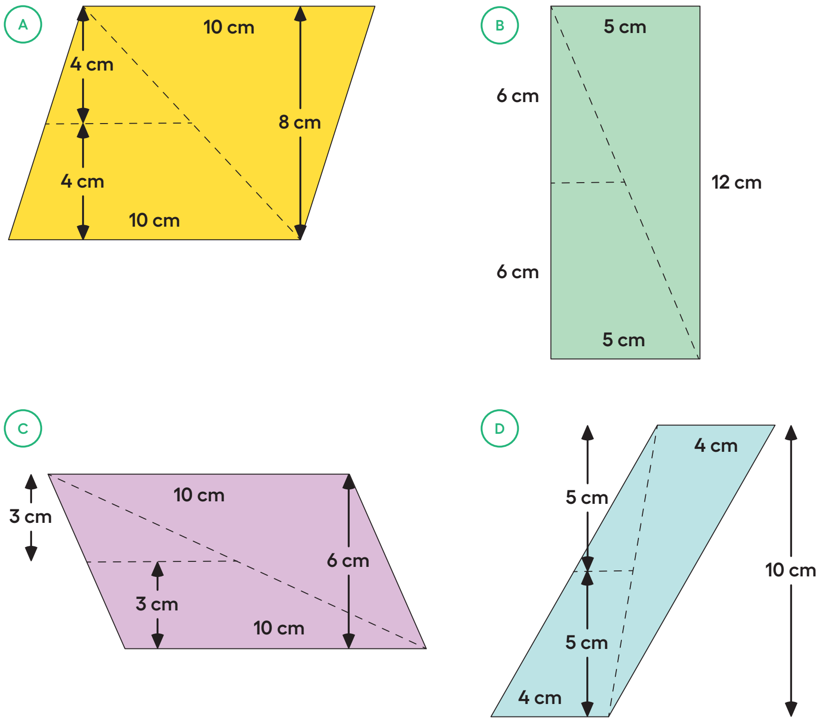
Decomposing a Parallelogram

25 min

Activity Narrative

This activity offers one more lens for thinking about the relationship between triangles and parallelograms. The reasoning here supports students in generalizing the process of finding the area of a triangle in a future lesson. Previously, students duplicated triangles to compose parallelograms. Here they see that a different set of parallelograms can be created from a triangle, not by duplicating it, but by decomposing it.

Students are assigned a parallelogram to be cut into two congruent triangles. They take one triangle and decompose it into smaller pieces by cutting along a line that goes through the midpoints of two sides. They then use these pieces—a trapezoid and a small triangle—to compose a new parallelogram and reason about its area. Two parallelograms can be created. Monitor for students who create different parallelograms from the same pieces.



Students notice that the height of this new parallelogram is half of the height of the original parallelogram, and the area is also half of the area of the original parallelogram. Because the new parallelogram is composed of the same parts as the remaining (or uncut) large triangle, the area of the triangle is also half of that of the original parallelogram. This reasoning provides another way to understand the formula for the area of triangles.

Of the four given parallelograms, Parallelogram B is likely the most manageable for students. When decomposed, its pieces (each with a right angle) resemble those seen in earlier work on parallelograms. Consider this when assigning parallelograms to students.

Instructional Routines

MLR7: Compare and Connect

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Access for Multilingual Learners (Activity 2, Narrative)

MLR7: Compare and Connect
This activity uses the *Compare and Connect* math language routine to advance representing and conversing as students use mathematically precise language in discussion.

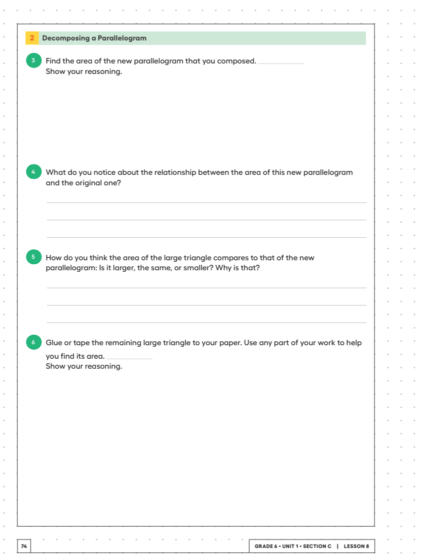
Access for Students with Diverse Abilities (Activity 2, Student Task)

Action and Expression: Internalize Executive Functions.
To support development of organizational skills in problem-solving, chunk this task into more manageable parts. For example, reveal only one question at a time, pausing to check for understanding before moving on.
Supports accessibility for: Organization, Attention

Building on Student Thinking

Students may struggle to form a new parallelogram because the two composing pieces are not both facing up (either the triangle or the trapezoid is facing down). Tell them that the shaded side of the cut-outs should face up.
Students may struggle to use the appropriate measurements needed to find the area of the parallelogram in the first question. They may multiply more numbers than necessary because the measurements are given. If this happens, remind them that only two measurements (base and height) are needed to determine the area of a parallelogram.

Student Workbook


2 Decomposing a Parallelogram

3 Find the area of the new parallelogram that you composed. Show your reasoning.

4 What do you notice about the relationship between the area of this new parallelogram and the original one?

5 How do you think the area of the large triangle compares to that of the new parallelogram: Is it larger, the same, or smaller? Why is that?

6 Glue or tape the remaining large triangle to your paper. Use any part of your work to help you find its area. Show your reasoning.

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Launch

Tell students that they will investigate another way in which triangles and parallelograms are related. Arrange students in groups of 2–4. Assign a different parallelogram from the student workbook to each student in the group. Give each student access to a pair of scissors and some tape or glue.

Each parallelogram shows some measurements and dotted lines for cutting. For the first question, students who have Parallelograms C and D should *not* cut off the measurements shown outside of the figures.

Give students 10 minutes to complete the activity, followed by a few minutes to discuss their work (especially the last three questions). Ask students who finish early to find someone with the same original parallelogram and compare their work.

Select work from students who composed different parallelograms from the same cut-up pieces to share later.

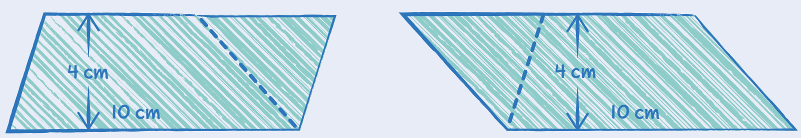
Student Task Statement

1. Your teacher will assign you a parallelogram. Cut out both copies. Glue or tape *one* copy of your parallelogram here and find its area. Show your reasoning.
2. Decompose the second copy of your parallelogram by cutting along the dotted lines. Take *only* the small triangle and the trapezoid, and rearrange these two pieces into a different parallelogram. Glue or tape the newly composed parallelogram on your paper.
3. Find the area of the new parallelogram that you composed. Show your reasoning.
4. What do you notice about the relationship between the area of this new parallelogram and the original one?
5. How do you think the area of the large triangle compares to that of the new parallelogram: Is it larger, the same, or smaller? Why is that?
6. Glue or tape the remaining large triangle to your paper. Use any part of your work to help you find its area. Show your reasoning.

Parallelogram A:

1. 80 sq cm. $10 \cdot 8 = 80$

2.

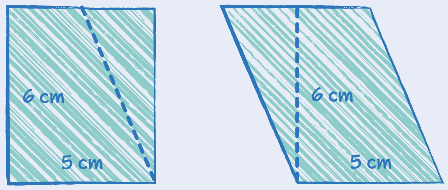


3. 40 sq cm. $10 \cdot 4 = 40$

Parallelogram B:

1. $5 \cdot 12 = 60$

2.

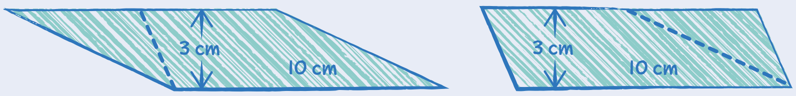


3. 30 sq cm. $5 \cdot 6 = 30$

Parallelogram C:

1. 60 sq cm. $10 \cdot 6 = 60$

2.

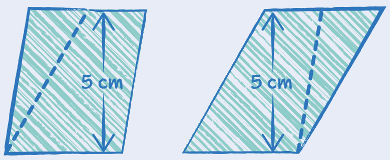


3. 30 sq cm. $10 \cdot 3 = 30$

Parallelogram D:

1. 40 sq cm. $4 \cdot 10 = 40$

2.



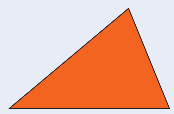
3. 20 sq cm. $4 \cdot 5 = 20$

All parallelograms:

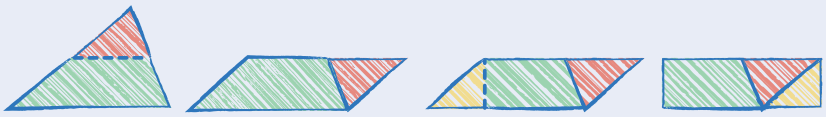
1. The area of the new parallelogram is half the area of the original one.
2. Sample responses:
   - The area of the large triangle is the same as that of the new parallelogram. I know that because the trapezoid and little triangle together can be arranged into a triangle that is identical to the large triangle.
   - The new parallelogram and the large triangle have the same area since they are two halves of the original parallelogram.
3. Sample responses:
   - The large triangle in Parallelogram A has an area of 40 sq cm since that is the area of the new parallelogram.
   - The large triangle in Parallelogram D has an area of 20 sq cm since it is half of the original parallelogram, which has an area of 40 sq cm.

Are You Ready for More?

Can you decompose this triangle and rearrange its parts to form a rectangle? Describe how it could be done.



Sample response: Cutting the triangle at half its height, parallel to the base, creates a parallelogram, then another cut helps create a rectangle.



Activity Synthesis

The goal of this discussion is to enable students to further explain the relationship between the area of a triangle and a related parallelogram with the same base and height.

Display 2–3 approaches from previously selected students for all to see: Two different parallelograms that could be composed from the trapezoid and small triangle cut out from each Parallelogram A, B, C, and D. Use *Compare and Connect* to help students compare, contrast, and connect the area of each original parallelogram and the areas of the shapes that compose it. Here are some questions for discussion:

"What do the new parallelograms have in common?"

They are shorter and smaller than the original parallelogram. They are all composed of a trapezoid and a triangle. Each parallelogram in the new pair has the same area.

"How does the area of each new parallelogram compare to the area of the original parallelogram? How do you know?"

It is half the area of the original. The original and new parallelograms have a base that is the same length, but the height of the new parallelogram is half of that of the original.

"How does the area of each new parallelogram compare to the area of the large triangle? How do you know?"

They are equal. Each new parallelogram is made of two shapes that can be rearranged to match the large triangle exactly.

Reiterate that we can establish two things about the area of each newly composed parallelogram:

- It is half of the area of the original parallelogram.
- It is equal to the area of the larger triangle.

As a result, we know that the area of a large triangle (formed by decomposing the parallelogram into two equal triangles) is also half of the area of the original parallelogram.

Lesson Synthesis

In this lesson, students practiced using what they know about parallelograms to reason about areas of triangles. They duplicated a triangle to make a parallelogram, decomposed and rearranged a triangle into a parallelogram, or enclosed a triangle with one or more rectangles.

To reiterate the connections between the areas of triangles and parallelograms, consider asking students:

- *"What can we say about the area of a triangle and that of a parallelogram with the same height?"*

  The area of the triangle is half of the area of the related parallelogram.

- *"In the second activity, we cut a triangle along a line that goes through the midpoints of two sides and rearranged the pieces into a parallelogram. What did we notice about the area and the height of the resulting parallelogram?"*

  It has the same area as the original triangle but half its height.

- *"How might we start finding the area of any triangle, in general?"*

  Start by finding the area of a related parallelogram whose base is also a side of the triangle.

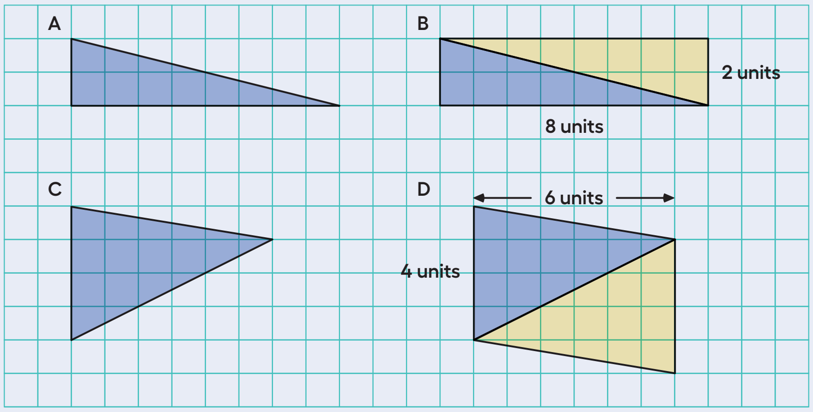
Math Community

Invite 2–3 students to share what "Doing Math" actions they noticed. Record and display their responses for all to see, such as by adding check marks to any already listed items or adding new items near the chart for the class to consider adding. Next, give students 1–2 minutes with a partner to discuss any changes or revisions they think the chart needs. Tell students they can suggest revisions during the *Cool-down*.

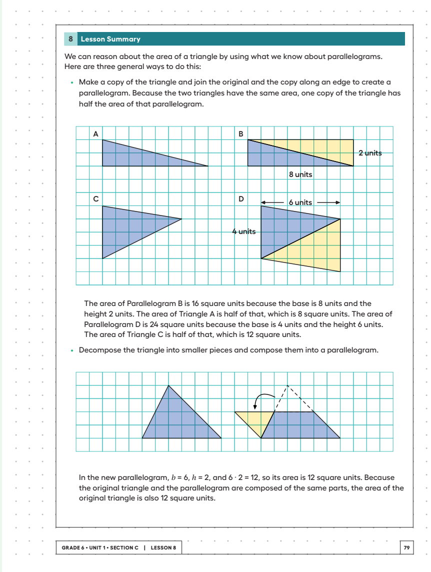
Lesson Summary

We can reason about the area of a triangle by using what we know about parallelograms. Here are three general ways to do this:

- Make a copy of the triangle and join the original and the copy along an edge to create a parallelogram. Because the two triangles have the same area, one copy of the triangle has half the area of that parallelogram.



Student Workbook



Lesson Summary

We can reason about the area of a triangle by using what we know about parallelograms. Here are three general ways to do this:

- Make a copy of the triangle and join the original and the copy along an edge to create a parallelogram. Because the two triangles have the same area, one copy of the triangle has half the area of that parallelogram.

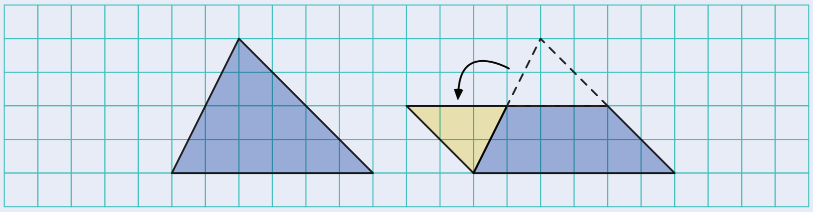
The area of Parallelogram B is 16 square units because the base is 8 units and the height 2 units. The area of Triangle A is half of that, which is 8 square units. The area of Parallelogram D is 24 square units because the base is 4 units and the height 6 units. The area of Triangle C is half of that, which is 12 square units.

- Decompose the triangle into smaller pieces and compose them into a parallelogram.

In the new parallelogram, $b = 6$, $h = 2$, and $6 \cdot 2 = 12$, so its area is 12 square units. Because the original triangle and the parallelogram are composed of the same parts, the area of the original triangle is also 12 square units.

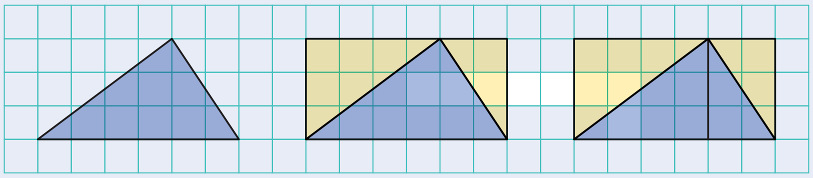
The area of Parallelogram B is 16 square units because the base is 8 units and the height 2 units. The area of Triangle A is half of that, which is 8 square units. The area of Parallelogram D is 24 square units because the base is 4 units and the height 6 units. The area of Triangle C is half of that, which is 12 square units.

- Decompose the triangle into smaller pieces and compose them into a parallelogram.



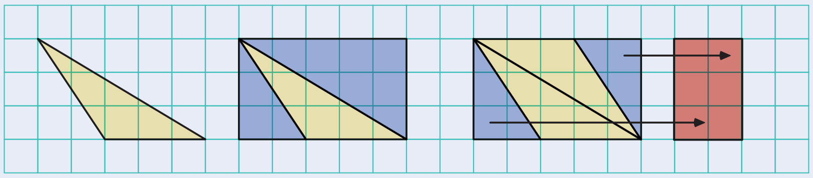
In the new parallelogram, $b = 6$, $h = 2$, and $6 \cdot 2 = 12$, so its area is 12 square units. Because the original triangle and the parallelogram are composed of the same parts, the area of the original triangle is also 12 square units.

- Draw a rectangle around the triangle. Sometimes the triangle has half of the area of the rectangle.



The large rectangle can be decomposed into smaller rectangles. The one on the left has area $4 \cdot 3$ or 12 square units; the one on the right has area $2 \cdot 3$ or 6 square units. The large triangle is also decomposed into two right triangles. Each of the right triangles is half of a smaller rectangle, so their areas are 6 square units and 3 square units. The large triangle has an area of 9 square units.

Sometimes, the triangle is half of what is left of the rectangle after removing two copies of the smaller right triangles.



The right triangles being removed can be composed into a small rectangle with area $(2 \cdot 3)$ square units. What is left is a parallelogram with area $5 \cdot 3 - 2 \cdot 3$, which equals $15 - 6$ or 9 square units. Notice that we can compose the same parallelogram with two copies of the original triangle!

The original triangle is half of the parallelogram, so its area is $\frac{1}{2} \cdot 9$ or 4.5 square units.

Math Community

Before distributing the *Cool-downs*, display the Math Community Chart and the community building question "What additions or revisions would you make to the Math Community Chart?" Ask students to respond to the question after completing the *Cool-down* on the same sheet.

After collecting the *Cool-downs*, identify themes from the community building question. Use them to add to or revise the Math Community Chart before Exercise 5.

Cool-down

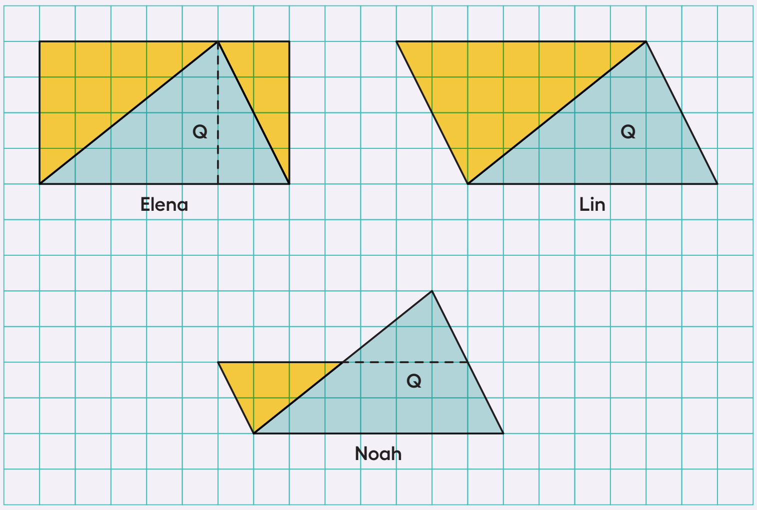
An Area of 14

5 min

Students have explored several ways to reason about the area of a triangle. This *Cool-down* prompts them to articulate at least one way to do so. Not all methods will be equally intuitive or clear to them. In writing a commentary about at least one approach, students can show what makes sense to them at this point.

Student Task Statement

Elena, Lin, and Noah all found the area of Triangle Q to be 14 square units but reasoned about it differently, as shown in the diagrams. Explain *at least one* student's way of thinking and why his or her answer is correct.



Responding To Student Thinking

Points to Emphasize

If students struggle with explaining the area of the triangle, give students opportunities to justify the areas of triangles over the next several lessons. For example, in this activity, after students find the areas of Triangles A–D and before discussing a general formula for area, encourage students to verbally explain the area of one or more triangles:

Unit 1, Lesson 9, Activity 1 Finding a Formula for the Area of a Triangle

Sample responses:

- Elena drew two rectangles that decomposed the triangle into two right triangles. She found the area of each right triangle to be half of the area of its enclosing rectangle. This means that the area of the original triangle is the sum of half of the area of the rectangle on the left and half of the rectangle on the right. Half of $(4 \cdot 5)$ plus half of $(4 \cdot 2)$ is $10 + 4$, so the area is 14 square units.
- Lin saw it as half of a parallelogram with the base of 7 units and height of 4 units (and thus an area of 28 square units). Half of 28 is 14.
- Noah decomposed the triangle by cutting it at half of the triangle's height, turning the top triangle around, and joining it with the bottom trapezoid to make a parallelogram. He then calculated the area of that parallelogram, which has the same base length but half the height of the triangle. $7 \cdot 2 = 14$, so the area is 14 square units.

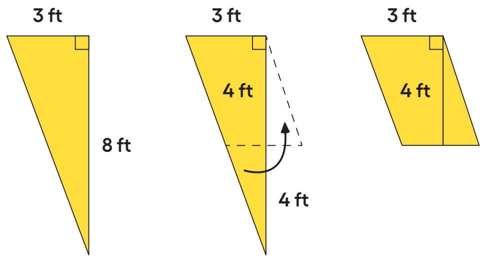
Lesson 8

Practice Problems

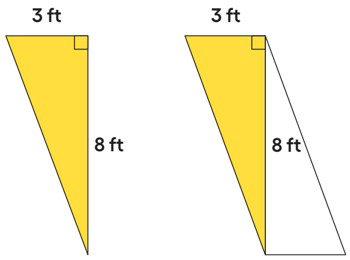
5 Problems

Problem 1

To find the area of this right triangle, Diego and Jada used different strategies. Diego drew a line through the midpoints of the two longer sides, which decomposes the triangle into a trapezoid and a smaller triangle. He then rearranged the two shapes into a parallelogram.



Jada made a copy of the triangle, rotated it, and lined it up against one side of the original triangle so that the two triangles make a parallelogram.



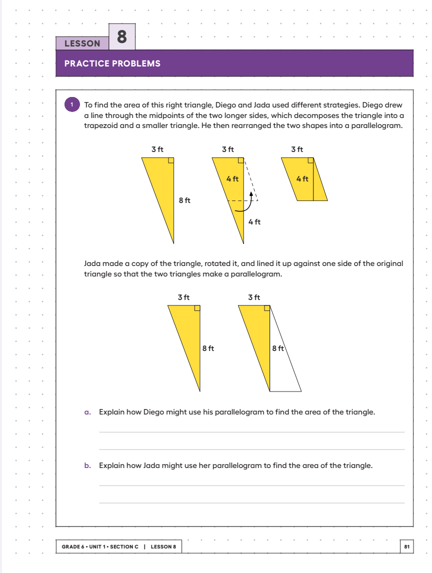
a. Explain how Diego might use his parallelogram to find the area of the triangle.

Sample response: Diego's parallelogram has a base of 3 feet and a height of 4 feet, so its area is 12 square feet. Because the original right triangle and the parallelogram are composed of the same parts, they have the same area. The area of the triangle is also 12 square feet.

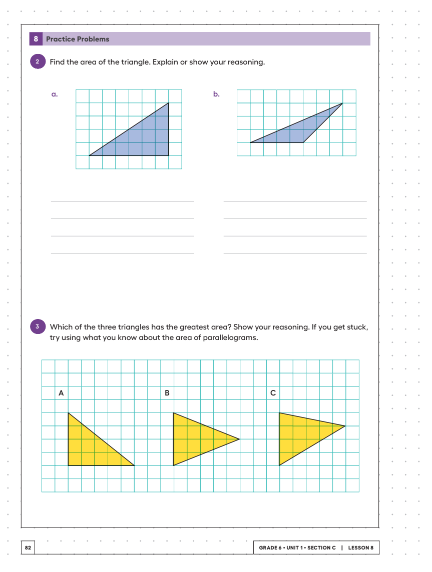
b. Explain how Jada might use her parallelogram to find the area of the triangle.

Sample response: Jada's parallelogram has a base of 3 feet and a height of 8 feet, so its area is 24 square feet. Because it is composed of two copies of the right triangle, she could divide 24 by 2 to find the area of the triangle. $24 \div 2 = 12$ or 12 square feet.

Student Workbook



Student Workbook


8 Practice Problems

2 Find the area of the triangle. Explain or show your reasoning.

a.

b.

3 Which of the three triangles has the greatest area? Show your reasoning. If you get stuck, try using what you know about the area of parallelograms.

A B C

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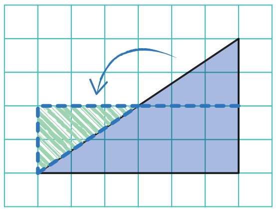
Problem 2

Find the area of the triangle. Explain or show your reasoning.

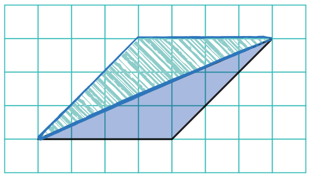
a.



12 square units

Sample reasoning: Make a horizontal cut, and rearrange the pieces to make a rectangle. The rectangle is 2 units by 6 units, so its area is 12 square units.

b.

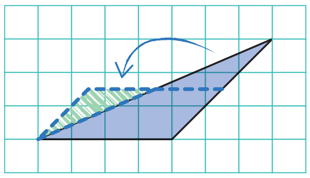


6 square units

Sample reasoning:

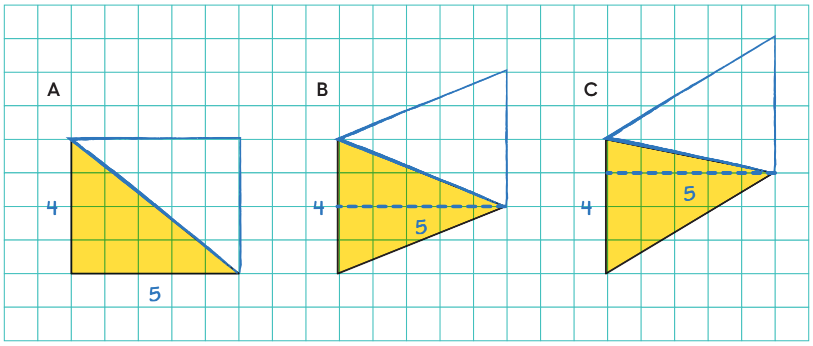
- Duplicate the triangle, and rearrange the pieces to make a parallelogram. The parallelogram has a base of 4 units and a height of 3 units, so its area is 12 square units. Since the parallelogram's area is double the triangle's, the triangle's area is 6 square units.
- Decompose the triangle with a cut line half-way between the base and the opposite vertex. Rearrange the smaller triangle to form a parallelogram. This parallelogram has a horizontal base of length 4 units and a height of 1.5 units, so its area is 6 square units. That means the area of the original triangle is 6 square units.

b.



Problem 3

Which of the three triangles has the greatest area? Show your reasoning. If you get stuck, try using what you know about the area of parallelograms.



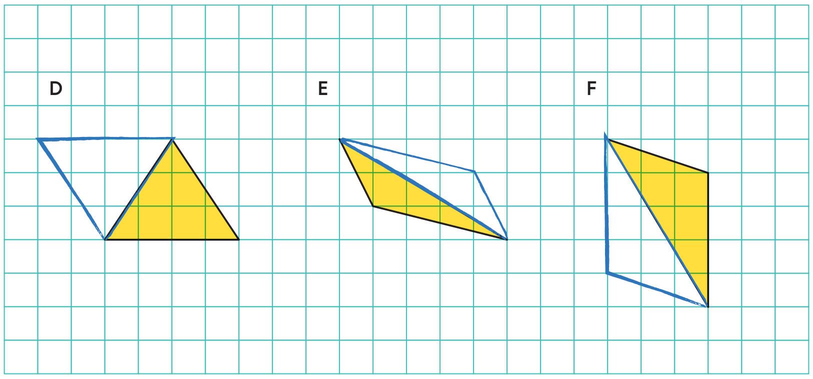
All three triangles have the same area of 10 square units. Sample reasoning: Two identical copies of each triangle can be composed into a parallelogram with a base of 5 units and a corresponding height of 4 units, which means an area of 20 square units. The area of each triangle is half of that of the parallelogram. $\frac{1}{2} \cdot 20 = 10$

Problem 4

from Unit 1, Lesson 7

Draw an identical copy of each triangle such that the two copies together form a parallelogram. If you get stuck, consider using tracing paper.

Sample response:



Problem 5

from Unit 1, Lesson 6

a. A parallelogram has a base of 3.5 units and a corresponding height of 2 units. What is its area?

7 square units

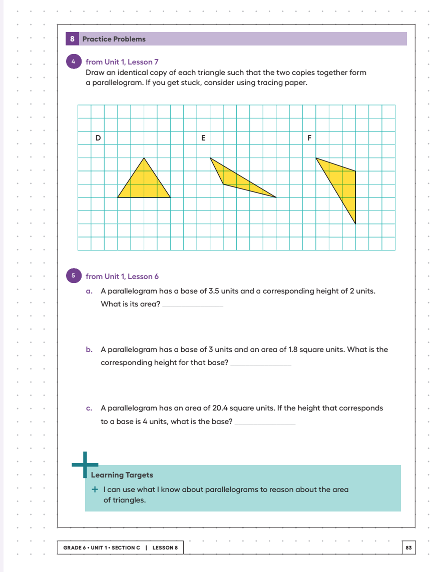
b. A parallelogram has a base of 3 units and an area of 1.8 square units. What is the corresponding height for that base?

0.6 units

c. A parallelogram has an area of 20.4 square units. If the height that corresponds to a base is 4 units, what is the base?

5.1 units

Student Workbook


8 Practice Problems

4 from Unit 1, Lesson 7
Draw an identical copy of each triangle such that the two copies together form a parallelogram. If you get stuck, consider using tracing paper.

5 from Unit 1, Lesson 6
a. A parallelogram has a base of 3.5 units and a corresponding height of 2 units. What is its area?
b. A parallelogram has a base of 3 units and an area of 1.8 square units. What is the corresponding height for that base?
c. A parallelogram has an area of 20.4 square units. If the height that corresponds to a base is 4 units, what is the base?

Learning Targets
+ I can use what I know about parallelograms to reason about the area of triangles.

GRADE 6 • UNIT 1 • SECTION C | LESSON 8