

NAME _____

DATE _____

PERIOD _____

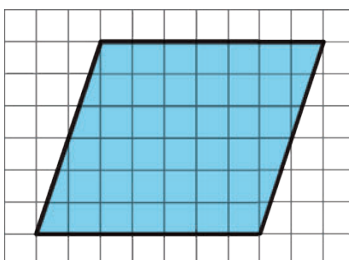
Unit 1, Lesson 5: Bases and Heights of Parallelograms

Let's investigate the area of parallelograms some more.

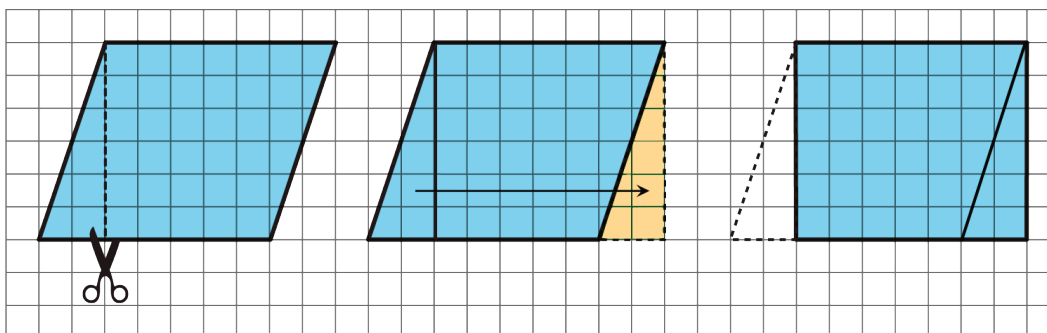
5.1: A Parallelogram and Its Rectangles

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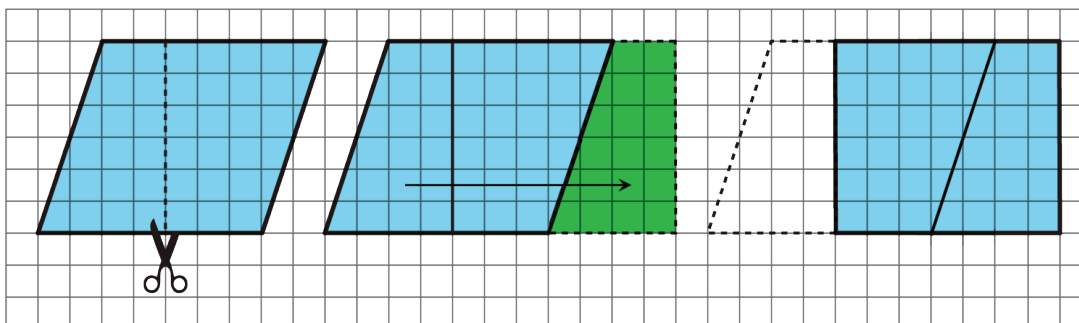
Elena and Tyler were finding the area of this parallelogram:



Here is how Elena did it:



Here is how Tyler did it:



How are the two strategies for finding the area of a parallelogram the same? How they are different?

NAME _____

DATE _____

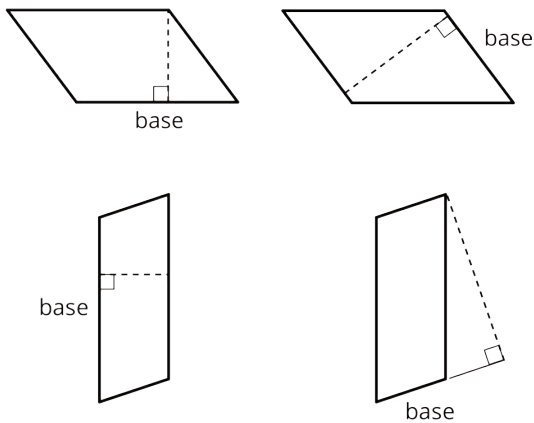
PERIOD _____

5.2: The Right Height?

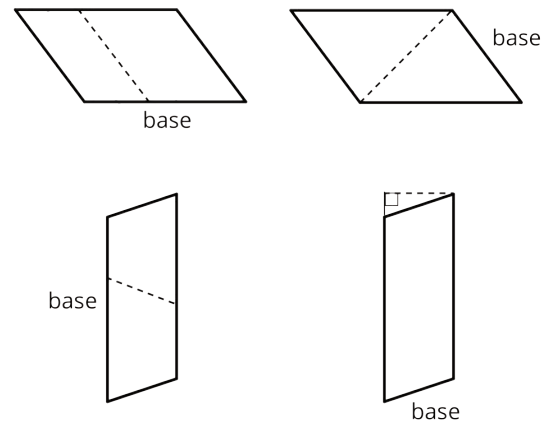
1. Each parallelogram has a side that is labeled “base.”

Study the examples and non-examples of **bases** and **heights** of parallelograms. Then, answer the questions that follow.

Examples: The dashed segment in each drawing represents the corresponding height for the given base.



Non-examples: The dashed segment in each drawing does *not* represent the corresponding height for the given base.



Select **all** statements that are true about bases and heights in a parallelogram.

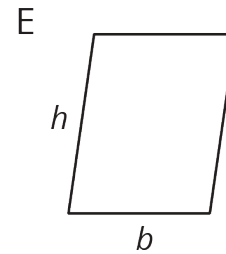
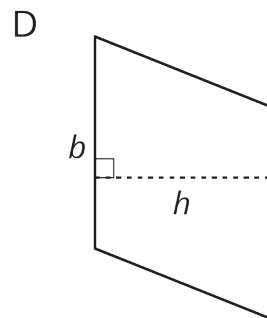
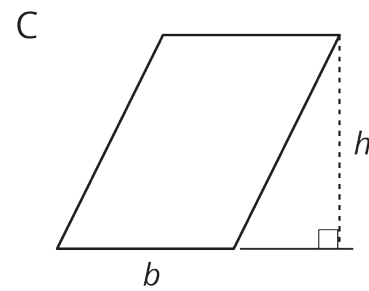
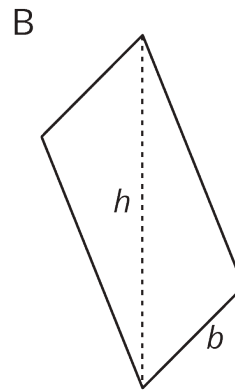
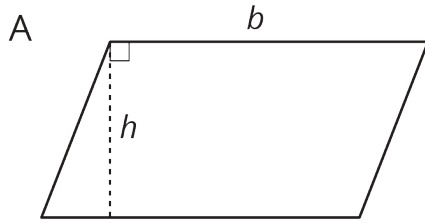
- Only a horizontal side of a parallelogram can be a base.
- Any side of a parallelogram can be a base.
- A height can be drawn at any angle to the side chosen as the base.
- A base and its corresponding height must be perpendicular to each other.
- A height can only be drawn inside a parallelogram.
- A height can be drawn outside of the parallelogram, as long as it is drawn at a 90-degree angle to the base.
- A base cannot be extended to meet a height.

NAME _____

DATE _____

PERIOD _____

2. Five students labeled a base b and a corresponding height h for each of these parallelograms. Are all drawings correctly labeled? Explain how you know.



NAME _____

DATE _____

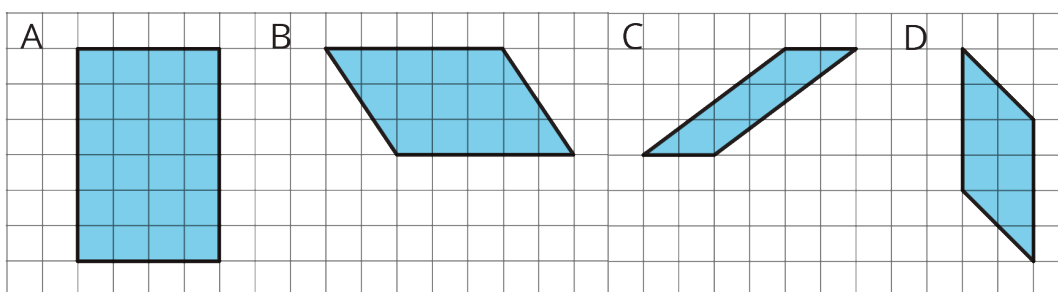
PERIOD _____

5.3: Finding the Formula for Area of Parallelograms

For each parallelogram:

- Identify a base and a corresponding height, and record their lengths in the table that follows.
- Find the area and record it in the right-most column.

In the last row, write an expression using b and h for the area of any parallelogram.



parallelogram	base (units)	height (units)	area (sq units)
A			
B			
C			
D			
any parallelogram	b	h	

Are you ready for more?

1. What happens to the area of a parallelogram if the height doubles but the base is unchanged? If the height triples? If the height is 100 times the original?
2. What happens to the area if both the base and the height double? Both triple? Both are 100 times their original lengths?

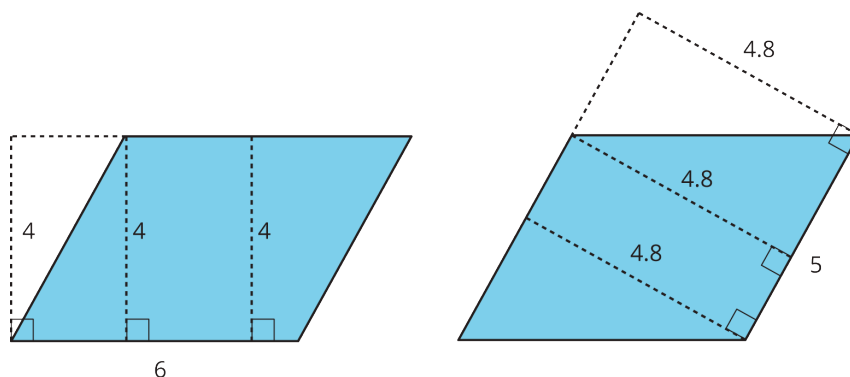
NAME _____

DATE _____

PERIOD _____

Lesson 5 Summary

- We can choose any of the four sides of a parallelogram as the **base**. Both the side (the segment) and its length (the measurement) are called the base.
- If we draw any perpendicular segment from a point on the base to the opposite side of the parallelogram, that segment will always have the same length. We call that value the **height**. There are infinitely many line segments that can represent the height!



Here are two copies of the same parallelogram. On the left, the side that is the base is 6 units long. Its corresponding height is 4 units. On the right, the side that is the base is 5 units long. Its height is 4.8 units. For both, three different segments are shown to represent the height. We could draw in many more!

No matter which side is chosen as the base, the area of the parallelogram is the product of that base and its corresponding height. We can check it:

$$4 \times 6 = 24$$

and

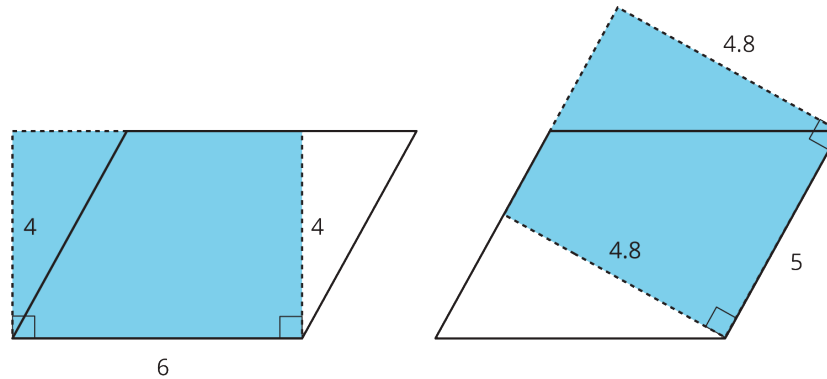
$$4.8 \times 5 = 24$$

NAME _____

DATE _____

PERIOD _____

We can see why this is true by decomposing and rearranging the parallelograms into rectangles.



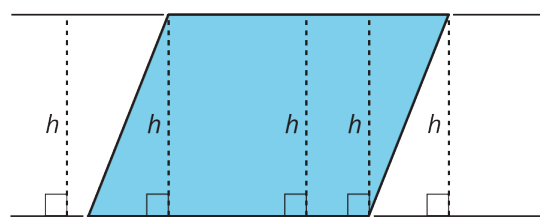
Notice that the side lengths of each rectangle are the base and height of the parallelogram. Even though the two rectangles have different side lengths, the products of the side lengths are equal, so they have the same area! And both rectangles have the same area as the parallelogram.

We often use letters to stand for numbers. If b is base of a parallelogram (in units), and h is the corresponding height (in units), then the area of the parallelogram (in square units) is the product of these two numbers.

$$b \cdot h$$

Notice that we write the multiplication symbol with a small dot instead of a \times symbol. This is so that we don't get confused about whether \times means multiply, or whether the letter x is standing in for a number.

In high school, you will be able to prove that a perpendicular segment from a point on one side of a parallelogram to the opposite side will always have the same length.



You can see this most easily when you draw a parallelogram on graph paper. For now, we will just use this as a fact.

Lesson 5 Glossary Terms

- base/height of a parallelogram

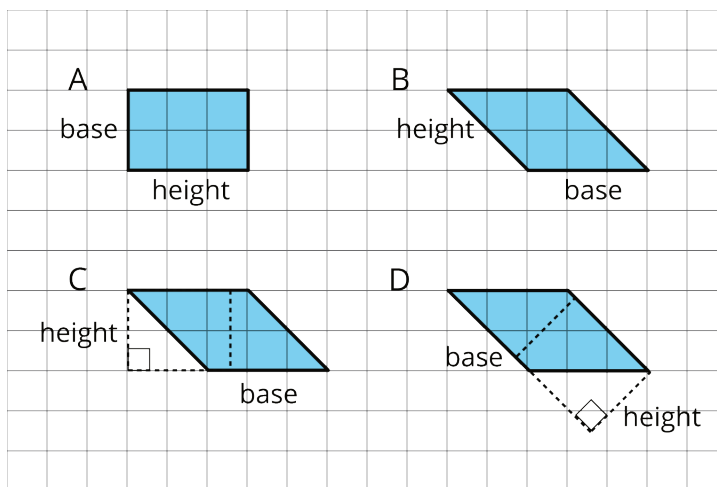
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DATE _____

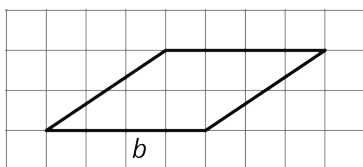
PERIOD _____

Unit 1, Lesson 5: Bases and Heights of Parallelograms

1. Select **all** parallelograms that have a correct height labeled for the given base.

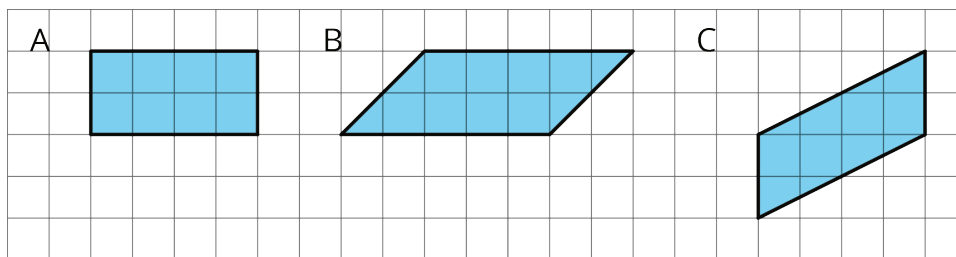


2. The side labeled b has been chosen as the base for this parallelogram.



Draw a segment showing the height corresponding to that base.

3. Find the area of each parallelogram.

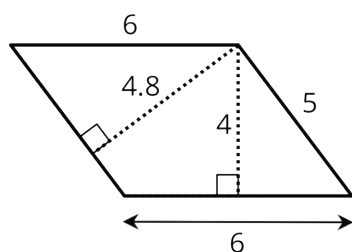


4. If the side that is 6 units long is the base of this parallelogram, what is its corresponding height?

NAME _____

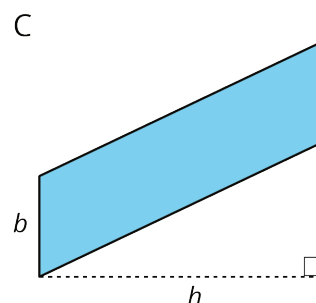
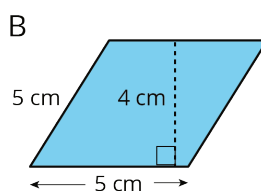
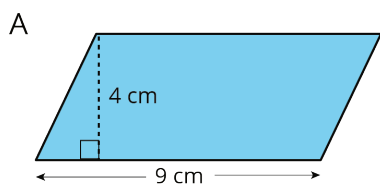
DATE _____

PERIOD _____



- A. 6 units
- B. 4.8 units
- C. 4 units
- D. 5 units

5. Find the area of each parallelogram.



6. Do you agree with each of these statements? Explain your reasoning.

- a. A parallelogram has six sides.
- b. Opposite sides of a parallelogram are parallel.
- c. A parallelogram can have one pair or two pairs of parallel sides.
- d. All sides of a parallelogram have the same length.
- e. All angles of a parallelogram have the same measure.

(from Unit 1, Lesson 4)

7. A square with an area of 1 square meter is decomposed into 9 identical small squares. Each small square is decomposed into two identical triangles.

- a. What is the area, in square meters, of 6 triangles? If you get stuck, draw a diagram.
- b. How many triangles are needed to compose a region that is $1\frac{1}{2}$ square meters?

NAME

DATE

PERIOD

(from Unit 1, Lesson 2)