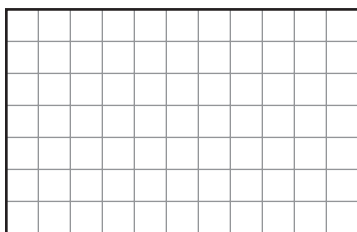# All About That Base. . . and Height

## Area of Triangles and Quadrilaterals

**3**

## WARM UP

Write 3 different expressions to describe the total area of the rectangle shown.



## LEARNING GOALS

- State and compare the attributes of different figures.
- Explain that the area of a parallelogram is the same as the area of a rectangle with the same base length and height.
- Derive the formulas for the areas of triangles, parallelograms, and trapezoids by composing or decomposing the various figures into rectangles and triangles.
- Solve real-world and mathematical problems by composing and decomposing figures.

## KEY TERMS

- parallelogram
- variable
- straightedge
- trapezoid

You can take a figure apart and put it back together in a different way without changing its area. How can you compose and decompose rectangles to reason about the areas of common figures?
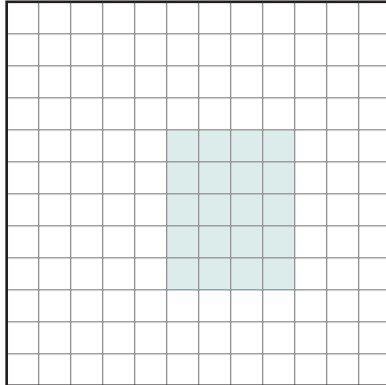
## In the 20s

Consider each two-dimensional figure.

**1. Name each figure and describe the attributes.**

**Take Note...**

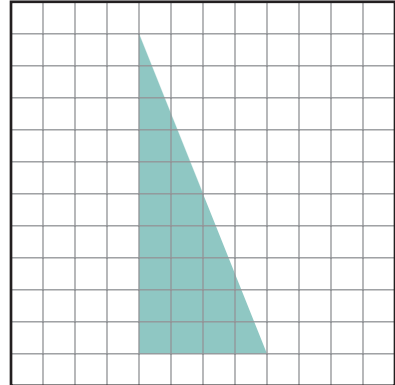An attribute is a characteristic to describe a figure.
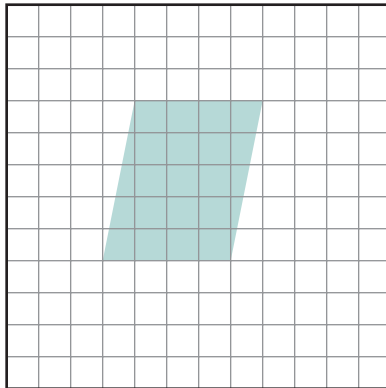
**a.**

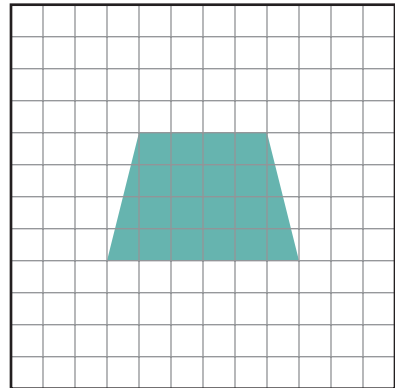Name: _____
Attributes:

**b.**

Name: _____
Attributes:

**c.**

Name: _____
Attributes:

**d.**

Name: _____
Attributes:

**2. Each shaded figure shown has an area of exactly 20 square units. Show how you know.**

# Investigating the Area of a Parallelogram

In this activity, you will investigate the area of a *parallelogram* using what you know about the area of a rectangle. A **parallelogram** is a four-sided figure with two pairs of parallel sides and opposite sides that are equal in length.
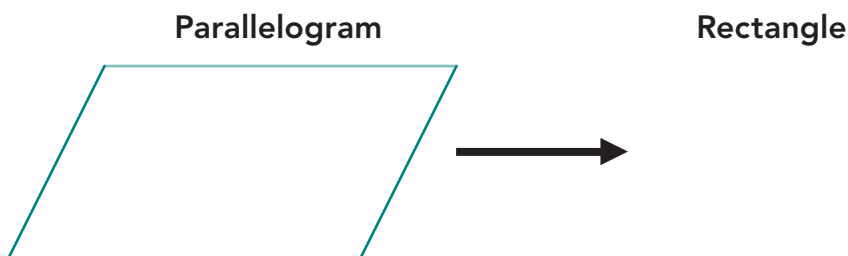
Cut out a parallelogram from the grid located on page 11.



**Shape Cut Outs**

Parallelogram Cutouts

LESSON 3: All About That Base . . . and Height • 11
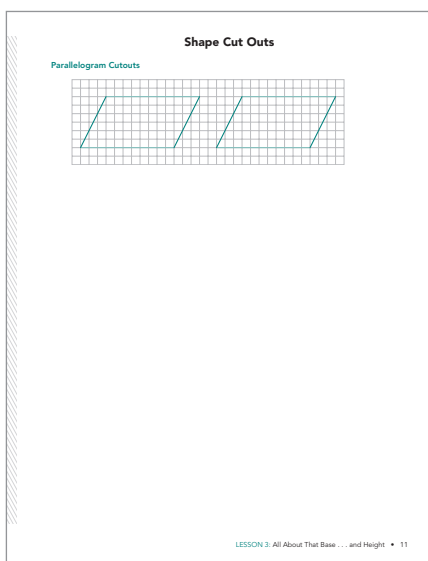
**Remember...**

A rectangle is a special type of parallelogram.

1. **Cut your parallelogram into pieces so that you can reassemble it to form a rectangle. Tape your rectangle in the space provided.**

| Parallelogram | Rectangle |
|---|---|



In a parallelogram, you can label any of the four sides as the base. The height, represented by a line segment, is the perpendicular distance from a base to its opposite side.

2. **Label the base and height of the parallelogram and rectangle.**

**Take Note...**

The right angle symbol indicates that the lines are perpendicular.

Compare the attributes of the parallelogram and the rectangle you composed.

3. **How does the height of the parallelogram relate to the height of the rectangle? How does the length of the base of the parallelogram relate to the length of the base of the rectangle? Explain your reasoning.**

4. **Describe the relationship between the areas of a parallelogram and rectangle that have the same base and height.**

5. **Use the terms *base* and *height* to describe how to calculate the area of a parallelogram.**

When you want to represent a quantity that varies or changes, you can use a *variable*. The use of variables helps you write formulas to express relationships.

6. **Write the formulas to calculate the areas of a parallelogram and a rectangle. Use *b* to represent the length of the base and *h* to represent the height.**
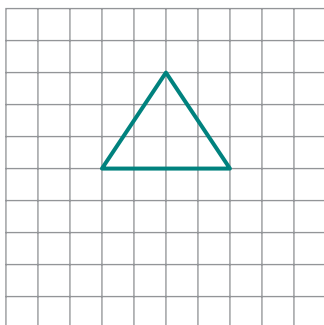
# ACTIVITY 3.2

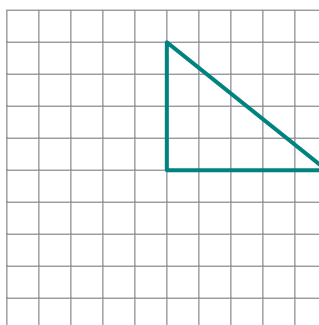## Investigating the Area of a Triangle

In this activity, you will investigate the area of a triangle using what you know about the area of a parallelogram.
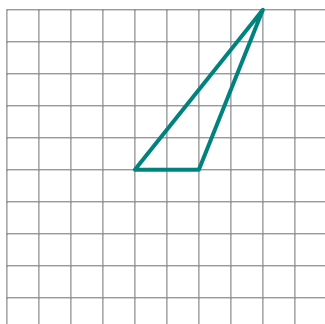
Consider each triangle shown.

**Triangle 1**



**Triangle 2**



**Triangle 3**



1. Use a separate piece of patty paper to trace each triangle.
   a. Rotate the patty paper to create a parallelogram composed of two identical triangles.
   b. Draw the parallelogram you created on your patty paper and label its base and height.

**Take Note...**

When you trace or draw a figure, use a *straightedge*.

A **straightedge** is a tool to draw straight lines.

2. For each triangle, compose a second parallelogram using a different side of the triangle.

3. Determine the area of each parallelogram you created.

4. How does the area of each triangle relate to the area of the parallelogram?

5. Write a formula to calculate the area of a triangle using the formula for the area of a parallelogram. Use *b* to represent the length of the base and *h* to represent the height.

## WORKED EXAMPLE

As with the base of a parallelogram, the base of a triangle can be any of its sides. The height of a triangle, represented by a line segment, is the perpendicular distance from a vertex to the line containing the base.

**Triangle *ABC* is shown in three different positions.**
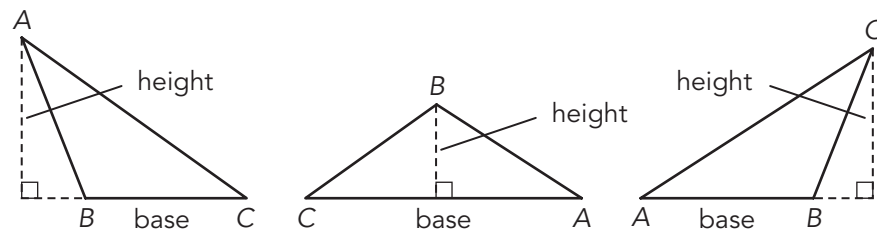


6. Analyze the Worked Example. What general statement can you make about determining the area of a triangle? Explain your reasoning.

# Investigating the Area of a Trapezoid

You have seen that decomposing and composing can help you think about shapes differently to determine their areas. In this activity, you will use the same strategy to determine the formula for calculating the area of a *trapezoid*.

A **trapezoid** is a quadrilateral with two bases that are parallel to each other. The other two sides of a trapezoid are called the *legs* of the trapezoid. A height of a trapezoid is the length of a line segment drawn perpendicular from one base to the other.
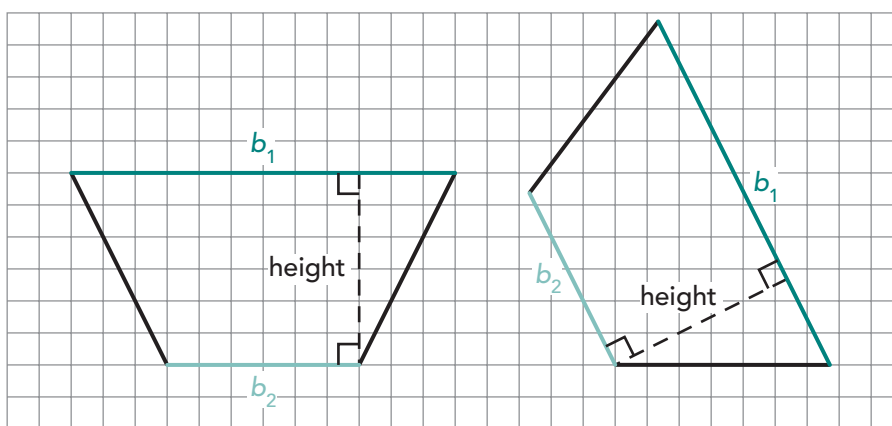


**Take Note...**

The variable $b$ represents a base, but a trapezoid has two bases. So, we use subscripts to distinguish between the two different bases: $b_1$ and $b_2$ are not equal in length.

1. **To figure out the exact area of the trapezoid shown, compose two trapezoids into a parallelogram. Show how you can determine the area of the trapezoid.**
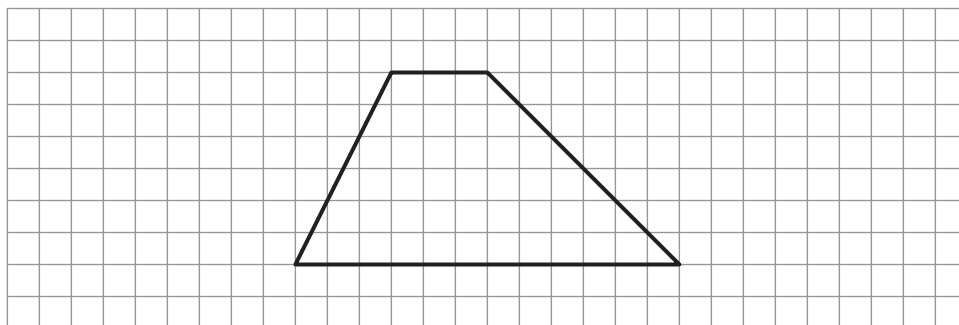


2. **Describe how to calculate the area of any trapezoid in terms of the two bases and the height.**
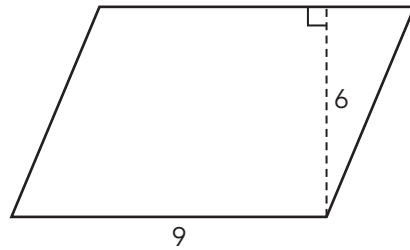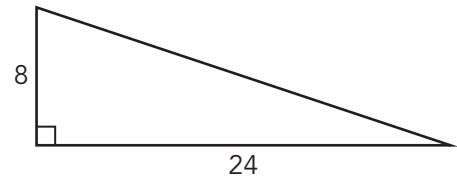
# Calculating Areas of Figures

Calculate the area of each figure.

**1.**



**2.**



**3.**



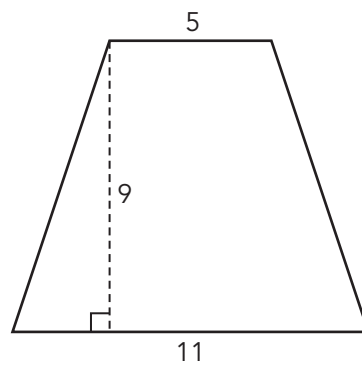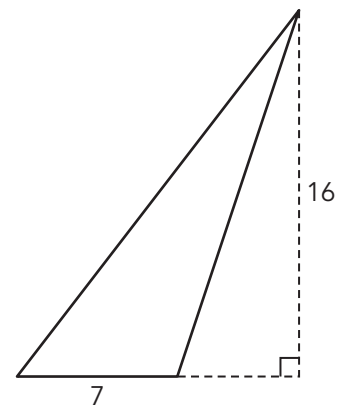**4.**



Determine the unknown length in each figure.

**5. A parallelogram has an area of 63 square units. The height of the parallelogram is 7 units. What is the base length of the parallelogram?**

6. A triangle has an area of 24 square units. The base length of the triangle is 4 units. What is the height of the triangle?
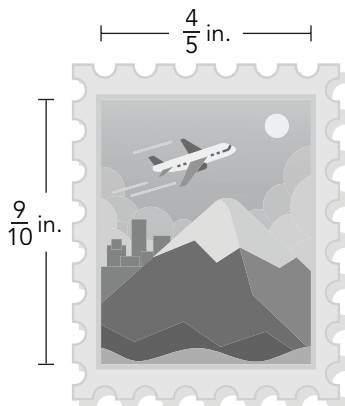
Solve each area problem.

7. Sanjay has enough material to build a rectangular dance floor with an area of 200 square feet. The greatest width the dance floor can be is $12\frac{1}{2}$ feet. What would be the length of this dance floor?
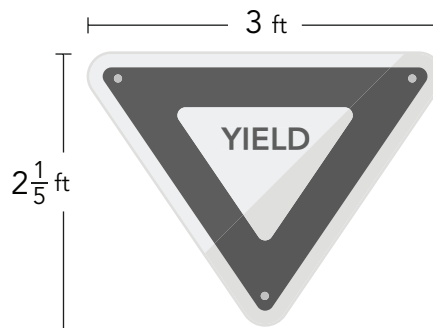
8. Determine the area of each object.

a.



$\frac{4}{5}$ in.
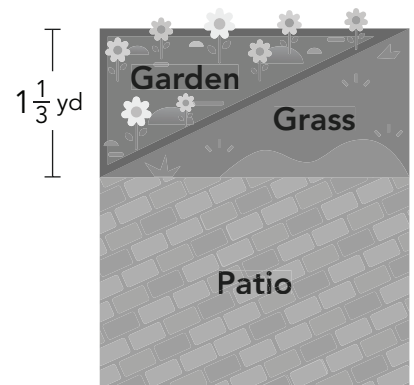
$\frac{9}{10}$ in.

b.



3 ft

$2\frac{1}{5}$ ft

YIELD

9. Tara has enough garden soil to make a garden bed with an area of 6 square yards. She wants to build the garden bed in the corner of her yard so it is the shape of a right triangle. Because of the location of her patio, one leg of the triangle must be $1\frac{1}{3}$ yards long. Determine the length of the other leg of the triangle.



$1\frac{1}{3}$ yd

Garden

Grass

Patio

## TALK the TALK 💬

## Figure 'Em Out!

You have decomposed and composed parallelograms in this lesson to derive the formulas for the area of a parallelogram, triangle, and trapezoid.

1. **Draw each figure and then label a base and height. Next, write the formula to calculate the area of each. Use *A* for the area, *b* for the length of the base, and *h* for the height.**
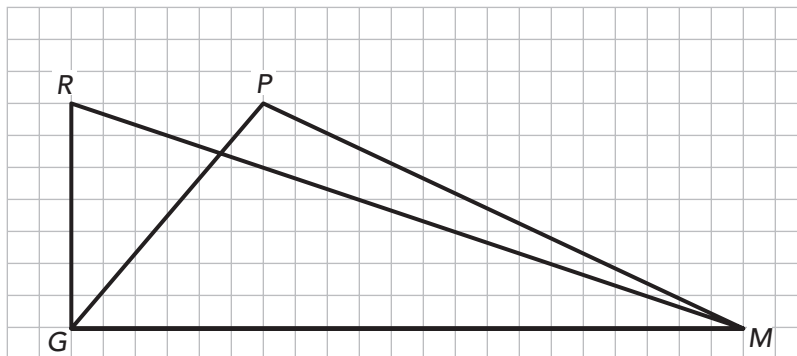
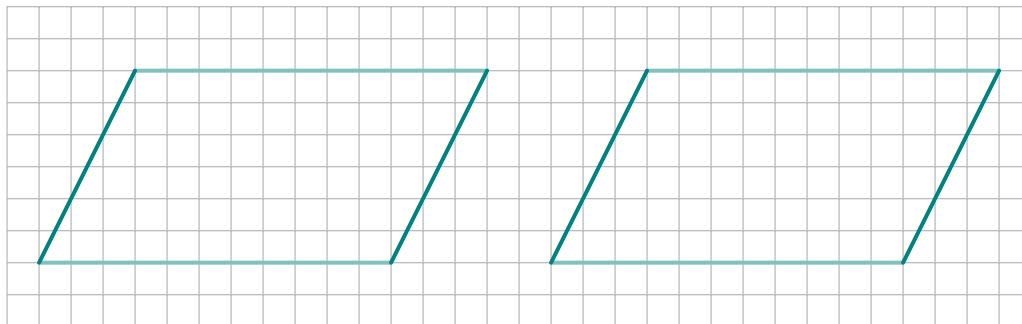   a. **parallelogram**              b. **triangle**

   c. **trapezoid**

Consider △*RGM* and △*PGM*.

2. **Without performing any calculations, determine which triangle has the greater area. Write a sentence to explain your reasoning.**

# Shape Cut Outs

## Parallelogram Cutouts

# Why is this page blank?

So you can cut out the shapes on the other side.