Math Objectives

- Students will be able to describe how the area of a parallelogram relates to the area of a rectangle with the same base and height.
- Students will be able to describe how the area of a triangle relates to the area of a parallelogram with the same base and height.
- Students will be able to describe how the area of a trapezoid relates to the area of a parallelogram with the same height and with a base equal to the sum of the bases of the trapezoid.
- Students will be able to use relationships to compute the areas of parallelograms, triangles, and trapezoids given their dimensions.
- Students will reason abstractly and quantitatively. (CCSS Mathematical Practice)
- Students will look for and make use of structure. (CCSS Mathematical Practice)

Vocabulary

- rectangle
- parallelogram
- triangle
- trapezoid

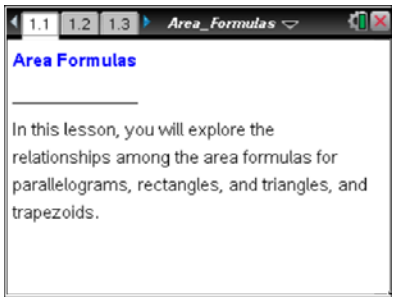
About the Lesson

Students will:

- Observe the relationships between figures and compare the areas of the figures.
- Formulate expressions to compute the area of parallelograms, triangles, and trapezoids.

TI-Nspire™ Navigator™ System

- Quick Poll
- Screen Capture



TI-Nspire™ Technology Skills:

- Download a TI-Nspire document
- Open a document
- Move between pages
- Grab and drag a point

Tech Tips:

- Make sure the font size on your TI-Nspire handhelds is set to Medium.
- You can hide the function entry line by pressing ctrl G.

Lesson Materials:

Student Activity
Area_Formulas.pdf
Area_Formulas.doc

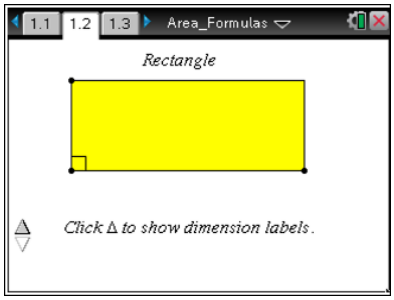
TI-Nspire document
Area_Formulas.tns

Visit www.mathnspired.com for lesson updates and tech tip videos.

Discussion Points and Possible Answers

Tech Tip: If students experience difficulty dragging a point, check to make sure that they have moved the arrow until it becomes a hand (☜) getting ready to grab the point. Then press ctrl ☜ to grab the point and close the hand (✊). When finished moving the point, press esc to release the point.

Move to page 1.2.



1. Click ▲ to show the dimension labels of the rectangle.
   a. What are the labels for the dimensions of the given rectangle?

   Answer: base and height

   b. What is the formula for the area of the rectangle in terms of base and height?

   Answer: Area = base × height

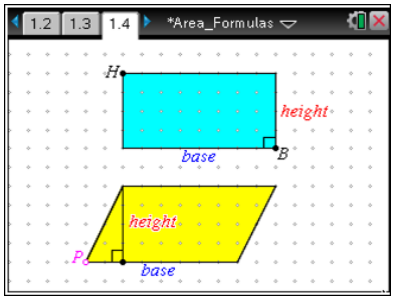
   Teacher Tip: You may want to discuss the different vocabulary (labels) used for the dimensions of the rectangle (width and height, length and width, and base and height). For this activity, the dimensions will be referred to as base and height.

2. Drag the top left or bottom right vertex to change the dimensions of the rectangle. If you change the dimensions of the rectangle, would this change the formula for the area of the rectangle?

   Answer: No, it would still be Area = base × height.

TI-Nspire Navigator Opportunity: *Quick Poll*
See Note 1 at the end of this lesson.

Move to page 1.3. After reading the instructions, move to page 1.4.

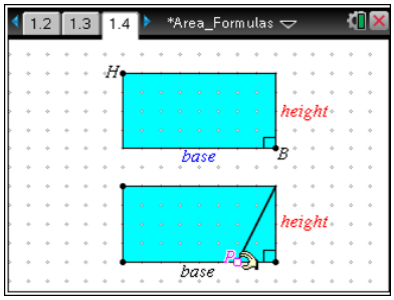


3. a. How do the base and height of the parallelogram compare to the base and height of the rectangle at the top of the screen?

Answer: The base of the parallelogram = the base of the rectangle.
The height of the parallelogram = the height of the rectangle.

b. Move point *H* or point *B*. Describe the changes that occur in the rectangle and the changes in the parallelogram.

Answer: As the base of the rectangle changes, the base of the parallelogram changes accordingly. As the height of the rectangle changes, the height of the parallelogram changes accordingly.



4. Drag point *P* to the right as far as you can.
   a. Explain why the new figure on the bottom of the screen is a rectangle.

Answer: The new figure is a quadrilateral with right angles.

b. What does this tell you about the area of the original parallelogram?

Answer: The original parallelogram has the same area as the rectangle.

c. Why do the parallelogram and the rectangle have the same area?

Answer: They have the same base and height.

d. What could be a formula for the area of the parallelogram?

Answer: Area = base × height

Teacher Tip: Make sure students understand they can't always just measure the sides to find area. You could ask students probing questions such as: Is a side length ever a height? If you know the area, can you find the base and height?

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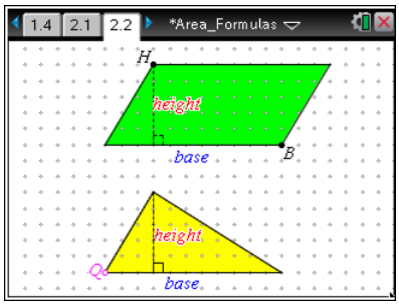
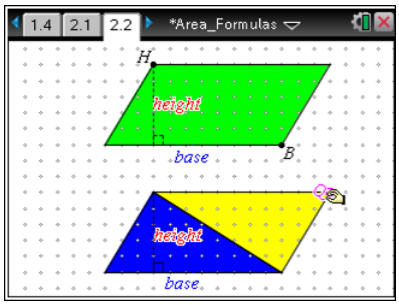


5. a. How do the base and height of the triangle compare to the base and height of the parallelogram at the top of the screen?

Answer: The base of the triangle = the base of the parallelogram.
The height of the triangle = the height of the parallelogram.

b. Move point *H* or point *B* on the parallelogram. Describe the changes that occur in the parallelogram and the changes in the triangle.

Answer: As the base of the parallelogram changes, the base of the triangle changes accordingly. As the height of the parallelogram changes, the height of the triangle changes accordingly.



6. Rotate point *Q* until it is as far right as possible.
   a. What type of figure is formed?

Answer: a parallelogram

b. How does the area of the original shaded triangle compare to the area of the parallelogram?

Answer: The area of the triangle is half the area of the parallelogram. (It takes two triangles to equal the parallelogram.)

7. If the area of a parallelogram is base times height, then what could be a formula for the area of the triangle?

Answer: Area = $\frac{1}{2} \times$ base $\times$ height

CCSS Mathematical Practice: Students will reason abstractly and quantitatively.
Mathematically proficient students will not only use the formula for the area of the triangle but also attend to how the formula is related to the area of a parallelogram with equal base and height.

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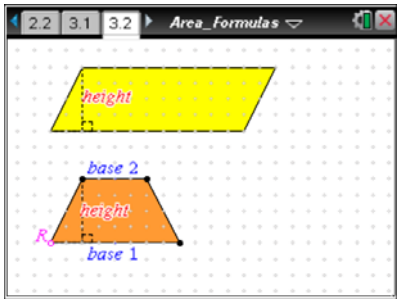
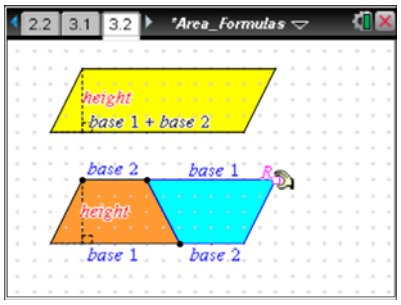


8. Rotate point *R* until it is as far right as possible.
   a. What type of figure is formed?

Answer: a parallelogram



   b. How is the base of the parallelogram related to the trapezoid?

Answer: The base of the parallelogram is the sum of the bases of the trapezoid, base1 + base2.

   c. Write an expression to represent the area of the parallelogram—either the parallelogram on the top of the screen or the newly formed parallelogram at the bottom of the screen.

Answer: Area of the parallelogram = (base1 + base2) $\times$ height

TI-Nspire Navigator Opportunity: *Screen Capture*
See Note 2 at the end of this lesson.

9. How does the area of the original shaded trapezoid compare to the area of the parallelogram?

Answer: The area of the trapezoid is half the area of the parallelogram.

10. If the area of a parallelogram is base times height, then what could be a formula for the area of the trapezoid?

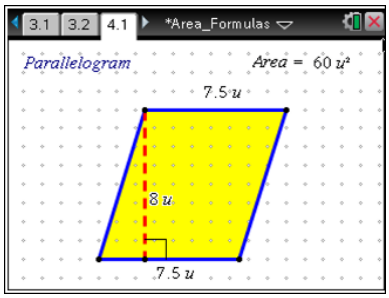
Answer: Area of the trapezoid = $\frac{1}{2}$ (base1 + base2) × height

CCSS Mathematical Practice: Students will look for and make use of structure.
Mathematically proficient students will look closely to see how the parallelogram on top is composed of the trapezoids on the bottom. They will discern the pattern from the previous problems to generalize the area of the trapezoid.

Teacher Tip: The following problems are designed to help students correctly associate specific shapes with the appropriate formula for area. In addition, the problems provide an opportunity for you to assess their understanding of how the variables and formulas are used. Students are expected to substitute values in the correct formula to find the area.

11. For each problem below:
    - Draw the figure.
    - Write a formula that could be used to find the area of each figure.
    - Use your formula to find the area of each figure.

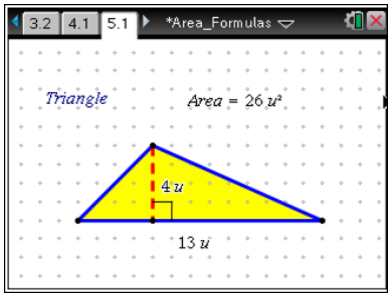
a. A parallelogram with base of 7.5 units and height of 8 units



Answer: Area = base × height

Area = 7.5 units × 8 units = 60 square units (60 u^2)

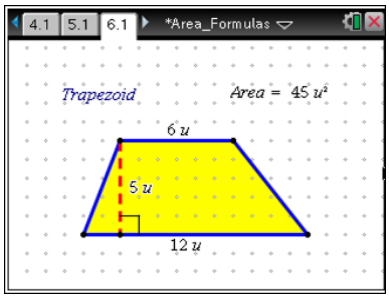
b. A triangle with base of 13 units and height of 4 units



Answer: Area = $\frac{1}{2}$ × base × height

Area = $\frac{1}{2}$ × 13 units × 4 units = 26 square units (26 u^2)

c. A trapezoid with height of 5 units, and bases of 12 units and 6 units



Answer: Area = $\frac{1}{2}$ (base1 + base2) × height

Area = $\frac{1}{2}$ (12 + 6) units × 5 units = 45 square units (45 u^2)

TI-Nspire Navigator Opportunity: *Quick Poll*
See Note 3 at the end of this lesson.

Wrap Up

Upon completion of the discussion, the teacher should ensure that students:

- Understand how the area of a parallelogram relates to the area of a rectangle with the same base and height.
- Understand how the area of a triangle relates to the area of a parallelogram with the same base and height.
- Understand how the area of a trapezoid relates to the area of a parallelogram with the same height and with base equal to the sum of the bases of the trapezoid.

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Note 1

Question 2, *Quick Poll*:

Send students the following Always/Sometimes/Never Quick Poll, and then have students justify their responses.

Rectangles with the same perimeter have the same area.

Answer: Sometimes. 3 rectangles with a perimeter of 12 units could have dimensions 2 × 4, 4 × 2, and 1 × 5.

Note 2

Question 8, *Screen Capture*:

Have students change the base and/or height of the trapezoid. Show a Screen Capture to the class so that students can see the relationship between the trapezoid and parallelogram above it for shaped trapezoids with various shapes.

Note 3

Question 11, *Quick Poll*:

Have students send in their responses to the area problems using an Open Response Quick Poll.