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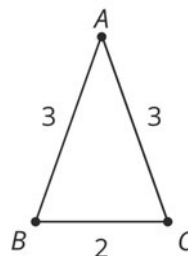
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## Unit 1, Lesson 10: Composing Figures

Let's use reasoning about rigid transformations to find measurements without measuring.

### 10.1: Angles of an Isosceles Triangle

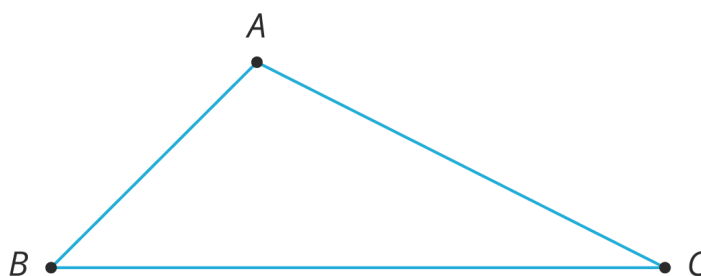
Here is a triangle.



1. Reflect triangle  $ABC$  over line  $AB$ . Label the image of  $C$  as  $C'$ .
2. Rotate triangle  $ABC'$  around  $A$  so that  $C'$  matches up with  $B$ .
3. What can you say about the measures of angles  $B$  and  $C$ ?

### 10.2: Triangle Plus One

Here is triangle  $ABC$ .



1. Draw midpoint  $M$  of side  $AC$ .
2. Rotate triangle  $ABC$  180 degrees using center  $M$  to form triangle  $CDA$ . Draw and label this triangle.
3. What kind of quadrilateral is  $ABCD$ ? Explain how you know.

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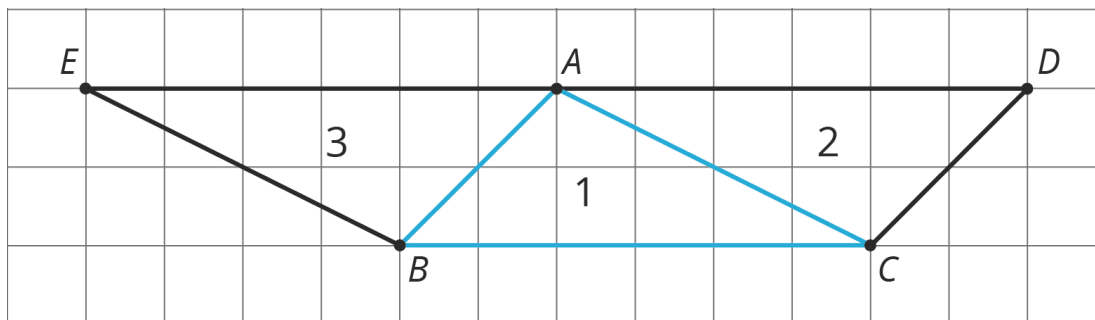
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### Are you ready for more?

In the activity, we made a parallelogram by taking a triangle and its image under a 180-degree rotation around the midpoint of a side. This picture helps you justify a well-known formula for the area of a triangle. What is the formula and how does the figure help justify it?

### 10.3: Triangle Plus Two

The picture shows 3 triangles. Triangle 2 and Triangle 3 are images of Triangle 1 under rigid transformations.



1. Describe a rigid transformation that takes Triangle 1 to Triangle 2. What points in Triangle 2 correspond to points  $A$ ,  $B$ , and  $C$  in the original triangle?
  
2. Describe a rigid transformation that takes Triangle 1 to Triangle 3. What points in Triangle 3 correspond to points  $A$ ,  $B$ , and  $C$  in the original triangle?

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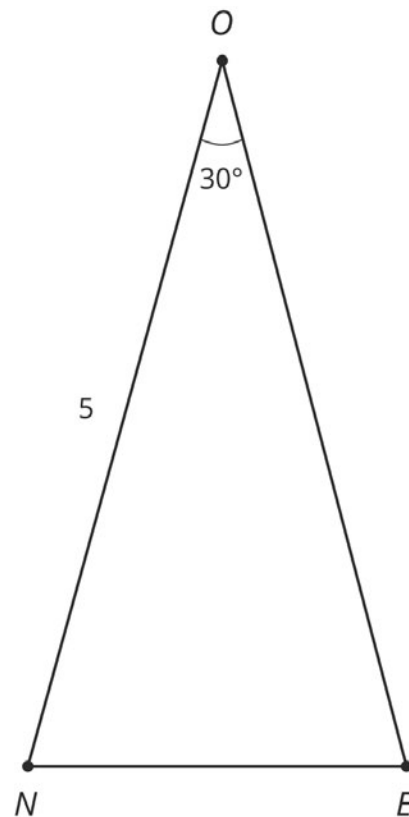
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3. Find two pairs of line segments in the diagram that are the same length, and explain how you know they are the same length.

4. Find two pairs of angles in the diagram that have the same measure, and explain how you know they have the same measure.

### 10.4: Triangle ONE Plus

Here is isosceles triangle  $ONE$ . Its sides  $ON$  and  $OE$  have equal lengths. Angle  $O$  is 30 degrees. The length of  $ON$  is 5 units.



1. Reflect triangle  $ONE$  across segment  $ON$ . Label the new vertex  $M$ .

2. What is the measure of angle  $MON$ ?

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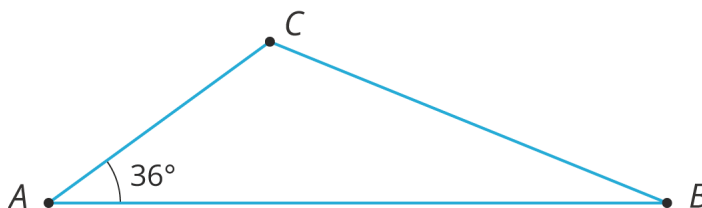
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3. What is the measure of angle  $MOE$ ?
4. Reflect triangle  $MON$  across segment  $OM$ . Label the point that corresponds to  $N$  as  $T$ .
5. How long is  $\overline{OT}$ ? How do you know?
6. What is the measure of angle  $TOE$ ?
7. If you continue to reflect each new triangle this way to make a pattern, what will the pattern look like?

### Lesson 10 Summary

Earlier, we learned that if we apply a sequence of rigid transformations to a figure, then corresponding sides have equal length and corresponding angles have equal measure. These facts let us figure out things without having to measure them!

For example, here is triangle  $ABC$ .

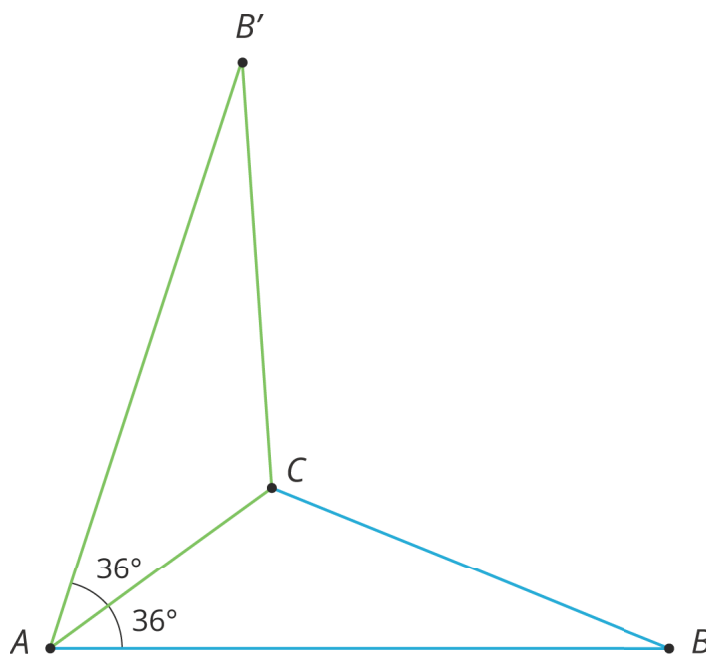


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We can reflect triangle  $ABC$  across side  $AC$  to form a new triangle:



Because points  $A$  and  $C$  are on the line of reflection, they do not move. So the image of triangle  $ABC$  is  $AB'C$ . We also know that:

- Angle  $B'AC$  measures  $36^\circ$  because it is the image of angle  $BAC$ .
- Segment  $AB'$  has the same length as segment  $AB$ .

When we construct figures using copies of a figure made with rigid transformations, we know that the measures of the images of segments and angles will be equal to the measures of the original segments and angles.

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## Unit 1, Lesson 10: Composing Figures

1. Here is the design for the flag of Trinidad and Tobago.



Describe a sequence of translations, rotations, and reflections that take the lower left triangle to the upper right triangle.

2. Here is a picture of an older version of the flag of Great Britain. There is a rigid transformation that takes Triangle 1 to Triangle 2, another that takes Triangle 1 to Triangle 3, and another that takes Triangle 1 to Triangle 4.



a. Measure the lengths of the sides in Triangles 1 and 2. What do you notice?

b. What are the side lengths of Triangle 3? Explain how you know.

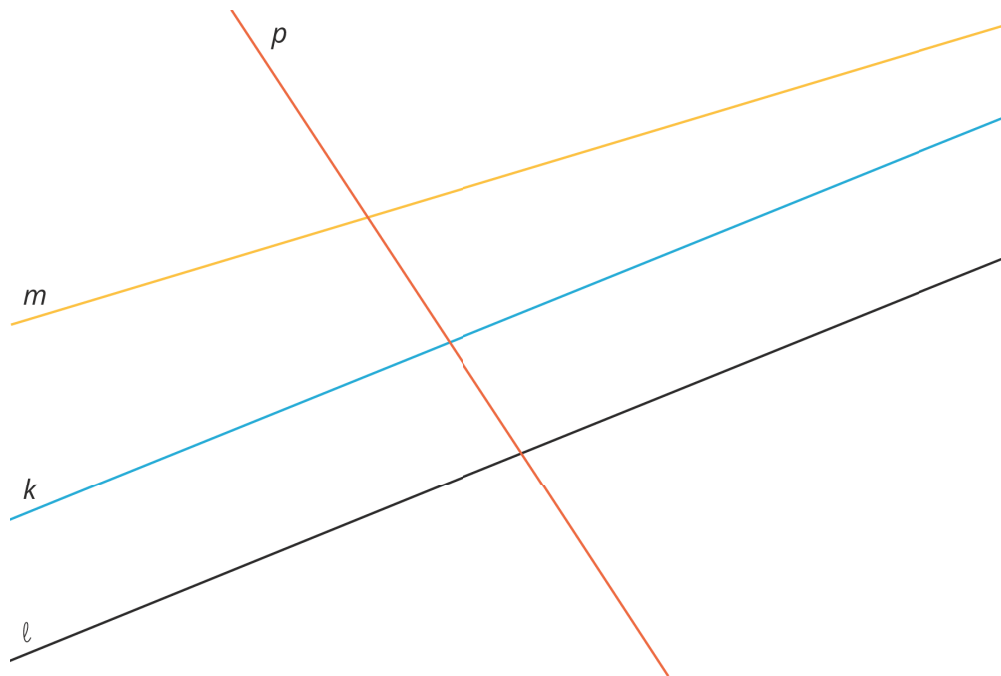
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c. Do all eight triangles in the flag have the same area? Explain how you know.

3. a. Which of the lines in the picture is parallel to line  $\ell$ ? Explain how you know.



b. Explain how to translate, rotate or reflect line  $\ell$  to obtain line  $k$ .

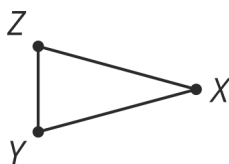
c. Explain how to translate, rotate or reflect line  $\ell$  to obtain line  $p$ .

(from Unit 1, Lesson 9)

4. Point  $A$  has coordinates  $(3, 4)$ . After a translation 4 units left, a reflection across the  $x$ -axis, and a translation 2 units down, what are the coordinates of the image?

(from Unit 1, Lesson 6)

5. Here is triangle  $XYZ$ :



Draw these three rotations of triangle  $XYZ$  together.

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- a. Rotate triangle  $XYZ$  90 degrees clockwise around  $Z$ .
- b. Rotate triangle  $XYZ$  180 degrees around  $Z$ .
- c. Rotate triangle  $XYZ$  270 degrees clockwise around  $Z$ .

(from Unit 1, Lesson 8)