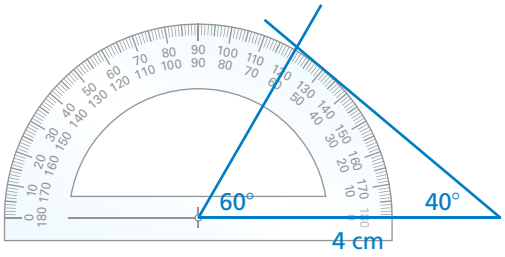
3.4 Using Similar Triangles

Essential Question How can you use angles to tell whether triangles are similar?

1 ACTIVITY: Constructing Similar Triangles

Work with a partner.

- **Use a straightedge to draw a line segment that is 4 centimeters long.**
- **Then use the line segment and a protractor to draw a triangle that has a 60° and a 40° angle, as shown. Label the triangle *ABC*.**



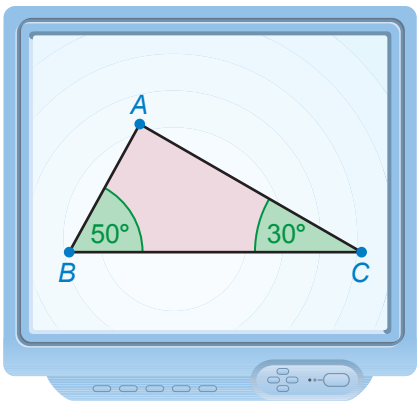
a. Explain how to draw a larger triangle that has the same two angle measures. Label the triangle *JKL*.

b. Explain how to draw a smaller triangle that has the same two angle measures. Label the triangle *PQR*.

c. Are all of the triangles similar? Explain.

2 ACTIVITY: Using Technology to Explore Triangles

Work with a partner. Use geometry software to draw the triangle below.



a. Dilate the triangle by the following scale factors.

$$2 \qquad \frac{1}{2} \qquad \frac{1}{4} \qquad 2.5$$

b. Measure the third angle in each triangle. What do you notice?

c. **REASONING** You have two triangles. Two angles in the first triangle are congruent to two angles in the second triangle. Can you conclude that the triangles are similar? Explain.

Common Core

Geometry

In this lesson, you will

- understand the concept of similar triangles.
- identify similar triangles.
- use indirect measurement to find missing measures.

Learning Standard 8.G.5

3 ACTIVITY: Indirect Measurement

Math Practice 2

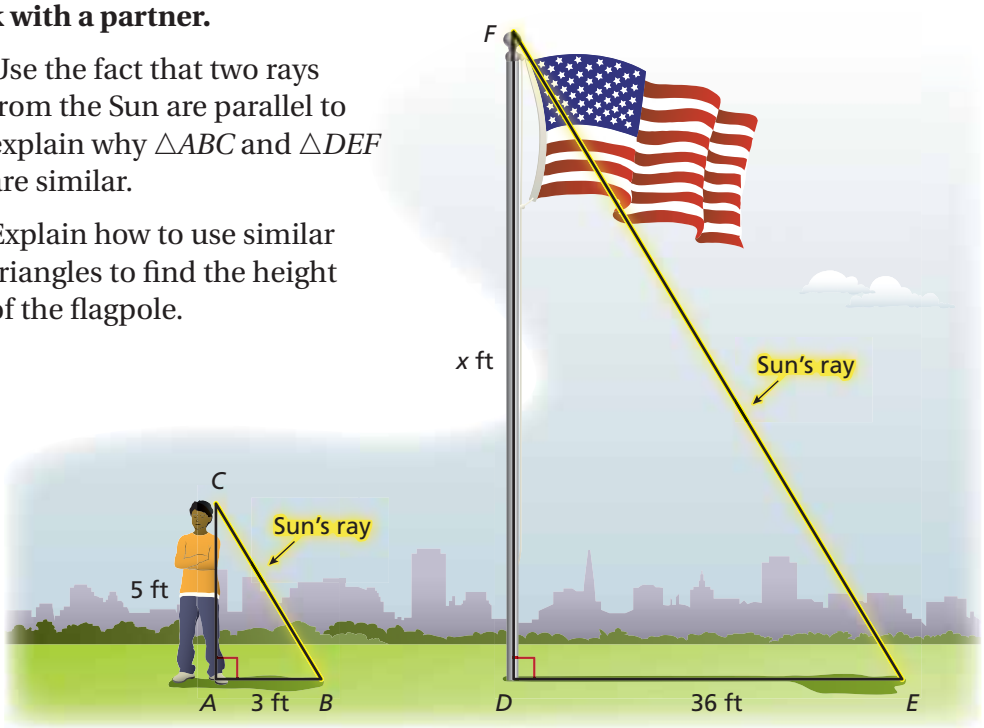
Make Sense of Quantities

What do you know about the sides of the triangles when the triangles are similar?

Work with a partner.

a. Use the fact that two rays from the Sun are parallel to explain why $\triangle ABC$ and $\triangle DEF$ are similar.

b. Explain how to use similar triangles to find the height of the flagpole.



What Is Your Answer?

4. IN YOUR OWN WORDS How can you use angles to tell whether triangles are similar?

5. PROJECT Work with a partner or in a small group.

a. Explain why the process in Activity 3 is called "indirect" measurement.

b. CHOOSE TOOLS Use indirect measurement to measure the height of something outside your school (a tree, a building, a flagpole). Before going outside, decide what materials you need to take with you.

c. MODELING Draw a diagram of the indirect measurement process you used. In the diagram, label the lengths that you actually measured and also the lengths that you calculated.

6. PRECISION Look back at Exercise 17 in Section 2.5. Explain how you can show that the two triangles are similar.

Practice Use what you learned about similar triangles to complete Exercises 4 and 5 on page 130.

3.4 Lesson

Check It Out
Lesson Tutorials
BigIdeasMath.com

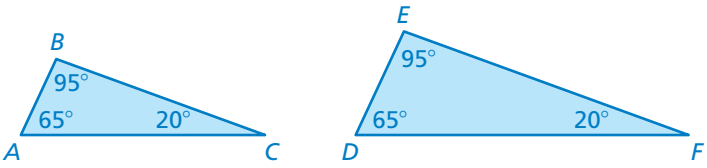
Key Vocabulary
indirect measurement, *p. 129*

Key Idea

Angles of Similar Triangles

Words When two angles in one triangle are congruent to two angles in another triangle, the third angles are also congruent and the triangles are similar.

Example

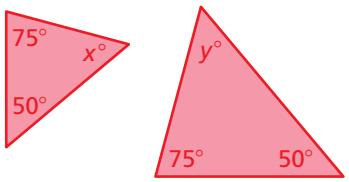


Triangle ABC is similar to Triangle DEF: $\triangle ABC \sim \triangle DEF$.

EXAMPLE 1 Identifying Similar Triangles

Tell whether the triangles are similar. Explain.

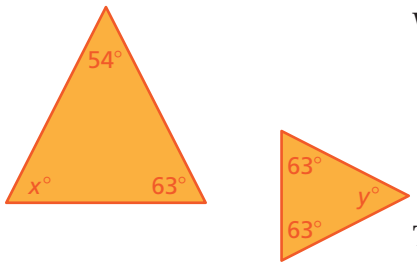
a.



The triangles have two pairs of congruent angles.

∴ So, the third angles are congruent, and the triangles are similar.

b.



Write and solve an equation to find x.

$x + 54 + 63 = 180$

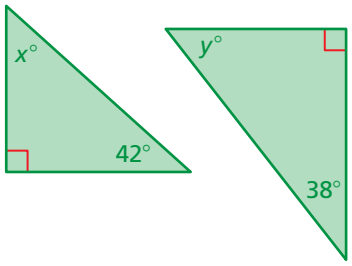
$x + 117 = 180$

$x = 63$

The triangles have two pairs of congruent angles.

∴ So, the third angles are congruent, and the triangles are similar.

c.



Write and solve an equation to find x.

$x + 90 + 42 = 180$

$x + 132 = 180$

$x = 48$

The triangles do not have two pairs of congruent angles.

∴ So, the triangles are not similar.

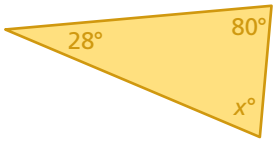
Multi-Language Glossary at BigIdeasMath.com

On Your Own

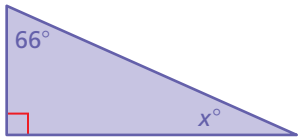
Now You're Ready
Exercises 6–9

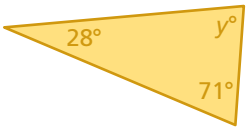
Tell whether the triangles are similar. Explain.

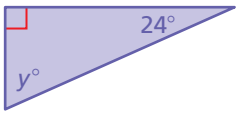
1.



2.

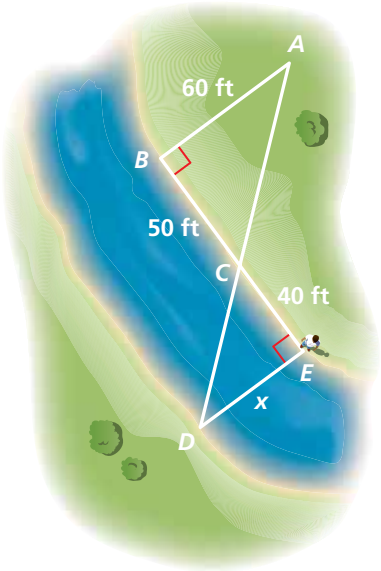






Indirect measurement uses similar figures to find a missing measure when it is difficult to find directly.

EXAMPLE 2 Using Indirect Measurement



You plan to cross a river and want to know how far it is to the other side. You take measurements on your side of the river and make the drawing shown. (a) Explain why $\triangle ABC$ and $\triangle DEC$ are similar. (b) What is the distance x across the river?

a. $\angle B$ and $\angle E$ are right angles, so they are congruent. $\angle ACB$ and $\angle DCE$ are vertical angles, so they are congruent.

Because two angles in $\triangle ABC$ are congruent to two angles in $\triangle DEC$, the third angles are also congruent and the triangles are similar.

b. The ratios of the corresponding side lengths in similar triangles are equal. Write and solve a proportion to find x.

$$\frac{x}{60} = \frac{40}{50}$$ Write a proportion.

$$60 \cdot \frac{x}{60} = 60 \cdot \frac{40}{50}$$ Multiplication Property of Equality

$$x = 48$$ Simplify.

∴ So, the distance across the river is 48 feet.

On Your Own

Now You're Ready
Exercise 13

3. WHAT IF? The distance from vertex A to vertex B is 55 feet. What is the distance across the river?

3.4 Exercises

Check It Out
Help with Homework
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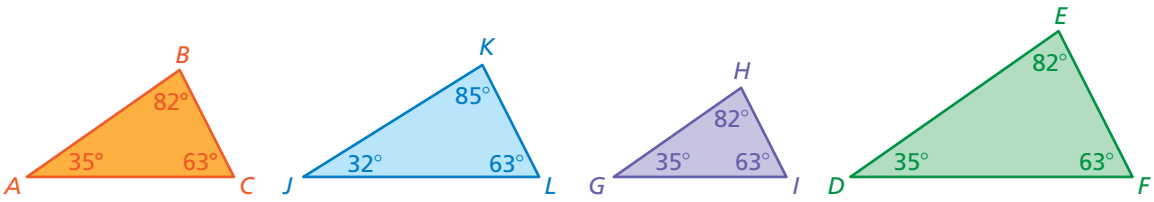
Vocabulary and Concept Check

1. **REASONING** How can you use similar triangles to find a missing measurement?
2. **WHICH ONE DOESN'T BELONG?** Which triangle does *not* belong with the other three? Explain your reasoning.

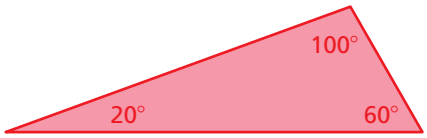


3. **WRITING** Two triangles have two pairs of congruent angles. In your own words, explain why you do not need to find the measures of the third pair of angles to determine that they are congruent.

Practice and Problem Solving

Make a triangle that is larger or smaller than the one given and has the same angle measures. Find the ratios of the corresponding side lengths.

4.



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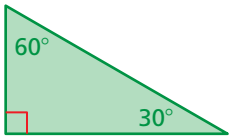
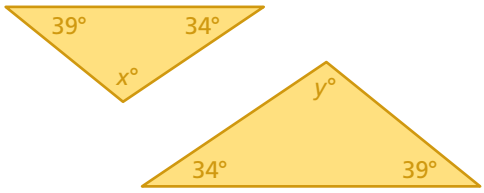


Tell whether the triangles are similar. Explain.

1 6.



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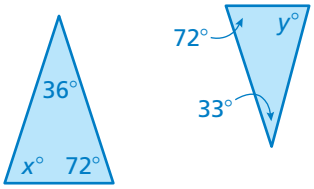

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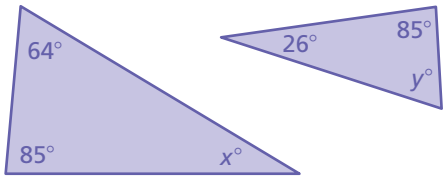

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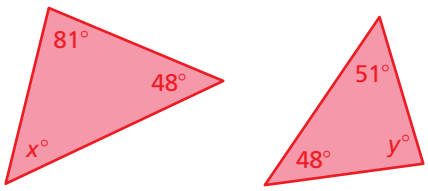
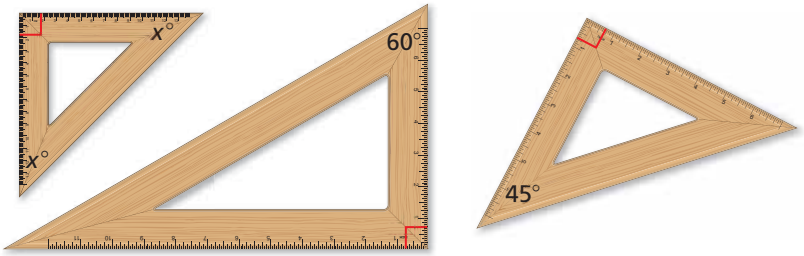
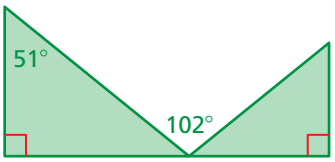


10. **RULERS** Which of the rulers are similar in shape? Explain.



Tell whether the triangles are similar. Explain.

11.



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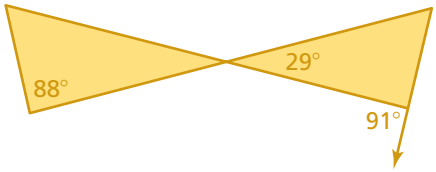
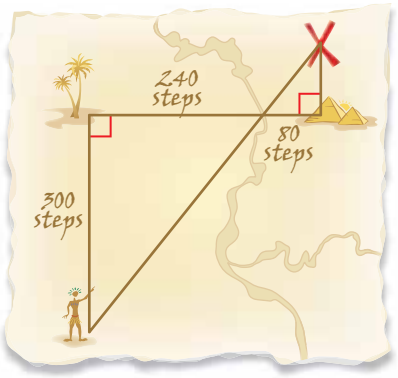
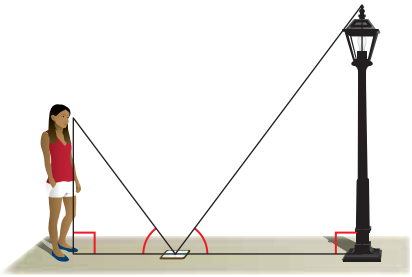


13. TREASURE The map shows the number of steps you must take to get to the treasure. However, the map is old, and the last dimension is unreadable. Explain why the triangles are similar. How many steps do you take from the pyramids to the treasure?



14. CRITICAL THINKING The side lengths of a triangle are increased by 50% to make a similar triangle. Does the area increase by 50% as well? Explain.

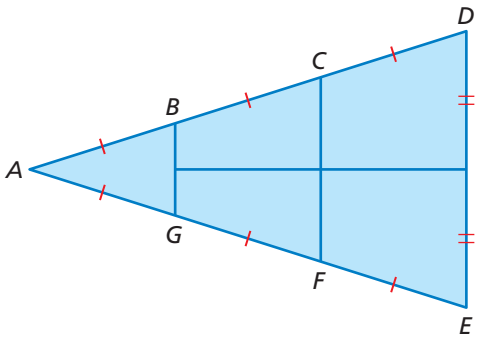


15. PINE TREE A person who is 6 feet tall casts a 3-foot-long shadow. A nearby pine tree casts a 15-foot-long shadow. What is the height h of the pine tree?

16. OPEN-ENDED You place a mirror on the ground 6 feet from the lamppost. You move back 3 feet and see the top of the lamppost in the mirror. What is the height of the lamppost?

17. REASONING In each of two right triangles, one angle measure is two times another angle measure. Are the triangles similar? Explain your reasoning.

18. Geometry In the diagram, segments BG, CF, and DE are parallel. The length of segment BD is 6.32 feet, and the length of segment DE is 6 feet. Name all pairs of similar triangles in the diagram. Then find the lengths of segments BG and CF.



Fair Game Review What you learned in previous grades & lessons

Solve the equation for y. *(Section 1.4)*

19. $y - 5x = 3$ **20.** $4x + 6y = 12$ **21.** $2x - \frac{1}{4}y = 1$

22. MULTIPLE CHOICE What is the value of x? *(Section 3.2)*

Ⓐ 17 Ⓑ 62

Ⓒ 118 Ⓓ 152