8.3 Proving Triangle Similarity by SSS and SAS

Essential Question What are two ways to use corresponding sides of two triangles to determine that the triangles are similar?

EXPLORATION 1 Deciding Whether Triangles Are Similar

Work with a partner. Use dynamic geometry software.

a. Construct $\triangle ABC$ and $\triangle DEF$ with the side lengths given in column 1 of the table below.

	1.	2.	3.	4.	5.	6.	7.
AB	5	5	6	15	9	24	
BC	8	8	8	20	12	18	
AC	10	10	10	10	8	16	
DE	10	15	9	12	12	8	
EF	16	24	12	16	15	6	
DF	20	30	15	8	10	8	
$m\angle A$							
$m\angle B$							
$m\angle C$							
$m\angle D$							
$m\angle E$							
$m\angle F$							

CONSTRUCTING VIABLE ARGUMENTS

To be proficient in math, you need to analyze situations by breaking them into cases and recognize and use counterexamples.

b. Copy the table and complete column 1.

c. Are the triangles similar? Explain your reasoning.

d. Repeat parts (a)–(c) for columns 2–6 in the table.

e. How are the corresponding side lengths related in each pair of triangles that are similar? Is this true for each pair of triangles that are not similar?

f. Make a conjecture about the similarity of two triangles based on their corresponding side lengths.

g. Use your conjecture to write another set of side lengths of two similar triangles. Use the side lengths to complete column 7 of the table.

EXPLORATION 2 Deciding Whether Triangles Are Similar

Work with a partner. Use dynamic geometry software. Construct any $\triangle ABC$.

a. Find AB, AC, and $m\angle A$. Choose any positive rational number k and construct $\triangle DEF$ so that $DE = k \cdot AB$, $DF = k \cdot AC$, and $m\angle D = m\angle A$.

b. Is $\triangle DEF$ similar to $\triangle ABC$? Explain your reasoning.

c. Repeat parts (a) and (b) several times by changing $\triangle ABC$ and k. Describe your results.

Communicate Your Answer

3. What are two ways to use corresponding sides of two triangles to determine that the triangles are similar?

8.3 Lesson

Core Vocabulary

Previous
similar figures
corresponding parts
slope
parallel lines
perpendicular lines

What You Will Learn

- Use the Side-Side-Side Similarity Theorem.
- Use the Side-Angle-Side Similarity Theorem.
- Prove slope criteria using similar triangles.

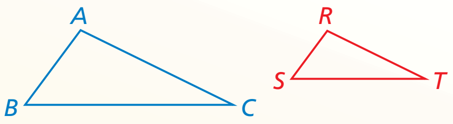
Using the Side-Side-Side Similarity Theorem

In addition to using congruent corresponding angles to show that two triangles are similar, you can use proportional corresponding side lengths.

Theorem

Theorem 8.4 Side-Side-Side (SSS) Similarity Theorem

If the corresponding side lengths of two triangles are proportional, then the triangles are similar.

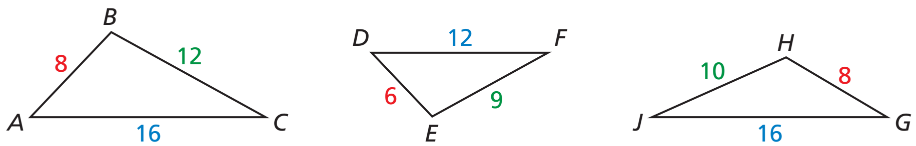


If $\frac{AB}{RS} = \frac{BC}{ST} = \frac{CA}{TR}$, then $\triangle ABC \sim \triangle RST$.

Proof p. 437

EXAMPLE 1 Using the SSS Similarity Theorem

Is either $\triangle DEF$ or $\triangle GHJ$ similar to $\triangle ABC$?



FINDING AN ENTRY POINT

When using the SSS Similarity Theorem, compare the shortest sides, the longest sides, and then the remaining sides.

SOLUTION

Compare $\triangle ABC$ and $\triangle DEF$ by finding ratios of corresponding side lengths.

Shortest sides	**Longest sides**	**Remaining sides**
$\frac{AB}{DE} = \frac{8}{6}$	$\frac{CA}{FD} = \frac{16}{12}$	$\frac{BC}{EF} = \frac{12}{9}$
$= \frac{4}{3}$	$= \frac{4}{3}$	$= \frac{4}{3}$

- All the ratios are equal, so $\triangle ABC \sim \triangle DEF$.

Compare $\triangle ABC$ and $\triangle GHJ$ by finding ratios of corresponding side lengths.

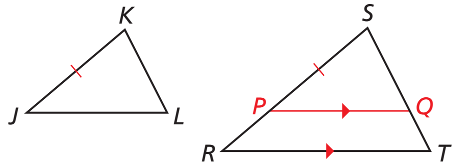
Shortest sides	**Longest sides**	**Remaining sides**
$\frac{AB}{GH} = \frac{8}{8}$	$\frac{CA}{JG} = \frac{16}{16}$	$\frac{BC}{HJ} = \frac{12}{10}$
$= 1$	$= 1$	$= \frac{6}{5}$

- The ratios are not all equal, so $\triangle ABC$ and $\triangle GHJ$ are not similar.

PROOF SSS Similarity Theorem

Given $\dfrac{RS}{JK} = \dfrac{ST}{KL} = \dfrac{TR}{LJ}$

Prove $\triangle RST \sim \triangle JKL$



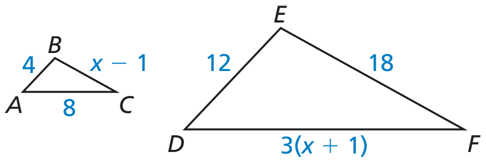
Locate P on $\overline{RS}$ so that $PS = JK$. Draw $\overline{PQ}$ so that $\overline{PQ} \parallel \overline{RT}$. Then $\triangle RST \sim \triangle PSQ$ by the AA Similarity Theorem (Theorem 8.3), and $\dfrac{RS}{PS} = \dfrac{ST}{SQ} = \dfrac{TR}{QP}$. You can use the given proportion and the fact that $PS = JK$ to deduce that $SQ = KL$ and $QP = LJ$. By the SSS Congruence Theorem (Theorem 5.8), it follows that $\triangle PSQ \cong \triangle JKL$. Finally, use the definition of congruent triangles and the AA Similarity Theorem (Theorem 8.3) to conclude that $\triangle RST \sim \triangle JKL$.

JUSTIFYING STEPS

The Parallel Postulate (Postulate 3.1) allows you to draw an auxiliary line $\overleftrightarrow{PQ}$ in $\triangle RST$. There is only one line through point P parallel to $\overleftrightarrow{RT}$, so you are able to draw it.

EXAMPLE 2 Using the SSS Similarity Theorem

Find the value of x that makes $\triangle ABC \sim \triangle DEF$.



SOLUTION

Step 1 Find the value of x that makes corresponding side lengths proportional.

$$\frac{AB}{DE} = \frac{BC}{EF} \qquad \text{Write proportion.}$$

$$\frac{4}{12} = \frac{x-1}{18} \qquad \text{Substitute.}$$

$$4 \cdot 18 = 12(x-1) \qquad \text{Cross Products Property}$$

$$72 = 12x - 12 \qquad \text{Simplify.}$$

$$7 = x \qquad \text{Solve for } x.$$

FINDING AN ENTRY POINT

You can use either $\dfrac{AB}{DE} = \dfrac{BC}{EF}$ or $\dfrac{AB}{DE} = \dfrac{AC}{DF}$ in Step 1.

Step 2 Check that the side lengths are proportional when $x = 7$.

$BC = x - 1 = 6$ $\qquad$ $DF = 3(x + 1) = 24$

$\dfrac{AB}{DE} \stackrel{?}{=} \dfrac{BC}{EF} \rightarrow \dfrac{4}{12} = \dfrac{6}{18}$ ✓ $\qquad$ $\dfrac{AB}{DE} \stackrel{?}{=} \dfrac{AC}{DF} \rightarrow \dfrac{4}{12} = \dfrac{8}{24}$ ✓

▶ When $x = 7$, the triangles are similar by the SSS Similarity Theorem.

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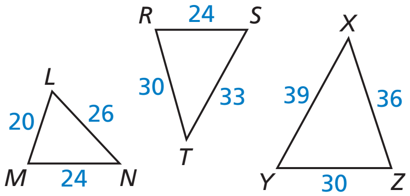
Use the diagram.



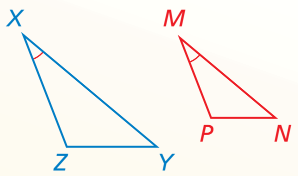
1. Which of the three triangles are similar? Write a similarity statement.
2. The shortest side of a triangle similar to $\triangle RST$ is 12 units long. Find the other side lengths of the triangle.

Using the Side-Angle-Side Similarity Theorem

Theorem

Theorem 8.5 Side-Angle-Side (SAS) Similarity Theorem

If an angle of one triangle is congruent to an angle of a second triangle and the lengths of the sides including these angles are proportional, then the triangles are similar.

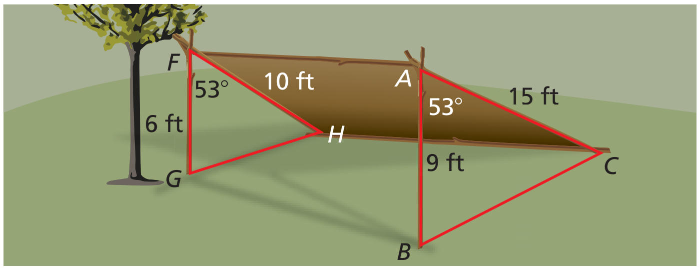


If $\angle X \cong \angle M$ and $\dfrac{ZX}{PM} = \dfrac{XY}{MN}$, then $\triangle XYZ \sim \triangle MNP$.

Proof Ex. 33, p. 443

EXAMPLE 3 Using the SAS Similarity Theorem

You are building a lean-to shelter starting from a tree branch, as shown. Can you construct the right end so it is similar to the left end using the angle measure and lengths shown?



SOLUTION

Both $m\angle A$ and $m\angle F$ equal 53°, so $\angle A \cong \angle F$. Next, compare the ratios of the lengths of the sides that include $\angle A$ and $\angle F$.

Shorter sides	Longer sides
$\dfrac{AB}{FG} = \dfrac{9}{6}$	$\dfrac{AC}{FH} = \dfrac{15}{10}$
$= \dfrac{3}{2}$	$= \dfrac{3}{2}$

The lengths of the sides that include $\angle A$ and $\angle F$ are proportional. So, by the SAS Similarity Theorem, $\triangle ABC \sim \triangle FGH$.

▶ Yes, you can make the right end similar to the left end of the shelter.

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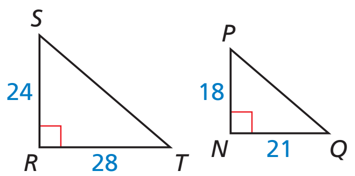
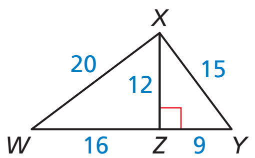
Explain how to show that the indicated triangles are similar.

3. $\triangle SRT \sim \triangle PNQ$



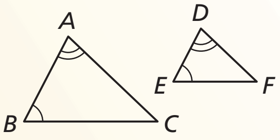
4. $\triangle XZW \sim \triangle YZX$



Concept Summary

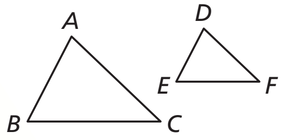
Triangle Similarity Theorems

AA Similarity Theorem



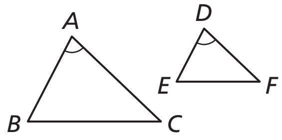
If $\angle A \cong \angle D$ and $\angle B \cong \angle E$, then $\triangle ABC \sim \triangle DEF$.

SSS Similarity Theorem



If $\dfrac{AB}{DE} = \dfrac{BC}{EF} = \dfrac{AC}{DF}$, then $\triangle ABC \sim \triangle DEF$.

SAS Similarity Theorem



If $\angle A \cong \angle D$ and $\dfrac{AB}{DE} = \dfrac{AC}{DF}$, then $\triangle ABC \sim \triangle DEF$.

Proving Slope Criteria Using Similar Triangles

You can use similar triangles to prove the Slopes of Parallel Lines Theorem (Theorem 3.13). Because the theorem is biconditional, you must prove both parts.

1. If two nonvertical lines are parallel, then they have the same slope.
2. If two nonvertical lines have the same slope, then they are parallel.

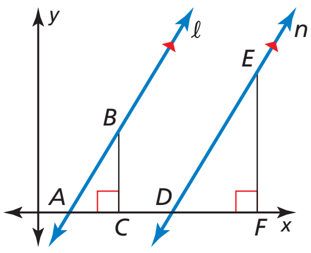
The first part is proved below. The second part is proved in the exercises.

PROOF **Part of Slopes of Parallel Lines Theorem (Theorem 3.13)**

Given $\ell \parallel n$, ℓ and n are nonvertical.

Prove $m_\ell = m_n$

First, consider the case where ℓ and n are horizontal. Because all horizontal lines are parallel and have a slope of 0, the statement is true for horizontal lines.



For the case of nonhorizontal, nonvertical lines, draw two such parallel lines, ℓ and n, and label their x-intercepts A and D, respectively. Draw a vertical segment $\overline{BC}$ parallel to the y-axis from point B on line ℓ to point C on the x-axis. Draw a vertical segment $\overline{EF}$ parallel to the y-axis from point E on line n to point F on the x-axis. Because vertical and horizontal lines are perpendicular, $\angle BCA$ and $\angle EFD$ are right angles.

STATEMENTS	REASONS
1. $\ell \parallel n$	**1.** Given
2. $\angle BAC \cong \angle EDF$	**2.** Corresponding Angles Theorem (Thm. 3.1)
3. $\angle BCA \cong \angle EFD$	**3.** Right Angles Congruence Theorem (Thm. 2.3)
4. $\triangle ABC \sim \triangle DEF$	**4.** AA Similarity Theorem (Thm. 8.3)
5. $\dfrac{BC}{EF} = \dfrac{AC}{DF}$	**5.** Corresponding sides of similar figures are proportional.
6. $\dfrac{BC}{AC} = \dfrac{EF}{DF}$	**6.** Rewrite proportion.
7. $m_\ell = \dfrac{BC}{AC}$, $m_n = \dfrac{EF}{DF}$	**7.** Definition of slope
8. $m_n = \dfrac{BC}{AC}$	**8.** Substitution Property of Equality
9. $m_\ell = m_n$	**9.** Transitive Property of Equality

To prove the Slopes of Perpendicular Lines Theorem (Theorem 3.14), you must prove both parts.

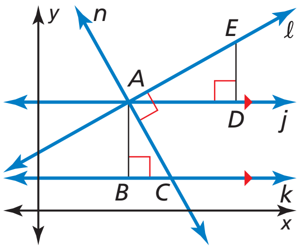
1. If two nonvertical lines are perpendicular, then the product of their slopes is -1.
2. If the product of the slopes of two nonvertical lines is -1, then the lines are perpendicular.

The first part is proved below. The second part is proved in the exercises.

PROOF Part of Slopes of Perpendicular Lines Theorem (Theorem 3.14)

Given $\ell \perp n$, ℓ and n are nonvertical.

Prove $m_\ell m_n = -1$



Draw two nonvertical, perpendicular lines, ℓ and n, that intersect at point A. Draw a horizontal line j parallel to the x-axis through point A. Draw a horizontal line k parallel to the x-axis through point C on line n. Because horizontal lines are parallel, $j \parallel k$. Draw a vertical segment $\overline{AB}$ parallel to the y-axis from point A to point B on line k. Draw a vertical segment $\overline{ED}$ parallel to the y-axis from point E on line ℓ to point D on line j. Because horizontal and vertical lines are perpendicular, $\angle ABC$ and $\angle ADE$ are right angles.

STATEMENTS	REASONS
1. $\ell \perp n$	1. Given
2. $m\angle CAE = 90°$	2. $\ell \perp n$
3. $m\angle CAE = m\angle DAE + m\angle CAD$	3. Angle Addition Postulate (Post. 1.4)
4. $m\angle DAE + m\angle CAD = 90°$	4. Transitive Property of Equality
5. $\angle BCA \cong \angle CAD$	5. Alternate Interior Angles Theorem (Thm. 3.2)
6. $m\angle BCA = m\angle CAD$	6. Definition of congruent angles
7. $m\angle DAE + m\angle BCA = 90°$	7. Substitution Property of Equality
8. $m\angle DAE = 90° - m\angle BCA$	8. Solve statement 7 for $m\angle DAE$.
9. $m\angle BCA + m\angle BAC + 90° = 180°$	9. Triangle Sum Theorem (Thm. 5.1)
10. $m\angle BAC = 90° - m\angle BCA$	10. Solve statement 9 for $m\angle BAC$.
11. $m\angle DAE = m\angle BAC$	11. Transitive Property of Equality
12. $\angle DAE \cong \angle BAC$	12. Definition of congruent angles
13. $\angle ABC \cong \angle ADE$	13. Right Angles Congruence Theorem (Thm. 2.3)
14. $\triangle ABC \sim \triangle ADE$	14. AA Similarity Theorem (Thm. 8.3)
15. $\frac{AD}{AB} = \frac{DE}{BC}$	15. Corresponding sides of similar figures are proportional.
16. $\frac{AD}{DE} = \frac{AB}{BC}$	16. Rewrite proportion.
17. $m_\ell = \frac{DE}{AD}$, $m_n = -\frac{AB}{BC}$	17. Definition of slope
18. $m_\ell m_n = \frac{DE}{AD} \cdot \left(-\frac{AB}{BC}\right)$	18. Substitution Property of Equality
19. $m_\ell m_n = \frac{DE}{AD} \cdot \left(-\frac{AD}{DE}\right)$	19. Substitution Property of Equality
20. $m_\ell m_n = -1$	20. Simplify.

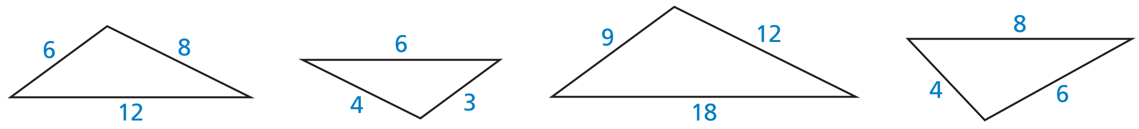
8.3 Exercises

Dynamic Solutions available at *BigIdeasMath.com*

Vocabulary and Core Concept Check

1. COMPLETE THE SENTENCE You plan to show that $\triangle QRS$ is similar to $\triangle XYZ$ by the SSS Similarity Theorem (Theorem 8.4). Copy and complete the proportion that you will use: $\frac{QR}{\square} = \frac{\square}{YZ} = \frac{QS}{\square}$.

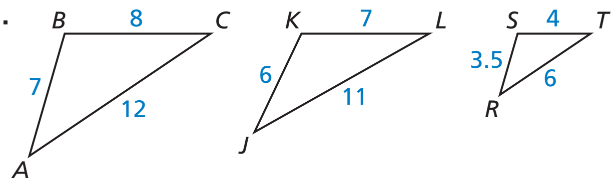
2. WHICH ONE DOESN'T BELONG? Which triangle does *not* belong with the other three? Explain your reasoning.



Monitoring Progress and Modeling with Mathematics

In Exercises 3 and 4, determine whether $\triangle JKL$ or $\triangle RST$ is similar to $\triangle ABC$. *(See Example 1.)*

3.



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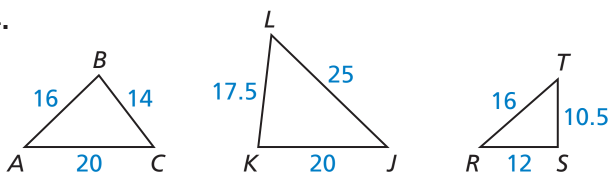
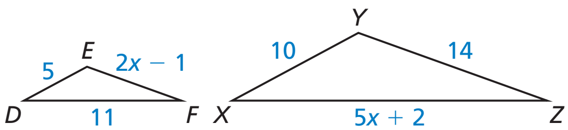


In Exercises 5 and 6, find the value of x that makes $\triangle DEF \sim \triangle XYZ$. *(See Example 2.)*

5.



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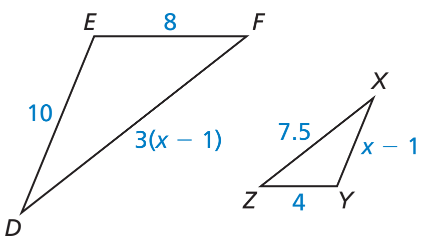


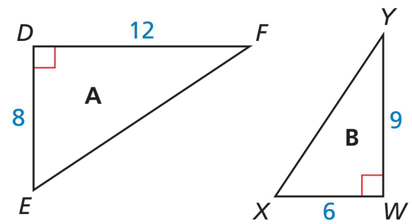
In Exercises 7 and 8, verify that $\triangle ABC \sim \triangle DEF$. Find the scale factor of $\triangle ABC$ to $\triangle DEF$.

7. $\triangle ABC$: $BC = 18$, $AB = 15$, $AC = 12$
$\triangle DEF$: $EF = 12$, $DE = 10$, $DF = 8$

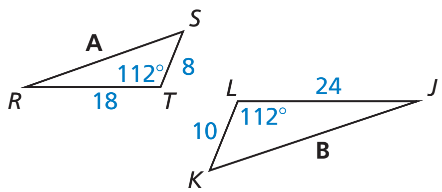
8. $\triangle ABC$: $AB = 10$, $BC = 16$, $CA = 20$
$\triangle DEF$: $DE = 25$, $EF = 40$, $FD = 50$

In Exercises 9 and 10, determine whether the two triangles are similar. If they are similar, write a similarity statement and find the scale factor of triangle B to triangle A. *(See Example 3.)*

9.



10.



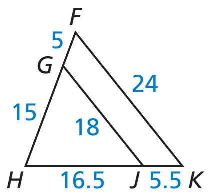
In Exercises 11 and 12, sketch the triangles using the given description. Then determine whether the two triangles can be similar.

11. In $\triangle RST$, $RS = 20$, $ST = 32$, and $m\angle S = 16°$. In $\triangle FGH$, $GH = 30$, $HF = 48$, and $m\angle H = 24°$.

12. The side lengths of $\triangle ABC$ are 24, $8x$, and 48, and the side lengths of $\triangle DEF$ are 15, 25, and $6x$.

In Exercises 13–16, show that the triangles are similar and write a similarity statement. Explain your reasoning.

13.



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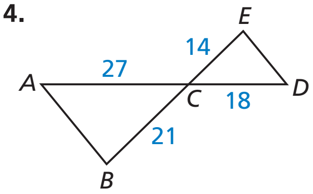

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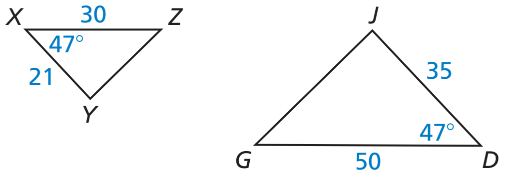

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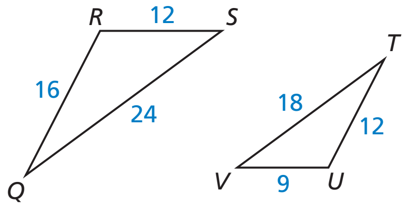
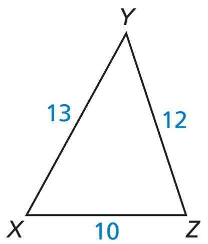


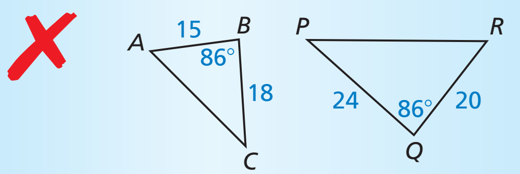
In Exercises 17 and 18, use $\triangle XYZ$.



17. The shortest side of a triangle similar to $\triangle XYZ$ is 20 units long. Find the other side lengths of the triangle.

18. The longest side of a triangle similar to $\triangle XYZ$ is 39 units long. Find the other side lengths of the triangle.

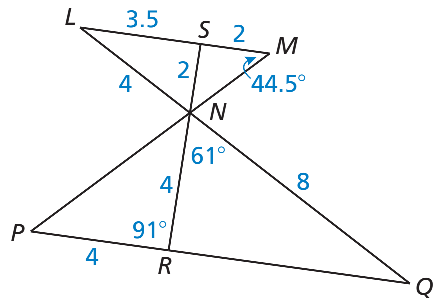
19. **ERROR ANALYSIS** Describe and correct the error in writing a similarity statement.



$\triangle ABC \sim \triangle PQR$ by the SAS Similarity Theorem (Theorem 8.5).

20. **MATHEMATICAL CONNECTIONS** Find the value of n that makes $\triangle DEF \sim \triangle XYZ$ when $DE = 4$, $EF = 5$, $XY = 4(n + 1)$, $YZ = 7n - 1$, and $\angle E \cong \angle Y$. Include a sketch.

ATTENDING TO PRECISION In Exercises 21–26, use the diagram to copy and complete the statement.



21. $m\angle LNS = \square$

22. $m\angle NRQ = \square$

23. $m\angle NQR = \square$

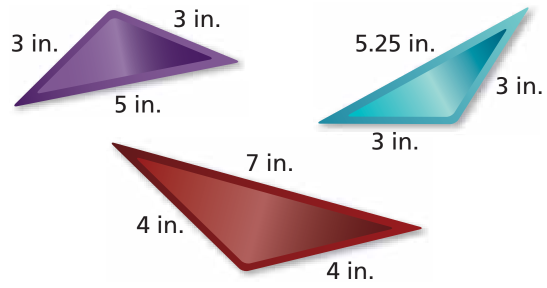
24. $RQ = \square$

25. $m\angle NSM = \square$

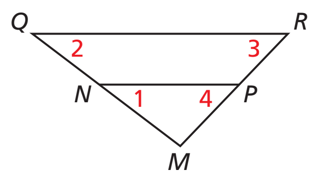
26. $m\angle NPR = \square$

27. **MAKING AN ARGUMENT** Your friend claims that $\triangle JKL \sim \triangle MNO$ by the SAS Similarity Theorem (Theorem 8.5) when $JK = 18$, $m\angle K = 130°$, $KL = 16$, $MN = 9$, $m\angle N = 65°$, and $NO = 8$. Do you support your friend's claim? Explain your reasoning.

28. **ANALYZING RELATIONSHIPS** Certain sections of stained glass are sold in triangular, beveled pieces. Which of the three beveled pieces, if any, are similar?



29. **ATTENDING TO PRECISION** In the diagram, $\frac{MN}{MR} = \frac{MP}{MQ}$. Which of the statements must be true? Select all that apply. Explain your reasoning.



(A) $\angle 1 \cong \angle 2$ (B) $\overline{QR} \parallel \overline{NP}$

(C) $\angle 1 \cong \angle 4$ (D) $\triangle MNP \sim \triangle MRQ$

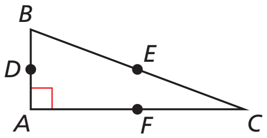
30. **WRITING** Are any two right triangles similar? Explain.

31. **MODELING WITH MATHEMATICS** In the portion of the shuffleboard court shown, $\frac{BC}{AC} = \frac{BD}{AE}$.

a. What additional information do you need to show that $\triangle BCD \sim \triangle ACE$ using the SSS Similarity Theorem (Theorem 8.4)?

b. What additional information do you need to show that $\triangle BCD \sim \triangle ACE$ using the SAS Similarity Theorem (Theorem 8.5)?

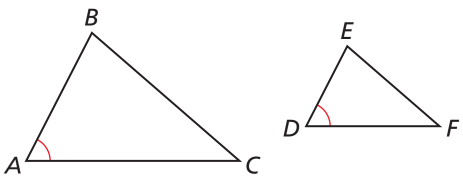
32. **PROOF** Given that $\triangle BAC$ is a right triangle and D, E, and F are midpoints, prove that $m\angle DEF = 90°$.



33. **PROVING A THEOREM** Write a two-column proof of the SAS Similarity Theorem (Theorem 8.5).

Given $\angle A \cong \angle D$, $\frac{AB}{DE} = \frac{AC}{DF}$

Prove $\triangle ABC \sim \triangle DEF$



34. **CRITICAL THINKING** You are given two right triangles with one pair of corresponding legs and the pair of hypotenuses having the same length ratios.

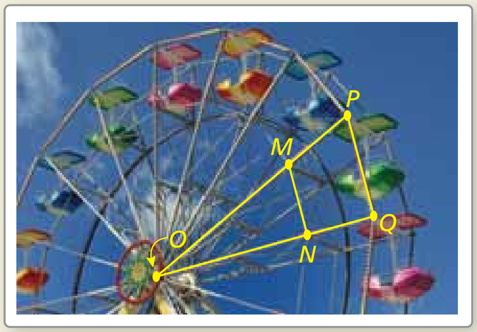
a. The lengths of the given pair of corresponding legs are 6 and 18, and the lengths of the hypotenuses are 10 and 30. Use the Pythagorean Theorem to find the lengths of the other pair of corresponding legs. Draw a diagram.

b. Write the ratio of the lengths of the second pair of corresponding legs.

c. Are these triangles similar? Does this suggest a Hypotenuse-Leg Similarity Theorem for right triangles? Explain.

35. **WRITING** Can two triangles have all three ratios of corresponding angle measures equal to a value greater than 1? less than 1? Explain.

36. **HOW DO YOU SEE IT?** Which theorem could you use to show that $\triangle OPQ \sim \triangle OMN$ in the portion of the Ferris wheel shown when $PM = QN = 5$ feet and $MO = NO = 10$ feet?



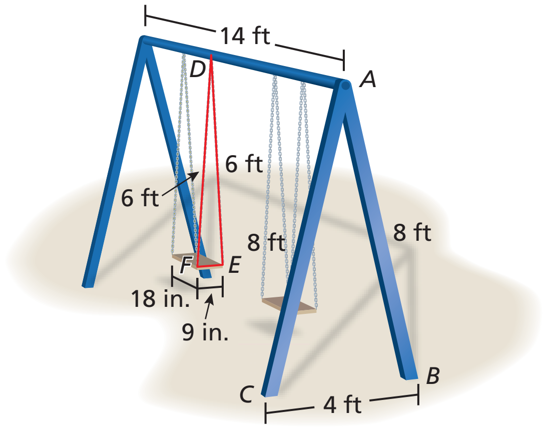
37. **DRAWING CONCLUSIONS** Explain why it is not necessary to have an Angle-Side-Angle Similarity Theorem.

38. **THOUGHT PROVOKING** Decide whether each is a valid method of showing that two quadrilaterals are similar. Justify your answer.

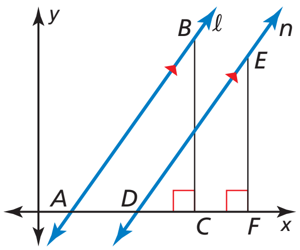
a. SASA **b.** SASAS **c.** SSSS **d.** SASSS

39. **MULTIPLE REPRESENTATIONS** Use a diagram to show why there is no Side-Side-Angle Similarity Theorem.

40. **MODELING WITH MATHEMATICS** The dimensions of an actual swing set are shown. You want to create a scale model of the swing set for a dollhouse using similar triangles. Sketch a drawing of your swing set and label each side length. Write a similarity statement for each pair of similar triangles. State the scale factor you used to create the scale model.



41. PROVING A THEOREM Copy and complete the paragraph proof of the second part of the Slopes of Parallel Lines Theorem (Theorem 3.13) from page 439.

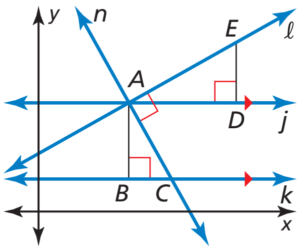


Given $m_\ell = m_n$, ℓ and n are nonvertical.

Prove $\ell \parallel n$

You are given that $m_\ell = m_n$. By the definition of slope, $m_\ell = \frac{BC}{AC}$ and $m_n = \frac{EF}{DF}$. By ______________________, $\frac{BC}{AC} = \frac{EF}{DF}$. Rewriting this proportion yields __________. By the Right Angles Congruence Theorem (Thm. 2.3), _________________. So, $\triangle ABC \sim \triangle DEF$ by ______________________. Because corresponding angles of similar triangles are congruent, $\angle BAC \cong \angle EDF$. By _____________________, $\ell \parallel n$.

42. PROVING A THEOREM Copy and complete the two-column proof of the second part of the Slopes of Perpendicular Lines Theorem (Theorem 3.14) from page 440.



Given $m_\ell m_n = -1$, ℓ and n are nonvertical.

Prove $\ell \perp n$

STATEMENTS	REASONS
1. $m_\ell m_n = -1$	**1.** Given
2. $m_\ell = \frac{DE}{AD}$, $m_n = -\frac{AB}{BC}$	**2.** Definition of slope
3. $\frac{DE}{AD} \cdot -\frac{AB}{BC} = -1$	**3.** ______________________
4. $\frac{DE}{AD} = \frac{BC}{AB}$	**4.** Multiply each side of statement 3 by $-\frac{BC}{AB}$.
5. $\frac{DE}{BC} = \frac{\quad}{\quad}$	**5.** Rewrite proportion.
6. ______________________	**6.** Right Angles Congruence Theorem (Thm. 2.3)
7. $\triangle ABC \sim \triangle ADE$	**7.** ______________________
8. $\angle BAC \cong \angle DAE$	**8.** Corresponding angles of similar figures are congruent.
9. $\angle BCA \cong \angle CAD$	**9.** Alternate Interior Angles Theorem (Thm. 3.2)
10. $m\angle BAC = m\angle DAE$, $m\angle BCA = m\angle CAD$	**10.** ______________________
11. $m\angle BAC + m\angle BCA + 90° = 180°$	**11.** ______________________
12. ______________________	**12.** Subtraction Property of Equality
13. $m\angle CAD + m\angle DAE = 90°$	**13.** Substitution Property of Equality
14. $m\angle CAE = m\angle DAE + m\angle CAD$	**14.** Angle Addition Postulate (Post. 1.4)
15. $m\angle CAE = 90°$	**15.** ______________________
16. ______________________	**16.** Definition of perpendicular lines

Maintaining Mathematical Proficiency

Reviewing what you learned in previous grades and lessons

Find the coordinates of point P along the directed line segment AB so that AP to PB is the given ratio. *(Section 3.5)*

43. $A(-3, 6)$, $B(2, 1)$; 3 to 2 **44.** $A(-3, -5)$, $B(9, -1)$; 1 to 3 **45.** $A(1, -2)$, $B(8, 12)$; 4 to 3