1.1

For Exercises 1 and 2, use the drawing at the right, which shows a person standing next to a ranger’s outlook tower.

1. Find the approximate height of the tower if the person is
   a. 6 feet tall
   b. 5 feet 6 inches tall

2. Find the approximate height of the person if the tower is
   a. 28 feet tall

For Exercises 8–11, find the perimeter and the area of each figure. In Exercises 10 and 11, the measurements are rounded.
13. Find the given percent of each number. Show your work.
   a. 25% of 120  
   b. 80% of 120  
   c. 120% of 80  
   d. 70% of 150

21. Amy's friend gave her a picture from Field Day. The picture is 3 in. by 2 in. Amy has a picture frame that is 6 in. by 4 in. She wants the photo to fit in the frame exactly. What percent enlargement does she need to make?

5. The diagram on the left is the floor plan for a model house. The diagram on the right is a scale drawing of the floor plan. The scale drawing was made by reducing the original on a copy machine.

   a. Estimate the copier size factor used. Give your answer as a percent.

   b. How do the segment lengths in the original plan compare to the corresponding segment lengths in the reduced image?

   c. Compare the area of the entire original floor plan to the area of the entire reduced image. Then, do the same with one room in the plan. Is the relationship between the areas of the rooms the same as the relationship between the areas of the whole plans? Explain.

   d. The scale on the original plan is 1 inch = 1 foot. This means that 1 inch on the floor plan represents 1 foot on the model house. What is the scale on the reduced plan?
18. One angle measure is given for each of the parallelograms below.
   - Find the measure of the other three angles in the parallelogram.
   - List all pairs of supplementary angles in the diagram. Then, classify each angle as acute, right, or obtuse.
   - For each parallelogram, find the measures of the angles formed by extending two adjacent sides through their common vertex.

\[ \text{Rule: } (x, y) \]

<table>
<thead>
<tr>
<th>Point</th>
<th>Mug Wump</th>
<th>Glum</th>
<th>Sum</th>
<th>Tum</th>
<th>Crum</th>
</tr>
</thead>
<tbody>
<tr>
<td>( M )</td>
<td>(2, 2)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( N )</td>
<td>(6, 2)</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>( O )</td>
<td>(6, 3)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( P )</td>
<td>(2, 3)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( Q )</td>
<td>(2, 2) (connect ( Q ) to ( M ))</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Nose (Start Over)

<table>
<thead>
<tr>
<th>Point</th>
<th>Mug Wump</th>
<th>Glum</th>
<th>Sum</th>
<th>Tum</th>
<th>Crum</th>
</tr>
</thead>
<tbody>
<tr>
<td>( R )</td>
<td>(3, 4)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( S )</td>
<td>(4, 5)</td>
<td></td>
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</tr>
<tr>
<td>( T )</td>
<td>(5, 4)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( U )</td>
<td>(3, 4) (connect ( U ) to ( R ))</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
For Exercises 14 and 15, the rule \((x, \frac{3}{4}y)\) is applied to a polygon.

14. Is the image similar to the original polygon? Explain.

15. Each of the following points is on the original polygon. Find the coordinates of each corresponding point on the image.

   a. \((6, 8)\)  
   b. \((9, 8)\)  
   c. \(\left(\frac{3}{2}, \frac{4}{3}\right)\)
3. a. Draw triangle $ABC$ with vertex coordinates $A(0, 2)$, $B(6, 2)$, and $C(4, 4)$ on the grid at the right.

b. Apply the rule $(1.5x, 1.5y)$ to the vertices of triangle $ABC$ to get triangle $PQR$.

\[
\begin{align*}
P ( & , ) \\
Q ( & , ) \\
R ( & , ) \\
\end{align*}
\]

Draw triangle $PQR$ on the grid.

Fill in the table. Then write statements that compare the corresponding measurements (side lengths, perimeter, area, angle measures) of the two triangles.

<table>
<thead>
<tr>
<th>Triangle</th>
<th>Side Lengths</th>
<th>Perimeter</th>
<th>Area</th>
<th>Angle Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>$ABC$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$PQR$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Statement 1:

Statement 2:

Statement 3
c. Apply the rule \((2x, 0.5y)\) to the vertices of triangle \(ABC\) to get triangle \(FGH\).

\[
\begin{align*}
F & (\quad, \quad) \\
G & (\quad, \quad) \\
H & (\quad, \quad)
\end{align*}
\]

Draw triangle \(FGH\) on the grid on the previous page.

Fill in the table. Then write statements that compare the corresponding measurements (side lengths, perimeter, area, angle measures) of the two triangles.

<table>
<thead>
<tr>
<th>Triangle</th>
<th>Side Lengths</th>
<th>Perimeter</th>
<th>Area</th>
<th>Angle Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>(ABC)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(FGH)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Statement 1:

Statement 2:

Statement 3:

d. Which triangle, \(PQR\) or \(FGH\), seems similar to triangle \(ABC\)?

Why?
4. On the grid above, draw parallelogram ABCD with vertex coordinates A(0,2), B(6,2), C(8,6), and D(2,6).

b. Write a rule to find the vertex coordinates of a parallelogram PQRS that is larger than, but similar to, ABCD. Test your rule to see if it works.

c. Write a rule to find the vertex coordinates of a parallelogram TUVW that is smaller than, but similar to, ABCD. Test your rule to see if it works.
Multiple Choice  For Exercises 16 and 17, what is the percent reduction or enlargement that will result if the rule is applied to a figure on a coordinate grid?

16. \((1.5x, 1.5y)\)
   A. 150%  B. 15%  C. 1.5%  D. None of these

17. \((0.7x, 0.7y)\)
   F. 700%  G. 7%  H. 0.7%  J. None of these

18. The rule \(\left( \frac{x}{3}, x - \frac{3}{4} \right)\) is applied to a polygon. For each vertex below of the polygon, find the coordinates of the corresponding vertex on the image.
   a. \((5, 3)\)  b. \(\left( \frac{1}{6}, \frac{1}{12} \right)\)  c. \(\left( \frac{9}{12}, \frac{4}{5} \right)\)

2.3

For Exercises 5 and 6, study the size and shape of the polygons below.

5. Multiple Choice  Choose the pair of similar figures.
   A. Z and Y  B. V and T  C. X and Y  D. Y and W
7. Copy the figures below accurately onto your own grid paper.

a. Draw a figure similar, but not identical, to the rectangle.

b. Draw a figure similar, but not identical, to the triangle.

c. How do you know your scale drawings are similar to the given figures?
8. The diagram below shows two similar polygons.

**Figure A**

**Figure B**

a. Write a rule for finding the coordinates of a point on Figure B from the corresponding point on Figure A.

b. Write a rule for finding the coordinates of a point on Figure A from the corresponding point on Figure B.

c. i. What is the scale factor from Figure A to Figure B?

ii. Use the scale factor to describe how the perimeter and area of Figure B are related to the perimeter and area of Figure A.

d. i. What is the scale factor from Figure B to Figure A?

ii. Use the scale factor to describe how the perimeter and area of Figure A are related to the perimeter and area of Figure B.

9. a. Suppose you make Figure C by applying the rule \((2x, 2y)\) to the points on Figure A from Exercise 8. Find the coordinates of the vertices of Figure C.

b. i. What is the scale factor from Figure A to Figure C?

ii. Use the scale factor to describe how the perimeter and area of Figure C are related to the perimeter and area of Figure A.
c. i. What is the scale factor from Figure C to Figure A?

ii. Use the scale factor to describe how the perimeter and area of Figure A are related to the perimeter and area of Figure C.

iii. Write a coordinate rule of the form \((mx, ny)\) that can be used to find the coordinates of any point of Figure A from the corresponding points of Figure C.

11. a. Use the polygons below. Which pairs of polygons are similar figures?

b. For each pair of similar figures, list corresponding sides and angles.

c. For each pair of similar figures, find the scale factor that relates side lengths of the larger figure to the corresponding side lengths of the smaller figure.
1. Look for rep-tile patterns in the designs below. For each design,
   - Decide whether the small quadrilaterals are similar to the large quadrilateral. Explain.
   - If the quadrilaterals are similar, give the scale factor from each small quadrilateral to the large quadrilateral.

   a. ![Diagram a]
   b. ![Diagram b]

   c. ![Diagram c]
   d. ![Diagram d]

2. Suppose you put together nine copies of a rectangle to make a larger, similar rectangle.
   a. How is the area of the larger rectangle related to the area of the smaller rectangle?

   b. What is the scale factor from the smaller rectangle to the larger rectangle?

3. Suppose you divide a rectangle into 25 smaller rectangles such that each rectangle is similar to the original rectangle.
   a. How is the area of each of the smaller rectangles related to the area of the original rectangle?

   b. What is the scale factor from the original rectangle to each of the smaller rectangles?
29. In the figure below, lines $L_1$ and $L_2$ are parallel.
   a. Use what you know about parallel lines to find the measures of angles $a$ through $g$.

   ![Diagram of parallel lines with angles labeled]

   b. List all pairs of *supplementary* angles in the diagram.

30. For each of the following angle measures, find the measure of its supplementary angle.
   a. $160^\circ$  
   b. $90^\circ$  
   c. $x^\circ$  

31. The right triangles below are similar.

   ![Diagram of two right triangles]

   a. Find the length of side $RS$.
   b. Find the length of side $RQ$.

   c. The measure of angle $x$ is about $40^\circ$. If the measure of angle $x$ were exactly $40^\circ$, what would be the measure of angle $y$?

   d. Use your answer from part (c) to find the measure of angle $R$. Explain how you can find the measure of angle $C$.

   e. Angle $x$ and angle $y$ are *complementary* angles. Find two additional pairs of complementary angles in Triangles $ABC$ and $QRS$.

32. For parts (a)–(f), find the number that makes the fractions equivalent.
   a. $\frac{1}{2} = \frac{3}{6}$  
   b. $\frac{5}{6} = \frac{25}{30}$  
   c. $\frac{3}{4} = \frac{6}{8}$  
   d. $\frac{8}{12} = \frac{2}{3}$  
   e. $\frac{3}{5} = \frac{100}{166}$  
   f. $\frac{6}{4} = \frac{10}{6}$
4. Look for rep-tile patterns in the figures below.
   - Tell whether the small triangles are similar to the large triangle. Explain.
   - If the triangles are similar, give the scale factor from each small triangle to the large triangle.

   ![Figure a](image1)
   ![Figure b](image2)
   
   ![Figure c](image3)
   ![Figure d](image4)

5. a. For rectangles E–G, give the length and width of a different, similar rectangle. Explain how you know the new rectangles are similar.

   ![Grid with E, F, G rectangles](image5)

   b. Give the scale factor from each original rectangle in part (a) to the similar rectangles you described. Explain what the scale factor tells you about the corresponding lengths, perimeters, and areas.
33. For parts (a)–(f), suppose you copy a figure on a copier using the given scale factor. Find the scale factor from the original figure to the copy in decimal form.
   a. 200%   b. 50%   c. 150%   d. 125%   e. 75%   f. 25%

34. Write each fraction as a decimal and as a percent.
   a. \(\frac{2}{5}\)   b. \(\frac{3}{4}\)   c. \(\frac{3}{10}\)   d. \(\frac{1}{4}\)
   e. \(\frac{7}{10}\)   f. \(\frac{7}{20}\)   g. \(\frac{4}{5}\)   h. \(\frac{7}{8}\)
   i. \(\frac{15}{20}\)   j. \(\frac{3}{5}\)

35. For parts (a)–(d), tell whether the figures are mathematically similar. Explain your reasoning. If the figures are similar, give the scale factor from the left figure to the right figure.

   a.
   b.
   c.
   d.
For Exercises 36-38, decide whether the statement is true or false. Explain your reasoning.

36. All squares are similar.
37. All rectangles are similar.
38. If the scale factor between two similar shapes is 1, then the two shapes are the same size.

7. Use the figures below.

a. Sketch a triangle similar to Triangle X with an area that is \( \frac{1}{4} \) the area of Triangle X.

b. Sketch a rectangle similar to Rectangle Y with a perimeter that is 0.5 times the perimeter of Rectangle Y.

c. Sketch a parallelogram similar to Parallelogram Z with side lengths that are 1.5 times the side lengths of Parallelogram Z.
Triangle $ABC$ is similar to triangle $PQR$. For Exercises 9–14, find the indicated angle measure or side length.

9. angle $A$ 
10. angle $Q$

11. angle $P$ 
12. length of side $AB$

13. length of side $AC$ 
14. perimeter of triangle $ABC$

Multiple Choice  For Exercises 15–18, use the similar parallelograms below.

15. What is the measure of angle $BR$?
   - A. $55^\circ$
   - B. $97.5^\circ$
   - C. $125^\circ$
   - D. $135^\circ$

16. What is the measure of angle $R$?
   - F. $55^\circ$
   - G. $97.5^\circ$
   - H. $125^\circ$
   - J. $135^\circ$

17. What is the measure of angle $S$?
   - A. $55^\circ$
   - B. $97.5^\circ$
   - C. $125^\circ$
   - D. $135^\circ$

18. What is length of side $AB$?
   - F. 3.75 cm
   - G. 13 cm
   - H. 15 cm
   - J. 26 cm
22. Anya and Jalen disagree about whether the two figures below are similar. Do you agree with Anya or with Jalen? Explain.

Anya’s Reasoning
The two rectangles are not similar. The height of Rectangle D is almost 6 times the height of Rectangle C, but the widths are almost the same. Similar rectangles must have the same scale factor for the base and the height.

Jalen’s Reasoning
The two rectangles are similar. The scale factor from C to D is $\frac{7}{3}$. You can multiply the short side of C (the height) by to get 14 inches, which is the short side of D (the base). This scale factor also works for the long sides of the rectangles since $15 \times \frac{7}{3} = 35$.

23. Evan, Melanie, and Wyatt discuss whether the two figures at the right are similar. Do you agree with Evan, Melanie, or Wyatt? Explain.

Evan’s Reasoning
Rectangles E and F are similar because each shape has four right angles. Also, each rectangle has at least one side that is 12 meters long.

Melanie’s Reasoning
The scale factor for the height from rectangle E to rectangle F is $\frac{12}{9}$, or $\frac{4}{3}$. The scale factor for the base is $\frac{15}{12}$ or $\frac{5}{4}$. $\frac{4}{3} \neq \frac{5}{4}$, so the rectangles are not similar.
25. Judy lies on the ground 45 feet from her tent. Both the top of the tent and the top of a tall cliff are in her line of sight. Her tent is 10 feet tall. About how high is the cliff? Assume the two triangles are similar.

29. In the figure below, lines \( L_1 \) and \( L_2 \) are parallel.
   a. Use what you know about parallel lines to find the measures of angles \( a \) through \( g \).

   \[ \begin{array}{c}
   L_1 \\
   a \quad b
   \end{array} \quad \begin{array}{c}
   c \quad 120^\circ
   \end{array} \quad \begin{array}{c}
   L_2 \\
   d \quad e
   \end{array} \quad \begin{array}{c}
   g \quad f
   \end{array} \]

   b. List all pairs of supplementary angles in the diagram.

30. For each of the following angle measures, find the measure of its supplementary angle.
   a. \( 160^\circ \)  
   b. \( 90^\circ \)  
   c. \( x^\circ \)

40. **Multiple Choice** What is the value of \( x \)? The diagram is not to scale.

   \[ \begin{array}{c}
   \begin{array}{c}
   7.5 \text{ cm}
   \end{array}
   \end{array} \quad \begin{array}{c}
   \begin{array}{c}
   2.5 \text{ cm}
   \end{array}
   \end{array} \quad \begin{array}{c}
   \begin{array}{c}
   30 \text{ cm}
   \end{array}
   \end{array} \]

   A. 3 cm  
   B. 10 cm  
   C. 12 cm  
   D. 90 cm
For Exercises 41 and 42, find the missing side length. The diagrams are not to scale.

41.

42.

4.1

1. For parts (a)–(c), use the parallelograms below.

\[ \text{A} \]
\[ \text{B} \]
\[ \text{C} \]
\[ \text{D} \]
\[ \text{E} \]
\[ \text{F} \]

a. List all the pairs of similar parallelograms. Explain your reasoning.

b. For each pair of similar parallelograms, find the ratio of two adjacent side lengths in one parallelogram. Find the ratio of the corresponding side lengths in the other parallelogram. How do these ratios compare?

c. For each pair of similar parallelograms, find the scale factor from one shape to the other. Explain how the information given by the scale factors is different from the information given by the ratios of adjacent side lengths.
2. a. On grid paper, draw two similar rectangles where the scale factor from one rectangle to the other is 2.5. Label the length and width of each rectangle.

b. For each rectangle, find the ratio of the length to the width.

c. Draw a third rectangle that is similar to one of the rectangles in part (a). Find the scale factor from the new rectangle to the one from part (a).

d. Find the ratio of the length to the width for the new rectangle.

e. What can you say about the length-to-width ratios of the three rectangles? Is this true for another rectangle that is similar to one of the three rectangles? Explain.
41. For parts (a) and (b), use a straightedge and an angle ruler or protractor.

a. Draw two different triangles that each have angle measures of 30°, 60°, and 90°. Do the triangles appear to be similar?

b. Draw two different triangles that each have angle measures of 40°, 80°, and 60°. Do the triangles appear to be similar?

c. Based on your findings for parts (a) and (b), make a conjecture about triangles with congruent angle measures.

3. For parts (a)-(d), use the triangles below. The drawings are not to scale.

a. List all the pairs of similar triangles. Explain why they are similar.
b. For each pair of similar triangles, find the ratio of two side lengths in one triangle. Find the ratio of the corresponding side lengths in the other. How do these ratios compare?

c. For each pair of similar triangles, find the scale factor from one shape to the other. Explain how the information given by the scale factors is different than the information given by the ratios of side lengths.

d. How are corresponding angles related in similar triangles? Is it the same relationship as for corresponding side lengths? Explain.

14. The Washington Monument is the tallest structure in Washington, D.C. At a certain time, the monument casts a shadow that is about 500 feet long. At the same time, a 40-foot flagpole nearby casts a shadow that is about 36 feet long. About how tall is the monument? Sketch a diagram.

15. Darius uses the shadow method to estimate the height of a flagpole. He finds that a 5-foot stick casts a 4-foot shadow. At the same time, he finds that the flagpole casts a 20-foot shadow. What is the height of the flagpole? Sketch a diagram.
16. a. Greg and Zola are trying to find the height of their school building. Zola takes a picture of Greg standing next to the building. How might this picture help them determine the height of the building?

b. Greg is 5 feet tall. The picture Zola took shows Greg as $\frac{1}{4}$ inch tall. If the building is 25 feet tall in real life, how tall should the building be in the picture? Explain.

17. Movie screens often have an *aspect ratio* of 16 by 9. This means that for every 16 feet of width along the base of the screen there are 9 feet of height. The width of the screen at a local drive-in theater is about 115 feet wide. The screen has a 16 : 9 aspect ratio. About how tall is the screen?

For Exercises 44–48, suppose a photographer for the school newspaper took this picture. The editors want to resize the photo to fit in a specific space on a page.

44. Can the original photo be changed to a similar rectangle with the given measurements (in inches)?

   a. 8 by 12  
   b. 9 by 11  
   c. 6 by 9  
   d. 3 by 4.5
4.4

36. For each angle measure, find the measure of its complement and the measure of its supplement.

Sample: 30° complement: 60°; supplement: 150°

a. 20°

b. 70°

c. 45°

37. The rectangles at the right are similar.

a. What is the scale factor from Rectangle A to Rectangle B?

![Diagram of Rectangle A and Rectangle B]

b. Complete the following sentence in two different ways. Use the side lengths of Rectangles A and B.

The ratio of □ to □ is equivalent to the ratio of □ to □.

c. What is the value of x? Explain your reasoning.

d. What is the ratio of the area of Rectangle A to the area of Rectangle B?

For Exercises 38 , use the rectangles below.

![Diagrams of Rectangles L, M, N, P, Q, R]

38. **Multiple Choice** Which pair of rectangles listed below is similar?

A. L and M  
B. L and Q  
C. L and N  
D. P and R