Similarity and Dilations

Name: _____	Date: _____	Score: _____ / 24

Quick Review

A **dilation** resizes a figure by a **scale factor** k from a center point. If $k > 1$ the figure grows; if $0 < k < 1$ it shrinks. Centered at the origin, a dilation follows the rule $(x, y) \to (kx,\ ky)$. Two figures are **similar** when one is a dilation (possibly with rigid motions) of the other: their matching *angles are equal* and their matching *sides are proportional*. Similar figures have the same shape but *not necessarily* the same size — think of a photo and its enlargement.

◇ **Example:** A point $P(6, 9)$ is dilated by a scale factor of $\frac{2}{3}$ centered at the origin. Find P'.
⇒ A dilation centered at the origin just multiplies both coordinates by the scale factor. Here $k = \frac{2}{3}$, so multiply each coordinate by $\frac{2}{3}$: the x-value becomes $\frac{2}{3} \cdot 6 = 4$, and the y-value becomes $\frac{2}{3} \cdot 9 = 6$. Because k is less than 1, the point moved *closer* to the origin — the figure shrank.

Answer: $P' = (4,\ 6)$

PRACTICE

Find the image under the dilation, or the missing similar measure.

1. $(2, 3),\ k = 2,$ center origin _____
2. $(5, 1),\ k = 3,$ center origin _____
3. $(8, 4),\ k = \frac{1}{2},$ center origin _____
4. $(9, 6),\ k = \frac{1}{3},$ center origin _____
5. $(10, 15),\ k = \frac{2}{5},$ center origin _____
6. $(-4, 6),\ k = 2,$ center origin _____
7. $(7, -3),\ k = 4,$ center origin _____
8. $(12, -8),\ k = \frac{3}{4},$ center origin _____
9. Scale factor from a 4 cm side to an 12 cm side _____
10. Scale factor from a 20 cm side to a 5 cm side _____
11. Similar: sides $3, 4, 5$ scaled by 4. New longest side _____
12. Similar: $6, 8, 10$ scaled to $3, 4, ?$ _____
13. $\frac{x}{6} = \frac{10}{4}$ (similar sides) _____
14. $\frac{8}{x} = \frac{4}{9}$ (similar sides) _____
15. $\frac{x}{12} = \frac{5}{3}$ (similar sides) _____
16. Two similar triangles, scale 3. Perimeter 7 $\to ?$ _____
17. Similar rectangles, scale $\frac{1}{2}$. Perimeter 24 $\to ?$ _____
18. In similar figures, matching angles are _____
19. $(6, 9),\ k = \frac{1}{3},$ center origin _____
20. A 5 ft model is $\frac{1}{20}$ of a building. Building height? _____

♦ Word Problems

21. A photo that is 4 inches wide and 6 inches tall is enlarged by a scale factor of 2.5. What are the new width and height? _____
22. On a map, two cities are drawn 3 cm apart, and the map's scale factor to real life is $1 : 500{,}000$. What is the real distance in kilometers? _____
23. Triangle ABC is similar to triangle DEF. In $\triangle ABC$ the sides are 9, 12, and 15 cm. The shortest side of $\triangle DEF$ is 3 cm. Find the other two sides of $\triangle DEF$. _____
24. A flagpole casts a 24 ft shadow at the same time a 5 ft student casts a 4 ft shadow. The triangles formed are similar. How tall is the flagpole? _____

Answer Keys

1. $(4, 6)$
2. $(15, 3)$
3. $(4, 2)$
4. $(3, 2)$
5. $(4, 6)$
6. $(-8, 12)$
7. $(28, -12)$
8. $(9, -6)$
9. 3
10. $\frac{1}{4}$
11. 20
12. 5
13. $x = 15$
14. $x = 18$
15. $x = 20$
16. 21
17. 12
18. equal
19. $(2, 3)$
20. 100 ft
21. 10 in wide, 15 in tall
22. 15 km
23. 4 cm and 5 cm
24. 30 ft

Step-by-Step Explanations

1. Multiply both coordinates by 2: $(2 \cdot 2,\ 3 \cdot 2) = (4, 6)$.
2. Multiply both by 3: $(15, 3)$.
3. Multiply both by $\frac{1}{2}$: $(4, 2)$. Since $k < 1$, it shrinks.
4. Multiply both by $\frac{1}{3}$: $(3, 2)$.
5. $\frac{2}{5} \cdot 10 = 4$ and $\frac{2}{5} \cdot 15 = 6$.
6. Multiply both by 2: $(-8, 12)$.
7. Multiply both by 4: $(28, -12)$.
8. $\frac{3}{4} \cdot 12 = 9$ and $\frac{3}{4} \cdot (-8) = -6$.
9. Scale factor $= \frac{\text{new}}{\text{old}} = \frac{12}{4} = 3$.
10. Scale factor $= \frac{5}{20} = \frac{1}{4}$ — a shrink.
11. Multiply the longest side by 4: $5 \cdot 4 = 20$.
12. The scale factor is $\frac{3}{6} = \frac{1}{2}$, so $10 \cdot \frac{1}{2} = 5$.
13. Cross multiply: $4x = 60$, so $x = 15$.
14. Cross multiply: $4x = 72$, so $x = 18$.
15. Cross multiply: $3x = 60$, so $x = 20$.
16. All sides triple, so the perimeter also triples: $7 \cdot 3 = 21$.
17. Every side is halved, so the perimeter is halved: $24 \cdot \frac{1}{2} = 12$.
18. Similarity keeps shape, so corresponding angles stay equal.
19. Multiply both by $\frac{1}{3}$: $(2, 3)$.
20. The real building is 20 times the model: $5 \cdot 20 = 100$ ft.
21. Multiply each dimension by 2.5: width $4 \times 2.5 = 10$ in and height $6 \times 2.5 = 15$ in.
22. Real distance $= 3$ cm $\times\ 500{,}000 = 1{,}500{,}000$ cm $= 15{,}000$ m $= 15$ km.
23. The scale factor is $\frac{3}{9} = \frac{1}{3}$. So the sides shrink: $12 \times \frac{1}{3} = 4$ cm and $15 \times \frac{1}{3} = 5$ cm.
24. Set up the proportion $\frac{h}{24} = \frac{5}{4}$. Cross multiplying gives $4h = 120$, so $h = 30$ ft.

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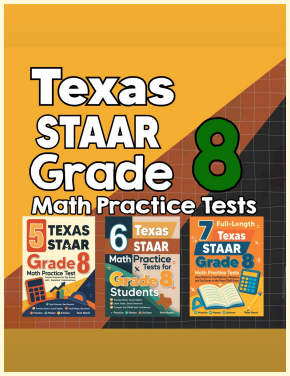

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