

Similarity and Dilations

Name: _____ Date: _____ Score: _____ / 24

Q 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 $(x, y) \rightarrow (kx, ky)$. 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.

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

◆ 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

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

Step-by-Step Explanations

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