

Similarity and Dilations: practice solutions, Grade 10

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Written solutions to the chapter problems. Check each step, then correct yourself.

1 Dilating a segment from the origin



(a) The rule is $(x, y) \mapsto (3x, 3y)$, so $P' = (3, 6)$ and $Q' = (12, -3)$.

$$(b) PQ = \sqrt{(4-1)^2 + (-1-2)^2} = \sqrt{18} = 3\sqrt{2}.$$

$$P'Q' = \sqrt{(12-3)^2 + (-3-6)^2} = \sqrt{162} = 9\sqrt{2}.$$

The ratio is $\frac{9\sqrt{2}}{3\sqrt{2}} = 3 = k$. The segment is three times as long.

2 Find the scale factor



(a) $k = \frac{12.5}{5} = 2.5$. Since $k > 1$, it is an enlargement.

(b) $k = \frac{6}{18} = \frac{1}{3}$. Since $0 < k < 1$, it is a reduction.

3 Missing sides of similar triangles



The scale factor is $k = \frac{DE}{AB} = \frac{10}{4} = 2.5$.

$$EF = 7 \cdot 2.5 = 17.5 \text{ and } DF = 6 \cdot 2.5 = 15.$$

4 Always similar? True or false



- (a) True: all angles are 90° and the sides are in the same ratio (side over side).
- (b) False: a 2 by 6 rectangle and a 3 by 8 rectangle have equal angles, but $\frac{3}{2} = 1.5$ and $\frac{8}{6} \approx 1.33$.
- (c) True: all angles are 60° , so AA applies.
- (d) False: a rhombus with angles $60^\circ/120^\circ$ is not similar to a square, which is also a rhombus.

5 AA with computed angles



The third angle of triangle 1 is $180 - 52 - 71 = 57^\circ$. The third angle of triangle 2 is $180 - 71 - 57 = 52^\circ$.

Both triangles have angles 52° , 57° , and 71° , so they are similar by AA.

6 Enlarging a photo



- (a) $k = \frac{30}{4} = 7.5$. The long side is $6 \cdot 7.5 = 45$ in.
- (b) $30 \div 12 = 2.5$ ft.

7 A line parallel to the base



- (a) By the Triangle Proportionality Theorem, $\frac{3}{9} = \frac{2}{EC}$, so $3 \cdot EC = 18$ and $EC = 6$.
- (b) $AB = 3 + 9 = 12$, so $\frac{DE}{BC} = \frac{3}{12} = \frac{1}{4}$ and $DE = 20 \cdot \frac{1}{4} = 5$.

8 SSS or not?



- (a) $\frac{12}{9} = \frac{4}{3}$, $\frac{16}{12} = \frac{4}{3}$, $\frac{24}{18} = \frac{4}{3}$. All equal, so the triangles are similar by SSS with $k = \frac{4}{3}$.
- (b) $\frac{10}{5} = 2$, $\frac{14}{7} = 2$, but $\frac{20}{9} \approx 2.22$. The ratios differ, so the triangles are not similar.

9 SAS and a missing side



- (a) $\frac{XY}{PQ} = \frac{8}{6} = \frac{4}{3}$ and $\frac{XZ}{PR} = \frac{12}{9} = \frac{4}{3}$. The included angles $\angle P$ and $\angle X$ are congruent, so the triangles are similar by SAS.
- (b) $YZ = QR \cdot \frac{4}{3} = 7.5 \cdot \frac{4}{3} = 10$.

10 Height of a flagpole



The two right triangles share the sun's angle, so they are similar by AA.

$$\frac{h}{6} = \frac{18}{4.5} = 4, \text{ so } h = 24 \text{ ft.}$$

$24 \times 0.3048 \approx 7.3$ m. The flagpole is about 24 ft (7.3 m) tall.

11 Splitting a side with a bisector



$\frac{BD}{DC} = \frac{AB}{AC} = \frac{10}{14} = \frac{5}{7}$. So BC is split in $5 + 7 = 12$ shares of $18 \div 12 = 1.5$.

$BD = 5 \cdot 1.5 = 7.5$ and $DC = 7 \cdot 1.5 = 10.5$. Check: $7.5 + 10.5 = 18$.

12 Perimeters and areas



The scale factor from small to large is $k = \frac{36}{24} = \frac{3}{2}$. The area ratio is $k^2 = \frac{9}{4}$.

Small area = $81 \div \frac{9}{4} = 81 \cdot \frac{4}{9} = 36 \text{ ft}^2$.

13 Dilation with a center other than the origin



Use $(x, y) \mapsto (1 + 2(x - 1), 1 + 2(y - 1))$.

$$A' = (1 + 2 \cdot 2, 1 + 2 \cdot 1) = (5, 3). B' = (1 + 2 \cdot (-2), 1 + 2 \cdot 3) = (-3, 7).$$

Check: $CA = \sqrt{4+1} = \sqrt{5}$ and $CA' = \sqrt{16+4} = 2\sqrt{5}$, so the distance doubled.

14 Solve for x



$$\frac{AD}{DB} = \frac{AE}{EC} \text{ gives } \frac{x}{x+2} = \frac{6}{9} = \frac{2}{3}.$$

Cross-multiply: $9x = 6(x + 2)$, so $9x = 6x + 12$ and $x = 4$. Then $AD = 4$ and $DB = 6$.

15 A similarity proof



Statements and reasons:

1. $DE \parallel BC$: given.
2. $\angle ADE \cong \angle ABC$: corresponding angles formed by parallel lines and transversal AB .
3. $\angle A \cong \angle A$: shared angle.
4. $\triangle ADE \sim \triangle ABC$: AA similarity.

Corresponding sides of similar triangles are proportional, and DE corresponds to BC

while AD corresponds to AB , so $\frac{DE}{BC} = \frac{AD}{AB}$.

16 Altitude to the hypotenuse

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(a) Both triangles have the angle A in common. $\angle ADC$ and $\angle ACB$ are both right angles. So $\triangle ACD \sim \triangle ABC$ by AA (vertices in order: $A \rightarrow A, C \rightarrow B, D \rightarrow C$).

$$(b) \frac{AD}{AC} = \frac{AC}{AB}, \text{ so } AD = \frac{15^2}{25} = 9.$$

$$\frac{CD}{BC} = \frac{AC}{AB}, \text{ so } CD = \frac{20 \cdot 15}{25} = 12.$$

Check: $DB = 25 - 9 = 16$ and $CD^2 = 144 = 9 \cdot 16$.

17 Diagonals of a trapezoid

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(a) $\angle BAE \cong \angle DCE$ and $\angle ABE \cong \angle CDE$ are alternate interior angles for parallel lines AB and CD . So $\triangle ABE \sim \triangle CDE$ by AA.

(b) The scale factor is $\frac{AB}{CD} = \frac{12}{20} = \frac{3}{5}$, so $AE : EC = 3 : 5$. Then $AE = 24 \cdot \frac{3}{8} = 9$ and $EC = 24 \cdot \frac{5}{8} = 15$.

(c) The area ratio is $\left(\frac{3}{5}\right)^2 = \frac{9}{25}$.

18 Reading a map

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(a) Lengths are multiplied by $k = 2$ (miles per inch, so 1 in becomes 2 mi).

(b) Perimeter: $8 \cdot 2 = 16$ mi. Area: $3.5 \cdot 2^2 = 14$ mi². The area is multiplied by $k^2 = 4$, not by 2.

19 Similar triangles with algebra

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$$\frac{AB}{DE} = \frac{BC}{EF} \text{ gives } \frac{x+3}{10} = \frac{2x}{12}.$$

$12(x+3) = 20x$, so $12x + 36 = 20x$, $36 = 8x$, and $x = 4.5$.

$AB = 7.5$ and $BC = 9$. Check: $\frac{7.5}{10} = 0.75 = \frac{9}{12}$.

20 Bisector and perimeter



$BC = 6 + 9 = 15$, so $AB + AC = 50 - 15 = 35$.

The Angle Bisector Theorem gives $\frac{AB}{AC} = \frac{6}{9} = \frac{2}{3}$. So $AB : AC = 2 : 3$ and the 35 splits into 5 shares of 7.

$AB = 14$ and $AC = 21$. Check: $14 + 21 + 15 = 50$.

21 Similar tanks



(a) $k = \frac{5}{2} = 2.5$.

(b) Volumes scale by $k^3 = \frac{125}{8}$, so the volume is $16 \cdot \frac{125}{8} = 250$ gallons.



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